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# ABSTRACT BOOK

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## **MP01: Built Environment Plenary/ John Goldsmith Award and Lecture, Seymour Centre, September 25, 2017, 08:30 - 10:00**

Creating healthy, liveable sustainable cities: Why, what and how?

**Billie Giles-Corti**

In the 21<sup>st</sup> century, we are facing massive health challenges globally: population growth, rapid urbanisation, traffic congestion and climate change combined with increases in physical inactivity, unhealthy diets, non-communicable diseases (NCDs), road trauma, and obesity. Optimising city planning to promote physical and mental health and community wellbeing, in the face of rapidly growing urban populations is critical. A comprehensive set of integrated regional urban and transport planning and local urban design strategies is needed to achieve health-promoting cities that promote health and wellbeing, and to achieve the UN's Sustainable Development Goals. While local conditions will determine the mix of interventions, our overall goal must be to create safe, liveable, convivial and healthy cities that promote active lifestyles and reduce non-communicable diseases and other adverse health risks, while at the same time protecting growing urban populations from traffic, environmental pollution, noise, crime, and violence. This will require integrated metropolitan and regional urban and transport planning incorporating pedestrian- and cycling-friendly local urban design. There is an urgent need for more policy-relevant research to be undertaken in partnership with policy-makers; as well as advocacy to ensure that the rhetoric of 'healthy cities', translates into well designed cities that can confront these major 21<sup>st</sup> century challenges. This is a big agenda that requires 'all hands on deck'. The question for public health academics is, are we up for it? And if so, what needs to be done and how? This talk will consider these questions by drawing of recent policy-relevant research conceptualising and measuring 'urban liveability'.

## **MP01: Built Environment Plenary/ John Goldsmith Award and Lecture, Seymour Centre, September 25, 2017, 08:30 - 10:00**

### Pathways to healthy urban living

**Mark Nieuwenhuijsen**

Over 50% of the world's population is living in cities and this is expected to rise to 70% over the next few decades. Cities are society's predominant engine of innovation and wealth creation, but also main sources of crime, pollution, and disease. Partly due to poor urban and transport planning, or the lack thereof, we have cities that are too car dominated. All the urban planning in the world seems for cars. People do not matter. This has led to high air pollution and noise levels, heat island effects and lack of green space and physical activity that are all detrimental to health. For example, a recent health impact assessment in Barcelona estimated that 20% of premature mortality was due to urban and transport related exposures. Electric cars and/or autonomous vehicles have been mentioned as possible solutions, but they are unlikely to be, and solutions need to be sought elsewhere. A new long term visioning of healthy urban future is needed that bring health, sustainability and livability at the forefront of urban and transport planning. Systemic approaches to the current problems and e.g. a shift away from our grey car centric cities towards cities with more public and active transportation and green space are urgently needed. Collaboration between e.g. urban and transport planners, environmentalists and public health professionals is essential to create healthy sustainable and liveable cities.

## MC01: Environmental disasters

024, September 25, 2017, 10:30 - 12:00

### Temporal trends in cardiovascular hospital discharges before and after a mass chlorine exposure event in Graniteville, South Carolina

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**Background/Aim:** In January, 2005, a train derailed in Graniteville, South Carolina, releasing nearly 60,000 kg of toxic chlorine gas. The disaster left 9 people dead and was responsible for hundreds of hospitalizations and outpatient visits in the subsequent days and weeks. While chlorine primarily affects the respiratory tract, a growing body of evidence suggests acute exposure may also cause vascular injury and cardiac toxicity. We describe the incidence of cardiovascular hospitalizations among residents of the zip codes most affected by the chlorine gas plume, and compare the incidence of cardiovascular discharges in the years leading up to the event (2000-2004) with the years following the event (2005-2014).

**Methods:** A quasi-experimental design was utilized with time series data to examine hospital discharge rates for three cardiovascular diagnoses: hypertension, acute myocardial infarction (AMI), and coronary heart disease. We used linear regression with autoregressive error correction to compare slopes for the two time periods, and demographic information from the 2000 and 2010 census to provide information on potential demographic shifts over the course of the study period.

**Results:** A significant increase in hypertension-related rates was observed for the years following the Graniteville chlorine spill (slope 8.2,  $p < 0.001$ ). This change was notably greater than concurrent changes to CHD and AMI hospital discharge rates (slopes -2.3 and 1.9,  $p = 0.05$  and  $0.04$ , respectively) and cannot be attributed to an aging population.

**Conclusions:** An unusual increase in hypertension-related hospital discharge rates in the area affected by the Graniteville chlorine spill contrasts with national and state-level trends. We suggest a combination of increased susceptibility to vascular pathologies and disaster-induced hypertension may be behind the finding. Further research is needed to determine whether acutely exposed individuals are at an increased risk for hypertensive heart disease

# MC01: Environmental disasters

024, September 25, 2017, 10:30 - 12:00

## Combining acrylonitrile air measurements and human biological monitoring in integrated environmental health assessments A case-study following a major train accident in Belgium

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### Background/Aim

On May 4, 2013, a train loaded with several tons of acrylonitrile (ACN) derailed in the village of Wetteren (Belgium), leading to the evacuation of 2000 residents. In a previous study, we have presented the results of the measurements of N-2-cyanoethylvaline in the residents and the associated health symptoms. In this study, we describe the pattern of the acrylonitrile measures in the air.

### Methods

Security perimeters were delimited in function of the physicochemical characteristics of ACN by the Crisis Management Cell. To monitor environmental exposure, in- and outdoor ACN air samples were collected by the firemen from May 4 – 24. Dräger CDS kits and photoionization detectors were used. For the analyses, ACN concentrations were divided in 4 categories in ppm (INERIS, 2008), i.e. immediate hazard (>90), risk ( $22 \leq \text{ppm} \leq 90$ ), vigilance ( $4 \leq \text{ppm} \leq 21$ ), and below the safety threshold (<4).

### Results

On the integrated map of the period May 4-24, presenting the highest value for each measuring point, the highest ACN values were seen downwind of the train accident and in parallel with the sewerage system. From the day-by-day mapping, it became clear that ACN followed the trajectory of the railway, the gravitational sewerage network, and ended up in the water treatment plant. Maximum values of ACN were seen in the sewerage system (330ppm) and the streets (196ppm), followed by the public buildings (107ppm) and the houses (54ppm). Both in the public buildings and the houses, the toilets were the rooms with the highest observed concentrations.

### Conclusions

The patterns as seen on the basis of the ACN air measurements were in perfect agreement with the ones observed previously in the HBM study. This study shows the added value of integrated risk and health impact assessments in disaster management of chemical incidents.

## MC01: Environmental disasters

024, September 25, 2017, 10:30 - 12:00

### In utero dioxin exposure and fertility of the Seveso second generation

#### Background/Aim

In animal studies, maternal exposure to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) is associated with decreased fertility in offspring. The Seveso Women's Health Study (SWHS) of women exposed to TCDD in 1976 is unique in that we measured TCDD blood levels near the time of the explosion. In 2014, we initiated the Seveso Second Generation Health Study. We aim to examine the relationship of *in utero* TCDD exposure with time to pregnancy (TTP) and infertility among SWHS daughters.

#### Methods

We asked SWHS children  $\geq 18$  years about their pregnancy history, including time to pregnancy and infertility. Of 225 daughters, 80 had attempted pregnancy. Of these, 66 had delivered a livebirth not associated with contraceptive failure and 4 reported still trying unsuccessfully after 12 or more months. We defined *in utero* TCDD exposure as: 1) initial maternal serum TCDD concentration and 2) TCDD estimated at pregnancy. We examined the relation of *in utero* TCDD to TTP (parameterized as the monthly probability of conception within the first 12 months of trying) and to infertility (defined as conception after at least 12 months of trying). We modelled fecundability with discrete-time Cox proportional hazards regression and fertility with logistic regression.

#### Results

Women averaged 30.0 ( $\pm 3.5$ ) years at the time of attempting pregnancy. Median TTP was 2 months and 15.7% reported taking 12 or more months to conceive. A 10-fold increase in initial maternal TCDD was non-significantly associated with longer TTP (adjusted fecundability odds ratio = 0.61; 95%CI: 0.32, 1.18) and increased odds of infertility (adjusted odds ratio = 1.38; 95%CI: 0.36, 5.36). Results for TCDD estimated at pregnancy will be presented.

#### Conclusions

These results are consistent with animal studies and suggest *in utero* TCDD exposure may alter fertility in female offspring. However, sample size of pregnancies is lower than expected given the age of the female population

## MC01: Environmental disasters

024, September 25, 2017, 10:30 - 12:00

### In Utero Dioxin Exposure and Thyroid Hormone Levels in the Seveso Second Generation

#### Background/Aim

In animal studies, prenatal TCDD exposure alters thyroid homeostasis and thyroid hormone concentrations; epidemiologic evidence is limited. The Seveso Women's Health Study (SWHS) of women exposed to a single high dose of TCDD during or before their child-bearing years is unique. Initial, individual-level TCDD exposure measures are available for this first-generation cohort. Nearly 40 years after the explosion, data collection to follow up the second generation of the SWHS cohort is complete. We aim to examine the relationship of *in utero* TCDD exposure with thyroid function among SWHS children.

#### Methods

We included 429 children who were 18+ years with complete follow-up data, including a fasting blood draw. Serum levels of total thyroxine (TT4), free thyroxine (FT4), free triiodothyronine (FT3), and thyroid stimulating hormone (TSH) were measured using immunoassays. *In utero* TCDD exposure was defined in two ways: 1) TCDD concentration measured in maternal serum collected soon after the explosion and 2) TCDD estimated at pregnancy.

#### Results

The children (223 female, 206 male) averaged 28.6 ( $\pm 6.0$ ) years of age. A 10-fold increase in TCDD estimated at pregnancy was negatively associated with FT3 (adj- $\beta = -0.11$ , 95% CI -0.19, -0.02), but not FT4 (adj- $\beta = -0.26$ , 95% CI -0.60, 0.09), TT4 (adj- $\beta = -0.19$ , 95% CI -0.58, 0.20) or TSH (adj- $\beta = 5.4\%$ , 95% CI -8.7, 21.6). Stratifying by child sex, TCDD estimated at pregnancy was positively associated with TSH among daughters (adj- $\beta = 21.7\%$ , 95% CI -0.9, 49.5), but not sons (adj- $\beta = -11.0\%$ , 95% CI -25.1, 5.8) (*p-int*=0.02). Results were similar when we considered initial maternal serum TCDD concentration, but less significant. Results including the SWHS children under 18 years, will be presented.

#### Conclusion

These results suggest *in utero* exposure to TCDD, a potent endocrine-disrupting compound, may alter thyroid function later in life, in this case decreased FT3 levels and increased TSH levels in daughters exposed to TCDD

## MC01: Environmental disasters

024, September 25, 2017, 10:30 - 12:00

### Evaluating injury emergency department visit after Hurricane Sandy and developing community vulnerability index

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**Background/Aim:** Extreme weather events such as hurricanes was found to be related to multiple health outcomes.

However, significant gaps remain in our understanding of the impacts of Hurricane Sandy on injury especially the modification effect of community-level factors. Furthermore, little is known about the vulnerability of population during the events. This study was designed to assess injury emergency department (ED) visit after Sandy in New York State (NYS), and to develop community vulnerability index (CVI) to identify areas that might be more vulnerable to future storms.

**Method:** Distributed Lag Nonlinear Models (DLNM) were used to examine the impact of Sandy on injury ED visit for each county. Meta regression was used to pool county-level estimations and identify the modification effect of community-level factors on Sandy-injury association. Sandy-attributable number of cases estimated with DLNM and community-level factors identified with meta regression were then incorporated into Boosted Regression Tree (BRT) models to determine the weight and the direction of the impact of each factor for developing CVI.

**Results:** Overall, the risk of injury significantly increased 3-4 days after Sandy. The impact of Sandy varied across the study areas, with the *RR* highest in directly affected areas (*RR*: 1.1~2.5). In terms of community vulnerability, percentage of mobile homes had the largest contribution ( $P=0.001$ , weight=-25.87%) to the spatial variation of cumulative *RR* of injury related to Sandy, followed by the percentage of uninsured people ( $P=0.001$ , weight=24.90%), M/F sex ratio ( $P<0.001$ , weight=-10.26%) and the percentage of Hispanic ( $P<0.001$ , weight=8.95%). Counties with high CVI ( $>M+1.5SD$ ) was clustering in directly affected areas.

**Conclusion:** The risk of injury ED visit increased after Hurricane Sandy in directly affected areas, compared to indirectly affected areas. Community-level factors have significantly modified the impact of Hurricane Sandy. The residents living in Sandy areas have the highest vulnerability.

## MC01: Environmental disasters

024, September 25, 2017, 10:30 - 12:00

### Ethical Concerns in Epidemiology which are unique to Environmental Disasters

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Balancing ethical concerns within public health research and practice are challenging enough in non-disaster settings. The ISEE has developed guidelines to balance such ethical research concerns within non-disaster settings. In the context of environmental disasters, however, these concerns become ever more complex and their public health implications more dramatic.

Recent scholarship has identified several ethical concerns which require unique consideration during the public health management and epidemiologic research of environmental disasters. Although these are not comprehensive, these include balancing social versus individual research benefit, vulnerability and exploitation, participant safety, competing research and practice priorities, risk communication, proactive community engagement, health services delivery, and timeliness. These ethical concerns present unique and impactful influences on disaster epidemiology which are often differential as a function of disaster type.

Although ethical concerns are common across environmental disasters, their individual proportional influence varies across environmental disasters. Therefore, there is no fixed protocol to consider when planning environmental epidemiology activities within environmental disasters. Rather, complementary guidelines for ethical research and practice should be developed and considered *a priori*. This ethics discussion will be a first step in that process.

Relevant ethical principles will be discussed and prioritized in the context of the environmental disasters presented within the conference session. Which ethical concerns were common, and which were different across the environmental disaster cases? Which ethical concerns were most influential, and least influential? Which ethical concerns should be universally considered within guidelines for disaster epidemiology within environmental disasters? How should they be considered? The goal of this ethics discussion is to identify the ethical concerns which are the highest priority within the environmental disasters presented so that a foundation may be laid for further development of ethics guidelines for use within environmental disaster epidemiology.

## MC02: Built Environment & Greenness

026, September 25, 2017, 10:30 - 12:00

### Greenness and Breast Cancer in a US-Based Nationwide Prospective Cohort Study

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**Background/Aim:** Evidence is growing that exposure to nature may provide opportunities for physical activity, decrease exposure to pollution, increase social engagement, and enable psychological restoration. These factors have been hypothesized to influence breast cancer risk; however, few studies have directly assessed nature exposure and breast cancer incidence. We examined the association between residential satellite-based vegetation and breast cancer incidence using data from the prospective nationwide US-based Nurses' Health Study II cohort.

**Methods:** We followed 109,643 women from 1989-2013. Cumulative average vegetation exposure was estimated using time-varying normalized difference vegetation index (NDVI) Advanced Very High Resolution Radiometer satellite data at ~1 km<sup>2</sup> scale for each residence over follow-up. NDVI data from summer (July) was chosen to maximize variability. Incident invasive breast cancer cases were self-reported and confirmed by medical record review. We used Cox proportional hazard models to calculate hazard ratios (HRs) and 95% confidence intervals (CIs), adjusting for age, calendar year, race, benign breast disease history, family history of breast cancer, age at menarche, height, body mass index (BMI) at age 18, current BMI, personal income, parity/age at first birth, menopausal status, mammography screening, smoking status, marital status, living alone, night shift work, diet (based on the Alternative Healthy Eating Index), and physical activity.

**Results:** We identified 3,458 incident breast cancer cases from 1989-2013. The average age of participants at baseline was 34.4 years and 95.5% of participants were white. In fully-adjusted models, participants living in the top quintile of cumulative average NDVI had a 13% lower risk of incident breast cancer (95% CI 0.75, 1.01, p for trend 0.02) compared to those in the bottom quintile.

**Conclusions:** Although further research is required to identify the mechanisms involved, our findings suggest that living in a neighbourhood with higher levels of greenness is associated with decreased risk of invasive breast cancer.

## MC02: Built Environment & Greenness

026, September 25, 2017, 10:30 - 12:00

### Urban residential greenness and adiposity: A longitudinal cohort study in Stockholm County

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**Background/Aim:** This longitudinal cohort study, using objectively measured exposure and outcomes, aims to explore the association between residential green space and body fat distribution, potentially mediated via psycho-endocrine mechanisms.

**Methods:** Based on the Stockholm Diabetes Prevention Program (SDPP), this study included 5 355 subjects from Stockholm County aged 35-56 years at recruitment in 1992-1994, and followed up 2002-2006. We defined surrounding greenness as a time-weighted average of satellite-based Normalized Difference Vegetation Index (NDVI) at 30 m x 30 m resolution during 1990-2015 in buffers of 100 m, 250 m, and 500 m around participants' place of residence. Multiple linear regressions with adjustment for potential confounders at individual and contextual level, including behavioural, socio-economic and environmental factors (traffic-related air pollution and noise), were used to estimate the change in BMI, waist circumference and waist-hip ratio.

**Results:** Waist circumference increased on average by 0.51 cm/year in this population, and time-weighted NDVI in 500 m buffers ranged 0.2-0.7. Higher levels of surrounding greenness were associated with reduced increase in waist circumference, with 0.78 cm less increase in waist circumference per year for one unit difference in NDVI, (95% CI 0.16-1.41). This is equivalent to an average annual increase of 0.60 cm among the 10 percent least exposed to greenness, compared to 0.43 cm among the 10 percent most exposed. A modest but yet statistically significant association was observed for the waist-hip ratio, but no significant association was found between NDVI and change in BMI. Using the 100 m and 250 m buffers generated less clear associations than for 500 m.

**Conclusion:** Our findings suggest a beneficial impact of surrounding greenness on waist circumference and waist-hip ratio. The absence of a statistically significant relationship between NDVI and BMI suggests that the effect of NDVI may be mediated by the cortisol-induced differences in body fat distribution.

## MC02: Built Environment & Greenness

026, September 25, 2017, 10:30 - 12:00

### Urban green space interventions deliver positive health and equity outcomes

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#### Background/Aim

The introduction of green space within the built environment can help address many urban health issues. Empirical evidence, however, of the effectiveness of green space interventions is partial. This presentation explores the findings of a WHO project that examined the impacts of urban green space interventions.

#### Methods

A systematic evidence review on urban green space interventions summarized environmental, social and health impacts from 38 published studies. In parallel, 48 local case studies were compiled to describe urban green space projects and the respective lessons learned. A WHO expert meeting discussed the material and generated key principles and practical guidance on green space planning and management.

#### Results

There was promising evidence to support some green space intervention approaches, such as park-based interventions which incorporated promotion and marketing elements, greening of vacant lots, provision of urban street trees and green infrastructure for stormwater management. The evidence indicated the potential of green space interventions to generate environmental, social and health-related benefits, but also showed that equity considerations need to be better integrated. The local case studies showed that environmental and behavioural outcomes were the most frequently reported primary intervention objectives while health and equity benefits were considered a co-benefit. Still, many of the urban green space intervention case studies successfully created healthy built environments while also benefiting equity. However, challenges were observed regarding the need to monitor and evaluate local green space projects.

#### Conclusions

The project showed that urban green space interventions can have a wide range of benefits for urban residents, and that any type of green space can make a positive difference. The project helped to derive practical guidance on green space action to support urban practitioners, but also indicated that more reliable evaluations of urban green space intervention impacts are required to inform local policies and planning decisions.

## MC02: Built Environment & Greenness

026, September 25, 2017, 10:30 - 12:00

### Green Spaces and Spectacles Use in Schoolchildren

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#### Background/Aim

Myopia is one of the major causes of low visual acuity during childhood, and hence of the need for spectacles. Myopia is generally more prevalent in urban areas where children are often less exposed to green spaces than in rural areas. This study aimed to evaluate the association between exposure to green space and use of spectacles (as a surrogate measure for myopia) in schoolchildren.

#### Methods

This study was based on a cohort of 2727 schoolchildren (7-10 years old) recruited from 39 primary schools in Barcelona (2012-2015). We assessed exposure to green spaces by characterizing outdoor surrounding greenness at home and school and during commuting using satellite data on greenness (Normalized Difference Vegetation Index). We also obtained data on the annual average time children spent playing in green spaces through questionnaires. Cross-sectional analyses were conducted based on prevalent cases of spectacles at baseline data collection campaign and longitudinal analyses based on incident cases of spectacles use during the three-year period between the baseline and last data collection campaigns.

#### Results

An interquartile range increase in exposure to green space at home, school, and commuting was associated with 15%-30% decrease in spectacles use in cross-sectional and longitudinal analyses. Similarly, in longitudinal analyses an interquartile increase in time playing in green spaces was associated with a 28% reduction in the risk of spectacles use.

#### Conclusions

Risk of spectacles use by primary schoolchildren was inversely associated with outdoor green space at their living environment and time spent by them playing in green spaces.

## MC02: Built Environment & Greenness

026, September 25, 2017, 10:30 - 12:00

### Association of neighborhood green space with depressive and anxiety symptoms in older adults

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#### Background/Aim

Mental health disorders are the third leading cause of global disease burden worldwide. Despite that a role of neighborhood green space in the pathogenesis of mental disorders has been suggested, current epidemiologic evidence on such association remain conflicting.

#### Methods

We examined the association of Normalized Difference Vegetation Index (NDVI), a measure of surrounding green space, with depressive and anxiety symptoms in community-dwelling adults (aged  $\geq 57$ ) of the National Social Life, Health and Aging Project, a nationally representative, longitudinal sample of older adults in the United States. Current symptoms of depression and anxiety were evaluated using standardized questionnaires, with cases identified by dichotomizing questionnaire scores using well-established cutoffs. We restricted our analysis to 722 participants whose residence was within 1.25km radius from the NDVI sample point, and assessed the association of NDVI (categorized into tertiles) and mood disorders using generalized linear mixed models, with adjustment of confounders (e.g., socioeconomic status), and to explore effect modification.

#### Results

In models adjusted for age, gender, race, calendar year, season, day of week, region and individual- and neighborhood-level socioeconomic status, participants living in the most green neighborhood had 57% lower odds of adverse depressive symptoms (95%CI: 0.17, 0.67), and 78% lower odds of adverse anxiety symptoms (95%CI: 0.11, 0.43), compared with those living in the least green neighborhood. Most association remains robust upon adjustment of nitrogen dioxide and other covariates. The association with depression was stronger among individuals who were younger, more educated, had hypertension, and lived in an affluent and least urban neighborhood, whereas the association with anxiety was stronger among men, those who were more educated, had higher BMI scores, and lived in an affluent neighborhood.

#### Conclusion

NDVI was associated with depressive and anxiety symptoms, suggesting that green space may be a newly identified environmental buffer for mental health.

## MC02: Built Environment & Greenness

026, September 25, 2017, 10:30 - 12:00

### Green space, noise and air pollution and mortality in Barcelona

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on behalf of the study group.

**Background and introduction:** Relatively few studies have evaluated simultaneously the relationship between green space, air pollution and noise and mortality in urban setting We conducted a study to evaluate the relationship between green space, noise and air pollution and all cause mortality in Barcelona using a large patient database with individual level mortality and covariate data..

**Method:** Both men and women of 18 years and above registered on January 1 2010 by the Sistema d'Informació pel Desenvolupament de la Investigació en Atenció Primària (SIDIAP) were included in the cohort and followed up until 31 December 2014 or until death. SIDIAP is a primary care computerized medical records of a representative sample of 0.8 million people in Barcelona. We used different definitions of green space (greenness and access to green space), noise maps and air pollution estimates from land use regression modeling.

From the SIDIAP database we extracted Individual level covariate data such as age, gender, country of origin, smoking status, and BMI. For each year of study on a census tract level we also obtained MEDEA social economic status (SES), urbanity level, and built environment measures. We used Cox proportional hazards regression models [hazard ratios (HRs)] with time-dependent exposures and age as the time scale to estimate associations between green space, noise and air pollution and all cause mortality.

**Results:** Initial results show independent effects of the exposures with an increase in mortality with increasing levels of noise and air pollution and a decrease in mortality with increasing levels of green space. Risk estimates were similar to previous studies where only one exposure was examined.

**Conclusion:** The study provides evidence for policy making, specifically for urban planning and management, environment and health.

## MC03: Child Health: PFAS, PBDE, BPA and other exposures

020, September 25, 2017, 10:30 - 12:00

### **Prenatal exposure to bisphenol A and bisphenol S and neurodevelopment in children at 2 years of age: Results from the APron cohort study**

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**Background:** Bisphenol A (BPA) is an endocrine disruptor highly detected in human biofluids. Experimental laboratory evidence and epidemiology studies suggest that BPA is a neurodevelopmental toxicant with sex-specific effects. Bisphenol S (BPS), as an alternative BPA, has already been widely used in commercial products and frequently detected in human samples with a lower exposure level compared to BPA. It has similar structure compared to BPA and equally affects neurodevelopment in animal experiment, yet epidemiology study of BPS remains limited.

**Objective:** We examined the effects of prenatal exposure of BPA and BPS, adjusting for maternal nutrients status, co-exposure of heavy metals and hypothesizing sex-specific effects.

**Method:** Total BPA and BPS were detected in spot urine samples collected during 2<sup>nd</sup> and 3<sup>rd</sup> trimesters from 402 pregnant women, who also provided blood samples for detecting nutrients status and co-exposure level of heavy metals. The development of children at 2 years of age was evaluated using Bayley III scales. Associations between prenatal exposure of BPA and BPS and development of children were estimated using multiple regression models with adjustments for potential confounders, which were selected from a pool of covariates including co-exposure of heavy metals and maternal nutrients status during pregnancy. The selected confounders are those remaining significantly correlated ( $p < 0.05$ ) with at least one of the Bayley III composite scores.

**Results:** Significant interaction ( $p < 0.05$ ) was observed between prenatal BPA exposure ( $\log_{10}$  transformed BPA after creatinine adjustment) and child sex on Social Emotional. The prenatal BPA exposure was negatively associated with the scores of Social Emotional for boys [ $\beta = -5.2$ ; 95% confidence interval (CI): -9.8, -0.62]. This association for boys remained significant after adjusting family income, ethnicity, maternal status of vitamin B12, folate, copper, manganese, selenium and co-exposure of cadmium at 2<sup>nd</sup> trimester of pregnancy ( $\beta = -4.5$ ; 95% CI: -8.9, -0.07). No significant association between prenatal BPA exposure and Bayley III scores was observed among girls. Significant interaction ( $p < 0.05$ ) was also observed between prenatal BPS exposure and sex on Language. High prenatal BPS exposure (upper quartile vs. other three quartiles) was associated with significantly lower composite scores of Language ( $\beta = -4.8$ ; 95% CI: -9.5, -0.23) for girls, while no significant association was observed among boys. The estimate of this association for girls remained negative after adjusting confounders ( $\beta = -3.4$ ; 95% CI: -7.8, 1.1), but the p-value increased to 0.136.

**Conclusions:** The results suggest negative association between prenatal exposure of BPA and BPS and development of children at 2 years of age, with different effects among boys and girls

# MC03: Child Health: PFAS, PBDE, BPA and other exposures

020, September 25, 2017, 10:30 - 12:00

## Prenatal exposure to PFAS and neuropsychological development throughout the first 6 years of life: The INMA Study, Spain

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### Background/Aim

Animal studies indicate that perfluoroalkyl substances (PFAS), including perfluorohexanesulfonic acid (PFHxS), perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorononanoic acid (PFNA), may be neurotoxicants. Few birth cohorts have studied possible PFAS effects in child brain development longitudinally. We investigated the association between plasma PFAS concentrations at gestational week 12 and neuropsychological development throughout the first 6 years of life.

### Methods

The study population was 1,239 mother-child pairs from the Gipuzkoa, Sabadell, and Valencia INMA-cohorts, Spain (recruitment period: 2003-2008). Brain development was assessed using two Bayley scales at age 11-18 months (Cognitive and Motor Scales) and three McCarthy scales at age 4-6.5 years (General Cognitive Index, which is a combination of verbal, perceptual-performance, and quantitative domains, and Gross and Fine Motor Scales). Raw scores were standardized to a mean(SD) of 100(15) for child's age in days at evaluation and the psychologist who administered the test. Multivariate regression analyses between log<sub>2</sub>-transformed(PFAS) and neuropsychological scores were conducted in each sub-cohort and estimates were then pooled by meta-analysis to account for possible heterogeneity. Linearity was accepted after using generalized additive models.

### Results

Median concentrations of PFHxS, PFOA, PFOS, and PFNA were: 0.58, 2.36, 6.06, and 0.66 ng/mL, respectively. Inverse significant associations ( $p \leq 0.05$ ) were found between PFAS and the Bayley Motor Scale with betas ranging between -1.45 (PFNA) and -1.87 (PFOS) per doubling of PFAS concentrations. Negative associations were also found with the Gross Motor McCarthy Scale, but statistical significance was only reached for PFOA (Beta[95%CI]: -1.22[-2.43, 0.00]). No association was found between PFAS and the Bayley or the McCarthy Cognitive scales.

### Conclusions

Results suggest a possible effect of prenatal PFAS exposure on psychomotor but not cognitive development during childhood, this being clearer during the 1<sup>st</sup>-2<sup>nd</sup> years of life.

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## MC03: Child Health: PFAS, PBDE, BPA and other exposures

020, September 25, 2017, 10:30 - 12:00

### Prenatal exposure to perfluoroalkyl substances and isomers link to depressed toxoid antibody responses in early childhood: Guangzhou Birth Cohort Study

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#### Background/Aim

Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are ubiquitous and persistent environmental chemicals and are suggested to have immunosuppressive effects. Studies indicate that prenatal exposure to PFAS may lead to suppressed immune responses in early life. However, human studies of immune effects are inconsistent. In this study, we aim to assess the association between prenatal exposure of PFASs with isomers and serum antibody concentrations against measles, coxsackievirus A 16 (CA16) and enterovirus 71 (EV71) toxoids in newborn and infant at 3 months.

#### Methods

We recruited 295 pairs of mothers and their infants in Guangzhou Birth Cohort Study, China from July to October 2013. Measles IgG antibody was examined using ELISA assay, neutralizing antibodies titers against CA16, EV71 toxoids were performed in cord blood serum and infant aged 3 months, respectively. A PFAS isomer-specific analysis method based on high performance liquid chromatography-mass spectrometry (HPLC-MS/MS) was applied to determine the PFASs and isomers concentration in cord blood serum.

#### Results

For measles antibody, PFOA showed the strongest negative correlations with toxoid antibody concentration in newborn and 3-month infant. A doubling of lnPFOA level (ng/ml) increasing among newborn and 3-m infant was associated with a difference of -24.4% (95% CI: -30.7, -17.5) and -33.3% (95% CI: -43.9, -20.6) in measles antibody concentration, respectively. A doubling ln-unit (ng/ml) increase in total branch PFOS isomers in 3-month infant was associated with higher odds ratio of 1.70 (95%: 1.03, 2.79) and 2.49 (95%, 1.45, 4.28) than that with linear PFOS for falling below a clinically protection level (<1:8 titers) for CA16 and EV71 antibody, respectively. This association was more obvious in boys than in girls. Interestingly, we observed that long-chain PFASs, such as perfluorotetradodecanoic acid (PFDoDA) and perfluoroundecanoic acid (PFUnDA) exposure were negatively associated with measles, CA16 and EV71 antibody level in both newborn and 3-month infant.

#### Conclusions

Elevated prenatal exposures to PFASs, including long-chain PFASs were associated with depressed toxoid antibody response in newborn and infant. Branch isomer shows higher impact on CA16 and EV71 antibody level in 3-month infant for bellowing clinical protection.

**Key Words:** Perfluoroalkyl and polyfluoroalkyl substance; isomer; measles; coxsackievirus A 16; enterovirus 71; prenatal exposure

## MC03: Child Health: PFAS, PBDE, BPA and other exposures

020, September 25, 2017, 10:30 - 12:00

### Prenatal Polybrominated Diphenyl Ether (PBDE) Exposure and Social Cognition at Age 14

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**Background/Aim:** PBDEs may act as developmental neurotoxicants in humans, but epidemiologic findings to date on PBDE exposure and autism spectrum disorders (ASD) are very limited. Among young adolescents in the CHAMACOS (Center for the Health Assessment of Mothers and Children of Salinas) birth cohort study, we examined associations of prenatal PBDE concentrations with social cognition, a trait impaired in individuals with ASD.

**Methods:** We measured concentrations of four common PBDE congeners (BDE-47, 99, 100, 153) in blood collected from CHAMACOS mothers during the second half of pregnancy (in 2000-2002). When children were aged 14 years, parents completed the Social Responsiveness Scale, Second Edition (SRS-2), a rating scale of traits related to ASD. Using linear regression models, we examined associations of serum lipid-adjusted PBDE concentrations in relation to sex-standardized SRS-2 T-scores (population standard mean=50, standard deviation=10), with adjustment for language of SRS-2 administration (Spanish or English), child's age at assessment, breastfeeding duration, household poverty, maternal characteristics (age, parity, education, country of origin, years in the United States, pre-pregnancy body mass index, and IQ), and measures of maternal depression and home environment.

**Results:** 170 participants with complete data were included. Median (25%–75%) serum lipid-adjusted PBDE concentrations were: 15.5 ng/g lipid (9.5–24.5) [BDE-47], 3.8 (2.5–6.4) [BDE-99], 2.5 (1.7–4.2) [BDE-100], 2.1 (1.4–3.6) [BDE-153]. SRS-2 T-scores ranged from 41–88 with a mean (standard deviation) of 55.7 (8.0). SRS-2 scores were somewhat higher (representing more autistic behaviors) among children whose mothers had higher concentrations of BDE-153 in pregnancy ( $\beta=2.3$ ; 95% confidence interval: -1.7, 6.2 per 10-fold increase in maternal BDE-153 concentration), but were not associated with other measured PBDEs or the sum of the four measured PBDEs.

**Conclusions:** Among young adolescents living in a low-income agricultural community in California, we did not observe strong evidence of associations of prenatal PBDE concentrations with behaviors related to ASD.

## MC03: Child Health: PFAS, PBDE, BPA and other exposures

020, September 25, 2017, 10:30 - 12:00

### Influences of Chemical and Non-Chemical Stressors on Childhood Obesity

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**Background/Aim:** Children are exposed to diverse chemical and non-chemical stressors in their built, natural, and social environments; and these are thought to contribute to their health and well-being during each developmental stage throughout life. Here we focus on growing evidence that interacting stressors in children's environments contribute to recent and marked increases in childhood overweight/obesity/obesity-related metabolic dysfunction. Additionally, inherent characteristics (age, sex, genetics) and lifestage-specific activities and behaviors need to be considered along with the stressors. Our objective is to show evidence of the interrelationships between chemical and non-chemical stressors, inherent characteristics, and activities/behaviors in addressing childhood overweight/obesity/obesity-related metabolic dysfunction.

**Methods:** Literature reviews, data mining, meta-analyses, and laboratory work collected information on chemical and non-chemical stressors and their links to childhood overweight/obesity/obesity-related metabolic dysfunction. In vitro evaluations of the obesogenic potentials of chemicals were conducted with the 3T3-L1 pre-adipocyte culture system.

**Results:** A literature survey identified many stressors associated with childhood obesity. In our individual stressor meta-analyses, smoking in the home/during pregnancy, early life antibiotic use, bisphenol A, family income, access to supermarkets, diet, and stress had significant ( $p < 0.05$ ) results and increased odds of the child being overweight/obese. Hours of television and sedentary behavior also increased the odds of the child being overweight/obese. Breastfeeding was associated with reduced odds ( $p < 0.05$ ). Cross-sectional analyses suggested childhood metabolic dysfunction may be associated with interactions between endocrine-disrupting chemicals and selected non-chemical stressors such as family income. Cell culture analyses illustrated the influence of perfluorinated chemicals on adipocyte differentiation and function.

**Conclusions:** Our analyses suggest that childhood overweight/obesity/obesity-related metabolic dysfunction result from interactions of many chemical and non-chemical stressors in combination with inherent characteristics and children's activities and behaviors. Further research is required to infer causal associations.

## MC03: Child Health: PFAS, PBDE, BPA and other exposures

020, September 25, 2017, 10:30 - 12:00

### Center for Children's Health, the Environment, Microbiome, and Metabolomics (C-CHEM2): Project 1- Characterizing Exposures in an Urban Environment (CHERUB) Study Preliminary Results

Author information; Arial 8pt (please overtype this)

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#### Background/Aim

Emory University's Center for Children's Health the Environment, Microbiome, and Metabolomics (C-CHEM2) is a multi-component investigation designed to evaluate environmental exposures influencing the infant microbiome and leading to neurodevelopmental sequelae in a population of African-American mothers.

#### Methods

In the first phase we have collected environmental and biological data on toxicant exposures from samples collected at prenatal and home visits. C-CHEM2's first project, Characterizing Exposures in an Urban Environment, is designed to validate protocols for office and field sampling and determine the relationship between environmental media concentrations and biomarkers relevant to the microbiome of infants. Environmental and biological samples are taken from mothers during pregnancy and in-home environmental samples, prior to delivery. These samples will be analyzed for parabens, phthalates, alkylphenols, bisphenol A, organophosphate insecticides, pyrethroid insecticides, air pollutants (PAHs), and brominated flame retardants or appropriate metabolites

#### Results

Presently, we have collected 151 first hospital visit and 93 second hospital visit urines from expectant mothers and followed that up with home visits gathering 67 urine sample, 105 dust samples, and 25 home air samples. Analysis has been completed for some of the analytes and is continuing for others. Further, recruitment continues with an ultimate target of 300 participating women and approximately 100 individual homes each monitored several times. Currently we have completed approximately one-third of the projected first home visits and begun second home visits on early recruits.

#### Conclusions

Results for bisphenol A and related compounds indicating that this populations shows concentrations higher than the national average as measured in NHANES investigations and also higher than the African-American sub-population from the same investigations. Analysis continues correlating results from other measures on environmental exposure and biomarkers of such exposure.

## MC04: Exposure Assessment PM<sub>2.5</sub>

022, September 25, 2017, 10:30 - 12:00

Intraurban distributions of NO<sub>2</sub> and PM<sub>2.5</sub> at three dimensions in Lanzhou, China

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### Background/Aim

Previous research linked maternal exposures to NO<sub>2</sub> or PM<sub>10</sub> with increased risks of adverse birth outcomes in Lanzhou. To improve the accuracy of exposure assessment, a land use regression study at ground level with consideration of vertical variation by building height was conducted in Lanzhou.

### Methods

In each of four seasons in 2016-2017, NO<sub>2</sub> was measured using Ogawa badges for 2 weeks at 75 ground-level sites. PM<sub>2.5</sub> was measured using DataRAM pdr-1000 at a subset (N=38) of the 75 sites. The PM<sub>2.5</sub> monitor was systematically moved in pre-determined patterns around each site. The measurements were adjusted for temporal trend using government monitoring data. Vertical profile measurements were conducted at 18 sites evenly distributed at increasing floors of 2 buildings: one facing traffic and the other facing away from traffic. The annual and seasonal concentrations of NO<sub>2</sub> and PM<sub>2.5</sub> at ground level were regressed against spatial predictors, including elevation, population, road network, land cover, and land use with buffers 100-2000 m around each site. The vertical variations were investigated using polynomial models.

### Results

NO<sub>2</sub> concentrations were associated with lengths of major roads and of all roads, slope, and cultivated land (adjusted R<sup>2</sup>: 0.61). PM<sub>2.5</sub> concentrations were higher in certain districts, and associated with population density, lengths of roads with vehicles, and elevation (adjusted R<sup>2</sup>: 0.56). From the 1<sup>st</sup> to 32<sup>nd</sup> floors in the building facing traffic, NO<sub>2</sub> and PM<sub>2.5</sub> concentrations decreased 22% and 26%, respectively. These distributions showed seasonal and diurnal variations.

### Conclusions

The ground-level NO<sub>2</sub> and PM<sub>2.5</sub> showed different patterns, which was not captured by the limited government monitors in Lanzhou. Concentrations of these pollutants decreased substantially with height. Therefore, characterizing 3-dimensional distributions of multiple pollutants might be crucial for exposure and risk assessment in cities with mixed pollution sources and tall buildings, and potentially have important policy implications.

## MC04: Exposure Assessment PM<sub>2.5</sub>

022, September 25, 2017, 10:30 - 12:00

### Full-coverage high-resolution daily PM<sub>2.5</sub> estimation using MAIAC AOD in the Yangtze River Delta of China

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**Background/Aim:** Satellite aerosol optical depth (AOD) has been used to assess population exposure to fine particulate matter (PM<sub>2.5</sub>); however, non-random missing AOD due to cloud/snow cover or high surface reflectance makes this task challenging. Previous studies filled the data gap by spatially interpolating neighboring PM<sub>2.5</sub> measurements or predictions. This strategy ignored the effect of cloud cover on aerosol loadings and has been shown to exhibit poor performance when monitoring stations are sparse or when there is seasonal large-scale missingness.

**Methods:** Using the Yangtze River Delta of China as an example, we present a Multiple Imputation (MI) method that combines available high-resolution satellite retrievals with chemical transport model (CTM) simulations to fill missing AOD. A two-stage statistical model driven by gap-filled AOD, meteorology and land use information was then fitted to estimate daily ground PM<sub>2.5</sub> concentrations in 2013 and 2014 at 1 km resolution with complete coverage in space and time.

**Results:** The daily MI models have an average R<sup>2</sup> of 0.77, with an inter-quartile range of 0.71 to 0.82 across days. We increased the coverage of PM<sub>2.5</sub> prediction by about two-fold per year. The overall model 10-fold cross-validation R<sup>2</sup> (root mean square error) were 0.81 (25 µg/m<sup>3</sup>) and 0.73 (18 µg/m<sup>3</sup>) for year 2013 and 2014, respectively. Predictions with only observational AOD or only imputed AOD showed similar accuracy.

**Conclusions:** This method provides reliable PM<sub>2.5</sub> predictions with complete coverage at high resolution. By including all the pixels of all days into model development, this method corrected the sampling bias in exposure assessment due to non-random missingness in AOD. This study advanced our capabilities to integrate ground observations, satellite data, model simulations, and land cover information in PM<sub>2.5</sub> exposure modeling, and will support epidemiological studies on the air pollution related health burden in China.

## MC04: Exposure Assessment PM<sub>2.5</sub>

022, September 25, 2017, 10:30 - 12:00

Evaluation of a Data Fusion Approach to Estimate Daily PM<sub>2.5</sub> Levels in North China.

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### Background/Aim

PM<sub>2.5</sub> air pollution has been a growing concern worldwide. Previous studies have conducted several techniques to estimate PM<sub>2.5</sub> exposure spatiotemporally in China, but all these have limitations. This study was to develop a new spatiotemporal model with data fusion approach based on Kriging and Chemistry Module models.

### Methods

Two techniques were applied to create daily spatial cover of PM<sub>2.5</sub> in grid cells with a resolution of 10 km in North China in 2013, respectively, which was kriging with an external drift (KED) and Weather Research and Forecast Model with Chemistry Module (WRF-Chem). A data fusion technique was developed by fusing PM<sub>2.5</sub> concentration predicted by KED and WRF-Chem, accounting for the distance from the central of grid cell to the nearest ground observations and daily spatial correlations between WRF-Chem and observations. Model performance was evaluated by comparing them with ground observations and the spatial prediction errors.

### Results

KED and data fusion performed better with a daily model R<sup>2</sup> of 0.95 and 0.94, respectively and the PM<sub>2.5</sub> was overestimated by WRF-Chem (R<sup>2</sup>=0.51). The annual mean PM<sub>2.5</sub> concentration of the 365 ground monitors was 90.9 µg/m<sup>3</sup>, similar with the PM<sub>2.5</sub> fields modeled by KED and data fusion at monitoring sites, but lower than that simulated by WRF-Chem. KED and the data fusion model performed better around the ground monitors (15-35 µg/m<sup>3</sup>), WRF-Chem performed relative worse with high prediction errors in northern Henan, southeastern Hebei and southern Shanxi (65-75 µg/m<sup>3</sup>)

### Conclusions

Both KED and data fusion technique provided highly accurate PM<sub>2.5</sub>. Current monitoring network in North China was dense enough to provide a reliable PM<sub>2.5</sub> prediction by interpolation technique. Data fusion is an effective approach to improve the accuracy of WRF-Chem simulation spatiotemporally.

## MC04: Exposure Assessment PM<sub>2.5</sub>

022, September 25, 2017, 10:30 - 12:00

### Assessment of indoor and outdoor PM<sub>2.5</sub> in slums of Mumbai, India

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**Background/Aim:** Mumbai slums, which house more than 50% of the city's population could be at a higher risk of air pollution due to its proximity to major outdoor air pollution sources, poor ventilation and presence of indoor emission sources. The aim of this study is to measure and model the indoor air pollution exposures of Mumbai slum population vis-a-vis the outdoor levels.

**Methods:** Household questionnaire survey having demographic, indoor source activity, ventilation and respiratory health symptoms was conducted in 500 randomly selected homes of seven slums in Mumbai to identify possible sources and factors affecting indoor air pollutants' exposures. In two of the slums, inside 10 homes each, 24-hour indoor gravimetric PM<sub>2.5</sub> monitoring was also conducted.

**Results:** Significant number of homes are poorly ventilated (~90% homes with no cross ventilation) and experience overcrowding (~30% homes with  $\geq 4$  person/room). >50% kitchens have no separation from the living rooms. Mean PM<sub>2.5</sub> concentrations are  $39 \pm 17 \mu\text{g}/\text{m}^3$  indoors and  $23 \pm 4 \mu\text{g}/\text{m}^3$  outdoors. The in/out PM<sub>2.5</sub> ratio ranged from 0.9 to 3.7, higher than the values observed in non-slum homes. Frequent brief excursions are observed in indoor PM<sub>2.5</sub> and BC, which are 2-3 times higher than the median concentrations, during cooking activities. Multivariate linear regression analysis shows proximity to the major traffic roads and separation of the kitchen from adjacent living rooms as the most dominant determinants of the indoor PM<sub>2.5</sub> exposures. Additional indoor PM<sub>2.5</sub> monitoring in ~80 homes in these slums is currently underway which will be used for developing models for predicting indoor PM<sub>2.5</sub> exposures.

**Conclusion:** Indoor PM<sub>2.5</sub> exposures in poorly ventilated homes in slums of Mumbai seem to be driven largely by outdoor road traffic emissions as well as indoor activities such as cooking.

## MC04: Exposure Assessment PM<sub>2.5</sub>

022, September 25, 2017, 10:30 - 12:00

### A Real-Time Low-Cost Optical Sensors in the Measurement of Household PM<sub>2.5</sub> in Rural Bangladesh

#### Background/Aim

In order to accurately evaluate public health outcomes linked to particulate matter exposure (PM<sub>2.5</sub>), it is important to know the validity of the instruments used in studies. We are currently conducting research to investigate the adverse health effects of biomass fuel exposure on pregnancy outcomes and incidence of pneumonia in infants in rural Bangladesh. This longitudinal study requires sampling in 720 households with an aim to build an appropriate exposure model for a major air pollutant in cook stove smoke. Although filter-based approaches are the gold standard in the measurement of PM<sub>2.5</sub>, it is expensive and only provides information on integrated time-scales. It is highly desirable to have real-time, low-cost measurements of PM<sub>2.5</sub> in health studies.

#### Methods

Here we use real-time optical sensors developed at Duke University to measure PM<sub>2.5</sub>, at a cost that is more than an order of magnitude less than filter-based measurements. We concurrently collected samples using filter-based and sensor-based approaches from different locations at thirty different households for 24-hour durations. For reliability, we ran nine optical sensors at the same location for 30 minutes every 3<sup>rd</sup> day for a period of 30 days. Assessment was carried out by checking correlation via multivariable linear regression.

#### Results

PM<sub>2.5</sub> readings obtained from the optical sensors showed strong, positive correlation (R-square 0.82) with filter-based measurements. After controlling for the range of PM<sub>2.5</sub> level, humidity, and temperature, the R<sup>2</sup> was 0.81. The recorded minimum-maximum PM<sub>2.5</sub>, humidity and temperature were 89-195 µg/m<sup>3</sup>, 60-70%, and 23.5-28.1°C, respectively. High correlations (R<sup>2</sup>= 0.94-0.99) were observed for collocated optical sensors.

#### Conclusions

Based on this pilot study we found that the Duke optical sensors provide a reasonably accurate measurement of PM<sub>2.5</sub> and the measurements were highly reliable. We are currently collecting more data to develop a prediction model for PM<sub>2.5</sub> in rural households of Bangladesh.

## MC05: Ambient air & cardiovascular mortality

100, September 25, 2017, 10:30 - 12:00

Case-crossover and nested case-control analyses of the association between mortality and spatially-resolved daily ambient concentrations of NO<sub>2</sub> among elderly persons with congestive heart failure, Montreal, 1991-2002.

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### Background/Aim

We used time-stratified case-crossover and nested case-control designs to determine the association between daily non-accidental mortality among elderly persons with congestive heart failure using different spatiotemporal prediction models of nitrogen dioxide (NO<sub>2</sub>) in Montreal, 1991-2002.

### Methods

For the case-crossover analysis we matched the day in which each subject died to all similar weekdays within the same month. In the nested case-control we randomly selected 100 controls matched to each case by day of death and gender. We adjusted for age and area-based indicators of socio-economic status, whereas weather and temporal trends were controlled by design. Exposure was assigned from different methods predicting spatially-resolved, daily residential NO<sub>2</sub> concentrations: 1) concentrations from the nearest monitor; 2) inverse-distance weighting interpolation; 3) back-extrapolation from a land-use regression model from a dense monitoring survey; and 4) the mean of all stations (case-crossover only). We accounted for the effects of air pollution and weather (case-crossover only) on mortality using distributed lag nonlinear models over lags 0 to 3 days.

### Results

All response functions were linear. For the case-crossover design, results were consistent across the different exposure metrics. The mean percent change (MPC) accumulated over lags 0 to 3-days across exposure models ranged from 2.6% (95%CI: -0.6, 5.9%) to 3.4% (95%CI: 0.0, 6.9%) per increase equal to the interquartile range (i.e., approximately 10 ppb). For the nested case-control results using the back-extrapolation method, we found a MPC of 3.0% (95%CI: -0.8, 7.0%), consistent to that of the case-crossover analysis. However, we found negative associations using the nearest station approach (MPC: -5.5%; 95%CI: -8.0, -2.8%), and using inverse-distance weighting (MPC: -8.8%; 95%CI: -15.0, -2.1%).

### Conclusions

Exposure to ambient NO<sub>2</sub> may increase the risk of daily mortality in congestive heart failure, but for some exposure metrics the associations were not consistent across the two designs.

# MC05: Ambient air & cardiovascular mortality

100, September 25, 2017, 10:30 - 12:00

## Modification Effect of Temperature on the Association between Ultrafine Particles and Mortality in Eight European Urban Areas

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### Background/Aim

Few studies have explored potential interactions between air temperature and air pollution on mortality and the results are inconsistent. Moreover, whether temperature modifies the effect of ultrafine particles remains unclear. In this study, we investigated the modification of the effects of ultrafine particles on mortality by temperature in eight European urban areas.

### Methods

We collected daily data on natural, cardiovascular and respiratory mortality, particle number concentrations (PNC, as a proxy for ultrafine particles), fine particles (PM<sub>2.5</sub>), ozone (O<sub>3</sub>), and mean air temperature in eight urban areas of Finland, Sweden, Denmark, Germany, Italy, Spain, and Greece during 1999-2013. We first applied Poisson generalized additive models with over-dispersion adjusting for temperature, long-term and seasonal trend, day of the week, influenza epidemics, and population dynamics due to summer vacation and holiday to estimate the interactive effects of temperature categorized into high (>75<sup>th</sup> percentile), medium, and low (<25<sup>th</sup> percentile) and PNC on mortality in each city, then pooled the city-level estimates using random-effects meta-analyses.

### Results

The mortality effects of PNC at lag 6 were generally stronger during periods with high compared to low temperature, though the interactions were not statistically significant. A 10,000 particles/cm<sup>3</sup> increase in PNC during periods with high temperature was associated with 1.16% [95% confidence interval (CI): -1.06%; 3.44%], 2.52% [-0.16%; 5.27%] and 0.91% [-3.78%; 5.83%] increases in natural, cardiovascular, and respiratory mortality, respectively. Corresponding estimates for PNC during periods with low temperature were 0.30% [-0.22%; 0.83%], 0.04% [-0.75%; 0.84%], and -0.49% [-2.37%, 1.42%]. This interaction pattern remained when adjusting for other pollutants (PM<sub>2.5</sub> and O<sub>3</sub>).

### Conclusions

We found that high temperature may modify the acute effects of ultrafine particles on cause-specific mortality.

## MC05: Ambient air & cardiovascular mortality

100, September 25, 2017, 10:30 - 12:00

### A Nationwide Case-crossover Study on Air Pollution and Mortality in the Medicare Population

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**Background:** Many time-series studies have established associations between short-term exposure to ambient fine particles (PM<sub>2.5</sub>) or ozone and increased mortality. However, those studies have generally been limited to large cities, and evidence for the associations below the current National Ambient Air Quality Standards (NAAQS) is limited. Also, many previous studies had inadequate power to identify susceptible sub-groups.

We examined the association of acute exposure to ambient PM<sub>2.5</sub> and ozone with mortality using the case-crossover approach, on a large nationwide sample consisting of all Medicare participants in the U.S.

**Methods:** We conducted national case-crossover analyses to estimate the effects of PM<sub>2.5</sub> and ozone on over 22 million deaths of Medicare participants during 2000 to 2012. Daily PM<sub>2.5</sub> and ozone levels were assessed by previously published and validated prediction models. Daily exposures were matched to every ZIP code. We used conditional logistical regression to examine the association between mortality and PM<sub>2.5</sub> and ozone in two-pollutant models. Effect modification by age, race, sex, socio-economic status (SES), and population density was also examined. In addition, we estimated the dose-response curves for PM<sub>2.5</sub> and ozone.

**Results:** We found that mortality increased by 1.04% [95% confidence interval (CI): 0.95%, 1.14%] and 0.51% (95% CI: 0.41%, 0.61%) for every 10 µg/m<sup>3</sup> and 10 ppb increase in PM<sub>2.5</sub> and ozone, respectively. Sub-group analyses showed that blacks, people with a low SES, elders and females had higher risk estimates associated with air pollution. We observed a dose-response curve that showed linearity at low doses and attenuated at higher doses for the relationship between mortality and both PM<sub>2.5</sub> and ozone.

**Conclusions:** Exposures to PM<sub>2.5</sub> and ozone were significantly associated with higher risk of mortality, even at levels below current U.S. standards. Disadvantaged groups are more susceptible to air pollution. Tighter air quality standards are needed to protect public health.

## MC05: Ambient air & cardiovascular mortality

100, September 25, 2017, 10:30 - 12:00

### Long Term Exposure to Black Carbon and Cardiovascular Mortality: A study based on A Dynamic Three-Dimensional Exposure Model in an elderly cohort

Author information; Arial 8pt (please overtype this)

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#### Background/Aim

It has been well documented that air pollution is linked to adverse cardiovascular and respiratory health effects.

Nevertheless, there has only been a few epidemiologic studies focusing on health effects of long term exposure of black carbon (BC). In addition, most of the studies have not accounted for the 3 Dimensional landscapes in cities and mobility of the population. We aim to estimate BC based on a novel dynamic 3 dimensional (D3D) land use regression (LUR) model and assess the long-term effects on mortality in a large elderly cohort in Hong Kong.

#### Methods

We conducted a cohort study of BC and cardiovascular mortality among 66,820 subjects aged 65 years old or older in Hong Kong from 1998-2011. BC concentrations were estimated by LUR model and assigned to all participants based on their residential addresses at baseline periods, adjusted the vertical and dynamic components. Cox regression models were used to estimate the hazard ratios (HRs) of mortality associated with BC.

#### Results

Statistically associations were observed not only for all natural causes mortality (HR=1.05; 95%CI: 1.03, 1.07) and cardiovascular disease (HR=1.1; 95%CI: 1.04, 1.17) but also for the two subcategories, IHD (HR=1.11; 95%CI: 1.04, 1.17) and cerebrovascular disease (HR=1.07; 95%CI: 1.01, 1.15) per IQR increase of BC.

#### Conclusions

This cohort study demonstrated that long-term exposure to ambient BC was associated with an increased risk of cardiovascular mortality. These findings suggested that BC may play a role in the association between traffic related air pollutants and mortality

## MC06: Health impacts in Asia Pacific region

102, September 25, 2017, 10:30 - 12:00

### Elevated blood pressure and household solid fuel use in premenopausal women: Analysis of 12 Demographic and Health Surveys from 10 countries

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#### Background/Aim

Exposure to household air pollution (HAP) from cooking with traditional fuels are still common in low- and middle-income countries. Studies from single setting have linked HAP with blood pressure (BP), which is itself an important risk factor for CVD. No study has yet explored cross-country similarity/difference in HAP-BP risk in diverse population. We examined the association between HAP exposure from self-reported solid fuel use and BP in 77,630 young premenopausal women from ten resource-poor countries, using a nationally representative and internationally comparable data.

#### Methods

We used data from 12 Demographic and Health Surveys (DHS) from ten countries: Albania, Armenia, Azerbaijan, Bangladesh, Benin, Ghana, Kyrgyzstan, Lesotho, Namibia, and Peru. Our measure of HAP exposure was use of solid fuels for cooking (coal, charcoal, wood, and animal dung) vs. cleaner fuels (electricity and gas). Our outcomes of interest were average systolic and diastolic BP, and hypertension, defined as an average systolic BP  $\geq 140/90$  mm Hg. In a meta-analytical approach, we estimated the associations of systolic and diastolic BP with HAP across countries.

#### Results

The women in our sample were with low prevalence of hypertension (11%). The overall systolic and diastolic BP (SD) were 117 (16) and 74 (11) mmHg, respectively. Systolic BP was, on average, significantly higher by  $\sim 2$  mmHg among electricity or gas users compared to those who cooked using solid fuels (118 mmHg vs. 116 mmHg; 95% CI: 1.4-2.0 mmHg), however, the relationship reversed in the multivariate analysis. After adjusting for age, BMI, ethnicity, education, occupation, wealth index, rural/urban location, and month of interview, use of solid fuels was associated with 0.58 mmHg higher systolic BP (95% CI: 0.23, 0.93), and higher odds of hypertension [OR=1.08 (95% CI: 0.99, 1.16)] when compared with cleaner fuels. There was no significant statistical heterogeneity across country-specific estimates ( $I^2$  statistic = 1.0%, p-value = 0.656).

#### Conclusions

We observed small but statistically significant, positive pooled effect estimates of solid fuel use on systolic BP. Switching to cleaner fuels could potentially result in cardiovascular health improvements in developing countries.

## MC06: Health impacts in Asia Pacific region

102, September 25, 2017, 10:30 - 12:00

### Impacts of ambient temperature on acute myocardial infarction in Central Coast of Vietnam

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#### **Background/Aim**

Little research has been undertaken in the field of climate change and human health in developing countries with a tropical climate. Vietnam is one of the countries most affected by climate change, but few studies have focused on the health effects of climate variation/change for its inhabitants. This research aimed to examine the seasonality of hospital admissions (HAs) of acute myocardial infarction (AMI) and association between temperature variation and AMI HAs in the Central Coast of Vietnam.

#### **Methods**

Information from all 3328 local cases of AMI HAs was collected from the three biggest hospitals in Thua Thien Hue (TTH-1274), Khanh Hoa (KH-1342) and Quang Binh (QB-712) provinces from 2008 to 2015. Data on weather and air pollution were obtained from the authorised national centres of the Vietnamese Government. Generalised linear modelling was used to assess the association between temperature and AMI after adjustment for population, long term trend, air pollutants (PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub> and O<sub>3</sub>), and other meteorological variables (relative humidity, air pressure and wind speed).

#### **Results**

The incidence of AMI was higher in winter than summer: rate ratio are 1.32 (95% CI: 1.12-1.57) and 1.47 (95%CI: 1.10-1.99) for TTH and QB respectively; but, there was no such significant difference in KH. Moreover, in TTH, for each 1°C increase, the AMI HAs rate decreases by 0.03 (95%CI: 0.02-0.05); and similarly for QB was 0.02 (95%CI: 0.01-0.04).

#### **Conclusions**

Hospital admission rate of AMI was higher in winter than summer for the tropical monsoon climate regions (TTH and QB) while there was no significant difference for a tropical savanna climate region (KH). Temperature was a significant predictor for AMI HAs rate in tropical monsoon climate regions but not for tropical savanna climate. Further research is warranted to evaluate how the pattern of AMI will change as climate change proceeds in Vietnam.

## MC06: Health impacts in Asia Pacific region

102, September 25, 2017, 10:30 - 12:00

Update of the exposure response function for the evaluation of the impact of PM2.5 on natural mortality

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### **Background/Aims.**

Epidemiologic evidence provides a reliable basis for air pollution impact assessment summarized in the form of exposure-response functions (ERFs) that quantify the increase in the risks of mortality in relations to exposure to different levels of air pollution. A WHO Regional Office for Europe document (HRAPIE, 2013) provided rationale and indications in order to perform health impact assessment of air pollution (in the context of cost-benefit analysis of policies at European level) based on linear or log-linear functions relating particulate matter of a diameter less than 2.5  $\mu\text{m}$  (PM2.5) to natural mortality and other specific outcomes. In the HRAPIE report, the meta-analysis by Hoek (2013) was based on 11 studies and provided the ERF for the PM2.5-all-cause (or natural-cause) mortality association (6% excess mortality, 95% Confidence Interval, CI = 4-8.3%, per 10  $\mu\text{g}/\text{m}^3$  PM2.5).

### **Methods.**

We reviewed 19 studies available until December 2016 on the relationship between long-term exposure to PM2.5 and natural mortality (10 studies included in Hoek et al, the extension of the Canada National Cohort, and 8 new studies). We performed meta-analysis using random effects methods of DerSimonian and Laird (1986).

### **Results.**

The new synthesis indicates a summary effect estimate considerably higher (10%, 95% CI = 6-14% per 10  $\mu\text{g}/\text{m}^3$  PM2.5 over the range of 5-30  $\mu\text{g}/\text{m}^3$ ) than the value previously estimated. The resulting ERF tends to be non-linear with higher coefficients in the region 5-20  $\mu\text{g}/\text{m}^3$  and lower values above 20  $\mu\text{g}/\text{m}^3$ . There are few observations above an annual average of 20  $\mu\text{g}/\text{m}^3$ , as there are few epidemiological studies on mortality risk from long-term exposure to PM2.5 in the world's most polluted regions.

### **Conclusions.**

Given the importance of health impact estimation for normative and policy evaluation activities, including Sustainable Development Goals reporting, the development of stable exposure-response functions is key and natural mortality represents a reliable epidemiologic measure. Scientific literature is progressing and adaptation and improvement of the exposure-response functions over time is also needed.

## MC06: Health impacts in Asia Pacific region

102, September 25, 2017, 10:30 - 12:00

### Prevalence and risk factors of COPD in Karachi, Pakistan: findings from the Adult Asthma Study-Karachi

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#### **Background/Aim:**

Limited data is available regarding burden and risk factors of COPD from developing countries through community based epidemiological assessment comprising spirometry. So to determine the prevalence and risk factors of COPD among adult population of Karachi, Pakistan.

#### **Methodology:**

A multi-stage, community-based cross-sectional survey was conducted from May 2014-August 2015 comprising of 1630 adult ( $\geq 18$  years) participants from 75 randomly selected (out of 9400) clusters in Karachi. From each cluster, 25 households were selected randomly and all eligible participants were recruited. Data was collected through questionnaire-based interviews in Urdu, consisting of respiratory health related questions (American Thoracic Society questionnaire; ATS-DLD 78A), socio-demographic characteristics and risk factors for asthma. Pre and post-bronchodilator spirometry was performed according to the ATS criteria. COPD was defined as a post-bronchodilator  $FEV_1/FVC$  ratio  $< 0.70$  according to the GOLD criteria.

#### **Results:**

Among 930 participants with acceptable spirometry we found the overall prevalence of COPD to be 10.9% ( $n=101$ ; 95%CI: 8.9-12.8). Among them, the prevalence was 19.4% ( $n=78$ ; 95%CI: 15.5-23.2) among adults aged 40 and above. Out of 101 participants having COPD, 20.8% have mild, 59.4% have moderate, 18.8% have severe and 1% have very severe disease according to the GOLD criteria of airflow limitation severity in COPD. Risk of COPD was increased with increasing age (AOR: 5.2, 95%CI: 3.1-8.5), increase in pack years of smoking (AOR: 3.3, 95%CI: 1.8-5.9) and among participants reporting history of allergies (AOR: 2.2, 95% CI: 1.4-3.4). Risk of COPD was decreased among those categorized as white collar employees compared to those not working or unemployed (AOR: 0.5, 95% CI: 0.3-0.9).

**Conclusion:** This study provides evidence through robust epidemiological assessment regarding the actual burden of COPD among adults in Pakistan. Targeted preventive measures should be taken to reduce smoking habit and promote better environmental conditions at work places.

**Key words:** COPD, predictors, spirometry, Pakistan

## MC06: Health impacts in Asia Pacific region

102, September 25, 2017, 10:30 - 12:00

### Water Quality and links to undetermined CKD in Sri Lanka: an ecological pilot study

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#### Background/Aim

Prevalence of undetermined chronic kidney disease (CKD) has increased rapidly in the tropics over the last decade. The cause of this rise is unknown, but is suggested to have an environmental cause. A wide range of risk factors including pesticides, infections, natural toxins and dehydration has been proposed, but no firm associations found. Cyanobacterial toxin cylindrospermopsin has previously been found to be nephrotoxic.

#### Methods

Water samples were obtained from 50 sites across Sri Lanka including those with high and low uCKD prevalence, different water sources (tank, ground water, tube, shallow and deep well) and in different geographical/climate areas (North Central and Uva Province). Samples were analysed for 72 pesticides, 9 metals and the presence of genes encoding four cyanobacterial toxins.

#### Results

No pesticides or metals measured were at levels above WHO guidelines or at levels estimated to be harmful. Genes for the production of cylindrospermopsin and saxitoxin were detected in 9 of 49 samples (microcystin/nodularin genes were not detected). 16% of water samples in villages with endemic uCKD were found to have cyanotoxin genes: water samples in areas not endemic with uCKD had only 8% with cyanotoxins ( $p=0.36$ ; Fisher's exact). 9% of water samples had potential for cylindrospermopsin in uCKD endemic areas compared with no presence of cylindrospermopsin genes in control areas ( $p=0.08$ ; Fisher's exact).

#### Conclusions

Cyanobacterial toxins may be a uCKD risk factor in regions across Sri Lanka, but larger studies are required / more regions need to be studied.

# MC07: Methodologic advances in time series analyses

105, September 25, 2017, 10:30 - 12:00

## A Bayesian detection model for chronic disease surveillance: application to COPD hospitalisation data

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### Background/Aim

In chronic disease surveillance it is crucial to be able to detect any temporal changes that might occur in particular areas, as this might be indicative of an emerged localised risk factor. In this work, we propose an extension of BaySTDetect, a Bayesian hierarchical model introduced by Li et al.(2012), which is able to detect areas with an unusual temporal trend, and a simulation study is carried out to assess the performance of the model. The method is illustrated by application to chronic obstructive pulmonary disease (COPD) hospitalisation data in England.

### Methods

We extend the BaySTDetect method to a more general framework which can provide information on both the area and the time point of the unusual observation, and can be appropriate for longer time periods.

In addition, we modify the model so that it is more flexible to detect different patterns of unusual behaviour. The performance of the proposed model is investigated through a simulation study. Finally, the model is applied to a set of hospitalisation data on COPD in England at the Clinical Commissioning Group (CCG) level between April 2010 and March 2011.

### Results

Simulation results showed that the model performs well under three different time scenarios, giving much lower false positive proportions than BaySTDetect and adequate sensitivity and specificity values. Under the proposed model, thirty three areas were found to have unusual COPD hospitalisation trends in at least one month during the time period considered.

### Conclusions

We proposed a flexible approach to perform disease surveillance on small area data. The case study on COPD data in England showed that a number of areas were detected as unusual in terms of time pattern over the months April 2010 and March 2011. Further investigation is needed to explain this behaviour.

Li, G., N. Best, A. L. Hansell, I. Ahmed, and S. Richardson (2012). BaySTDetect: detecting unusual temporal patterns in small area data via Bayesian model choice. *Biostatistics* 13 (4), 695-710.

## MC07: Methodologic advances in time series analyses

105, September 25, 2017, 10:30 - 12:00

### Time series analysis of air pollution and health accounting for time-varying overdispersion

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#### Background/Aim

The time series design is one of the most frequently used methods for estimating short-term health effects of environmental exposures, such as air pollution, extreme temperature, and heavy rainfall. Overdispersion in the health outcome is common and is routinely accounted for by scaling the standard error of the health effect estimate when performing inference. To our knowledge, all previous analyses have assumed a constant overdispersion over time. Here, we extend the standard Poisson log-linear model to account for time-varying overdispersion. A better characterization of overdispersion may further improve the accuracy and precision of health effect estimates.

#### Methods

We investigated covariate-dependent time-varying generalized Poisson and negative binomial models. Inference was accomplished under a Bayesian framework to fully account for uncertainty in overdispersion estimation. We applied the proposed models to an analysis of ground-level ozone and emergency department (ED) visits for respiratory diseases in Atlanta, USA, 1999-2009. We also conducted simulation studies to evaluate estimation performance of the log relative risk for air pollution when time-varying overdispersion is ignored.

#### Results

In the Atlanta case study, allowing for time-varying overdispersion resulted in a reduction in ozone effect standard error compared to the standard quasi-Poisson approach (0.5% versus 0.7% for the log relative risk per interquartile range increase in ozone). The ozone-associated relative risk remained robust and positive to different model specifications for overdispersion. Through simulation studies, we similarly found that the standard approach can result in larger standard error for the air pollution effect estimate when the constant overdispersion assumption is violated.

#### Conclusions

Our findings suggest that improved characterization of overdispersion may result in more accurate and precise health effect estimates in time series studies of short-term environmental exposures.

## MC07: Methodologic advances in time series analyses

105, September 25, 2017, 10:30 - 12:00

### Projecting temperature-related health impacts under climate change scenarios: a methodological overview

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#### Background/Aim

In addition to other indirect pathways, climate change is expected to affect health by varying the exposure to non-optimal outdoor temperatures. However, the empirical quantification of this direct impact involves several methodological issues, which have not been systematically discussed in the literature. Here we provide a critical overview, illustrating practical steps and related methodological problems.

#### Methods

Projections of temperature-related health burdens involve a series of steps. First, researchers need reliable estimates of location-specific exposure-response relationships, commonly obtained from observed data. These relationships are characterized by complex non-linear and delayed patterns, and alternative models can be applied, from simple linear-threshold to complex distributed lag non-linear parameterizations. Alongside, future temperature series must be projected by running climate models under various climate change scenarios. These modelled data must be calibrated with the observed series, and several bias-correction methods are available for this purpose, although little is known on their comparative performance. The health impact can then be projected, although this involves extrapolating the exposure-responses in temperature regions never observed, and separating heat/cold contributions. The associated uncertainty, arising from both exposure-response estimation and climate projections, must be quantified. Projections into the future can also account for adaptation, whose mechanisms are little known, together with demographic trends and other changes. Finally, several summary measures, such as total, heat/cold and net contributions can be defined, and the counterfactual comparisons and related interpretation are not always straightforward.

#### Results

All these methodological problems, together with assumptions and limitations of alternative approaches, will be illustrated and discussed through explanatory examples of single and multi-city analyses, using data from London and from other locations in different regions of the world, respectively.

#### Conclusions

This overview will contribute to the definition of a structured methodological framework for projecting temperature-related health impacts under climate change, also clarifying limitations and future research directions.

# MC07: Methodologic advances in time series analyses

105, September 25, 2017, 10:30 - 12:00

## Time series trends and seasonal analysis of Salmonellosis and Campylobacteriosis in Australia

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### Background/Aim

Gastrointestinal (GI) infection is a common medical condition with high morbidity rates. However, few studies examined the seasonal difference between Campylobacteriosis and Salmonellosis infection. This study aims to use time series analysis methods to compare the trends and seasonal pattern between Campylobacteriosis and Salmonellosis and explore the possibility of developing a forecast model of GI infection in Australia.

### Methods

Monthly Campylobacteriosis and Salmonellosis notification rates data were extracted from Australian National Notifiable Diseases Surveillance System for the period of 1<sup>st</sup> January 2000 to 31<sup>st</sup> December 2016. Time-series seasonal decomposition analysis was used to explore the difference of the trend and seasonal factors between Campylobacteriosis and Salmonellosis.

### Results

Of all the GI diseases, Campylobacteriosis and Salmonellosis had the highest incidence rates in Australia. Average monthly notification rate of Campylobacteriosis infections (9.7/100,000, Range 6.40 - 15.20) was higher than that of Salmonellosis infections (4.01/100,000, Range 1.40 – 9.80). Time series trend analysis showed a steady increase in the notification rate for both diseases. However, time series seasonal decomposition showed that Campylobacteriosis and Salmonellosis are most commonly reported in January. For Salmonellosis, there is a dramatic decrease between March and June followed by a steady drop from June to September. However, a sharp increase is evident between September and January. Campylobacteriosis shows a gradual downward trend from February to April. There is a fluctuation between April and July followed by a stable trend by September. Further detailed investigations are required to determine the potential effect of confounding factors especially for weather variability.

### Conclusions

Despite health system improvements, GI infection's incidence rates are increasing. In the face of climate warming, our findings suggested it is needed to further assess the relationship between weather variability and GI infection and develop early warning systems for these types of infections.

## MC07: Methodologic advances in time series analyses

105, September 25, 2017, 10:30 - 12:00

### A National Multi-City Instrumental Variable Analysis of the Causal Effect of Local Particles on Mortality

Author information; Arial 8pt (please overtype this)

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Petros Koutrakis, Harvard TH Chan School of Public Health, Boston, USA

#### Background/Aim

Many studies have reported short-term associations of PM<sub>2.5</sub> and ozone with mortality, but few have applied causal modeling methods. Short-term exposure to NO<sub>2</sub>, a marker of local traffic, also has associations with mortality, but is less studied. We previously found a causal effect between PM<sub>2.5</sub> and mortality in Boston. Here we extend the analysis to 135 US cities to estimate the causal effects of local pollution on mortality.

#### Methods

We estimated the effect of local pollution by using an instrumental variable analysis, with planetary boundary layer, wind speed, and sea level pressure as instruments; a negative exposure control analysis; and a marginal structural model with weights based on propensity scores to help separate the effects of NO<sub>2</sub> from the effects of PM<sub>2.5</sub>.

#### Results

In 7.3 million deaths, with the instrument we estimated a causal increase in mortality of 1.6% (95% CI: 1.2%, 2.0%) per 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub>. The negative control exposure was not associated with mortality. With Marginal Structural Models we found positive significant increase in deaths with both PM<sub>2.5</sub> and NO<sub>2</sub>. Restricting our analysis to days with PM<sub>2.5</sub> below 25 µg/m<sup>3</sup>, we found a 0.91% (95% CI 0.40%, 1.41%) increase.

#### Conclusions

We applied several causal modelling techniques, each of which provides a causal estimate subject to different assumptions. If the assumptions of any approach are valid, those analyses provide a causal estimate of the effect of locally generated pollutants on daily deaths, with effects also at concentrations below the current EPA daily PM<sub>2.5</sub> and NO<sub>2</sub> standards.

## MC08: Built Environment & Transport

026, September 25, 2017, 14:00 - 15:30

Is the relationship between age and utilitarian walking influenced by the neighbourhood built environment?

Author information;

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**Background/Aim:** Neighbourhood built environments provide opportunities to incorporate walking for transport (WfT) into daily activities, contributing to overall physical activity. Within the same city, the relationship between age and WfT can vary significantly across neighbourhoods; however, little is known about the reasons for this variation. This cross-sectional study investigates whether the neighbourhood built environment contributes to between-neighborhood variation in the age-WfT relationship.

**Methods:** This investigation used 2007 data from How Areas in Brisbane Influence Health and Activity (HABITAT) Study. The sample included 11,035 residents aged 40-65 years living in 200 neighborhoods in Brisbane, Australia (72.6% response rate). Self-reported minutes per week of WfR were categorised into none (0mins) and some (1-840mins); age was categorised into 40-48, 49-57 and 58-65 years. Objectively assessed neighbourhood level measures included residential density, street connectivity and land-use mix. Data were analysed using multilevel binomial logistic regression, adjusted for neighborhood self-selection, gender, socio-economic position and neighborhood disadvantage.

**Results:** On average, older groups were less likely to walk for transport (OR 0.86, 95% CrI 0.77-0.96 for those aged 49-57 years and OR 0.73, 95% CrI 0.65-0.83 for those aged 58-65 years). The age-WfT relationship varied significantly across neighborhoods and the variation was larger in the older groups (about double). Residential density and street connectivity moderately explained the between-neighborhood variation in the age-WfT relationship. These reductions were not observed for land-use mix.

**Conclusions:** Neighbourhood-level factors differentially influence the WfT behaviors of young and old individuals, with older groups being more sensitive. Residential density and street connectivity moderately contributed to the between-neighborhood variation in the age-WfT relationship in Brisbane, while land-use mix did not. This research can inform the tailoring of multilevel interventions that increase WfT for all age groups everywhere, supporting healthy aging. Future research should investigate between-neighborhood variation in walking behaviors in other urban contexts.

## MC08: Built Environment & Transport

026, September 25, 2017, 14:00 - 15:30

### Assessing the Impact of Transport Mode, Trip Purpose, and the Built Environment on Mood Using a Smartphone App

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**Background/Aim:** Active travel (i.e., walking or cycling) leads to improved mood compared to sedentary modes (i.e., driving). Previous studies rely on participants' recall of their mood from prior trips. Using a smartphone app that allows for assessment directly after trips may provide more accurate responses and more nuanced information on mood during transport. We aim to explore how mood during travel is related to mode, trip purpose, and the built environment.

**Methods:** We recruited participants in southwest Virginia and Washington, D.C to download the phone app Daynamica to track their trips for two weeks (31 participants; ~1,300 individual trips). After each trip, participants completed surveys to assess mood and trip purpose. In a previous study, we conducted a factor-analysis on the mood survey to create a mood score; the survey was unidimensional with high reliability (Cronbach's alpha = 0.92). We employed regression analysis to assess how mood varies based on transport mode (i.e., active vs. sedentary), trip purpose (i.e., recreational vs. utilitarian), and the built environment (i.e., "walkscore").

**Results:** We used "car" as the reference case in our regressions and found that mood was higher when using a bike ( $\beta=0.11$ ;  $p<0.01$ ) and lower when using transit ( $\beta=-0.13$ ;  $p<0.01$ ). We did not find a significant relationship between walkscore and mood. However, we found a significant interaction between walking and walkscore ( $\beta=-0.12$ ;  $p<0.01$ ). We ran alternate models for trip purpose and used "work" as the reference case. Mood was higher for recreational trips ( $\beta=0.20$ ;  $p<0.01$ ), eating out ( $\beta=0.09$ ;  $p<0.01$ ) and going shopping ( $\beta=0.06$ ;  $p=0.04$ ).

**Conclusions:** Active travel improves physical (e.g., physical activity) and environmental (e.g., reducing emissions) health. We explore a third potential health-promoting outcome: improved mood. Our work demonstrates how information on mood and satisfaction could be used to promote sustainable forms of transportation.

## MC08: Built Environment & Transport

026, September 25, 2017, 14:00 - 15:30

Examining the effect of service quality, impact of usage and attitude on the intention to use rail transit among motorists in Kuala Lumpur, Malaysia

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### Background/Aim

Public transits have been widely promulgated as an effective way to reduce transport emissions with trickledown co-benefits on population health. This study revealed the significance of behavioural factors behind the intention to use rail transport system among motorists in the setting of Greater Kuala Lumpur (GKL), Malaysia.

### Method

We conducted a cross sectional survey along the corridor of an upcoming metro rail system in GKL. Respondents were asked to rate a list of items on behavioural beliefs of rail transport on a Likert scale. We then used the data obtained to test a hypothesized structural equation model. We tested the effects of behavioural beliefs on service quality and impacts from using rail transport, with attitude as the mediator, on the intention to use. We used the Maximum Likelihood (ML) estimation method to test the model.

### Results

The behavioural beliefs of both service quality and impacts from using rail transport had significantly positive effects on the intention to use it, with partial mediation by attitude. Reliability, convenience and comfort were the most important attributes of service quality while health faired lowly on impacts. Besides, the construct framework was significantly moderated by age groups, income groups, and having children below 18 years old. There was a stronger effect of service quality on the intention to use among the higher age groups while attitude played a significant role among the higher income groups. However, there was a low direct effect of service quality on attitude specifically among the higher income groups.

### Conclusion

This study demonstrated the importance of behavioural belief factors on the intention to use rail transport among motorists. Government policies and rail service providers could use this information to target on population behaviours in the efforts to increase utilization of public transits in a city and attain the coveted health co-benefits.

## MC08: Built Environment & Transport

026, September 25, 2017, 14:00 - 15:30

### Impacts of the Built Environment on Active Travel: Evidence from 20 US Metropolitan Areas

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**Background/Aim:** Walking and bicycling are health-promoting (e.g., physical activity) and environmentally friendly (e.g., reducing emissions) alternatives to the automobile. Previous studies have used city-specific traffic counts to assess correlates of active travel and the built environment; however, lack of spatial and temporal coverage of traffic counts on a national scale precludes generalizability from these studies. Our work aims to address this limitation by modelling the relationship between the built environment and active travel at a national scale.

**Methods:** We sourced and aggregated pedestrian and bicycle traffic counts over 15 years for 20 US metropolitan areas (n=6,342 count locations). For each count location, we tabulated various land use, traffic, accessibility, and socio-demographic variables at 12 buffer sizes (100-3,000m). We used stepwise linear regression to develop four base-case models for morning and afternoon peak-hour bicycle and pedestrian traffic volumes.

**Results:** Our models demonstrate reasonable goodness-of-fit for both bicyclists (adj-R<sup>2</sup>: 0.36-0.47) and pedestrians (adj-R<sup>2</sup>: 0.70-0.73). Built environment features were significant across all four models. In general, areas with easy access to water bodies, high rates of active commuting, as well as industrial, retail, and service land uses were associated with higher bicycle and pedestrian volumes (household density was associated with pedestrian volumes only); precipitation was associated with lower volumes. Cross-validation of our models (via a Monte Carlo 10% hold-out) showed a modest (~0.01) drop in adj-R<sup>2</sup> across models.

**Conclusions:** Our work offers insight for designing health-promoting cities. For example, our models could be used to estimate exposure to hazards such as crashes and air pollution. By incorporating bicycle and pedestrian counts across many cities, our models provide more generalized estimates of the magnitude of the impact of land use on zero-emissions travel behaviour to improve air quality and increase physical activity.

## MC08: Built Environment & Transport

026, September 25, 2017, 14:00 - 15:30

### The contribution of walkability to geographic variation in psychosocial distress and role limitation due to emotional problems in Sydney, Australia

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#### Background/Aim

The aim of this study was to assess ecological associations between area-level walkability and the spatial distribution of high psychosocial distress (HPSD) and role limitation due to emotional problems (RLEP) in Sydney.

#### Methods

Data on HPSD and RLEP were analysed for 91,142 Sydney respondents to the baseline survey of the 45 and Up Study conducted between January 2006 and April 2010. We used conditional auto regressive (CAR) models fit at the postal area level to create smoothed "disease maps" for HPSD and RLEP, and assess their associations with area-level walkability adjusted for area-level socioeconomic disadvantage, and individual level demographic, social and economic factors.

#### Results

Risk of HPSD and RLEP was geographically correlated with over 90% of variation due to unobserved spatial random effects for HPSD (ICC=0.99) and RLEP (ICC=0.93). Variation was reduced by 45.6% for HPSD and 43.5% for RLEP with the addition of individual and area level variables to CAR models. Postal area walkability was associated with RLEP but not HPSD, while postal area socioeconomic status was related to HPSD but not RLEP. Compared to the lowest walkability postal areas, the relative risk (RR) of RLEP was lower for postal areas in the second (RR=0.95, 95% CI = 0.91-0.98) and third (RR=0.95, 95% CI = 0.91-0.99) least walkable quartiles but similar for the most walkable quartile (RR=1.02, 95% CI = 0.97-1.07). Area level socioeconomic disadvantage did not modify the association between walkability and HPSD or RLEP.

#### Conclusions

Postal area walkability is associated with population levels of RLEP but not HPSD in Sydney, Australia. Interventions to increase opportunities for active transportation that improve the walkability of built environments may also help reduce functional role limitation due to emotional problems.

# MC08: Built Environment & Transport

026, September 25, 2017, 14:00 - 15:30

## The built environment correlates of a walking hotspot in the Australian Capital Territory

Author information; Arial 8pt (please overtype this)

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### Background/Aim

Walking is a significant physical activity and is known to be driven by aspects of the built environment. While many studies investigate relationships between the built environment and walking behaviours few are able to pin point hotspots of walkers and their correlates.

### Methods

We explored spatial patterns of walking and the built environment correlates of walking in the ACT. Specifically we explored Design, Density, Diversity, Distance to transit and Destinations (5 Ds) and their relation to the walking environment in Canberra. We investigated this relationship by examining the overlap of 'hotspots' of walking behaviours with hotspots of one built aspect each, from the domains of Design, Diversity, Density, Distance to transit and Destinations.

### Results

While three of the domains display overlapping clusters or hotspots in one area of the ACT- Civic, which forms the central business district of the ACT. We find no hotspots of Diversity and the hotspot of Design lies in a relatively newly built suburb. Results point toward probable utilitarian walking among people residing in the hotspots.

### Conclusions

Our results demonstrate the importance of the built environment in driving utilitarian walking behaviours, in addition to the salience of the location and age of the built environment in influencing these behaviours

## MC08: Built Environment & Transport

026, September 25, 2017, 14:00 - 15:30

### Maternal use of household pesticides during pregnancy and risk of childhood brain tumor and neuroblastoma in the offspring

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#### Background/Aim

Childhood brain tumor (CBT) and neuroblastoma (NB) are two of the most common solid tumors in childhood. Their etiologies remain still unknown, but the early age at onset suggests that events during the perinatal period or early childhood may have a role. Prenatal exposure to pesticides may be one such factor. The aim of this study was to explore whether there is an association between maternal use of household pesticides during pregnancy and the risk of NB or CBT in the child.

#### Methods

We conducted a pooled analysis of two French national population-based case-control studies based on the French Registry of Childhood Cancers. Cases and controls were aged under 15 years were frequency-matched by age and gender. Mothers answered a structured telephone interview. Unconditional logistic regression was used to estimate pooled odds ratios and 95% confidence intervals. As more than 90% of children with NB were diagnosed before six years of age, analyses for NB were restricted to this age group.

#### Results

After controlling for matching variables, source study and potential confounders, the maternal use of any type of pesticide during pregnancy was associated with both NB (OR 1.5 [95% CI 1.2-1.9]) (357 cases and 1,783 controls) and CBT (OR 1.4 [95% CI 1.2-1.8]) (437 cases and 3,102 controls). Few women used herbicides or fungicides alone during pregnancy and most of them also used insecticides. Results were robust to sensitivity analyses.

#### Conclusion

Although potential recall bias cannot be excluded, our findings support the hypothesis that residential maternal use of pesticides during pregnancy may increase the risk of NB or CBT.

## MC09: Child Health: pesticides and dioxins

020, September 25, 2017, 14:00 - 15:30

### Combined Exposures to Prenatal Pesticides and Folic Acid Intake in Relation to Autism Spectrum Disorder

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#### Background/Aim

Maternal folic acid (FA) protects against developmental toxicity from certain environmental chemicals. Our objective was to examine combined exposures to maternal FA and pesticides, in relation to autism spectrum disorder (ASD).

#### Methods

Participants were California children born 2000-2007, enrolled in the CHARGE case-control study at age 2-5 years, clinically confirmed to have ASD ( $n=296$ ) or typical development ( $n=220$ ) and had information on maternal supplemental FA and pesticide exposures. Maternal supplemental FA and household pesticide product use were retrospectively collected in telephone interviews from 2003-2011. Mothers' addresses were linked to a statewide database of commercial applications to estimate agricultural pesticide exposure.

#### Results

Above median FA intake ( $\geq 800\mu\text{g}$ ) during the first pregnancy month and no known pesticide exposure was the reference group for all analyses. Compared with this group, ASD was increased in association with  $<800\mu\text{g}$  FA and any indoor pesticide exposure (adjusted OR=2.5; 95% CI: 1.3, 4.7) compared to low FA (OR=1.2; 95% CI: 0.7, 2.2) or indoor pesticides (OR=1.7; 95% CI: 1.1, 2.8) alone. ORs for the combination of low FA and regular pregnancy exposure (6+ months) to pet pesticides or outdoor sprays and foggers were 3.9 (1.4, 11.5) and 4.1 (1.7, 10.1), respectively. ORs for low maternal FA and agricultural pesticide exposure 3 months before or after conception were: 2.2 (0.7, 6.5) for chlorpyrifos, 2.3 (0.98, 5.3) for organophosphates, 2.1 (0.9, 4.8) for pyrethroids, and 1.5 (0.5, 4.8) for carbamates. Except for carbamates, these ORs were about two times greater than those for either exposure alone, or for the expected multiplicative or additive combined ORs.

#### Conclusions

In this study population, associations between pesticide exposures and ASD were attenuated among those with high versus low FA intake during the first month of pregnancy. Confirmatory and mechanistic studies are needed.

## MC09: Child Health: pesticides and dioxins

020, September 25, 2017, 14:00 - 15:30

*In utero* pyrethroid pesticide exposure and risk of Autism Spectrum Disorders or other non-typical development at 3 years and child gene expression in the MARBLES longitudinal cohort

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**Background/Aim:** Little is known about the effects of pregnancy pyrethroid pesticide exposure on child development. We assessed the relation between pyrethroid pregnancy exposure and (1) autism spectrum disorders (ASD) or other non-typical development (ONT) at 3 years, (2) child gene expression in a subset.

**Methods:** Participants were mother-child pairs (n=177) in the MARBLES (Markers of Autism Risk in Babies-Learning Early Signs) cohort. Because family recurrence risks in siblings are about 20%, MARBLES enrolls pregnant women who already had a child with ASD. Children were clinically assessed at 3 years and classified into 3 diagnostic categories: ASD, ONT, or typically developing (TD). Repeated maternal second and third trimester urine samples were analyzed for pyrethroid metabolite 3-phenoxybenzoic acid (3-PBA). Based on number of urine samples per woman and the intraclass correlation, we calculated weights for use in regression models. Weighted multinomial logistic regression was used to obtain odds ratios (OR) for log-transformed pregnancy average 3-PBA concentrations relative to child's diagnosis. For a subsample (n=86) with genome-wide RNA sequencing from cord blood samples we used linear regression models to investigate the association of prenatal pyrethroids with expression of genes selected for relevance to neurodevelopment from the wnt signaling pathway (SFRP2, VANGL2) and PON1, overall and by diagnosis.

**Results:** Adjusting for specific gravity, education, race/ethnicity, season, and birth year, prenatal 3-PBA concentrations were weakly associated with higher risk of ASD (OR 1.4, 95% CI: 0.8 - 1.6) and lower risk of ONT (OR 0.7, 95% CI: 0.4 - 1.1) compared to TD children. In strata of child's diagnosis; 3-PBA pregnancy concentrations were significantly associated with lower PON1 expression for children diagnosed with ASD ( $\beta = -0.16$ ,  $p = 0.053$ ) and ONT ( $\beta = -0.09$ ,  $p = 0.049$ ) but not TD.

**Conclusions:** Future investigations are needed to understand the role of PON1 activity and its relationship with pyrethroid exposure on neurodevelopment.

## MC09: Child Health: pesticides and dioxins

020, September 25, 2017, 14:00 - 15:30

### Association between hair-concentrations of pesticides during pregnancy and birth weight: a multipollutant approach from the Elfe birth cohort

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#### Background/Aim

Pesticides are widely used in industrialized countries, exposing its general population to multiple residues of pesticides as shown by biomonitoring studies. A growing number of studies suggests that prenatal exposure to pesticides might impair the foetal development. Only few of them considered simultaneously several chemical families of pesticides. In order to better consider pesticides' mixture, we aimed to explore the influence of prenatal exposure to a large panel of pesticides (>20 chemical families) on birth weight.

#### Methods

The study population included 311 pregnant women from a French national birth cohort (Elfe). Lifestyle and medical information were collected based on self-reports and hospital data. Based on hair samples collected at delivery, we monitored 111 pesticides and 29 metabolites. Hair strands were 9cm length (IQR 8-9cm) to cover the whole pregnancy. Exposure variable were log-transformed if needed or categorised (<70% of detection). Using cross-validated Elastic-Net model (100 replications), we identified the best predictors among the pesticides/metabolites with  $n \geq 30$  detections and covariates. We then used multivariable linear regression to estimate the coefficients for the selected molecules.

#### Results

Median number of pesticides/metabolites detected per sample was 43 (IQR 38-47). Overall, 64 molecules were detected in  $\geq 30$  samples, including 28 in >70% of samples. The selected pesticides/metabolites associated to birth weight were bitertanol (Exposed vs. unexposed:  $\beta$  +98.4g; 95%CI: 3.7; 193.1); beta-endosulfan (third vs. first tertile:  $\beta$  -70.9g; 95%CI: -170.4, 28.7); imidacloprid (Exposed vs. unexposed:  $\beta$  -70.8g; 95%CI: -154.4, 12.7).

#### Conclusions

This study confirms the ubiquitous exposure to mixture of pesticides with  $\geq 25$  molecules in all pregnant women hair samples. Considering a mixture of 64 possible molecules with penalised regression model, birth weight appeared to be statistically significantly associated with prenatal exposure to one molecule, bitertanol (azole fungicide). This finding observed for the first time requires caution in interpretation.

## MC09: Child Health: pesticides and dioxins

020, September 25, 2017, 14:00 - 15:30

### Gene-Dioxin Interactions and Birthweight in the Seveso Second Generation Health Study

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#### Background/Aim

2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) is proposed to interfere with fetal growth via altered activity of the aryl hydrocarbon receptor (AhR) pathway which regulates diverse biological and developmental processes including xenobiotic metabolism. Genetic variation in the AhR pathway is an important driver of susceptibility to low birthweight in children exposed to prenatal smoking. Little is known about fetal susceptibility regarding gene-dioxin interactions.

#### Methods

The Seveso Women's Health Study (SWHS), initiated in 1996, is a cohort of 981 Italian women exposed to TCDD from an industrial explosion in July 1976. In 2014-2016, we enrolled post-accident offspring of the SWHS in the Seveso Second Generation Health Study. We genotyped 87 single nucleotide polymorphisms (SNPs) from 7 candidate genes in the AhR pathway in mothers (n=567) and their children (n=582). We measured TCDD concentrations in maternal serum. Birthweight was obtained from maternal report and confirmed with birth records in a subsample. We used multivariate regression to model the associations between individual SNPs and child birthweight.

#### Results

In preliminary analyses, we found 6 maternal and 17 child SNPs (together 21 different SNPs) across the aryl hydrocarbon receptor (AHR), aryl hydrocarbon receptor repressor (AHRR), AhR Nuclear Translocator (ARNT), and Cytochrome P450 1B1 (CYP1B1) genes to be significantly associated with birthweight. One SNP (AHR, rs2066853), a known functional missense mutation, was associated with the largest reduction in birthweight in models examining the mothers' genotypes (adj- $\beta$ =-161.0 grams, 95% CI: -259.7, -62.4). Significant interaction with maternal TCDD levels was observed with over 30 SNPs across 6 genes, including maternal and child genotypes of rs162562, a CYP1B1 variant associated with fetal development ( $p_{\text{int}} < 0.01$ ). We will present results from polygenic models as well as analyses jointly examining maternal and child genotypes.

#### Conclusions

This is the first study of how both maternal and child genetics shape fetal susceptibilities to dioxin exposure.

# MC10: Exposure Assessment Methods

022, September 25, 2017, 14:00 - 15:30

## Historical estimation of nitrogen dioxide exposures from a satellite-based land-use regression model for Australia

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### Background/Aim

Historical air pollution exposure assessment is important for investigating long-term health effects, but is often difficult due to sparse measurements. One option for estimating historical exposures is 'back-extrapolation' of land-use regression (LUR) model predictions. We assessed the ability of Australian national satellite-based LUR models for NO<sub>2</sub>, developed longitudinally for 2006-11, to capture concentrations during 1990-2005.

### Methods

We obtained data from all regulatory monitoring sites operating across Australia from 1990 through 2005 ( $n = 98$ ). We included data from sites with greater than 50% non-missing measurements in a year, provided at least one month was collected per season. Because historical LUR predictor data were unavailable, we applied three approaches to assess the validity of our model predictions from 2006: (1) 'do nothing'; (2) change the value of the 'year' predictor in our longitudinal models to match the year being predicted, and; (3) adjust 2006 predictions using the absolute difference and ratio of measurements in each year compared with those in 2006 at a subset of four sites. We used standard metrics to evaluate LUR model performance ( $R^2$ , MSE- $R^2$ , RMSE, bias).

### Results

The 'do nothing' approach captured 75% of spatial variability NO<sub>2</sub> averaged over 1990-2005, but prediction error and bias were higher than in our other analyses (2.4 ppb and -1.3 ppb, respectively) and absolute agreement was lower (MSE- $R^2 = 61\%$ ). The best performance was observed when we changed the year predictor, which had improved absolute agreement (MSE- $R^2 = 72\%$ ) and lower error and bias (2.1 ppb and -0.1 ppb, respectively).

### Conclusions

Despite the lack of historical predictor data, simple adjustments to our LUR models captured the majority of spatial variation in long-term NO<sub>2</sub> across Australia. Most (~75%) of the sites used for validation were also used to develop the LUR models, which should be considered when interpreting our results.

# MC10: Exposure Assessment Methods

022, September 25, 2017, 14:00 - 15:30

## Bayesian blending of nitrogen dioxide air pollution data for neighbourhood estimates for health research

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### Background/Aim

Exposure to nitrogen dioxide (NO<sub>2</sub>) pollution has been associated with a range of adverse health outcomes. Annual average pollutant concentrations are often used to estimate exposure, however, these estimates can be imprecise due to difficulty modelling spatial patterns at the resolution of neighbourhoods (e.g. a scale of tens of metres) rather than at a coarse scale (around several kilometres resolution). The objective of this study was to derive improved estimates of neighbourhood level pollutant concentrations for health studies by blending air pollutant measurements with modelled predictions using Bayesian analyses.

### Methods

We implemented the Bayesian Maximum Entropy (BME) approach to blend 'hard' data (considered precise) and probabilistic 'soft' data (with uncertainty defined using informative priors). We compiled and harmonised NO<sub>2</sub> data from fixed-site monitors, chemical transport models, and satellite-based land use regression models to estimate neighbourhood level annual average NO<sub>2</sub> concentrations in Sydney, Australia. The spatial model integrated the different underlying probabilities to produce a posterior probability density function of neighbourhood exposures. The mean of the posterior density was our estimate of NO<sub>2</sub> exposure.

### Results

Estimated annual average concentrations from the BME model ranged from 3 to 35 ppb. Validation using independent data from a separate set of samples (using passive sampling methods) showed improvement, with Root Mean Squared Error (RMSE) of 2.6 ppb compared with the land use regression (2.8 ppb) and chemical transport model (3.1 ppb).

### Conclusions

Our study implemented state-of-the-art methods for exposure assessment and demonstrated an improvement in validation test statistics. In future work we will explore the impact of these improvements on exposure misclassification bias when used in epidemiological analyses of the impact of air pollution on health.

## MC10: Exposure Assessment Methods

022, September 25, 2017, 14:00 - 15:30

### Deep Learning Architecture for Spatially and Temporally Resolved PM<sub>2.5</sub> Exposures in the Continental United States

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**Background.** Deep learning is a class of machine learning algorithms. Convolutional neural network, a deep learning algorithm, has brought about breakthroughs in processing image, speech, audio and text. Inside it, a convolutional layer takes information from nearby pixels to create high-level abstraction to improve model performance. This abstraction capacity is what traditional air pollution modelling lacks: traditional air pollution modelling uses variable values at monitor stations (in-situ information) to establish relationship and make prediction. However, neighbouring information (e.g., nearby traffic volume, neighbouring land-use type) also impacts local PM<sub>2.5</sub> measurements but is often ignored in previous modelling. Convolutional neural network can potentially take neighbouring information into account and improve model performance.

**Method.** We used a convolutional neural network with multiple predictors, including aerosol optical depth, chemical transport model outputs, land-use variables, meteorological variables, surface reflectance, absorbing aerosol index as predictors to model ground-level PM<sub>2.5</sub> from monitoring stations. For each variable, we extract its values at monitor stations as well as neighbouring locations as input information of the neural network. We incorporated multiple convolutional layers, pooling layers and full connection layers inside the neural network to model complex relationship between variables.

**Result.** Model performance on validation data set indicated a good performance with daily  $R^2 = 0.84$  and  $MSE = 2.94 \mu\text{g}/\text{m}^3$ . Model performance also exhibited regional variations with higher model performance in the Eastern and Central U.S. than the Western U.S. The Model still performed well at low PM<sub>2.5</sub> levels ( $<12 \mu\text{g}/\text{m}^3$ ). Prediction results indicated higher PM<sub>2.5</sub> concentrations in the Eastern and Central U.S. Summer time had higher PM<sub>2.5</sub> levels than other seasons.

**Conclusions.** This study explored a deep learning approach to model air pollutions with high accuracy, which facilitates follow-up epidemiological studies. This study suggests wider application of deep learning techniques in the field of environmental epidemiology.

## MC10: Exposure Assessment Methods

022, September 25, 2017, 14:00 - 15:30

### Land use regression models for BTEX volatile organic compounds in a Middle Eastern megacity: Tehran Study of Exposure Prediction for Environmental Health Research (Tehran SEPEHR)

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#### Background/Aim

Land use regression (LUR) models have not been applied, to date, to volatile organic compounds (VOCs) in highly polluted megacities. We aimed to develop LUR models for benzene, toluene, ethylbenzene, *p*-xylene, *m*-xylene, *o*-xylene (BTEX), and total BTEX in Tehran megacity, Iran.

#### Methods

We advanced LUR models for BTEX and total BTEX using measurement based estimates of annual means at 179 selected sites. In total, 520 potential predictors were used in the Tehran Study of Exposure Prediction for Environmental Health Research (Tehran SEPEHR). The annual high-resolution emission inventory of VOCs and meteorological estimates from the Weather Research and Forecasting (WRF) model (temperature, humidity, and wind speed) were also evaluated as predictors.

#### Results

The annual median (25<sup>th</sup>–75<sup>th</sup> percentile) for benzene, the most carcinogenic of the BTEX species, was 7.8 (6.3–9.9)  $\mu\text{g}/\text{m}^3$ . The final models with  $R^2$  values ranging from 0.64 for *p*-xylene to 0.70 for benzene were mainly driven by traffic-related variables but distance to sewage treatment plants was present in all models indicating a major local source of BTEX VOCs in the ambient air of megacities not used in any previous study. WRF-based variables and emission inventory did not explain long-term spatial variability of BTEX VOCs in Tehran. Overall, about 83% of Tehran's surface had predicted benzene concentrations above air quality standard of 5  $\mu\text{g}/\text{m}^3$  set by European Union with maximum values up to 29  $\mu\text{g}/\text{m}^3$ .

#### Conclusions

This is the largest LUR study to estimate fine-scale annual mean of all BTEX species in a megacity. These estimates could be used for health effects studies, urban planning, air quality management, and monitoring of evidence-based policy making.

## MC10: Exposure Assessment Methods

022, September 25, 2017, 14:00 - 15:30

### Physically-sound air pollution regression modelling with a heterogeneous wind field

Author information; Arial 8pt (please overtype this)

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#### Background/Aim

Detailed physical and chemical modelling of ambient pollutants transport is complex and requires extensive data and effort. Moreover, the output of such models often contain large errors. Alternatively, land use regression is often used but is limited as it lacks incorporation of the wind field – the single most influential parameter on pollutant dispersion. This work integrates a 1x1km data-driven meteorological model with a non-linear regression scheme and produces pollutant concentration maps at a high spatiotemporal resolution. We applied this model to estimate ambient NO<sub>x</sub> at the mountainous terrain of the Haifa Bay area, Israel.

#### Methods

This work enhances the previously developed Optimized Dispersion Model (ODM), replacing the euclidean distance between grid points with the newly formulated Shortest Wind-Path Distance (SWPD). We used Dijkstra's algorithm to determine the wind direction affected SWPD between each two grid points at each time-point. We use the calibrated model to estimate the relative influence of each sector (traffic, industry) on the observed NO<sub>x</sub> levels across the whole study area. Data on point source emissions was obtained from the Israeli Pollutant Release and Transfer Registry, while detailed traffic emissions proxies were obtained from aggregated vehicle-fleet GPS tracking.

#### Results

Complete leave-one-out cross-validation showed that the new model performs better than a previous ODM version and a benchmark geo-interpolation model. Model performance improved greatly for increasing time-averaging windows (i.e. the mean spatial Pearson correlation was 0.3 based on half-hourly measurements and 0.8 for the yearly mean). Traffic was shown to have the major contribution to observed ambient NO<sub>x</sub> in the study area, although industrial NO<sub>x</sub> emissions are much greater than traffic-induced emissions.

#### Conclusions

The new data-driven yet physically sound ODM air quality model enables much better exposure estimation for epidemiological research. Unlike other models, the new model can be applied in areas characterized by a heterogeneous wind field.

## MC10: Exposure Assessment Methods

022, September 25, 2017, 14:00 - 15:30

### Estimated effects of air pollution and space-time-activity on cardiopulmonary outcomes in healthy adults: a repeated-measures study

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#### Background/Aim

Air pollution exposure is known to affect health; however, short-term-effect findings have been inconsistent and often from isolated exposures among susceptible/unhealthy populations. We aimed to estimate separately the annual and daily effect of ambient air-pollution, as well as modification by space-time activity and confounding by other environmental exposures, on cardiopulmonary outcomes in healthy adults.

#### Methods

Cardiovascular health (blood pressure (BP)) and lung function (spirometry: forced-expiratory-volume-in-first-second {FEV<sub>1</sub>}; forced-vital-capacity {FVC}; sum-of-FEV<sub>1</sub>-and-FVC {SUM}) indicators were clinically-measured in participants (N=58: 54% female) on four mornings (>five days apart) from 2011–2014. Participant addresses (home, work) were spatially-attributed with air-pollution estimates (annual, daily) from ESCAPE-LUR models (except Ozone, attributed from closest station). Time-activity diaries indicated time spent at either address allowing daily-time-weighted estimation, and capturing metabolic-equivalent-of-task (MET) and environmental tobacco smoke (ETS) levels, in the three days preceding health measurements. Multivariate-adjusted linear mixed-effects models (single or multiple-pollutant, annual or daily-time-weighted, estimates) were adjusted for known/suspected environmental confounders (e.g. greenness, noise). All models controlled for age, height, sex, season.

#### Results

A 10 µg/m<sup>3</sup> increase in annual coarse-particulate-matter (PM<sub>10</sub>) concentration at the home address was significantly-associated with decreased lung function [FVC (β =-0.29 {95%CI: -0.49,-0.10}), SUM (-0.48 {-0.83,-0.12})]. Only the association with FVC remained robust when adjusting for annual Ozone, and for three-day-total MET, ETS and pollen. A 10 ppb increase in annual Ozone concentration was significantly-associated with an increased diastolic BP (β=6.29 {95%CI: 2.04,10.5}), which similarly remained robust when adjusting except for daytime weighted-average noise levels at the work address (0.29 {-11.5,12.1}). Substituting annual with daily-time-weighted estimates of air-pollution did not improve associations with any health outcomes.

#### Conclusions

Annual, rather than daily-time-weighted, levels of PM<sub>10</sub> and Ozone were significantly-associated with reduced lung function and elevated BP (respectively). This suggests that chronic rather than acute air-pollution exposure may be more relevant for healthy individuals when considering measurements in epidemiological/experimental studies.

# MC11: Cardiovascular effects of ambient fine & ultrafine particles

100, September 25, 2017, 14:00 - 15:30

## Air Purification and Vascular Health: A Randomized Crossover Trial in a Senior Living Facility

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**Background:** Although air pollution is known to adversely impact cardiovascular health, very few studies have investigated the effectiveness of interventions to mitigate these effects. In this study, we examined if indoor air filtration can improve the vascular health of seniors exposed to ambient air pollution.

**Methods:** We conducted a randomized crossover trial of 39 non-smoking adults ( $\geq 50$  years) in a Michigan independent senior living facility impacted by nearby roadways and industry. Subjects were randomized to one sham filtration period and one period of low- or high-efficiency filtration. Each intervention lasted 3 days separated by a one-week washout period. Each day, we measured brachial blood pressure on seated participants in a quiet room using an automated oscillometric monitor ( $>99\%$  data capture). We tested differences in systolic, diastolic, and pulse pressures between the intervention and sham periods using a mixed effects model adjusted for intervention order, time, and apparent temperature.

**Results:** Study participants were  $68 \pm 8$  years and 38% female. Without filtration, average systolic, diastolic, and pulse pressures were  $133 \pm 17$ ,  $82 \pm 11$ , and  $40 \pm 12$  mmHg, respectively. As compared to no filtration, the greatest reductions in blood pressure with low-efficiency filtration occurred on the third day with average declines of 4.7 (95% CI: -9.3, -0.2) and 2.5 (95% CI: -5.2, 0.1) mmHg in systolic and diastolic blood pressures, respectively. No differences were observed for pulse pressure. For high-efficiency filtration, the largest declines in blood pressure were observed on the first day of the intervention with 3.7 (95% CI: -8.5, 1.1) and 1.5 (95% CI: -4.4, 1.4) mmHg lower systolic and diastolic blood pressures, respectively, as compared to no filtration. Pulse pressure also declined under high-efficiency purification (-2.9, 95% CI: -5.9, 0.07) though this finding could not be distinguished from the null.

**Conclusions:** Air purification may be effective for reducing the adverse effects of air pollution on cardiovascular health.

# MC11: Cardiovascular effects of ambient fine & ultrafine particles

100, September 25, 2017, 14:00 - 15:30

Exposure to indoor PM<sub>2.5</sub> increases 24-hour blood pressure in adult urban population from Bucaramanga, Colombia.

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## Background/Aim

Fine particulate matter (PM<sub>2.5</sub>) is associated to high blood pressure (BP) and cardiovascular disease (CVD); however, most studies have used outdoor as proxy of indoor PM<sub>2.5</sub> and office-based or one-point BP measurements not reflecting physiological BP behaviour. We determined the relationship between indoor PM<sub>2.5</sub> and 24-hour ambulatory blood pressure (ABP).

## Methods

Cross-sectional study conducted in adults ( $\geq 40$  years, non-smokers, without CVD) from Bucaramanga, Colombia. We systematically sampled houses within a 1.5 km radius around two PM<sub>10/2.5</sub> area monitors of the local air quality network, searching for participants. Indoor PM<sub>2.5</sub> was measured in each participant's house with gravimetric sampling pumps (Casella Cel-TUFF; 3L/min flow) during 1-2 consecutive days ( $\geq 8$  hours/monitoring). Measurement of ABP (Spacelab, 90217A) was performed concurrently to indoor monitoring ( $\geq 60\%$  effective BP measurements were required for inclusion). We collected sociodemographic, anthropometric and physical activity data (GPAQ), and measured fasting blood glucose and lipids. Piecewise regression was used to evaluate the relationship between PM<sub>2.5</sub> and ABP adjusting for age, sex, adiposity, physical activity, outdoor PM<sub>2.5</sub>, and house-to-area monitor distance.

## Results

We evaluated 395 participants (mean age: 57.6 years; 23% men) and houses (mean indoor PM<sub>2.5</sub>: 23.7  $\mu\text{g}/\text{m}^3$  [SD=14.1  $\mu\text{g}/\text{m}^3$ ]). There were no univariate differences of age, sex, time at home, adiposity, physical activity, ABP or laboratory data by quintiles of indoor PM<sub>2.5</sub>; however, antihypertensive treatment was more prevalent at lower levels of PM<sub>2.5</sub>. In multivariable analysis, indoor PM<sub>2.5</sub> was positively associated with 24-hour mean systolic BP, but no other ABP indexes, after a threshold of 36.0  $\mu\text{g}/\text{m}^3$  in the whole sample (2.3 mmHg per 5  $\mu\text{g}/\text{m}^3$  [95%CI: 0.4, 4.1]) and in participants without antihypertensive treatment (2.7 mmHg per 5  $\mu\text{g}/\text{m}^3$  [95%CI: 0.7, 4.7]).

## Conclusions

Indoor PM<sub>2.5</sub> is non-linearly related to ambulatory BP in adults, regardless of antihypertensive treatment, with a threshold below Colombia's current normative outdoor PM<sub>2.5</sub> concentration.

# MC11: Cardiovascular effects of ambient fine & ultrafine particles

100, September 25, 2017, 14:00 - 15:30

## Long-term exposure to ultrafine particles and incidence of cardiovascular and cerebrovascular disease

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### Background/Aim

Multiple lines of research have indicated that exposure to ambient air pollution (mostly measured as particulate matter less than 2.5  $\mu\text{m}$  in size [ $\text{PM}_{2.5}$ ]) plays a significant role in morbidity and mortality. However, there is growing evidence that exposure to ultrafine particles (UFP – particles smaller than 100nm) may play an under-explored role in the aetiology of several illnesses, including cardiovascular disease.

### Methods

We studied the association between long-term exposure to UFP (predicted via land use regression) and incident cardiovascular disease using Cox proportional hazard models in a longitudinal study of 40,011 Dutch residents. Hazard ratios (HR) for UFP were compared to HRs for more routinely monitored air pollutants including  $\text{PM}_{10}$ ,  $\text{PM}_{2.5}$  and  $\text{NO}_2$ .

### Results

Long-term UFP exposure was associated with an increased risk for all incident cardiovascular disease (HR: 1.18 per 10,000 particles/ $\text{cm}^3$ , 95% CI: 1.03:1.34), myocardial infarction (HR: 1.34, 95% CI: 1.00:1.79), and heart failure (HR: 1.76, 95% CI 1.17:2.66). Similar findings were observed for  $\text{NO}_2$  and coarse PM (PM between 10 and 2.5  $\mu\text{m}$ ) but not for  $\text{PM}_{2.5}$ . Elevated (albeit non-statistically significant) HRs for UFP exposure were also observed for cerebrovascular diseases. Two-pollutant models (UFP +  $\text{NO}_2$  and UFP +  $\text{PM}_{\text{coarse}}$ ) identified that the elevated risk estimate remained for UFP, while results for  $\text{PM}_{\text{coarse}}$  and  $\text{NO}_2$  typically attenuated towards the null.

### Conclusions

These findings strengthen the evidence that UFP exposure plays an important role in cardiovascular health and that risks of ambient air pollution may have been underestimated based on conventional air pollution metrics such as  $\text{PM}_{2.5}$ .

# MC11: Cardiovascular effects of ambient fine & ultrafine particles

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## Cause-specific Risk and Medical Cost Associated with Acute Exposure to PM<sub>2.5</sub> among Older Adults

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### Background/Aim

There is insufficient evidence on what causes of admissions are associated with PM<sub>2.5</sub> and how much medical cost could have been saved for a reduction in PM<sub>2.5</sub>.

### Methods

Using hospital admission records among all Medicare beneficiaries during 2000-2012 residing in the continental US, we conducted an outcome-wide analysis searching causes of hospital admissions associated with acute exposure to PM<sub>2.5</sub> and estimating the associated Medicare cost. The exposure was lag 0-1 moving average PM<sub>2.5</sub> predicted using a novel hybrid model at the residing zip code of each beneficiary. We grouped the principal discharge ICD-9 code to 283 categories using a validated approach, and studied each category separately using a case-crossover design by matching each admission with controls by month, year, zip code, and day of the week. Temperature and day of the year were further adjusted for in conditional logistic regressions. The confidence intervals were adjusted using Bonferroni correction.

### Results

Acute exposure to PM<sub>2.5</sub> was associated with hospital admissions of infectious disease including septicaemia, metabolic disorders including diabetes, diseases of nervous system including Parkinson's disease, circulatory diseases including acute myocardial infarction and congestive heart failure, respiratory diseases including pneumonia and COPD, diseases of digestive system, and diseases of urinary system. Each 10 µg m<sup>-3</sup> reduction in PM<sub>2.5</sub> was associated with a saving of 0.7 billion USD (2012) of Medicare cost per year, with the top five reductions: septicaemia 1.7% (1.2-2.1%) in rate of admissions with 75 million in cost, congestive heart failure 1.3% (1.0-1.6%) with 61 million, pneumonia 1.3% (1.0-1.7%) with 54 million, acute and unspecified renal failure 3.4% (2.8-4.0%) with 47 million, and acute myocardial infarction 1.0% (0.5-1.4%) with 42 million.

### Conclusions

Acute exposure to PM<sub>2.5</sub> is associated with a range of causes of hospital admissions. Medicare cost could have been saved substantially, had PM<sub>2.5</sub> concentration been lowered.

# MC11: Cardiovascular effects of ambient fine & ultrafine particles

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Traffic related UFP and cardiovascular findings from the CAFEH study in Boston USA

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**Background/Aim:** We investigated exposures to near highway ultrafine particle concentration (UFP) and cardiovascular health effects in 3 near-highway neighborhoods with diverse populations.

**Methods:** We measured particle number concentration (PNC, UFP >4nm) by mobile monitoring in three pairs of neighborhoods near highways and >1km. Participants from each study area had blood biomarkers (hsCRP, IL-6, TNFR11 and fibrinogen) and blood pressure (BP) measured. Regression models of PNC included wind speed/direction, temperature, traffic volume, and distance from highway as predictors. We estimated PNC at residences hourly for a year at 20-meter resolution. PNC was adjusted for time-activity to derive an annual average (TAA-PNC). Multivariable regression modelling assessed associations of TAA-PNC with biomarkers (N=408), cardiovascular outcomes (N=703), and BP (N=409). We also tested short-term associations of biomarkers with central-site PNC (N=142). Plasma from non-smoking participants (N=59) were analyzed using high-resolution mass spectrometry to quantify levels of central metabolic intermediates, followed by a metabolome-wide association study (MWAS).

**Results:** TAA-PNC was associated with positive differences of 14.0% (95% CI: -4.6%, 36.2%) for hsCRP, 8.9% (95% CI: -0.4%, 10.9%) for IL-6, and 5.1% (95% CI: -0.4%, 10.9%) for TNFR11. There were non-significant associations of TAA-PNC with Stroke/IHD and hypertension but not with BP overall. Non-Hispanic whites had larger significant associations with inflammation biomarkers and BP, while Asians had smaller and not significant associations. Central site PNC was associated with biomarkers at 7 - 28 days. Comparison of quantified metabolites identified five differentially-expressed metabolites consistent with increased oxidative stress and endothelial dysfunction. MWAS identified metabolites related to lipid peroxidation, endogenous inhibitors of nitric oxide, and environmental chemicals arising from exhaust emissions. Network correlation analysis suggested involvement of metabolic pathways related to inflammation, oxidative stress, endothelial function and mitochondrial bioenergetics.

**Conclusions:** Our findings suggest cardiovascular effects of both short-term and chronic exposure to UFP of traffic origin.

## MC12: Health impacts on chronic diseases

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### Elevated level of exhaled carbon monoxide is associated with higher risk of cardiovascular disease and diabetes: a cross-sectional study of 286,256 never-smokers

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#### Background/Aim

Assessment of household air pollution (HAP) exposure relies largely on self-reported data on fuel use behaviour, and could be prone to misclassification. Exhaled carbon monoxide (COex) has been increasingly used as a biomarker of HAP. We investigated the cross-sectional association between COex levels and prevalent disease in the China Kadoorie Biobank (CKB).

#### Methods

Data from 286,256 never-smokers without a history of respiratory diseases (91% female) in the CKB were analysed. At baseline (2004-2008), participants received a physical examination, including the measurement of COex, blood pressure (BP), and random blood glucose (RBG), and a questionnaire on lifestyle and medical history. We defined cardiovascular disease (CVD) as self-reported physician-diagnosis of stroke, transient ischaemic attack or coronary heart disease; hypertension as self-reported physician-diagnosis with ongoing treatment or screen-detected hypertension based on measured BP; and diabetes as self-reported or screen-detected diabetes based on measured RBG. Odds ratios for COex with these health outcomes were estimated using logistic regression after adjustment for important confounders.

#### Results

Each 10 ppm higher COex level was associated with 2% (95% confidence interval: -1 - 6%), 11% (9 - 13%) and 9% (6 - 12%) higher odds of CVD, hypertension and diabetes, respectively. The associations of COex with hypertension were stronger in rural than in urban areas, with the converse for diabetes, and consistent findings across for CVD. There was no evidence of heterogeneity by education or income levels except for hypertension, where weaker associations were observed in higher income or more educated groups.

#### Conclusions

In a large population of never-smokers, levels of COex are positively associated with the prevalence of CVD, hypertension and diabetes. Prospective evidence is required to confirm or refute these associations.

## MC12: Health impacts on chronic diseases

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### Temporal variability of PM<sub>10</sub> risks in Seoul, Korea

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#### Background/Aim

Previous studies have questioned the variability of relative risk in PM<sub>10</sub> over time. Recently, in Seoul, Korea, there have been many changes in the political aspects and the population's perception on PM<sub>10</sub>. A new standard for PM<sub>2.5</sub> was established in 2011, and popularization of the prediction & warning system encouraged people to take cautionary measures such as wearing protective masks. In light of these changes, we hypothesized that PM<sub>10</sub> risks will be reduced over time.

#### Methods

Generalized linear models were applied to estimate the temporal trend of PM<sub>10</sub> risks on all-cause, cardiovascular, and respiratory mortality in Seoul, Korea for 2001-2015. Moving averages of 5 year windows were used to estimate temporal variations between PM<sub>10</sub> and mortality. We explored the variation with different lag periods: lag0, lag1, lag2, moving average of the same day to the previous day (lag01) and moving average of the same day to the previous 2 days (lag02).

#### Results

Increasing temporal trend of PM<sub>10</sub> risk were found in all-cause mortality for 2001-2009. However, after that, there was a distinct decreasing temporal trend upto 2015. Excess relative risk by 10ug/m<sup>3</sup> increase in PM<sub>10</sub> at lag02 for 2001-2005, 2005-2009, and 2011-2015 was 0.24% (95% confidence interval (CI): 0.00, 0.47), 0.36% (95% CI: 0.09, 0.63), and -0.08% (95% CI: -0.38, 0.23), respectively. The temporal variation of risk in cardiovascular and respiratory mortality showed similar trends with all-cause mortality.

#### Conclusions

We found a recent decreasing temporal trend of PM<sub>10</sub> risks. Possible explanations for this trend could be both population adaptation and strengthened air pollution policies.

## MC12: Health impacts on chronic diseases

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### The effects of climate and altitude variability on tuberculosis transmission: a systematic review

Author information: Arial 8pt (please overtype this)

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**Background/Aim:** In 2015, a total of 10.4 million tuberculosis (TB) cases and 1.4 million associated deaths have been estimated to have occurred. Studies have suggested that changing climatic factors and altitude determine the geographical limits of TB. We undertook a systematic review of evidence for an association between meteorological factors and the risk of morbidity, drug-resistant (DR-TB) and death due to TB.

**Methods:** A systematic review of the literature on the effect of climate and altitude on TB was performed using MOOSE guidelines. Electronic searches were undertaken from PubMed, EMBASE and Scopus. A quality score using the Newcastle-Ottawa scale for cross-sectional studies was attributed to assessing the strength of evidence on the association between climate and altitude and TB. A meta-analysis was performed on the association between altitude and TB morbidity.

**Results:** We identified 17 studies, including two articles on DR-TB, one article on death due to TB and 14 articles on TB morbidity. These studies found changing climate and altitude were positively and/or negatively associated with the occurrence of TB morbidity, DR-TB and death.

**Conclusions:** This review provides evidence for an association between TB morbidity and altitude and/or climate factors. TB control programs need to consider these factors in their strategies. However, there is limited evidence for the association between these factors and DR-TB and death from TB. More research is needed to estimate the contribution of these factors on TB infection, morbidity, drug-resistant and death and inform TB control strategies.

## MC12: Health impacts on chronic diseases

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### Mortality risks from a spectrum of causes associated with wide-ranging exposure to fine particulate matter: A case-crossover study in Beijing, China

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**Background/Aim** Exposure to fine particulate matter (<2.5 microns in aerodynamic diameter; PM<sub>2.5</sub>) has been shown to be associated with an increased risk of mortality due to cardiovascular, respiratory, and other pulmonary diseases. However, fewer studies have investigated the relationship between ambient PM<sub>2.5</sub> and human mortality for a wider range of causes of death, or for more specific causes of death within these broader categories, especially at the high PM<sub>2.5</sub> concentrations currently experienced in Chinese megacities. Beijing, China, has a very large population and a wide range of PM<sub>2.5</sub> exposures, allowing a prime opportunity to estimate such risks across a broad spectrum of causes, including rarer causes of death. To estimate the relative risk of cause-specific mortality associated with PM<sub>2.5</sub> for a spectrum of causes of death, as well as characterize the time course of cause-specific mortality following PM<sub>2.5</sub> exposure, in a location where PM<sub>2.5</sub> concentrations are representative of common exposures in Chinese megacities.

**Methods** We collected daily data on mortality counts of Beijing residents and Beijing weather and air pollution measurements for January 1, 2009 to December 31, 2012. We used a time-stratified case-crossover study design to estimate the association between ambient PM<sub>2.5</sub> concentrations and risk of death from several broad causes of death and from more refined specific causes within these broader categories. Primary results were estimated for risks the day of and the day following exposure (lag 0-1), but the time pattern of associated risk was also explored up to seven days following exposure.

**Results** Increased concentrations of PM<sub>2.5</sub> were associated with increased risks at lag days 0–1 of all-cause mortality (0.26% increase per 10 µg/m<sup>3</sup>; 95% confidence interval [CI]: 0.12%–0.39%), non-accidental deaths (0.25%; 95% CI: 0.11%–0.38%), circulatory deaths (0.39%; 95% CI: 0.21%–0.59%), respiratory deaths (0.43%; 95% CI: 0.05%–0.81%), intentional self-harm deaths (1.94%; 95% CI: 0.19%–3.73%) and nervous deaths (0.9%; 95% CI: -0.2%–2%), although the observed increase was not statistically significant for the final one rarer cause of death. In addition to these five broad death outcomes, risk also increased following PM<sub>2.5</sub> exposure at lag days 0–1 for deaths from several specific causes, including most of the specific circulatory causes considered. The largest observed increased risk by far was for one of the rarest causes of death considered, extrapyramidal and movement disorders (2.35%; 95% CI: 0.03%–4.72%).

**Conclusions** This study indicates that exposure to PM<sub>2.5</sub> in a study location more representative of exposures in developing cities is associated with an increased risk of mortality from broad range of causes of death, including some causes rarely studied previously in association with PM<sub>2.5</sub> exposure.

## MC12: Health impacts on chronic diseases

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Particulate matter related disease burden – a plethora of estimates – which ones to accept and which ones to trust?

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### Background/Aim

Environmental burden of disease estimates are increasingly used to inform society and politics about harmful effects arising from ambient particulate matter (PM<sub>2.5</sub>) pollution. Institutes and international bodies, such as WHO, EEA and IHME, provide estimates on the number of premature deaths and years of life lost, related to air pollution, which are not in agreement. Using estimates for Germany, the aim of the study was to systematically assess the differences in model assumptions leading to diverging estimates.

### Methods

Necessary information was extracted from publications and methodological appendices. The assumptions were systematically compiled and evaluated. As reference years for the estimates were not matching, we selected estimates from 2010-2015. The evaluation focused on exposure estimates, health data, exposure-response-functions and the theoretical minimum risk exposure level (TMREL).

### Results

Comparisons for Germany indicate considerable differences in the number of premature deaths attributable to air pollution. For 2012, WHO and EEA report 26,160 and 59,500 deaths, respectively. IHME's estimates for 2010 and 2015 are in between those with 40,993 and 43,117 deaths, respectively. The most salient difference is the choice of TMREL. EEA estimates are based on a counterfactual level of 0µg/m<sup>3</sup>, assuming no safe level for PM<sub>2.5</sub>-exposure, and thus are considerably higher than the other estimates, that use a uniform distribution for the TMREL (WHO: 5.9-8.7µg/m<sup>3</sup>; IHME: 2.4-5.9µg/m<sup>3</sup>).

### Conclusions

Policy makers often do not have the time and expertise to consider full details of methodologies used for estimating disease burdens. IHME's estimates provide a high level of transparency, as they follow the GATHER guidelines. The estimates from the WHO and EEA do not provide a comparable level of transparency and EEA does not even provide uncertainty intervals around their estimates. However, a formal validation of environmental burden of disease estimates is not possible, because e.g. death statistics cannot capture a person's risk-profile.

## MC12: Health impacts on chronic diseases

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Association between particulate matter air and the rheumatic diseases among adult

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### Background/Aim

Environmental factors may play a role in the development of rheumatic diseases, and some studies have shown that air pollution is associated with the development of autoimmune disease. The study was designed to investigate if particulate matter (PM10) affects development of adult rheumatic diseases including rheumatoid arthritis, ankylosing spondylitis, and systemic lupus erythematosus by using the Kriging data of PM10.

### Methods

A case-control cohort study was performed using the cohort database during 2010-2013 provided by National Health Insurance Service-National Sample Cohort in Korea. Data of kriging model were collected from the national air pollution monitoring data including PM10. We identified individuals with and without rheumatic diseases during 2013. A total number of 261 cases with rheumatic diseases and 2,871 controls without rheumatic diseases were matched by sex, age group, residential address, income level. Three year average concentrations of PM10 were predicted at each patient's residence starting from the date of first diagnosis of rheumatic diseases.

### Results

The arithmetic mean of PM10 was 47.89  $\mu\text{g}/\text{m}^3$  in case group and 48.86  $\mu\text{g}/\text{m}^3$  in control group. The binary logistic regression analysis, which is adjusted for insurance type showed positive association between PM10 exposure and the occurrence of rheumatic diseases at the age group of 20-44. (OR=1.04, 95% CI: 1.02-1.07) In the sex stratified adjusted model, only male had statistically significant relationship. (OR=1.07, 95% CI: 1.03-1.11)

### Conclusions

In conclusion, 3 years long-term exposure to PM10 in male showed significantly increased occurrence of rheumatic diseases. Male adult should be aware of PM10 exposure to prevent adverse effect of rheumatic diseases.

## MC13: Other Methodologic advances

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### Understanding the Replication Crisis and Its Implications for Environmental Epidemiology

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#### Background/Aim

In a recent years, investigators in variety of fields have reported that most published findings could not be replicated. Although publication bias and other types of selective reporting may contribute substantially to irreproducible results, statisticians have argued that underpowered statistical analyses also play a major role and that poor replicability may be common to all fields of study. This claim is easy to understand using familiar principles of diagnostic testing.

#### Methods

Consider any epidemiological association analysis as a type of diagnostic test, with statistical significance as a "positive" test result, lack of statistical significance as a "negative" test result, and the prevalence as the proportion of investigated disease associations that are true disease associations. In this context the statistical power of an association analysis is its sensitivity, and the confidence level is its specificity. The positive predictive value has a well-known mathematical relationship to the sensitivity, specificity, and prevalence, from which it is evident that either low statistical power or low prevalence of true disease associations will result in poor reliability of a statistically significant finding for predicting a true disease association.

#### Results

Though well intentioned, recent trends in environmental epidemiology will likely decrease replicability. Stratifying by sex or other factors increases the total number of investigated associations, likely decreasing the proportion of investigated associations that are true associations. Investigation of exposure mixtures and the emergence of "big data" pose similar risks. Many of these analyses are being conducted without power calculations, likely with poor sensitivity and low positive predictive values for reported associations. Researchers can counter these risks by ensuring that each analysis is well powered, by strictly controlling type I error, and by focusing on scientifically justified hypotheses.

#### Conclusions

Epidemiology is not immune to the replication crisis, but researchers can take concrete steps to address the problem.

## MC13: Other Methodologic advances

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### Data-based Structure Learning to Identify Confounders – air pollution and progression of subclinical atherosclerosis

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#### Background/Aim

Identifying confounders based on causal directed acyclic graphs (DAGs) is usually based solely on expert knowledge, although epidemiological studies provide observational data. We applied data-based structure learning algorithms for the specific purpose of identifying confounders, investigating the research question whether particulate matter with an aerodynamic diameter  $\leq 2.5 \mu\text{g}/\text{m}^3$  (PM<sub>2.5</sub>) affects progression of atherosclerosis, measured as yearly change in carotid intima media thickness ( $\Delta\text{cIMT}$ ).

#### Methods

We used 5-year follow-up data of the population-based Heinz Nixdorf Recall Study. Due to computational limitations, potentially relevant variables were restricted to continuously measured data and hence included age, BMI, smoking, blood pressure, HbA1c, LDL/HDL, education, income, neighborhood unemployment (nSES) rate, physical activity and alcohol consumption. Prior knowledge was based on causal chain assumptions regarding major causes of ischaemic heart disease<sup>1</sup>, and translated to prohibited arcs, i.e. given conditions (e.g. age) are unaffected by lifestyle variables (e.g. smoking) and lifestyle variables are unaffected by subclinical medical determinants (e.g. laboratory measures). We applied a *revised structure learning* algorithm to learn a causal DAG, including the score-based hill-climbing algorithm, a bootstrap-check to validate the conditional independence structure between variables, and a clustering of minimal sufficient adjustment set (MSAS)-equivalent subsets within the Markov equivalence-class.

#### Results

Based on 2279 participants, the revised structure learning resulted in one MSAS-equivalent cluster, including one DAG of 59 unambiguous arcs. The only biasing path from PM<sub>2.5</sub> to  $\Delta\text{cIMT}$  emanated from nSES. Suggested adjustment consisted of four confounder-equivalent MSAS ({nSES}; {age, physical activity, blood pressure}; {age, alcohol consumption, BMI, physical activity, smoking}; {age, BMI, education, income, physical activity, smoking}), yielding an identical exposure effect estimate of 0.002 mm (95%-CI: -0.002, 0.007) increase in cIMT per year per 5  $\mu\text{g}/\text{m}^3$  increase in PM<sub>2.5</sub>.

#### Conclusions

Data-based structure learning returned one unambiguous DAG widely matching general beliefs. Identical exposure effect estimates of confounder-equivalent MSAS underline a stable (causal) structure.

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## MC13: Other Methodologic advances

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### Inference with Cumulative Relative Risk in Environmental Epidemiology: Part III. Inference from lag variables

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#### Background/Aim

A distributed lag model (DLM) including a single lag variable has been widely used in air pollution and temperature studies. Researchers have questioned which is the unbiased model among the variety of candidate models. Causal inference from a lag variable (e.g. lag1) may be doubtful if it is not consistent with a lag time implied in toxicological studies. Based upon reasoning in Part I and Part II, we aimed to prove that a coefficient of interest including a single and a sum (i.e. cumulative) of coefficients should be treated as a lower bound of a true (cumulative) coefficient.

#### Methods

We simulated 5,000 runs of estimation of PM risk on all-cause mortality based upon real data. PM effect scenarios include 1) an effect on the same day, 2) effects upto the previous 2 days, 3) effects with exponential decay over time, 4) full harvesting, 5) limited harvesting with effects in longer lags. We compared candidate models in terms of bias, mean squared error (MSE), nominal coverage and probability of model selection by information criteria.

#### Results

DLM with sufficient lags provided unbiased estimates while MSE tended to be compromised. In this regard, information criteria performed poorly in selecting an unbiased model. In a harvesting scenario, models with limited lags were bound to away-from-the null bias. DLM with sufficient lags only for harvesting yielded an estimate smaller than or equal to a true effect. We call these types of bias as insufficient lag bias.

#### Conclusions

Inference based upon a face value of a lag variable should be disregarded if population dynamics cannot be ruled out. A coefficient/sum of coefficients of interest should be interpreted as a lower bound of a true cumulative coefficient. In epidemiologic studies, prior knowledge is crucial in order to reach an unbiased estimate.

## MC13: Other Methodologic advances

105, September 25, 2017, 14:00 - 15:30

### Methodological issues in studies of prenatal exposure to mixtures of endocrine disrupting chemicals: a systematic review

**Nina Lazarevic\***, School of Public Health, University of Queensland, Brisbane, Queensland, Australia

Adrian G. Barnett, School of Public Health and Social Work, Queensland University of Technology, Brisbane, Queensland, Australia

Peter D. Sly, Child Health Research Centre, University of Queensland, Brisbane, Queensland, Australia

Luke D. Knibbs, School of Public Health, University of Queensland, Brisbane, Queensland, Australia

#### Background/Aim

Prenatal exposures to endocrine disrupting chemicals (EDCs) during critical developmental windows have been implicated in the etiologies of a wide array of adverse perinatal and paediatric outcomes. Epidemiological studies have predominantly concentrated on the health effects of individual chemicals, despite the understanding that EDCs may act together via common mechanisms, that pregnant women are exposed to multiple EDCs simultaneously, and substantial toxicological evidence of adverse developmental effects following exposure to EDC-mixtures. There is a move towards multipollutant models in environmental epidemiology, however there is currently no consensus on the appropriate statistical methods. The need for context-specific guidance was recently expressed (NIEHS 2015) and EDCs possess several distinctive characteristics that affect method choice, e.g. nonmonotonicity in exposure-response relationships. We aimed to systematically review the statistical methods used in studies of prenatal exposure to EDC-mixtures, and determine their capabilities and limitations for addressing the challenges involved in these studies.

#### Methods

We searched Embase, Medline and Web of Science for studies of prenatal exposure to more than one EDC and perinatal/paediatric outcomes, and identified additional applicable methods from the related literature.

#### Results

We identified 75 studies and analysed the strategies for: estimating cumulative health effects, identifying important mixture components, accounting for nonlinearity and interactions, and assessing gestational windows of exposure susceptibility. We identified methods that were robust to collinearity, could account for measurement error, or could model nonlinearity and interactions in higher dimensional datasets. Frequentist and Bayesian methods were included, performing shrinkage, variable selection, dimension reduction, statistical learning, or smoothing.

#### Conclusions

There is compelling motivation for analysing EDCs as mixtures, yet many studies make simplifying assumptions about EDC additivity, relative potency, and linearity, or overlook the potential for bias due to differences in chemical persistence. We examined the impacts of these choices and suggest preferred methods for modelling prenatal exposures to EDC-mixtures.

#### References

NIEHS (National Institute of Environmental Health Sciences). 2015. Statistical approaches for assessing health effects of environmental chemical mixtures in epidemiology studies [Workshop], 13–14 July 2015, Research Triangle Park, North Carolina, USA. <http://www.niehs.nih.gov/about/events/pastmtg/2015/statistical/> [accessed 5 April 2017].

## MC13: Other Methodologic advances

105, September 25, 2017, 14:00 - 15:30

### Estimating the Effect of Exposure on Rate of Change in Environmental Epidemiology

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Lianne Sheppard\*, School of Public Health, University of Washington, Seattle, USA

#### Background

Mixed models for longitudinal analysis have several well-established benefits, including gaining information from unbalanced data and depending on less restrictive assumptions about missing data than other methods such as marginal models. While there are multiple longitudinal analysis methods to estimate the effect of exposure on an outcome's rate of change, in many applications a linear mixed model with a model for the baseline outcome, the modeled baseline mixed model, may provide the best rate of change estimates. This model also gives two distinct exposure effect estimates: the cross-sectional effect at baseline and the longitudinal effect of interest.

#### Methods

We conduct simulations to quantify characteristics of longitudinal exposure effect estimates from the modeled baseline mixed model and competing models for rate of change analysis: the measured baseline mixed model, and scaled change outcome. We also compare the longitudinal and cross-sectional effect estimates from the modeled baseline mixed model. We apply our insights to a real world application.

#### Results

When the outcome is measured with error, we show the modeled baseline mixed model avoids the bias produced by controlling for the outcome measurement at baseline in the measured baseline mixed model. Exposure effect estimates for rate of change from the modeled baseline mixed model are generally more precise than from the scaled change model. The two exposure estimates behave differently in the modeled baseline model. Factors important to the baseline measurements dominate the cross-sectional exposure effect estimate, while temporal exposure variation and other characteristics of the follow-up data more strongly influence the longitudinal effect estimate. Model parameterization can induce a correlation between these effect estimates.

#### Conclusions

Our work provides strong support for the use of the modeled baseline mixed model in environmental epidemiology and more broadly in many non-randomized longitudinal study contexts.

# SYM02: Symposium Pathways linking green-space exposure to health

101, September 25, 2017, 14:00 - 15:30

## Projecting future temperature-related transmission of paediatric hand, foot, and mouth disease in China under climate change scenarios

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**\*Yuming Guo, Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia**

### Background/Aim

Hand, foot, and mouth disease (HFMD) is the primary infectious disease of children in mainland China. But limited evidence is available about the associations between ambient temperature and HFMD. Here, we examined the temperature-HFMD associations across China, and projected the future temperature-related HFMD distribution by 2090s.

### Methods

Daily city-level childhood HFMD cases (0-14 years old) were collected from mainland China during 2008-2014. A Poisson regression with distributed lag non-linear model to assess the city-specific temperature-HFMD associations. Then random effect meta-analysis was used to pool the estimates in each province/municipality. Daily mean temperature by 2090s was simulated using 28 global climate models under the Representative Concentration Pathways (RCP) 4.5 and 8.5 scenarios. Finally, the city-specific change of HFMD cases by 2090s, compared with the 2008-2014 baseline, was evaluated by combining the fitted temperature-HFMD associations and projected future temperatures.

### Results

We observed 2 different temperature-HFMD relations in China: risk of HFMD reached the highest during hottest days in northern and western China but it peaked in a moderate temperature in southern and eastern regions. By 2090s, temperature-related HFMD cases are expected to rise in the northeast, Tibet plateau, Inner Mongolia Region, north, and northwest of China. But the HFMD epidemics are projected to keep steady in the south and decrease in the central region and east. The highest increases will be in cities with the lowest mean temperature while the morbidity will reduce in cities with moderate-but-not-highest temperature. The geographical difference will be more significant under RCP 8.5 scenario than RCP 4.5.

### Conclusions

The temperature-HFMD associations vary across mainland China, with 2 basic types observed. The temperature increase is expected to result in different epidemic patterns of HFMD by 2090s, and regions with low temperature will be more vulnerable while those with moderate temperature will benefit from global warming.

## **SYM02: Symposium Pathways linking green-space exposure to health**

**101, September 25, 2017, 14:00 - 15:30**

Overview of the pathways linking greenspace and health:  
how strong is the evidence?

**Iana Markevych\*, Institute for Occupational, Social, and Environmental Medicine, Ludwig-Maximilians-University of Munich; Institute of Epidemiology I, Helmholtz Zentrum München - German Research Center for Environmental Health, Munich/Neuherberg, Germany**

**Background/Aim.** Despite the recent boom in greenspace research and reported multiple health benefits of greenspace exposure, biological pathways behind such associations remain unclear. This presentation will summarize: (1) novel approach to organize hypothesized pathways linking greenspace and beneficial health outcomes and (2) strength of the existing evidence on specific pathways as well as (3) “side effects” of greening the cities.

**Methods.** This presentation is based on the discussions within a multidisciplinary expert workshop and narrative literature review.

**Results.** Potential pathways linking greenspace to beneficial health outcomes could be organized into three domains, which emphasize three general functions of greenspace: reducing harm (e.g. reducing exposures to air pollution, noise and heat), restoring abilities (e.g. attention restoration and stress reduction), and building capacities (e.g. encouraging physical activity and facilitating social cohesion). Only few studies so far explored pathways by mediation analyses. The most studied pathway is encouraging physical activity, which revealed mixed findings. No study tested the role of noise and heat reduction. Among notable adverse effects of urban greening are: spread of allergenic pollen and infectious diseases, increased potential for crime and gentrification, and physical damage to infrastructures.

**Conclusions.** Future studies in the field should go beyond descriptive analyses and investigate role of potential underlying pathways by mediation analyses. Such research is warranted to build solid evidence base for city planning and public health interventions.

# SYM02: Symposium Pathways linking green-space exposure to health

101, September 25, 2017, 14:00 - 15:30

Measuring policy-relevant (or amenable) exposures for a more consequentialist environmental epidemiology: a critique and some potential avenues for future studies of green space and health

**A/Prof Thomas Astell-Burt** \* 1,2,3  
Dr Xiaoqi Feng 1,2,3

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**Background/Aim:** Interest in the potential health benefits of green space, including parks and tree canopy, is growing among policymaking communities. Many studies seem to conclude that more green space is good for health. But is this broad statement sufficient to translate findings and affect the type of changes that can advance population health equity? Or is detailed research required on what types of green space exposures matter when, where and for whom?

**Method:** The content of this presentation is based upon experiences of communicating studies on green space and health to a range of social and environmental scientists, green space policymakers, planners and practitioners in Australia. Several of the ideas proposed were raised and discussed at a COST-sponsored workshop for international experts in green space and health, organised by Ludwig-Maximilians-Universität München in September 2016.

**Results:** There are many examples around the world in which urban greening initiatives and advocacy have/are taking place. Some initiatives cite evidence of direct and indirect benefits for health as an important rationale. These have occurred without detailed (and arguably more rigorous) evidence being available on what types of green spaces matter when, where and for whom. Policy makers and planners are now, however, asking for this more detailed evidence, especially within the context of urban densification and ageing populations. Large-scale studies are mostly absent, especially those of longitudinal design, with prior work having relied mainly upon quantity-focussed exposures (e.g., normalised difference vegetation index) and cross-sectional data. Moreover, some recent epidemiological studies have reported differential benefits of green space exposures, suggesting a one-size-fits-all policy may be less than ideal for advancing population health equity.

**Conclusions:** Coproduction of policy-relevant (or amenable) green space exposure measures and the translation of those which matter for health are important next steps for epidemiological studies in this area to remain consequential.

**Presentation preference:** Oral (Symposium – Pathways linking greenspace exposure to health outcomes)

# SYM02: Symposium Pathways linking green-space exposure to health

101, September 25, 2017, 14:00 - 15:30

## Analytical challenges in greenspace and health research

**Angel M. Dzhambov\***, Department of Hygiene and Ecomedicine, Faculty of Public Health, Medical University of Plovdiv, Plovdiv, Bulgaria

**Iana Markevych\***, Institute for Occupational, Social, and Environmental Medicine, Ludwig-Maximilians-University of Munich; Institute of Epidemiology I, Helmholtz Zentrum München - German Research Center for Environmental Health, München/Neuherberg, Germany

### Background/Aim

Multiple epidemiological studies have shown that greenspace exposure is beneficial for health; however the understanding and interpretation of these results is not always straightforward. The aim of this presentation is to summarize analytical challenges related to (1) statistical methods to explore pathways linking greenspace to health, (2) place and population groups' specifics of the associations, and (3) residual confounding.

### Methods

In order to identify potential methodological shortcomings of previous research, the epidemiological literature on the topic was reviewed and discussed by several experts working in various complimentary fields during an international COST-funded workshop.

### Results

Studies looking at potential mediators explaining the health benefits of greenspace failed to account for the fact that these mediators are intertwined. Assuming that the pathways are independent and operate in parallel rather than in serial could be one reason why some indirect paths were found non-significant in previous research. Thus, such findings could be rather due to model misspecification rather than to lack of a causal relationship. The traditional Baron and Kenny's mediation approach should be replaced by more flexible methods such as structural equation modelling. Moreover, previous research indicates that some associations between greenspace and health may be place-specific and vary by socioeconomic status, urbanicity, sex, and age. This effect modification is inconsistent and the evidence is mixed. Finally, in order to quantify the independent effect of greenspace accessibility and availability, studies need to consider residual confounding by unmeasured greenspace, greenspace usage (functions and time-spending patterns), and quality.

### Conclusions

Epidemiologists investigating greenspace effects should be aware of how the methodological handling of their data can impact on the results and their interpretation. By addressing the identified methodological issues future studies have the potential to fill some of existing knowledge gaps and to expand our understanding of how greenspace "works" to promote public health.

# **SYM02: Symposium Pathways linking green-space exposure to health**

**101, September 25, 2017, 14:00 - 15:30**

How can researchers shape urban green space planning and practice?

**Dave Kendal\***, School of Ecosystem and Forest Sciences, University of Melbourne, Australia

Melanie Davern; RMIT University, Melbourne, Australia

Alison Farrar, School of Ecosystem and Forest Sciences, University of Melbourne, Australia

## Background/Aim

There is renewed interest in planning for the multiple roles that green space plays in cities. Research is needed to provide an evidence base to support policy aimed at managing these multiple benefits, to understand synergies and trade-offs in the provision of them, and to identify unintended consequences of particular policy positions.

## Methods

A literature review and synthesis of study results across the domains of public health, environmental psychology, urban ecology and urban planning was conducted to identify a broad range of benefits provided by greenspace, and the characteristics of different kinds of green spaces related to the provision of benefits.

## Results

Green space plays multiple roles in cities: improving amenity and wellbeing, encouraging physical activity, reducing stress, providing ecosystem services and protecting biodiversity. Attributes of green space found to be important include tree canopy cover, species diversity, area, accessibility, colour, structure/complexity and visibility/surveillance. Some attributes of green space influence multiple benefits. For example, trees provide shade, help create walkable neighbourhoods, provide habitat for birds and animals, and improve amenity. However, there are tradeoffs e.g. trees also reduce the area available for active sports and reduce habitat for some kinds of animals. Different mechanisms (e.g. policy, education) can be used to influence greenspace attributes across different land uses and land tenures.

## Conclusions

It is possible to design green spaces that provide multiple benefits for human health and wellbeing, ecosystem services, and for biodiversity. However, there are inevitable tradeoffs. A diverse range of landscapes with different kinds of green space attributes are needed to provide a range of benefits and satisfy a range of needs. It is possible to inform and influence a range of processes that shape the quantity, location and quality of the different green spaces in our cities.

# **SYM03: Pushing boundaries in landscape fire smoke epidemiology for improved public health outcomes**

**024, September 25, 2017, 14:00 - 15:30**

Pushing boundaries in landscape fire smoke epidemiology for improved public health outcomes

**Fay H Johnston, Menzies Institute of Medical Research, University of Tasmania, Hobart, Australia and Geoffrey G Morgan, University Centre for Rural Health – North Coast, University of Sydney, Lismore, NSW, Australia.**  
*Sponsored by the Centre for Air Quality and Health Research and Evaluation, an Australian NHMRC Centre of Research Excellence.*

## **Abstract**

Exposure to landscape fire smoke is a growing public health problem with many special challenges in evaluating exposure and health outcomes, and strategies for mitigation. This symposium will focus on the quantification of health risks, historical and future smoke exposures, health burden estimation, surveillance, and effective population and personal interventions.

## **Presenters**

1. Ryan Gan, Department of Environmental and Radiological Health Sciences, Colorado State University, USA  
Ryan.Gan@colostate.edu

*Challenges in estimating fire smoke exposure for epidemiologic research*

2. Richard Broome, University of Sydney and Public Health Observatory, Sydney, New South Wales, Australia  
Richard.Broome@sswahs.nsw.gov.au

*Managing landscapes and managing air – agency responses to the increasing problem of episodic smoke*

3. Ana Rappold, United States Environment Protection Agency, USA  
Rappold.Ana@epa.gov

*Using crowd sourced data to understand health impacts*

4. Sarah Henderson, British Columbia Centre for Disease Control, Vancouver, Canada  
Sarah.Henderson@bccdc.ca

*Forecasting smoke and community health impacts – keeping a step ahead of the epidemiological curve*

5. Geoff Morgan, University Centre for Rural Health – North Coast, University of Sydney, Lismore, Australia  
Geoff.Morgan@ucr.edu.au

*Discussant*

# SYM03: Pushing boundaries in landscape fire smoke epidemiology for improved public health outcomes

024, September 25, 2017, 14:00 - 15:30

## Association between wildfire smoke and pulmonary-related morbidity during the 2012 Washington wildfires

Author information; Arial 8pt (please overtype this)

**Ryan Gan\*, Colorado State University, Fort Collins, United States**

Ambarish Vaidyanathan, Centers for Disease Control and Prevention, Atlanta, United States

Bonne Ford, Colorado State University, Fort Collins, United States

William Lassman, Colorado State University, Fort Collins, United States

Gabriele Pfister, National Center for Atmospheric Research, Boulder, United States

Emily Fischer, Colorado State University, Fort Collins, United States

John Volckens, Colorado State University, Fort Collins, United States

Jeffrey Pierce, Colorado State University, Fort Collins, United States

Sheryl Magzamen, Colorado State University, Fort Collins, United States

### Background/Aim

The state of Washington in the United States experienced a number of intense wildfires that produced a large amount of smoke during September 2012. We evaluated the association between wildfire smoke exposure and pulmonary morbidity.

### Methods

Smoke exposure was estimated from July 1<sup>th</sup> to October 31<sup>st</sup> 2012 using three methods: ordinary kriging of surface site monitors, a chemical-weather model using the Weather Research and Forecasting with Chemistry (WRF-Chem), and geographically weighted ridge regression (GWR). GWR is a data-fusion method that blends information from surface monitors, WRF-Chem, and satellites to estimate smoke particulate matter  $\leq 2.5$  microns in diameter (PM<sub>2.5</sub>). Population-weighted daily average estimates of smoke were linked with daily counts of county-aggregated pulmonary-related emergency department or urgent care hospital visits. The time series of daily smoke and daily morbidity counts was analysed using a mixed-effects Poisson regression adjusting for temperature, day of the week, and season; county was treated as a random effect.

### Results

A 10  $\mu\text{g}/\text{m}^3$  increases in smoke exposure was significantly associated with an increase in asthma hospitalizations for each smoke estimation method: kriging (Risk Ratio [RR]: 1.10, 95% confidence interval [95%CI]: 1.03–1.16), WRF-Chem (RR: 1.13, 95%CI: 1.08–1.17), and GWR (RR: 1.09, 95%CI: 1.03–1.14). However, differing results were observed for a 10  $\mu\text{g}/\text{m}^3$  increase in smoke and chronic obstructive pulmonary disease (COPD) hospitalizations. Significant associations were observed for kriging (RR: 1.08, 95%CI: 1.01–1.15) and GWR (RR: 1.06, 95%CI: 1.01–1.21), where no association was observed for WRF-Chem (RR: 0.99, 95%CI: 0.94–1.04).

### Conclusions

The magnitude (RR) and uncertainty (95%CI) of associations between smoke PM<sub>2.5</sub> and hospital admissions were dependent on estimation method used and pulmonary outcome evaluated. Choice of smoke exposure estimation method lead to some degree of exposure misclassification, which can impact the overall conclusion of the study.

# **SYM03: Pushing boundaries in landscape fire smoke epidemiology for improved public health outcomes**

**024, September 25, 2017, 14:00 - 15:30**

**A rapid assessment of the health impacts of PM2.5 from hazard reduction burning around Sydney in May 2016**

**Richard Broome\***, Public Health Observatory, Sydney Local Health District, Sydney, Australia

Fay Johnston, Menzies Institute for Medical Research, University of Tasmania, Hobart, Australia

Joshua Horsley, University of Sydney, Sydney, Australia

Geoffrey Morgan, University of Sydney, Sydney, Australia

## Background/Aim

Planned hazard reduction burning is used to reduce risks related to wildfires. But the smoke it produces has negative health effects.

In May 2016, an intense period of hazard reduction burning was conducted close to Sydney, a city of five million people. Because of the level of smoke, there was substantial government and public interest in the event. The aim of this rapid assessment was to provide a timely estimate of its health impact to inform management of future hazard reduction burns.

## Methods

The assessment used public PM2.5, population and mortality data. Smoky days were defined as those with a PM2.5 concentration above the 99<sup>th</sup> percentile for the region. The smoke-related PM2.5 concentration was assumed to be the difference in PM2.5 on smoky and non-smoky days. Standard concentration-response coefficients were used to quantify premature mortality, respiratory hospital admissions and cardiovascular hospital admissions attributable to smoke-related PM2.5.

## Results

Six days in May 2016 met our definition of smoky. The mean smoke-related PM2.5 concentration on these 6 days was 24  $\mu\text{g}/\text{m}^3$ . We estimated that 14 premature deaths, 29 cardiovascular hospital admissions and 58 respiratory hospital admissions were attributable to smoke-related PM2.5.

## Conclusions

This assessment showed that smoke from hazard reduction burns can have a substantial health impact when it affects a large city. While this does not mean that hazard reduction burning should be stopped, it demonstrates the need to make management of the health effects from smoke an integral part of the planning for these burns. There must be close collaboration between health, environment and fire management agencies to produce the best outcomes for community wellbeing.

# **SYM03: Pushing boundaries in landscape fire smoke epidemiology for improved public health outcomes**

**024, September 25, 2017, 14:00 - 15:30**

Smoke Sense – a crowd sourced study of health impacts of wildland fire smoke exposures

Author information; Arial 8pt (please overtype this)

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## Background/Aim

Exposures to wildland fire smoke are linked to a range of health outcomes, affecting wellbeing and productivity in the communities. We present the protocol and the results of the Smoke Sense study - the first crowd sourced study designed to quantify health impacts attributable to wildland fire smoke and to examine the ability of current risk communication strategies to improve health outcomes during wildland fire smoke events in the U.S.

## Methods

The Smoke Sense study leverages smartphone app to deliver real time air quality and recommended health risk messages to participants and to facilitate input about the health symptoms and smoke experienced in the affected communities as well as the actions they take to reduce their exposure. The study adopts principles of gamification to engage participants to learn about how air quality impacts their health and actions they can take to reduce exposures. We will use regression techniques to estimate associations between smoke exposure and health outcomes and examine modifications through behavioural changes, demographic characteristics, knowledge of air quality and baseline health.

## Results

Smoke Sense study will pilot during the summer months of 2017. We will present the protocol and the results from the pilot data collection including the magnitude and severity of cardiovascular, respiratory, eyes and ears, and other symptoms, medication usage and doctor's visits among the participants; actions, including behavioral changes, taken to reduce exposure; and the impact of those actions on the frequency of health outcomes. We will also present our efforts to engage communities and encourage participation.

## Conclusions

This study is expected to improve our understanding about the range of health outcomes experienced in the communities and assess whether health risk communication via mobile devices can improve public health outcomes.

Disclaimer: The views expressed in this abstract do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency

# SYM03: Pushing boundaries in landscape fire smoke epidemiology for improved public health outcomes

024, September 25, 2017, 14:00 - 15:30

Forecasting smoke and community health impacts – keeping one step ahead of the epidemiologic curve

Author information; Arial 8pt (please overtype this)

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**Sarah B. Henderson\***, Environmental Health Services, BC Centre for Disease Control, Vancouver, British Columbia, Canada

**Background/Aim:** Severe wildfires burned near densely populated regions of British Columbia, Canada in July 2015 and millions of individuals were exposed to the smoke. We aimed to evaluate the ability of an integrated surveillance system to predict the health effects of wildfire smoke exposure and to estimate the potentially preventable morbidity through public health interventions.

**Methods:** Daily PM<sub>2.5</sub> concentrations and counts of two respiratory health indicators were obtained for 41 local health areas in BC. Smoke forecasts from the BlueSky system were obtained for the 2015 smoky period. A computationally efficient hierarchical time series model was used to predict counts of the health indicators 24 and 48 hours into the future using the smoke forecasts. Potentially preventable morbidity was also estimated for a range of potential intervention scenarios.

**Results:** Asthma-related physician visits and dispensations of relief medications were increased by 34% and 27%, respectively, during the smoky period. On the smokiest day the increases were 72% and 78%, respectively. The 95% prediction intervals from the surveillance system contained the true observed values in 12 of the 14 dispensation forecasts, and 9 of the 14 physician visits forecasts. The system did not require exact smoke forecasts to produce reasonable health indicator forecasts, but the accuracy of health forecasts was affected by large errors in smoke forecasts. Simple, early interventions with lower effectiveness prevented more morbidity than delayed interventions with higher effectiveness.

**Conclusions:** Integrating data from multiple sources into a wildfire smoke forecasting model can accurately predict the health impacts of smoke exposure in a timely manner. Forecasts from such a system could be used to trigger public health action and guide the selection of interventions to prevent morbidity. Such a system will be implemented in British Columbia for summer 2017.

## MC14: Built Environment, Obesity & Mortality

024, September 25, 2017, 16:00 - 17:30

### Neighbourhood green space quantity, quality and 'equigenesis' of body mass index: Evidence among a cohort of Australian mothers

**A/Prof Thomas Astell-Burt** \* 1,2,3  
Dr Xiaoqi Feng 1,2,3

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**Background/Aim:** The 'equigenesis' hypothesis refers to the potential to disrupt the translation of socioeconomic disparities into health inequities via another exposure. The purpose of this study was to investigate the potential 'equigenic' effects of green space quantity and quality on body mass index (BMI).

**Method:** Multilevel models were used to analyse BMI among a cohort of 3684 mothers in wave 5k of the Longitudinal Study of Australian Children. Green space quantity was measured by the percentage of the local area covered by parkland. Green space quality was assessed with responses to the statement "there are good parks, playgrounds and play spaces in this neighbourhood." Models were adjusted for age, education, employment, child age and gender, neighbourhood disadvantage and area remoteness. Potential equigenic effects were tested using two-way interactions between green space quantity/quality and neighbourhood disadvantage. Additional controls reflecting other perceived features of the neighbourhood environment were investigated, including local service provision, access to public transport, presence of heavy traffic and indicators of area safety and social capital.

**Results:** Compared to mothers living in areas with 0 to 10% green space coverage, those in areas with 11% to 21% and >21% had lower mean BMI of -0.44kg/m<sup>2</sup> (95%CI -0.96 to 0.07) and -0.90kg/m<sup>2</sup> (95%CI -1.40 to -0.41), respectively. Green space quality was not associated with BMI and did not influence the association with green space quantity. Adjustment for other perceived neighbourhood variables similarly did not have an impact on the association between BMI and green space quantity. Fitting a two-way interaction between green space quantity and neighbourhood disadvantage did not result in meaningful evidence of effect measure modification.

**Conclusions:** The results indicate higher quantities of green space may be beneficial for BMI regardless of their socioeconomic circumstances (i.e., not equigenic). Green space quality may be less important than overall coverage.

**Presentation preference:** Oral (General Sessions)

## MC14: Built Environment, Obesity & Mortality

024, September 25, 2017, 16:00 - 17:30

Urban health: the climate vulnerability index and cause specific mortality in a large cohort followed from 2001 to 2013

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### Background/Aim

Recently, the Climate Vulnerability Map was developed as a tool for urban adaptation policies and strategies in Rome, Italy. The index of vulnerability, i.e. the degree to which a system is unable to cope with adverse effects of climate conditions, includes variables as night temperature, river flood and extreme rainfall, green proximity, NDVI, urban structure, soil and land cover, and population density. We aimed at investigating the relationship between the vulnerability index and cause-specific mortality.

### Methods

We used a large administrative cohort, enrolled at 2001 Census. We applied the vulnerability index at residential coordinates of one million 30+ year olds at inclusion.

We followed them until they died or until their migration or the end of 2013. We analysed death from non-accidental causes (ICD9: 001-799), cardiovascular causes (ICD9: 390-459), respiratory conditions (ICD9:460-519), and traumatic causes (ICD9:800-924).

We used Cox models to investigate the association between quintiles of vulnerability index and cause specific mortality, adjusting for age, sex, level of education, occupation, marital status, place of birth, and census tract socioeconomic position.

### Results

During the follow-up there were 165,496 deaths from non-accidental causes; 67,883 from cardiovascular; 10,472 from respiratory conditions, and 6,379 from traumatic causes.

With increasing vulnerability index there was an increase in mortality from non-accidental causes (5th vs 1st quintile HR=1.04, 95%CI: 1.02-1.06, p-trend<0.001). The estimates were slightly reduced when adjusting for air pollution exposure. The main index component related to the increase was the thermal component (5th vs 1st quintile HR=1.05, 95%CI: 1.03-1.07). The thermal component was related to higher cardiovascular and respiratory mortality risks (5th vs 1st quintile HR=1.05, 95%CI: 1.02-1.08, and HR=1.08, 95%CI: 1.00-1.14, respectively). There was no evidence of association between the vulnerability index and traumatic causes of death.

### Conclusions

Urban characteristics are important determinants of human health.

## MC14: Built Environment, Obesity & Mortality

024, September 25, 2017, 16:00 - 17:30

### Natural outdoors environments and obesity: the multicase-control study in Spain (MCC-Spain)

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#### Background/Aim

Overweight and obesity are associated with increased risk of coronary heart disease, stroke, respiratory disease, cancer and all cause mortality. The association between green spaces and reduced risk of overweight/obesity has been previously studied, but results are not consistent. We studied the association between surrounding greenness and residential proximity to green areas and overweight/obesity in Spain.

#### Methods

8112 study participants between 20-85 years old were recruited between 2008-13 from 23 hospitals in 12 provinces of Spain, as part of the multi-case control Spain study (MCC-Spain). We geocoded the current residence of each participant, and assigned different indicators of exposure to natural outdoor environments: access to urban green areas according to Urban Atlas; access to agricultural areas according to CORINE Land Cover 2006 and surrounding greenness according to the average of the Normalized Difference Vegetation Index. We used multinomial logistic mixed-effects models with a random effect for hospital and adjusted for potential confounders. We also explored the potential modifier effect of individual socio-economic status, degree of urbanization and sex.

#### Results

Access to urban green areas seemed to slightly reduce the risk of overweight/obesity after adjusting for age, sex, case-control status, education, socioeconomic status at individual and area level and degree of urbanization of place of residence [overweight: RRR (95%CI)=0.93 (0.79 – 1.09), obesity: IRR(95%CI)=0.89 (0.73-1.08)]. The protective effect of urban green spaces was more pronounced in densely populated areas. On the contrary, access to agricultural areas seemed to increase the risk [overweight: adjusted RRR (95%CI)=1.13 (0.97-1.32), obesity: adjusted IRR(95%CI)= 1.08 (0.9-1.3)]. No effect was observed for surrounding greenness [overweight: adjusted RRR (95%CI)= 0.97 (0.91-1.04), obesity: adjusted IRR(95%CI)= 0.97 (0.89-1.05)].

#### Conclusions

No clear association was observed between access to green spaces and overweight/obesity. The suggested effects however, were depended on land-use.

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## Residential green and mortality in Switzerland

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### Background/Aim

Residential green, i.e. greenspaces or greenness, may improve health and decrease mortality by promoting physical activity and enabling stress recovery. We investigated the association between residential green and specific causes of death.

### Methods

We used Cox proportional hazard models to study the association for all natural cause, all respiratory, all cardiovascular disease (CVD), ischemic heart disease, stroke and blood-pressure related mortality in the adult population of Switzerland using the Swiss National Cohort. Satellite-based normalised difference vegetation index (NDVI: greenness) and spatially resolved land use data (SwissTLM: greenspace) were used to model address-level exposure in the immediate surrounding and local neighbourhood. Hazard ratios (HR) were adjusted for sex, civil status, region, urbanity, job position, education, neighbourhood socio-economic position (SEP), and incrementally for NO<sub>2</sub>, total transportation noise and altitude.

### Results

With 4.2 million adults and 7.8 years of follow-up, we respectively accrued >363,000, >85,000 and >232,000 natural cause, respiratory and CVD deaths. In adjusted models, we found statistically significant protective effects for all outcomes with residential green. HR (95% confidence intervals) for NDVI [and SwissTLM] per IQR within 500m were: 0.94 (0.93 - 0.95) [0.94 (0.93 - 0.95)] for natural cause; 0.93 (0.91 - 0.95) [0.93 (0.91 - 0.96)] for respiratory; and 0.94 (0.93 - 0.95) [0.96 (0.94 - 0.97)] for CVD mortality. We found a stronger protective effect in younger individuals, and greater benefit for females. The protective effect of residential green was stronger in urban communities compared to rural and in the highest versus lowest SEP quartile. Incremental adjustment for NO<sub>2</sub>, noise and altitude did not substantially change the HRs.

### Conclusions

Residential green consistently and independently reduced the risk of all natural cause, respiratory and CVD death. The impact of residential green on health may go beyond the lack of noise, air pollution and other environmental hazards.

## MC14: Built Environment, Obesity & Mortality

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### Natural outdoor environments and mortality in Perth, Western Australia

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#### Background/Aim

Natural outdoor environments may mitigate harmful environmental factors associated with city living. We studied the longitudinal relationship between natural ('green and blue') outdoor environments and all-cause mortality in a cohort of men residing in Perth, Western Australia.

#### Methods

We used data from 9200 men aged 65 years and older from the Health In Men Study. Participants were recruited in 1996-99 and followed until 2014, during which 5872 deaths were observed. Time-varying surrounding greenness based on the Normalized Difference Vegetation Index around the residences and distance to waterbodies were defined to characterize the natural outdoor environments. All cause non-accidental mortality was ascertained with the Linked Data System in Western Australia.

#### Results

Preliminary analyses showed an 8% lower rate of all-cause non-accidental mortality (95% confidence interval 0.85, 0.99) for men living in the highest quartile of cumulative average surrounding greenness in 300m around their residence compared to those living in the lowest quartile, while adjusting for age. After further adjustments for marital status, country of birth, education, area-level socio-economic status, and smoking, associations attenuated and were no longer significant. Men living further away from waterbodies had a 9.6% higher rate of all-cause non-accidental mortality (95% confidence interval 1.02, 1.18) compared to those living closer (quartile 2 vs. 1), while adjusting for age, marital status, country of birth, highest education, area-level socio-economic status, and smoking.

#### Conclusions

We observed some evidence for higher surrounding greenness and shorter distance to waterbodies to be associated with a decreased risk of mortality. Living in areas with natural features may reduce mortality risk and may provide opportunities for the planning of healthy cities.

## MC14: Built Environment, Obesity & Mortality

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### Research into the built environment: some ethical considerations

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A well-designed built environment is a major aim for modern societies that seek to address the diabetes epidemic. There is a need to address the lack of physical activity due to the absence of opportunities to walk or be physically active in many cities around the world, especially in the more economically advanced countries of the world. As with most questions in environmental epidemiology, research into the built environment requires a multidisciplinary team to generate the needed data to examine the link between built environments, as exposures of interest, with different health outcomes. One ethical dilemma is whether a study on the built environment will benefit the higher socioeconomic neighborhoods differentially as compared with lower income neighborhoods that are known to need the intervention most. For poorer countries, there is no infrastructure, funding, or interest to tackle this problem and develop better built environments to facilitate by residents the pursuit of physical activity to limit the increase in early mortality and morbidity from diabetes. Therefore, research into the built environment needs to weigh the benefits of their research against the costs and any implied promises of benefit. Essentially, is it ethical to carry out interventions when such interventions cannot be scaled up or implemented by communities in need?

## MC15: Child Health: metal elements & other exposures

026, September 25, 2017, 16:00 - 17:30

### Associations between prenatal lead exposure and birth outcomes in Shanghai newborns: potentially affected by infant sex and maternal dietary intakes

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#### Background/Aim

Studies on the associations between prenatal lead exposure and birth outcomes have been inconsistent, and few data are available on the impacts of infant sex and maternal dietary intakes on these associations. The aims of this study were to probe the effects of prenatal lead exposure on neonatal birth outcomes and to assess the sex differences in these associations after adjusting for potential confounders.

#### Methods

The study was a cross-sectional multicenter survey of mother-infant pairs in Shanghai, the most economically developed city in eastern China. We measured the cord blood lead levels and used a series of multivariable linear regression models to determine their associations with birth outcomes, which included birth weight, birth length, head circumference, and the ponderal index, in the total sample and within sex subgroups.

#### Results

A total of 1,009 mother-infant pairs were enrolled from 10 hospitals in Shanghai between September 2008 and October 2009. The geometric mean of the cord blood lead concentrations was 4.07 µg/dl (95% CI: 3.98 to 4.17 µg/dl). A significant inverse association was found between cord blood lead levels and head circumference only in the male subgroup without adjustment for maternal dietary intakes, and increasing cord blood lead levels were related to significant decreases in the ponderal index only in females. The birth weights of the male infants were positively associated with cord blood lead levels; after adjusting for the maternal intake frequency of preserved eggs, the estimated mean differences in birth weights decreased by 11.7% for each 1-unit increase in the log<sub>10</sub>-transformed cord blood lead concentration.

#### Conclusions

Our findings suggest that prenatal lead exposure may have sex-specific effects on birth outcomes and that maternal dietary intake may be a potential confounder in these relationships. Further studies on this topic are highly warranted.

## MC15: Child Health: metal elements & other exposures

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### Maternal selenium status and child neuropsychological development in young children

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#### Background/aim

Selenium (Se) is an essential nutrient for humans. However, at high exposures, it has been linked to neurotoxicity during early development. Very few studies have evaluated the potential non-linear relationship between maternal Se status and child neuropsychological development among populations at intermediate Se levels. We aimed to explore this association among preschool children.

#### Methods

Study subjects were 490 mother-child pair participants in the INMA birth cohort study in Valencia, Spain (recruitment: 2003-2005). Se was measured in serum samples collected during the first trimester of pregnancy. Neuropsychological development was assessed using the McCarthy Scales of Children's Abilities at 5 years of age. Sociodemographic, lifestyle and dietary characteristics were obtained by questionnaires during pregnancy and childhood. Multivariate linear and generalized additive models were used to assess the relationship between Se and neuropsychological scores. Child sex and breastfeeding were tested as potential Se effect modifiers.

#### Results

The mean  $\pm$  standard deviation of Se was  $79.9 \pm 8.1$   $\mu\text{g/L}$ . A positive linear association was observed between Se and both motor and perceptive-manipulative scales. An inverted U-shape better described the relationship between Se and verbal, memory and general cognitive scales. Se was a relevant predictor of the motor, verbal and memory scales according to the Akaike Information Criterion. The association between Se and the scores followed an almost flat curve for breastfed children and had an inverted U-shape for the non-breastfed ones.

#### Conclusions

The shape of the association between maternal Se status and child neuropsychological development was found to be non-linear for the majority of the scales. Breastfeeding was found to be a relevant effect modifier of Se: breastfeeding seemed to attenuate the negative association observed between Se and some of the scales. Further research is needed in order to disentangle the complex association between Se status and child neuropsychological development.

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## MC15: Child Health: metal elements & other exposures

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### The impact of antibiotic exposure during prenatal and infant period on childhood overweight and obesity: a meta-analysis of population-based cohort studies

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#### Background/Aim

Studies have reported inconsistent results concerning the association of antibiotic exposure during prenatal and infant period with childhood overweight/obesity. We performed a meta-analysis to examine whether antibiotics exposure in early life increases the risk of childhood overweight/obesity.

#### Methods

PubMed, Embase, Medline and Web of Science were searched using different combinations of two groups of keywords: 'antibiotic(s)' and 'overweight/obesity/weight gain/adipogenesis/adiposity/body mass'. Cohort studies that reported the association of antibiotics use during prenatal or infant period (0-2 years) with childhood (3–12 years) overweight/obesity were eligible. Where possible, adjusted risk estimates were pooled using a random effects model; otherwise unadjusted estimates were pooled. Statistical heterogeneity was assessed with  $I^2$  statistics; the values of 25%, 50% and 75% were considered to indicate low, medium and high heterogeneity, respectively. We conducted a subgroup analysis to identify the sources of heterogeneity according to the gender of children.

#### Results

In total, eight cohort studies were identified and sex-specific risk estimates were included in the meta-analysis. The overall pooled odds ratio (OR) of childhood overweight/obesity for pregnant women and infant exposed to antibiotics compared with those who are not exposed to antibiotics was 1.19 (95%confidence interval (CI) 1.08, 1.31;  $I^2=85%$ ); In subgroup analysis, the overall pooled OR was 1.52 for boys (1.20, 1.93;  $I^2=22%$ ) and 1.15 for girls (0.90, 1.46;  $I^2=0%$ ). The ORs for childhood overweight and obesity tended to be lower for females compared with males.

#### Conclusions

Our results indicated that antibiotic exposure during prenatal and infant period was moderately associated with childhood overweight and obesity. Gender difference could be explained by the generally lower risk of overweight in girls. Further research might be needed to better understand the mechanism of gender difference on the antibiotics–overweight/obesity relationship. This finding has public health implications, given the antibiotic abuse in many countries.

## MC15: Child Health: metal elements & other exposures

026, September 25, 2017, 16:00 - 17:30

### The impacts of ambient temperature on stillbirth and preterm birth: Brisbane, 1994-2013

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**Background/Aim:** Evidence shows both high and low ambient temperature have impacts on human health. Pregnant women are particularly susceptible to ambient temperature during pregnancy which may be associated with adverse birth outcomes. This study aims to examine the effects of ambient temperature at three trimesters of pregnancy on preterm birth and stillbirth and check changes in these effects over time during 1994-2013.

**Methods:** Birth outcomes data and meteorological data were obtained in Brisbane, Australia from 1994 to 2013. Cox proportional hazards models were employed to evaluate the effects of mean temperature during each trimester of pregnancy on preterm birth and stillbirth. To check the potential changes in effects of temperature over time, an interaction term between time and temperature was used in models.

**Results:** Both low and high temperatures at the 3rd trimester of pregnancy significantly increased the risk of preterm birth, with similar hazard ratios (HRs) [95% confidence intervals (CIs)] for low [1.21 (1.16, 1.27)] and high [1.21 (1.16, 1.26)] temperatures. Increased risk of stillbirth was significantly associated with both low and high temperatures at the 2nd trimester of pregnancy, and lower HRs were observed for low temperature [1.23 (1.04, 1.45)] than high temperature [1.47 (1.24, 1.74)]. The HRs associated with low temperature increased while those with high temperature decreased from 1994 to 2013.

**Conclusions:** Both low and high ambient temperatures during pregnancy could increase the risks of preterm birth and stillbirth. Higher risk associated with cold temperature and lower risk with hot temperature were present during the past two decades in Brisbane, Australia.

# MC15: Child Health: metal elements & other exposures

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## Residential green space quantity and quality and child mental wellbeing: a longitudinal study

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**Background/Aim:** Although many studies report health benefits from neighbourhood green space, few studies supporting these claims are longitudinal, most focus on adult populations and explicit considerations of green space quality are scarce. We examined child mental wellbeing in relation to green space quantity and quality and how these associations may be dependent upon child age.

**Method:** 4968 participants were tracked for 5 waves in the Longitudinal Study of Australian Children. The main outcome was the Strengths and Difficulties Questionnaire Total Difficulties Score (TDS), with the 'internalizing' and 'externalizing' subscales as secondary outcomes. Multilevel growth curves were used to track these outcomes as children aged and in relation to an objectively measured indicator of neighbourhood green space quantity and a parent-reported indicator of green space quality. Models were adjusted for demographic and socioeconomic confounders. Effect modification of associations with green space quantity and quality were assessed using two-way interactions with child age.

**Results:** Unadjusted mean TDS among participants in the greenest category (41%+) was 9.27 (95%CI 8.82, 9.71), compared to 9.92 (95%CI 9.60, 10.24) in the least green category (0-5%). Likewise, more favourable TDS was observed among participants living nearby higher quality green space (8.55, 95%CI 8.28, 8.82) compared to those of lower quality (10.48, 95%CI 9.85, 11.12). Growth curves confirmed those findings and revealed the associations to non-linear. Benefits for child mental wellbeing appeared to be most optimal with 21-40% green space quantity. The benefit of green space quality were small at age 4-5y but increased as children grew older. These associations were replicated in the internalizing subscale. Disadvantaged areas tended to have lower green space quantity and quality.

**Conclusions:** Approximately 21-40% of residential land-use allocated to green space may be optimal for promoting child mental wellbeing, but the quality of this green space increases in importance as children age.

**Presentation preference:** Oral (General Sessions)

## MC15: Child Health: metal elements & other exposures

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Lead exposure in young children over a 5-year period using alternative exposure measures with the US EPA IEUBK model

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### Background/Aim

In predicting blood lead (PbB) levels in children, the IEUBK model recommends use of site specific data for soil, house dust, ambient air, water, and diet. We evaluated the model by substituting dust fall accumulation and hand wipe data instead of house dust collected by vacuum cleaner, and exterior dust sweepings instead of soil. Most uses have been on industrial sites such as mining and smelting.

### Methods

Simulations were undertaken on a comprehensive data set, including measured PbB, for 108 children monitored over a 5-year period in Sydney. In contrast to all other IEUBK model studies to our knowledge, data were stratified over the age ranges from 1 to 5 years as well as using data aggregated over the time of the study for each individual. Results were compared with those obtained by mixed model analyses and structural equation modelling.

### Results

The geometric mean contributions to total Pb intake for a child aged 1-2 years was 0.1% for air, 42% for diet, 5.3% for water and 42% for soil and dust. The median predicted versus measured PbB values were not significantly different over age of collection for soil with petri dish dust (PDD), soil with hand wipes, or sweepings with PDD although the geometric means showed large ranges over the different ages. The predicted PbB values are strongly influenced by soil Pb. Use of site specific soil values with default dust estimates results in higher predicted PbB with the contribution of soil+dust to total Pb exposure for default estimations being 8 to 42% higher than for site specific soil and dust.

### Conclusions

Our results indicate that it is possible to use alternative measures of soil and dust exposure to provide reliable predictions of PbB in urban environments although very high Pb values for sweepings give an overestimation of PbB.

## MC16: Air pollutant exposure estimates - which method suits your purpose?

020, September 25, 2017, 16:00 - 17:30

### Adoption of gas stoves reduces exposure to household air pollution among pregnant, rural Guatemalan women: A feasibility study

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**Background/Aim:** Household air pollution is the 8<sup>th</sup> leading cause of death and disability in Guatemala where over 95% of rural households use woodstoves for cooking. Even the best performing biomass stoves produce high emissions; thus, cleaner burning fuels must be prioritized. We describe exposure reductions among women provided with a liquid-petroleum gas (LPG) stove and a behavioral intervention to reduce smoke exposure.

**Methods:** Pregnant, rural Guatemalan women participated in this 10-month intervention study. In Phase 1, participants (n=25) received a 3-burner LPG stove, 10 free LPG tanks and a behavioral intervention consisting of three classes. In Phase 2, 25 additional women received the same supplemented with tailored behavioral reinforcements delivered in home during tank delivery. We measured 48-hour personal exposures of CO (Lascar USB-CO) and filter-based particulate matter (PM<sub>2.5</sub>) at baseline, when women used only wood-burning stoves, and four times after gas stove installation.

**Results:** At baseline, the median of the personal 48-hour mean PM<sub>2.5</sub> was 100.56 µg/m<sup>3</sup> (IQR: 62.47-209.79) and the median of the 48-hour mean CO was 4.14 ppm (IQR: 2.59-5.74); 100% of baseline PM<sub>2.5</sub> exposures exceeded the WHO guideline of 10 µg/m<sup>3</sup>. Two months after gas stove adoption, PM<sub>2.5</sub> exposures were greatly reduced (median: 57.1%; IQR: 18.4-87.3%) with CO reduced less (median: 32.3%; IQR: -7.4-61.7%). There were marked differences between participants in the two phases. The median reductions in CO exposure in Phases 1 and 2 were 18.9% (IQR: -18.4-60.2%) and 47.8% (IQR: 19.2-62.8%), respectively; those for PM<sub>2.5</sub> were 55.7% (IQR: 17.1-85.4%) and 85.7% (IQR: 21.4-89.9%). For most participants in phase 2, PM<sub>2.5</sub> exposure fell below interim-1 (35 µg/m<sup>3</sup>) (67%) and interim-2 (25 µg/m<sup>3</sup>) (56%) WHO targets.

**Conclusions:** LPG stove adoption and classes that promote behavior change significantly reduced household air pollution. However, household-level behavioral reinforcement achieved the WHO interim-1 targets that are needed to protect health.

# MC16: Air pollutant exposure estimates - which method suits your purpose?

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Personal and occupational exposure to traffic-related fine particulate matter in Accra, Ghana

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## Background/Aim

Air pollution levels in fast-growing sub-Saharan African cities are among the highest in the world, but human exposure studies are limited, especially, traffic-related exposures. Our aim was to measure personal fine particulate matter (PM<sub>2.5</sub>) exposure of commercial minibus and taxi drivers (the most popular means of public transportation in Ghana's capital), and street mobile vendors (hawkers) and street stationary vendors (vendors) in Accra, Ghana.

## Methods

We measured 24-hour personal PM<sub>2.5</sub> exposure of 99 subjects, comprising 29 minibus drivers, 26 taxi drivers, 29 street vendors, and 15 street hawkers in the Accra metropolis. PM<sub>2.5</sub> was measured both gravimetrically and continuously, with time-matched global positioning system coordinates. The instruments were placed in backpacks, which were worn by the vendors and hawkers during the 24-hour measurement period. Taxi drivers had the backpacks placed beside them near the front passenger's seat. For the mini bus drivers, field assistants carried the backpacks on their laps at the front passenger's seat and rode along the drivers.

## Results

Across all four occupational groups, average (SD) personal PM<sub>2.5</sub> exposure was 56.4 (63.2) µg/m<sup>3</sup>; group means ranged from 26.0 µg/m<sup>3</sup> for hawkers to 83.4 µg/m<sup>3</sup> for taxi drivers. Individual exposure was > 100 µg/m<sup>3</sup> for some drivers. Exposure was significantly higher among drivers than vendors (78 vs 29 µg/m<sup>3</sup>; 95% CI: 28, 70; p-value < 0.001). The highest exposure to the drivers occurred on major and secondary roads, although < 20% of their commute time was spent there compared to minor roads and alleys.

## Conclusions

Our results support the need for urban air quality management plans that will address the role traffic to reduce exposure to the thousands who commute daily by minibuses and taxis or work near roadways in Accra, and when combined with policies to reduce urban biomass use, will greatly reduce urban population exposure in Accra.

## MC16: Air pollutant exposure estimates - which method suits your purpose?

020, September 25, 2017, 16:00 - 17:30

### Development of land use regression model for fine particles in peri-urban South India

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**Background/Aim** – Land-use regression (LUR) models have been developed to estimate particulate matter (PM<sub>2.5</sub>) at fine spatial resolution in urbanized areas of developed countries. Their use in developing countries and peri-urban areas is limited by the wider range of sources, scarcity of monitoring data, and limited geographic data. As part of the CHAI project, we developed a LUR model to predict spatial variability of PM<sub>2.5</sub> in a peri-urban area outside Hyderabad, South India.

**Methods** – The study area covers 28 villages over ~540 km<sup>2</sup>. We measured PM<sub>2.5</sub> in 24 in-village sites selected to vary by distance to roads and industry, population density, and solid-fuel use. Sampling over 11 days was conducted in two seasons. Predictors were derived from manually geocoded non-residential places in villages (e.g. shops), households, industries, and roads. Other predictors were derived from remote sensing data (urbanization indicators and tree cover). We used a supervised stepwise selection approach to predict PM<sub>2.5</sub> at measurement sites according to the ESCAPE project methodology. “Evaluation” models were built using Monte Carlo random re-sampling, with 15 sets of 18 sites.

**Results** – Mean(sd) PM<sub>2.5</sub> was 34.1(3.2) µg/m<sup>3</sup>, ranging from 25.9 to 40.7 across sites. Final model predictors included village-level urbanization, tree cover within 300-m, longitude, industries within 2-km, distance to religious center and energy supplies within 300-m. The model explained 69% of the variance in measured PM<sub>2.5</sub>. Leave-one-out cross-validation showed good model performance, with similar explained variance and a mean(sd) root-mean square error of 2.4(2.3). “Evaluation” models indicated consistency in variables selected in model building.

**Conclusions** – Results suggest that, for the study location, spatial variation in outdoor PM<sub>2.5</sub> is mainly attributable to non-traffic sources. Results demonstrate the suitability of the LUR approach to estimate PM<sub>2.5</sub> in a peri-urban area of a developing country, but substantial field work is required to generate predictors representing local sources.

## MC16: Air pollutant exposure estimates - which method suits your purpose?

020, September 25, 2017, 16:00 - 17:30

### Incorporating Area Emission Sources in Land Use Regression Models of Volatile Organic Compounds

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**Background/Aim:** Land Use Regression (LUR) has been successfully applied to assess intra-urban variations of major criteria pollutants (e.g., NO<sub>x</sub>, particulate matter). LUR models of Volatile Organic Compound (VOC) concentrations normally focus on point sources (e.g., industrial facilities) or mobile sources (e.g., vehicles). Here, we incorporate area sources (e.g., dry cleaners, gas stations, auto shops) to develop LUR models for 60 VOCs.

**Methods:** We aggregated a VOC (n=60 species) monitoring dataset collected by the City of Minneapolis (MN) during eight sampling seasons (11/2013-8/2015) at 186 locations. We developed seasonal and annual-average models resulting in 300 LUR models (i.e., 60 compounds; 4 seasons/1 annual-average). We tabulated GIS-based predictor variables (n=22) that captured proximity and varied geographic scale (16 buffer sizes) of point, mobile, and area emission sources.

**Results:** For traffic-related VOCs (BTEX: Benzene, Toluene, Ethylbenzene, O-Xylene and m&p-Xylene), our annual-average models had modest goodness-of-fit (adj-R<sup>2</sup>: ~0.4), bias (9%) and absolute bias (28%). For VOC species that may be more influenced by area sources (and are not commonly studied) model performance varied: Acetone (adj-R<sup>2</sup>: 0.3), 2-Butanone (0.3), Chloromethane (0.4) and Tetrachloroethene (0.7); mean bias (5%); mean absolute bias (21%). Industrial area, gas stations, auto shops, and dry cleaners were frequently selected variables for area-source VOCs. These area source variables were mostly selected at ≤300m buffers indicating spatial location of area sources may impact exposure on small spatial scales. Models for most VOCs varied by season (e.g., 2-Butanone, Chloromethane, and BTEX demonstrated highest adj-R<sup>2</sup> in November); however, not all seasonal fluctuations were consistent among VOCs.

**Conclusions:** Incorporating area sources may help improve LUR models for VOCs and subsequent exposure assessment. Although some VOCs showed limited performance using LUR, our findings suggest that LUR can be refined to capture intra-urban VOC variability to inform siting and planning efforts.

# MC16: Air pollutant exposure estimates - which method suits your purpose?

020, September 25, 2017, 16:00 - 17:30

## Agreement between local LUR and national satellite-based LUR models for estimating NO<sub>2</sub> in Sydney, Australia

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### Background/Aim

Methods for estimating air pollutant exposures for epidemiological studies are rapidly evolving with more complex methods emerging. Our aim was to determine the agreement between two methods for estimating NO<sub>2</sub> exposures for a children's cohort (CAPS), based in Sydney, Australia. The two methods were a traditional city-scale land use regression (LUR) model and a national satellite-based LUR (Sat-LUR) model.

### Methods

We used methods consistent with ESCAPE methodology to develop a NO<sub>2</sub> LUR model, using Ogawa passive sampler data collected at 46 locations across western Sydney (two week periods over three seasons in 2013 and 2014). We collected data on land use, population density, and traffic volumes as potential predictor variables. These LUR estimates were compared to those from a national Sat-LUR model, which used data from the OMI sensor on the Aura satellite and land use data to predict NO<sub>2</sub> concentrations at 68 fixed-site monitors located across Australia. Each model was used to estimate annual average NO<sub>2</sub> concentrations for 2013 at each of 964 cohort addresses. A Bland-Altman assessment was used to compare the estimates.

### Results

The traditional LUR model predicted 84% of variability in NO<sub>2</sub> (adjusted R<sup>2</sup>=0.84; RMSE 1.2ppb; 82% cross validation) with predictors being major roads, population and dwelling density, heavy traffic and commercial land use. The Sat-LUR adjusted R<sup>2</sup> was 0.81 (RMSE 1.4 ppb) and predictor variables included major roads, industrial emissions, industrial land use and open space. The annual average means were 7.3 (SD 1.95) and 6.9 (SD 1.96) respectively. Comparing the two sets of estimates, the mean difference was 0.31 ppb (CI 0.209 to 0.404), limits of agreement ranged from -2.78 to 3.40, and the ICC was 0.69.

### Conclusions

The results indicate very good agreement between traditional LUR and satellite-based methods for estimating NO<sub>2</sub> in Sydney, providing confidence in their use for exposure-response analyses.

## MC16: Air pollutant exposure estimates - which method suits your purpose?

020, September 25, 2017, 16:00 - 17:30

### Can Real-time Knowledge of Environmental Conditions Improve Health?

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**Background/Aim:** Environmental hazards, including high exposures to smoke from biomass burns and aeroallergens, are often unpredictable in their frequency and magnitude. The AirRater project was developed in Tasmania, Australia to provide real-time localised information on air quality, airborne pollen and meteorological conditions through a smartphone app. The app tracks individual's symptoms and provides alerts when relevant environmental triggers are forecast. We evaluated the perceived utility of the app for people in risk groups to identify and mitigate the adverse health impacts precipitated by environmental conditions.

**Methods:** All registered users completed a short survey at sign-up, and were invited to provide feedback to the study team via two online surveys at different time points. Information was collected on health status, utility of the app, behaviour change in response to information provided by the app, and perceived benefits to health.

**Results:** Currently there are 3,200 users. 1,700 are registered participants while the remainder use the app anonymously. Of the registered users, 48% have self-reported, doctor-diagnosed asthma, 65% allergic rhinitis and 20% reported no chronic illnesses. Response rates to the surveys were 31% for the first survey at 1-3 months of use, and 26% for the second survey at 8-10 months. Respondents reported that they found the app useful (87%). Behaviour modifications included modifying personal environmental exposure (30%) and using preventive medication (30%). When comparing results from the first and second surveys, longer-term users reported they had become more aware of their environment, had increased their use of the app to manage their condition and medications and some were discussing results with their health professionals.

**Conclusions:** Access to real-time air quality and aeroallergen information is perceived as being useful. Most AirRater app users report changing behaviour in response to information provided, potentially providing a vehicle for reducing the health impacts of environmental hazards.

# MC17: Ambient air, inflammation & cardiovascular hospitalisation

022, September 25, 2017, 16:00 - 17:30

Joint short and long-term effects of air pollution on cardiac readmissions in a cohort of myocardial survivors

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## Background/Aim

Air pollution exposure has been associated with adverse cardiovascular outcomes either as a trigger for short-term effects in frail subjects, or because it can promote cardiovascular damage as a consequence of long-term exposure. However, a joint assessment of the two effects is lacking. The aim of the study is to quantify the independent effects of short and long-term exposures to particulate matter < 10 micron (PM10) on the risk of cardiac readmissions in a cohort of myocardial infarction (MI) survivors in Rome.

## Methods

We selected 10,471 subjects who had a diagnosis of MI between 2007 and 2012 and followed them up until 2013 for a first episode of cardiac readmission. Exposure to PM10 was attributed to each individual residential address by use of a hybrid spatiotemporal model based on satellite data, land use and meteorology. We defined long-term exposure as the annual average PM10 concentration, and short-term exposure as the deviation between daily concentrations and annual average. We split individual records by day, and applied time-varying multivariate Cox proportional-hazard models adjusted for both individual-level (age, sex, marital status, education level) and temporal covariates (year of follow-up, daily mean temperature)

## Results

Subjects were followed for 1,313 days on average, and originated 3,134 readmissions. Annual and daily average PM10 concentrations were both equal to 31  $\mu\text{g}/\text{m}^3$ , with different interquartile ranges (IQR=4 and 10  $\mu\text{g}/\text{m}^3$ , respectively). Their independent associations with cardiac readmissions, expressed as percent increases of risk, and 95% confidence intervals, were 2.10% (-3.31; 7.81) and 4.51% (-0.07; 9.28), per IQR increases of PM10, respectively. Results were robust to model specification and were similar when only long-term or short-term effects were assessed.

## Conclusions

In this study we found evidence of an adverse effect of daily PM10 concentrations on cardiac readmissions in a cohort of MI survivors, while long-term exposure to PM10 was only marginally associated with the study outcome. Further studies should be designed to investigate joint effects of long-term and short-term air pollution exposure in different cohorts and in the general population

## MC17: Ambient air, inflammation & cardiovascular hospitalisation

022, September 25, 2017, 16:00 - 17:30

A conditional Poisson analysis of fine particulate matter and U.S. Medicare hospitalization, 1999-2010, by individual-level chronic health conditions.

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**Background/Aim:** A previous analysis suggested that U.S. counties with higher county-level prevalence of chronic conditions had stronger associations of mortality with fine particulate matter (PM<sub>2.5</sub>). This study assesses the modification of the effect of PM<sub>2.5</sub> on daily hospitalizations by selected individual-level chronic health conditions.

**Methods:** Short-term admissions to inpatient hospitals for Medicare enrollees aged 65 and older from 1999-2010 for non-accidental causes were extracted and grouped by chronic health condition (U.S. Centers for Medicare & Medicaid Services). Readmissions within three days of a discharge were considered an extension of the prior hospitalization. We obtained air quality data from the U.S. Environmental Protection Agency and temperature data from the U.S. National Climatic Data Center. Spatially, daily counts were aggregated by Core-Base Statistical Areas (CBSA) based on county of residence at hospitalization. Conditional Poisson regression was used to estimate CBSA-specific associations of hospitalization with PM<sub>2.5</sub> at lag 1 conditioning on calendar month and day of week and adjusting for natural splines of current and lagged temperature (individual lags 1-3). These CBSA-specific effect estimates were combined using Bayesian pooling.

**Results:** For 298 CBSAs with sufficient environmental data, a 10 µg/m<sup>3</sup> increment in PM<sub>2.5</sub> at lag 1 was associated with a 0.30% increased hospitalization rate (95% Posterior Interval (PI) 0.21, 0.38). Enrollees with chronic health conditions had slightly higher rates: lung cancer 0.39% (95% PI 0.13, 0.65); chronic heart failure 0.35% (95% PI 0.24, 0.45); and depression 0.34% (95% PI 0.23, 0.45).

**Conclusions:** PM<sub>2.5</sub> is associated with an increased rate of hospitalization among all Medicare enrollees aged 65 and older. Enrollees with lung cancer, heart disease and depression have a slightly higher rate of hospitalization on the day after exposure to higher levels of PM<sub>2.5</sub>.

This abstract does not necessarily represent the views of the US EPA.

Limit 300 words

Current count 293 words

## MC17: Ambient air, inflammation & cardiovascular hospitalisation

022, September 25, 2017, 16:00 - 17:30

### Effects of short-term exposure to ambient air pollution on hospital admissions for acute myocardial infarction in Bangkok, Thailand

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**Background/Aim:** Although health effects of air pollutants are reported in many countries around the world especially in western countries, few studies have been conducted in Thailand where pollution mix, weather conditions, and demographic characteristics are different. This study aims to investigate the short-term effects of ambient air pollution on hospital admissions for acute myocardial infarction (AMI) in Bangkok, Thailand.

**Methods:** We obtained daily air pollution concentrations ( $O_3$ ,  $NO_2$ ,  $SO_2$ ,  $PM_{10}$ ,  $PM_{2.5}$ , and  $CO$ ) and weather variables monitored in Bangkok from 2006 to 2014. A total of 26,334 daily admissions for AMI were obtained from 72 hospitals in Bangkok during the study period. A time-series regression analysis with a generalized linear model was used to examine the effects of air pollution on hospital admissions by controlling for time trends and other possible confounders. The effect modifications by age (15-64 years and  $\geq 65$  years), gender, and season were also examined.

**Results:** We found that an increase of  $10 \mu g/m^3$  in  $O_3$ ,  $NO_2$ ,  $SO_2$ ,  $PM_{10}$ ,  $PM_{2.5}$  and  $1 mg/m^3$  in  $CO$  at lag 01 day were associated with a 2.65% (95% CI: 0.94 to 4.39), 2.10% (0.95 to 3.26), 11.24% (4.25 to 18.70), 1.96% (0.95 to 2.98), 2.04% (0.58 to 3.52) and 10.80% (4.43 to 17.55) increase in hospital admissions for AMI, respectively. The effect estimate was attenuated after adjusting for co-pollutants. The effects of air pollutants were more evident in winter (November to February) than in summer (March to May) and monsoon (June to October) with higher effect for adults (15-64 years) compared to elderly ( $\geq 65$  years). Males were more sensitive than females to the effect of air pollution, though the difference was not statistically significant.

**Conclusions:** This study suggests that exposure to ambient air pollution poses significant risk on hospital admission for AMI, providing the data to reduce air pollution concentrations.

# MC17: Ambient air, inflammation & cardiovascular hospitalisation

022, September 25, 2017, 16:00 - 17:30

## Long-term residential exposure to ultrafine particles and C-reactive protein (CRP)

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### Background/Aim

Long-term exposure to ambient air pollution contributes to the burden of disease and particularly affects cardiovascular (CV) causes of death. We investigated the association between particle number concentration (PNC), a marker for ultrafine particles (UFP), and other air pollutants and high sensitivity C-reactive protein (hs-CRP) as a potential link between air pollution and CV disease.

### Methods

A cross-sectional analysis was performed on data of the second follow-up of the KORA S4 survey in Augsburg, Germany (2013-2014). Residential long-term exposure to PNC, particulate matter <10µm and <2.5µm in aerodynamic diameter (PM<sub>10</sub> and PM<sub>2.5</sub>, respectively), PM<sub>coarse</sub> (2.5-10µm), absorbance of PM<sub>2.5</sub> (PM<sub>2.5abs</sub>), nitrogen dioxide (NO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) was estimated by land-use regression models. Associations between annual air pollution concentration and hs-CRP were modelled in 2,252 participants using linear regression adjusting for confounders. Possible effect-modifiers were examined by interaction terms. Two-pollutant models were calculated for pollutants with Spearman inter-correlation <0.70.

### Results

The results pointed to a positive association between PNC, PM<sub>10</sub>, PM<sub>coarse</sub>, PM<sub>2.5abs</sub>, NO<sub>2</sub> and NO<sub>x</sub> and hs-CRP. For PNC, an interquartile-range (IQR, 2,000 particles/cm<sup>3</sup>) increase was associated with a 3.63% [95% confidence interval (CI): -0.86%; 8.33%] increase in hs-CRP. Effect estimates were higher for women, non-obese and participants without history of CVD. Effect modification was also seen for participants without diabetes with the highest effect estimate of 14.71% [95% CI: 5.47%; 24.77%] for an IQR increase of 2.1 µg/m<sup>3</sup> in PM<sub>10</sub>. In two-pollutant models, adjustment for PM<sub>2.5</sub> strengthened the effect estimates for PNC and PM<sub>10</sub> (increase per IQR 6.31% [95% CI: 0.42%; 12.53%] and 7.34% [95%CI: 0.40%; 14.77%], respectively).

### Conclusions

Our results highlight the role of UFP within the complex mixture of ambient air pollution and their inflammatory potential and help fill a research gap since studies on chronic exposure to ultrafine particles are still scarce.

# MC17: Ambient air, inflammation & cardiovascular hospitalisation

022, September 25, 2017, 16:00 - 17:30

The synergistic effect of short and long term exposure to PM<sub>2.5</sub> and temperature on hospital admissions in New England

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## Background

Particulate-pollution and heat are strong predictors of morbidity, yet studies that assessed their joint effect on health, while assessing both short and long-term exposure, are scarce. We aimed to investigate the joint effect of short-term exposure to PM<sub>2.5</sub> and temperature on hospital admissions, accounting for the long-term exposures.

## Methods

We included respiratory, ischemic-heart-disease (IHD) and ischemic stroke admissions of residents (age≥65) across New-England between 2004-2011 and constructed daily counts per zip code. We obtained PM<sub>2.5</sub> and temperature exposure estimates from a model incorporating daily satellite remote sensing data at 1km spatial resolution. We defined short-term exposures as the difference between the two day average of exposures (lags 0-1) and the zip code mean exposure across the study period, and long term exposures as annual moving averages. We performed separate Poisson regressions with a random intercept per zip code for each admission-cause on short-term exposures (including their interaction) and long-term exposures, with adjustment for time and area-level socioeconomic factors. Results are presented as Relative Risks for IQR increase of PM<sub>2.5</sub> (6.1µg/m<sup>3</sup>) or temperature (9°C).

## Results

We found a significant interaction between short-term PM<sub>2.5</sub> and temperature for respiratory admissions, where the effect of PM<sub>2.5</sub> was larger in the 75<sup>th</sup> percentile of temperature (1.010[1.005;1.015]) compared to the 25<sup>th</sup> percentile (1.004[0.999;1.008]). Increase in long term exposure to PM<sub>2.5</sub> was associated with 1.077[1.033;1.123] increase in admissions. Increases in short and long-term exposures to PM<sub>2.5</sub> were associated with increases in admissions for IHD (1.009[1.003;1.016] and 1.082[1.018;1.150], respectively) and stroke (1.013[1.005;1.021] and 1.304[1.208;1.419], respectively). For temperature, long-term exposure was associated with increases of 2.229[1.737;2.859] and 1.191[0.984;1.442] in IHD and stroke admissions.

## Conclusions

We observed a synergistic effect of short-term exposures to PM<sub>2.5</sub> and temperature and respiratory admissions; with higher PM<sub>2.5</sub> effects on warmer days. Long-term exposures were translated into larger increases in hospital admissions compared to short-term exposures.

## MC18: Other Health impacts

100, September 25, 2017, 16:00 - 17:30

International Classification of Diseases codes of morbidity and mortality in populations in the vicinity of coal mining

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**Background/Aim.** Over the last three decades studies of the effects of coal mining on the health of populations living in the vicinity of coal mining have found substantial associations which could suggest public health impacts. However the expression of the outcomes in these studies do not always clearly align with the International Classification of Diseases (ICD). Health outcomes categorised according to the ICD can be used to identify and assess more specific health impacts. This review aimed to identify the ICD codes of morbidity and mortality in studies of general populations living in the vicinity of coal mining.

**Methods.** Systematic searches of three databases were conducted by two independent researchers to identify studies according to selection criteria (e.g. health outcomes that can be categorised in the ICD). The analysis conducted identified health outcomes and research methods, and the quality of the studies was evaluated. Health outcomes not presented as ICD codes were classified by a medical doctor according to the ICD.

**Results.** Twenty eight studies were selected and reviewed. The majority of studies (93%) found significant association between coal mining and one or more causes of morbidity or mortality. Of those studies, 50% presented health outcomes as ICD codes, and 50% had health outcomes which could be classified according to the ICD. Sixty two codes were identified in 10 ICD chapters. Codes in the chapters: external causes, neoplasms, circulatory, respiratory, and genitourinary systems were identified in studies of mortality. Codes in the chapters: neoplasms, metabolic, eye and skin diseases; congenital abnormalities, circulatory, respiratory, and genitourinary systems and perinatal conditions were identified in studies of morbidity.

**Conclusions.** Our review provided a clear framework of ICD codes to use when scrutinising health-based data sets for the prevalence of morbidity and/or mortality in populations residing in the vicinity of coal mining.

## MC18: Other Health impacts

100, September 25, 2017, 16:00 - 17:30

### New Insights into the PM<sub>2.5</sub> and Life-Expectancy Association Using Predicted County-Average PM<sub>2.5</sub> Concentrations

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#### Background

Much of the current evidence of associations between long-term average PM<sub>2.5</sub> exposures and health outcomes relies on exposures derived directly from regulatory monitoring data, using all available monitors in an area. These studies could be affected by limited data, particularly for time periods before 1999 when spatially extensive monitoring began. For instance, Pope et al. (2009) showed that between 1980 and 2000 a 10 µg/m<sup>3</sup> reduction in PM<sub>2.5</sub> was associated with 0.61±0.20 year longer life expectancy. That analysis used 1979-1983 averages of PM<sub>2.5</sub> across 51 U.S. metropolitan statistical areas estimated from about 100 monitoring sites in the Inhalable Particulate Network. Our reanalysis re-examines this association using population-representative county-level predicted concentrations of PM<sub>2.5</sub>.

#### Methods

We used the same life expectancy data in 211 continental U.S. counties as Pope et al. (2009). We predicted annual average PM<sub>2.5</sub> concentrations at 70,000 census tract centroids for 1979-2004, using a previously developed point prediction model. We averaged these to the county level for the same years (1979-1983 and 1999-2000) and estimated regression coefficients for a PM<sub>2.5</sub> reduction on life expectancy improvement over the 1980 and 2000 time periods, adjusting for area-level confounders.

#### Results

We found a 10 µg/m<sup>3</sup> decrease in predicted county average PM<sub>2.5</sub> was associated with an average 0.69±0.31 year increase in life expectancy, slightly higher than the estimate reported by Pope et al. (2009). The PM<sub>2.5</sub> effect estimates varied by pollutant averaging period and were larger when more recent years were included. However, all effect estimates had overlapping confidence intervals.

#### Conclusions

Our approach to estimating population-representative PM<sub>2.5</sub> concentrations lends additional support to the evidence that reduced in fine particulate matter contributes to improved life expectancy. Our estimates had wider confidence intervals because our county-averaged concentrations are less variable than those estimated directly from limited monitoring data.

## MC18: Other Health impacts

100, September 25, 2017, 16:00 - 17:30

### The effect of warm season temperature on *Salmonella* serotypes

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#### Background/Aim

*Salmonella* spp. are a temperature sensitive pathogen and rising temperature can have a substantial effect on disease burden affecting human health. We examined the relationship between warm season temperature and *Salmonella* spp. and serotype notifications in Adelaide, Australia.

#### Methods

Time-series Poisson regression models were fit to estimate the effect of temperature during warmer months on *Salmonella* spp. and serotype cases notified from 1990-2012. Long-term trends, seasonality, autocorrelation and lagged effects were included in the statistical models.

#### Results

Daily *Salmonella* spp. counts increased by 1.3% (IRR 1.013, 95% CI 1.008-1.019) per 1°C rise in temperature in the warm season with greater increases observed in specific serotype and phage type cases ranging from 3.4% (IRR 1.034, 95% CI 1.008-1.061) to 4.4% (IRR 1.044, 95% CI 1.024-1.064). We observed increased cases of *S.*Typhimurium PT9 and *S.*Typhimurium PT108 notifications above a threshold of 38°C.

#### Conclusions

This study has identified the impact of warm season temperature on different *Salmonella* spp. strains and confirms higher temperature has a greater effect on phage type notifications. The findings will contribute targeted information for public health policy interventions, including food safety programmes during warmer weather.

## MC18: Other Health impacts

100, September 25, 2017, 16:00 - 17:30

### Background/Aim

To assess the association between air pollution ( $\text{NO}_2$  and  $\text{PM}_{2.5}$ ) and all-cause mortality for participants who resided in the Sydney Metropolitan region of the 45 and Up Study.

### Methods

We used data from the '45 and Up' cohort study, which is based on 267,153 older residents of New South Wales (NSW), Australia and restricted participants to those who resided in metropolitan Sydney, Australia and who were less than 80 years of age at enrolment. Mortality data was extracted from a deaths register and linked to the baseline questionnaire. Pollutant concentrations at each residential address were estimated using satellite based land use regression models and chemical transport models for  $\text{NO}_2$  for 2007 and  $\text{PM}_{2.5}$  for 2010/11, respectively. Cox proportional hazards models were fitted to assess the associations between air pollution exposure and all-cause mortality, while adjusting for demographic and lifestyle factors and area-level factors.

### Results

For 77,468 participants who satisfied the inclusion criteria, adjusted models resulted in a hazard ratio (HR) of 1.035 (95% CI: 0.967-1.107) per  $1 \mu\text{g.m}^{-3}$  increase in  $\text{PM}_{2.5}$ , and corresponding HR of 1.001 (95% CI: 0.985-1.017) per 1 ppb increase in  $\text{NO}_2$ . However unadjusted models indicated significant associations with both pollutants with HRs of 1.063 (95% CI: 1.008-1.121) for  $\text{PM}_{2.5}$  and 1.013 (95% CI: 1.000-1.025) for  $\text{NO}_2$ . This finding differs from European studies performed in more polluted settings and using comparable models, where  $\text{PM}_{2.5}$  was significantly associated with natural cause mortality after a 14 year average follow-up with HR 1.014 (95% CI: 1.004-1.26). We did, however, observe similar results for  $\text{NO}_2$ .

### Conclusions

For the medium term follow-up period of the study (7.3 years), increases in air pollution had a detrimental impact on mortality for both pollutants, although these were not statistically significant.

## MC18: Other Health impacts

100, September 25, 2017, 16:00 - 17:30

### Distribution of extended-spectrum $\beta$ -lactamases and AmpC $\beta$ -lactamases-producing Enterobacteriaceae in urban and rural areas in Shandong, China

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#### Background/Aim

Antimicrobial consumption in China showed significant geographic distinction. This study aimed to investigate antimicrobial resistance and epidemiology of extended-spectrum  $\beta$ -lactamase (ESBLs), AmpC  $\beta$ -lactamases(ACBLs)-producing Enterobacteriaceae isolated from healthy populations in rural and urban areas in Shandong province, China.

#### Methods

We recruited 332 healthy people in urban and rural areas between 2012 to 2013. Fecal samples were collected and the isolates were identified to the species level. Antimicrobial susceptibility testing was performed by reference Kirby-Bauer method as described by NCCLS. Eighteen commonly used antimicrobial agents was tested. The double-disc synergy test, Etest and agar diffusion tests were used as screening tests to detect ESBLs. All the ceftioxin resistant isolates were subjected to determine ACBLs by combined disc diffusion test & modified three-dimensional test.

#### Results

Escherichia coli composed 76.9% of 351 isolated Enterobacteriaceae, followed by Klebsiella pneumoniae (19.4%). Participants were divided into three groups (adult, primary school and kindergarten children). The prevalence of ESBLs for each group was 6.8%, 15.9%, 25.0% in urban populations and 66.0%, 61.2%, 75.1% in rural populations respectively. Besides, the prevalence of ACBLs in those groups was 9.2%, 10.0%, 3.0% and 21.2%, 16.0%, 14.1%. Overall, sulfamethoxazole, amoxicillin and ampicillin were three major antibiotics which 85%-100% isolates exhibited resistance to. The prevalence of faecal carriage of ESBLs and ACBLs -producing Enterobacteriaceae was significantly higher in rural areas than urban areas. In urban areas, there is a tendency for younger to have higher rate of ESBLs-producing Enterobacteriaceae compared to adults.

#### Conclusions

Our results indicated that antimicrobial resistance in rural areas was more severe than urban areas which may arise from differences in antibiotic regulation and medication patterns. This finding has public health implications for selecting vulnerable populations, given the antibiotic abuse in China, especially in rural areas, and the age-specific difference on ESBLs distribution in urban areas.

## MC18: Other Health impacts

100, September 25, 2017, 16:00 - 17:30

Use of large electronic health record databases for environmental epidemiology studies.

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**Background:** Electronic health records (EHRs) are a ubiquitous component of the United States healthcare system and capture nearly all data collected in a clinic or hospital setting. EHR databases are attractive for secondary data analysis as they may contain detailed clinical records on millions of individuals, including many with rare conditions, with some individuals observed repeatedly over many years. However, the limitations of such databases when applied to environmental epidemiology research must be carefully considered.

**Method:** The Carolina Data Warehouse (CDW) is a large database of EHRs from individuals who visited a University of North Carolina affiliated hospital from January 1<sup>st</sup>, 2004 onward. Since inception the number of hospitals submitting data to the CDW has steadily increased and the number of distinct patients seen in a year has grown from 125,574 in 2004 to 752,621 in 2016. Since 2004 the CDW has recorded 18,211,428 hospital visits with an average of 4.2 visits per individual per year. We will use multivariate Cox proportional hazards models to analyze the relationship between residential air pollution exposure and mortality, effectively treating the CDW as a prospective open enrollment cohort. Despite the large sample size, limitations to consider include the lack of records for out-of-state hospital visits and deaths as well as potential biases within the population with respect to insurance status and underlying disease/reason for visit. Given the size of the CDW, potential confounding and biases may be addressed via both statistical methodologies and carefully considered subgroup analyses.

**Conclusion:** As EHRs become more prevalent and as standardized access for research purposes increases it will be important for researchers to utilize these novel resources in a carefully considered manner to understand relationships between air pollution exposure and health outcomes. This abstract does not necessarily reflect EPA policy.

# MC19: Indoor Air in Developing countries & Infectious Diseases

102, September 25, 2017, 16:00 - 17:30

## Household air pollution and pneumococcal carriage in 6 months old children in Malawi - MSCAPE study

Author information;

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### Background/Aim

Around 3 billion people globally rely on solid fuels for their everyday household cooking. The resultant household air pollution (HAP) causes childhood pneumonia. *Streptococcus pneumoniae* (SP) is the most important causative organism, and naso-pharyngeal carriage (NPC) is considered as a key step in acquiring pneumonia. Very little is known about the association of HAP with NPC. This study aims to investigate the effect of HAP reduction on NPC.

### Methods

The study was carried out at the Karonga Prevention Study, Malawi, where children born in homes with improved stoves and open fire were followed at 6 weeks and 6 months. Nasal swabs of children were obtained for culture and Lyt-A PCR and 48-hr PM<sub>2.5</sub> exposure were measured using the innovative RTI MicroPEM. Data on households, family, and vaccination status were obtained through interview and records.

### Results

The personal exposure measurements and nasopharyngeal carriage are available on 694 children. The incidence of SP carriage was 39% at six week and prevalence of SP carriage was 85% at 6 months of age. The average PM<sub>2.5</sub> exposure was significantly higher for 6-month old children (57.8µg/m<sup>3</sup>, 95%CI:53.8, 62.0) compared to 6-week old children (40.2µg/m<sup>3</sup>, 95%CI:36.4,44.4); p<0.0001). For 6-month old children, the mean exposure of PM<sub>2.5</sub> was higher among SP positive children compared to SP negative children (60.6 µg/m<sup>3</sup> vs 43.4 µg/m<sup>3</sup>; p=0.002). Logistic regression analysis indicates that the exposure to PM<sub>2.5</sub> in 6 month old children is significantly associated with NPC (OR:3.7; 95%CI:1.6-8.5).

### Conclusions

To our knowledge this is the first report showing the relationship between PM<sub>2.5</sub> exposure and SP carriage in young children. NPC is a necessary step leading to pneumonia in children and higher prevalence of NPC may indicate the pathway through which HAP causes pneumonia in young children. Further research is required to elucidate the mechanism of HAP facilitating the NPC.

# MC19: Indoor Air in Developing countries & Infectious Diseases

102, September 25, 2017, 16:00 - 17:30

## Exposure to indoor air pollutants and childhood pulmonary tuberculosis

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### Background/Aim

There is increasing evidence that indoor air pollution increases the risk for tuberculosis. These studies have used proxy measures of exposure. Our study aim was to determine association between exposure to indoor air pollutant (IAP) concentrations in the homes and childhood pulmonary tuberculosis (PTB).

### Methods

In this age- and sex-matched case control study, cases were children clinically diagnosed with PTB and controls were children without PTB. Questionnaires about children's health; and house characteristics and activities were administered to all the participants. A subset of the participants' homes (n=105) was sampled for measurements of PM<sub>10</sub> over a 24-hour period, and NO<sub>2</sub> and SO<sub>2</sub> over a period of 2 to 3 weeks. IAP concentrations were estimated in unsampled homes that using predictive models. Logistic regression was used to look for association between IAP concentrations and PTB.

### Results

Of the 131 participants, 107 were cases and 124 were controls. Pollutants concentrations for cases were PM<sub>10</sub> GM:51.5 (95%CI 46.5-57.1); NO<sub>2</sub> GM:15.7 (95%CI 14.5-17.0) and SO<sub>2</sub> GM:0.3 (95%CI 0.2-0.4); and for controls concentrations were PM<sub>10</sub> GM:49.7 (95%CI 46.1-53.6); NO<sub>2</sub> GM:15.6 (95%CI 14.7-16.6) and SO<sub>2</sub> GM:0.2 (95%CI 0.2-0.3). Day-to-day variability was large. All multivariate models were adjusted for age, sex, socioeconomic status, TB contact and HIV status. No significant association was observed between pollutant concentrations and PTB in children for PM<sub>10</sub>, NO<sub>2</sub>, and SO<sub>2</sub>. When using the crude exposure measure of fuel type (clean or dirty fuel) and environmental tobacco smoking (ETS) there was also no significant association with PTB, although the point estimate was high for fuel type (aOR 6.3; 95%CI 0.6-62.0). The latter predictors are less influenced by day-to-day variability.

### Conclusions

No clear association was found between household air pollution and childhood PTB. HIV status and TB contact are important factors of childhood PTB in this population.

# MC19: Indoor Air in Developing countries & Infectious Diseases

102, September 25, 2017, 16:00 - 17:30

## Effects of indoor and ambient absolute humidity on the outbreak of Influenza

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### Background/Aim

People spend almost 90% of their time in built environments, but most of the health-related ecological studies adopted the ambient meteorological factors as the indicators for individual exposure profile. Over or under estimates of health risks may cause due to the level difference of meteorological factors between indoors and outdoors. In winter, influenza is an epidemics contagious respiratory disease in Taiwan. This study is aimed to examine the differences of the effects between indoor and ambient absolute humidity (AH) on the outbreak of Influenza.

### Methods

Long-term-hourly indoor AH level was recorded from 30 residences in 11 cities of Taiwan from 2012 to 2015, and simultaneous ambient levels were also collected from nearby weather stations. The predictive models ( $R^2 = 75.5\%$ ) for indoor AH were established beforehand based on the above-mentioned dataset, and the levels of monthly-average indoor AH from 2012 to 2015 by 19 counties were further estimated. The corresponding period of monthly local influenza confirmed cases ( $n= 5210$ ) were retrieved from the centre for disease control (CDC) of Taiwan. The relationship between monthly influenza cases and estimated-indoor or ambient AH was examined by the generalized estimating equation method.

### Results

The average (sd) levels of ambient and estimated-indoor AH were 15.99 (3.699) and 16.53 (2.70), respectively. The result showed that every  $10 \text{ g/m}^3$  decrease of ambient AH was associated with the increase of 1.1 case of influenza ( $\beta = -1.1162$ ; 95 % C.I. = -2.0536, -0.1788). Moreover, every  $10 \text{ g/m}^3$  decrease of indoor AH was associated with the increase of 1.5 case of influenza ( $\beta = -1.5265$ ; 95 % C.I. = -2.8085, -0.2445).

### Conclusions

The preliminary result reveals that the effect of indoor AH on the outbreak of Influenza is greater than that of ambient AH. Indoor meteorological factors are critical to the preventive strategy of public health.

# MC19: Indoor Air in Developing countries & Infectious Diseases

102, September 25, 2017, 16:00 - 17:30

Exhaled carbon monoxide as a potential biomarker of household air pollution exposure: a cross-sectional study of 0.5 million Chinese adults

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## Background/Aim

Exhaled carbon monoxide (COex) is increasingly used as a biomarker for household air pollution (HAP) exposure, but there is uncertainty about the findings that highlights the need for reliable evidence. We investigated the association between COex and self-reported HAP exposure in 0.5 million adults.

## Methods

The China Kadoorie Biobank recruited 0.5 million adults aged 30-79 years from 10 diverse localities of China in 2004-2008. At baseline, participants undertook measurement of COex and reported fuel-related HAP exposure. Logistic regression was used to estimate the odds ratio (OR) for HAP exposure indicators with COex level  $\geq$  7ppm, after adjusting for important confounders. All analyses were conducted separately in never- and current-smokers surveyed in non-winter and winter months.

## Results

In never-smokers surveyed in non-winter months ( $n = 231,226$ ; 91% female), higher levels of COex were associated with the use of coal (OR [95% confidence interval]: 2.81 [2.69-2.93]), wood (1.36 [1.28-1.45]) and gas (1.72 [1.57-1.89]) for cooking (compared to electricity), longer duration of cooking ( $\geq 60$  mins: 1.24 [1.20-1.28]), regular use of slow burning stove (1.50 [1.45-1.56]), and exposure to more HAP indicators ( $\geq$  three: 2.39 [2.29-2.50]). The associations were stronger in winter. The use of coal (1.59 [1.52-1.66]) and wood (1.32 [1.24-1.41]) for heating were also associated with higher levels of COex compared to those without heating. The results were consistent across rural and urban areas, and they were broadly similar after mutual adjustment of HAP exposure or restriction to female participants not exposed to passive smoking. Current-smokers ( $n = 111,629$ , 95% male) who are exposed to  $\geq$  three HAP indicators also had higher levels of COex (non-winter: 1.68 [1.42-1.97]; winter: 1.74 [1.29-2.37]).

## Conclusions

This large scale study of 0.5 million Chinese adults provides supports for the use of COex as a potential biomarker for HAP particularly for coal-related fuel exposure.

# MC19: Indoor Air in Developing countries & Infectious Diseases

102, September 25, 2017, 16:00 - 17:30

## Global citizen-led insights into the composition and risks of household dust

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### Background

Australian and international science-public health experts have collaborated to launch at the ISEE 2017 a new global citizen science program (*DustSafe*) to examine environmental exposure from household dust. Currently, there is a lack of knowledge regarding indoor dust exposure even though people are spending increasing amounts of time indoors (up to ~90% of their day). Household dust particles may contain harmful agents that impact health via ingestion and inhalation pathways. However, the composition and risk associated with household dust is largely unknown. The program will address this knowledge gap by engaging with homeowners to collect and submit household vacuum dust samples and resident meta-data for geochemical and biological analysis.

### Method and approach

Vacuum cleaner dust, collected by citizen scientists, will be analysed for metal(loid) concentration using X-ray fluorescence spectrometry (XRF) while mineralogy will be determined using X-ray diffraction. The program will operate independently in each partner country, with the Australian node having experts in capital cities who co-ordinate enquiries, public outreach and analysis. Global data will be uploaded to a web portal providing summary spatial, geochemical and mineralogical interpretation and guidance for participants.

The program's goal is to analyse a randomly sampled subset of samples for a wider range of organic and inorganic contaminants: asbestos, flame retardants, allergens, anti-microbial resistance genes, pesticides and dioxins, perfluorinated chemicals and lead isotopes for fingerprinting and sourcing. Samples for this comprehensive '360' high-resolution analysis will be stratified according to household age (20-year age bands covering properties from < 20 years old to >100 years old).

### Conclusions

Dust is considered to be a key contaminant exposure source particularly for young children. The *DustSafe* program will provide insights into the prevalence of significant legacy and emerging contaminants and provide a unique platform for engaging the public about potential health risks from dust exposure in their homes.

## MC19: Indoor Air in Developing countries & Infectious Diseases

102, September 25, 2017, 16:00 - 17:30

### Ethical Considerations in Air Pollution Exposure Assessment

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Air pollution exposure is distinct by virtue of its involuntary nature from other more voluntary disease risk factors (e.g., diet, alcohol, and tobacco). Because individuals cannot usually choose to control their exposure to air pollution, research on air pollution is integral for upholding the ethical principle of protecting the public interest and vulnerable populations. However, the current state of the science raises numerous ethical considerations. The health burden of air pollution falls most heavily on low- and middle-income countries exposed to disparate sources of pollution such as traffic, industrial processes, and biomass burning. Yet, much of the seminal work that has contributed to our knowledge of air pollution exposures and health effects has occurred in European and North American populations. The appropriateness of extrapolating exposure-response relationships between different pollution sources, concentrations, and populations, for example, should be questioned. Studies focused on exposure only (and not health risk) can allow researchers to maximize limited resources to serve more people. Are there ethical obligations to communicate risks along with exposure results? Conversely, are there ethical problems with such communications when risk is not measured in the population? There is substantial evidence that indirect exposure estimates may not adequately capture personal exposures. Yet, new methods, for example ones that combine satellite data and exposure models, may provide low-burden options for estimating exposures in individuals or smaller populations. Because community engagement is integral to ethical research, researchers must consider a responsible level of interaction and communication with communities when undertaking indirect research. Further, the uncertainties involved in such exposure estimates must be recognized. This presentation will discuss these and other ethical considerations related to exposure assessment and the choices of study populations and methods to employ in future air pollution research.

## MC20: Ambient air child neurological

105, September 25, 2017, 16:00 - 17:30

### Air pollution and cognitive development in children of UK Millennium Cohort Study

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#### Background/Aim

There is increasing interest in the possible link between air pollution and cognitive development, but the evidence remains inconclusive. We investigated the association between long-term exposure to air pollution and cognitive development in children in the UK's Millennium Cohort Study (MCS).

#### Methods

The MCS follows children born in 2000-01, ~13,000 of whom (England 63%, Wales 15%, Scotland 11% and Northern Ireland 10%) were assessed for cognitive development. We linked each child to the annual mean concentration of PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub> and SO<sub>2</sub> at the postcode centroid for his/her home address at the time of assessment. Cognitive function was assessed at age 3, 5 and 7 years using the British Ability Scales (BAS) and National Foundation for Education Research methods. Age-normalized T-scores of each domain (two domains at age 3, three each at ages 5 and 7), and their changes over time, were analysed by multiple linear regression with adjustment for sex, ethnicity, socioeconomic status and country/region, and allowing for clustering by local authority or district.

#### Results

In England, a 10µg/m<sup>3</sup> increase in PM<sub>2.5</sub>, PM<sub>10</sub> and NO<sub>2</sub> was associated with a change of -5.2 (95%CI: -7.4, -2.9), -3.7 (-5.2, -2.3) and -1.1 (-1.6, -0.5) in Naming Vocabulary score at age 5, but small (not statistically significant) changes in the two other domains. At age 7, a 10µg/m<sup>3</sup> increase in PM<sub>2.5</sub> was associated with a change of -2.8 (-5.5, -0.1) in Pattern Construction scores, but no other pollutant-outcome combination showed evidence of adverse association. Results for Scotland were broadly similar to those for England, but somewhat different in Wales and Northern Ireland.

#### Conclusions

Higher PM<sub>2.5</sub>, PM<sub>10</sub> and NO<sub>2</sub> concentration was associated with lower cognitive ability in selected cognitive assessments at ages 5 and 7, but not consistently so in all countries of the UK and at all ages.

(297 words)

## MC20: Ambient air child neurological

105, September 25, 2017, 16:00 - 17:30

### Combined effect of air pollution and secondhand smoke on neurodevelopment at 24 months

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#### Background/Aim

Neurodevelopment of infants have been associated with exposure to secondhand smoke (SHS) and air pollution (AP), respectively. There has been very few previous studies of combined effect of AP and SHS on early neurodevelopment. We aim to investigate the combined effect of AP and SHS prenatal exposure on neurodevelopment of infants at 24 months of age.

#### Methods

We analyzed 721 mothers and their offspring from Korean multicenter birth cohort study: Mothers and Children Environmental Health (MOCEH). We measured maternal urinary cotinine to represent SHS exposure during pregnancy. Average exposure levels to PM<sub>10</sub> (particulate matter <10 in diameter) and nitrogen dioxide during the entire pregnancy were estimated using the inverse distance weighting method. Infant's mental developmental index (MDI) and psychomotor developmental index (PDI) were measured using the Bayley Scales of Infant Development at 24 months of age. General linear model was used to assess the relationship between combined exposure of AP and SHS and neurodevelopment.

#### Results

MDI score of 24 months aged infants was associated with cotinine [ $\beta = -2.56$ , 95% confidence interval (CI): -4.58, -0.53] in mothers with early pregnancy urinary cotinine levels >1.90 ng/ml. The MDI score of infant was more decreased in mothers exposed to both PM<sub>10</sub> >50  $\mu\text{g}/\text{m}^3$  during pregnancy and high exposure of SHS [ $\beta = -2.85$ , 95%CI: -5.17, -0.54]. The negative association was reduced when children received breast milk up to 6 months [ $\beta = 0.06$ , 95%CI: -3.13, 3.24]. However, the combined effect was more pronounced in mothers with both GSTM1/GSTT1 null type on MDI [ $\beta = -8.17$ , 95%CI: -12.27, -4.06] and PDI [ $\beta = -3.65$ , 95% CI: -7.38, 0.08].

#### Conclusions

These findings suggest that maternal combined exposure to PM<sub>10</sub> and SHS during pregnancy may result in delayed neurodevelopment in early childhood and propose its combined effects. The effect might be modified by genetic polymorphism and breastfeeding.

## MC20: Ambient air child neurological

105, September 25, 2017, 16:00 - 17:30

### The relationship between the natural environment, road density, and academic performance in Portland, Oregon

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#### Background/Aim

A growing number of studies suggest a link between the natural environment and cognitive function. However, few of these studies have focused on the influence of the natural environment on academic performance, despite academic performance being an important measure of cognitive function and the well-established links between academic performance and a range of short- and long-term health outcomes. In addition, all but one of these studies have used aggregate school-level measures of academic performance, and all have exclusively focused on the natural environment around a child's school, without consideration of the area around their home.

#### Methods

We examined the relation between individual-level standardized test scores and the natural environment around a child's school and home using data from Portland Public Schools (83 schools including over 17,000 students). We estimated linear mixed models with random effects for a child's school and a child's home neighborhood. Estimates were adjusted for student-level race/ethnicity, gender, grade, English as second language, free or reduced-cost lunch, attendance rate, neighbourhood-level socioeconomic status, crime, and road density (as a proxy for air pollution).

#### Results

We found that a 1-SD increase in tree cover within 200m of a child's home was associated with moving from the 50th percentile to the 51st percentile on math tests. A 1-SD increase in both tree and grass-and-shrub cover within 100m of a child's was associated with moving from the 50th percentile to the 52nd percentile on reading tests. Finally, a 1-SD increase in road density around a child's school was associated with moving from the 50th percentile to the 43rd percentile on reading tests.

#### Conclusions

Our results suggest that exposure to the natural environment is associated with small improvements in academic performance. Conversely, higher road density around a child's school may impair academic performance.

## MC20: Ambient air child neurological

105, September 25, 2017, 16:00 - 17:30

### Associations between prenatal exposure to air pollutants and developing autism: A population-based cohort study in Metro Vancouver, Canada

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**Background/Aim:** This study assesses the association between PM<sub>2.5</sub>, NO, and NO<sub>2</sub> exposures with autism spectrum disorder (ASD) incidence in a large population-based cohort. ASD is a neurodevelopmental condition characterized by impaired social communication and repetitive or stereotypic behaviours. The aetiology of ASD is poorly defined, but prior studies suggest an association between air pollution exposure and ASD.

**Methods:** We conducted a retrospective cohort study to evaluate prenatal exposure to PM<sub>2.5</sub>, NO, and NO<sub>2</sub> and the development of ASD among all live births in Metro Vancouver, Canada, from 2004–2009. Children were identified with ASD by the BC Autism Assessment Network, using standardized assessment of Autism Diagnostic Interview-Revised and Autism Diagnostic Observation Schedule (ADOS). We developed temporally adjusted land use regression models to estimate monthly mean exposures to ambient pollution at the home residence for each woman throughout the pregnancy. We used logistic regression to estimate odds ratios (OR) and 95% confidence intervals (CI) of exposure for the entire pregnancy, adjusting for maternal age and birthplace, parity, multiple births, co-parent status, income bands, and child sex.

**Results:** The cohort comprised 132,257 births, of which 1,307 (1%) children were diagnosed with ASD. The mean PM<sub>2.5</sub> exposure during pregnancy was 3.5 µg/m<sup>3</sup> (IQR = 1.5 µg/m<sup>3</sup>); the mean NO was 20.8 ppb (IQR = 10.7 ppb); and mean NO<sub>2</sub> was 15.2 ppb (IQR = 4.7 ppb). The adjusted OR for ASD per 10 µg/m<sup>3</sup> of PM<sub>2.5</sub> during pregnancy was 1.29 (95% CI: 0.92–1.79); per 10 ppb of NO, 1.05 (95% CI: 1.00–1.10); and per 10 ppb of NO<sub>2</sub>, 1.11 (95% CI: 0.99–1.25).

**Conclusions:** Using individual, specific diagnostic clinical data, we observed some evidence of associations between exposure to air pollutants and increased ASD risk in a population-based cohort with relatively low levels of air pollution.

## TUP01: Climate Change Plenary/McMichael Award and Rebecca James Baker Award

Seymour Centre, September 26, 2017, 08:30 - 10:00

Health and the Climate Crisis: Evidence for Pursuing a Low-carbon Economy

Jonathan Patz

Professor, University of Wisconsin at Madison

The global climate crisis poses large risks to public health through many exposure pathways, from heat waves and air pollution, to malnutrition, infectious diseases and social dislocation. At the same time, confronting the cause of climate change —reducing greenhouse gas emissions — offers benefits to health, especially by reducing chronic diseases. Current energy-intensive lifestyles in wealthy countries run counter to health promotion; for example, more than 60% of Americans do not meet the minimum recommended level of daily exercise, and obesity now ranks as the top health risk in the US. This keynote will include recent analyses that shows how mitigating global warming provides extensive health opportunities, as well as major savings in healthcare costs and worker productivity. Research results from three main sectors will be presented, including the energy, food, and transportation sectors. For example, over one million lives could be saved annually in China from replacing coal-based electricity with cleaner fuels. A diet with less red meat will both mitigate greenhouse gas emissions and reduce saturated fat and risk of cardiac disease. And finally, opportunities abound to enhance physical fitness through “active” transportation (via walking and biking) thereby reducing the risk of coronary heart disease, strokes, diabetes, depression and colon and breast cancer. Presenting recent quantitative scientific studies across all three sections (energy, food systems, and transportation) this keynote will review co-benefit studies of climate change policies and will demonstrate why achieving a low-carbon society may represent the largest public health opportunity of our times.

## **TUP01: Climate Change Plenary/McMichael Award and Rebecca James Baker Award**

**Seymour Centre, September 26, 2017, 08:30 - 10:00**

### **Navigating Adaptive Climate Change Pathways for Torres Strait Communities**

Maintaining health, building resilience and developing ways to adapt to the impacts of climate change around the world is a challenge faced by all citizens. Indigenous Peoples' globally bear the greatest physical, social, cultural and spiritual risks from human induced environmental changes that are often in direct opposition to their traditionally sustainable ways of living. Those working proactively in adaptation face enormous challenges with no one-size-fits-all methodology available to tackle the multitude of diverse scenarios and negotiate a course through the maze of optional corridors that these challenges present. This presentation will cover the journey undertaken by one unique group of Indigenous Australians, the Torres Strait Islander people, in striving to address their aspirations to secure a sustainable way of life for future generations and remain in their cultural homelands.

Situated between the northern tip of Queensland, Australia and Papua New Guinea, are the little known remote Torres Strait islands, home to over 4,600 people. The Islanders have been increasingly concerned over the past thirty years about noticeable changes to their local natural environment, including wildlife behavioural patterns, seasonal variations and dying corals, and particularly worrying, beach erosion and tidal inundation. Whilst the latter problems may be tackled through shorter term physical infrastructure remedies, including building seawalls and raising houses, people are beginning to realise there are many social and cultural impacts associated with these changes which are not all able to be simply fixed through financial aid. Following numerous scientific research studies on the likely impacts of the changing climate in this tropical environment, the Torres Strait Regional Adaptation and Resilience Plan 2016-2021 has been developed to address local concerns. This plan is the result of several years of consultation with the traditional owners of the sixteen individual communities deemed to be the most seriously affected. The National Climate Change Adaptation Research Facility praised the quality and significance of this achievement by awarding this speaker its highest honour as its 2016 Adaptation Champion in the Individual category.

Whilst the plan has been developed and accepted by most relevant government and scientific agencies as well as Torres Strait Islander leaders and communities, there are still challenges to overcome in securing buy-in and action by other important key stakeholders, including health authorities. There is an urgent need for innovative health research to support local communities' call for proactive action to protect their health and wellbeing.

# SYM05: Climate change adaptation and mitigation

104, September 26, 2017, 10:30 - 12:00

## Capacities and activities to adapt to the health risks of climate change in South-East Asia

**Kathryn Bowen\***, School of Population Health, Australian National University, Canberra, Australia

Kris Ebi, Centre for Health and the Global Environment, University of Washington, Seattle, United States

Payden, World Health Organization, South East Asian Regional Office, Delhi, India

### Background/Aim

The most vulnerable populations of South-East Asia<sup>1</sup> consist of farmers dependent on rain-fed agriculture, the rural poor, urban slum dwellers, mountain people, small island populations, and those living on the seacoast. The pre-existing high burdens of climate sensitive diseases, weak public health systems, and limited access to primary health care contribute to the vulnerability of millions of people in South-East Asia. Extreme weather events may further disrupt frail health infrastructure. The aim of this World Health Organization-commissioned project was to strengthen the climate change and health responses of South-East Asia member countries, by reviewing the adaptive capacity of the health sector to respond to climate change risks.

### Methods

The assessment included desk-based studies of relevant policy documents and peer-reviewed and grey literature, as well as field visits to a selected number of countries. Key stakeholder interviews were conducted, and an electronic survey was also used. The areas of focus for the review were – i) awareness levels; ii) mainstreaming; iii) partnerships; iv) priority; v) mitigation and adaptation activities; vi) gaps in plans and policies.

### Results

Current policies and programs are inadequate to address the health risks and additional supportive measures are needed to manage changing health burdens. Only a small number of national public health policies have included climate change as a key consideration. National climate change action plans identified health projects as one of their priorities, but there was generally very little information on implementation processes. Recommendations were suggested.

### Conclusions

Given that only a small number of national public health policies included climate change as a key consideration, it is difficult to develop appropriate responses to the health risks posed by climate change; garner necessary support from partner ministries; and access funding for health and climate change activities. Recommendations were suggested to strengthen the health sector's response.

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<sup>1</sup> Bangladesh, Bhutan, DPRK, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand and Timor-Leste

# **SYM05: Climate change adaptation and mitigation**

**104, September 26, 2017, 10:30 - 12:00**

## **Review of studies modelling the health co-benefits of climate mitigation policies and technologies**

**Kristie L. Ebi\*, School of Public Health, University of Washington, Seattle WA, USA**

**Background/Aim:** Significant reductions in greenhouse gas emissions beyond the Nationally Determined Commitments coming out of the 2015 Paris Climate Agreement are required to avoid warming of 2°C above pre-industrial temperatures. Ancillary health benefits represent selected near term, positive consequences of climate policies that can offset mitigation costs in the short term, before the benefits of those policies on the magnitude of climate change are evident.

**Methods:** We evaluated the range of methods and choices in modeling the health co-benefits of climate mitigation to identify opportunities for increased consistency and collaboration to better inform policy-making. We reviewed 40 studies quantifying the health co-benefits of climate change mitigation: (1) reducing the concentrations of ambient fine particulate matter (PM<sub>2.5</sub>) and secondary pollutants such as ozone; (2) increasing active transport; and (3) sustainable dietary changes, published since the 2009 Lancet Commission “Managing the health effects of climate change”. We documented approaches, methods chosen, scenarios, health-related exposures and health outcomes

**Results:** Air quality, transportation, and diet scenarios ranged from specific policy proposals to hypothetical scenarios, and from global recommendations to stakeholder-informed local guidance. Geographic and temporal scope as well as validity of scenarios determines policy relevance. More recent studies tended to have more sophisticated methods to address complexity in the relevant policy system.

**Conclusions:** Mitigation could improve health in the shorter term even as reduced emissions decrease the risks of climate change later in the century. Health co-benefits from mitigation policies in other areas are likely, with further exploration warranted to better estimate the full range of possible benefits for a basket of mitigation policies and technologies.

# SYM05: Climate change adaptation and mitigation

104, September 26, 2017, 10:30 - 12:00

## Evaluation for the Health Benefits of Coal fired PM2.5 Reduction in China

Author information; Arial 8pt (please overtype this)

**Xiaochuan Pan\***, Peking University School of Public Health, Beijing 100191, China

Guoxing Li, Peking University School of Public Health, Beijing 100191, China

Liqun Liu, Institute of Basic Medical Sciences, Chinese Academy of Medical Sciences & School of Basic Medicine, Peking Union Medical College, Beijing 100005, China.

### Background/Aim

The coal consumption is main source of energy use in China and accounted for about a half in the world. The coal fired emission has largely contributed to ambient PM2.5 pollution and related health impacts of exposed population, which becomes big challenges China must face to now. The aims of this study were to evaluate the long term effects of ambient PM2.5 in China, and to estimate quantitatively health benefits from the coal fired ambient PM2.5 reduction in different cities and scenarios in China.

### Methods

The ambient PM2.5 concentration and mortality data of exposed population for Ischemic Heart Disease (IHD); STROKE; chronic obstructive pulmonary disease (COPD) and LUNG CANCER were collected and distributed in 36kmX36km grid cell as a basic research unit for grid computing population density of overall population of Chinese mainland and corresponded area. Integrated Exposure Response (IER) function Based on international literature for GBD in 2012 was used to evaluate the population attributable risk (PAR) caused by coal fired PM2.5 emissions and the health benefits from the scenarios of coal fired PM2.5 reduction, based on expected coal control policies in China.

### Results

Excess mortalities of coal fired PM2.5 was 708,000 in 2012, which include 90,000 COPD mortalities, 173,000 IHD mortalities, 377,000 stroke mortalities and 69,000 and lung cancer mortalities respectively. Excess mortalities mainly distributed in eastern part of China. That excess mortalities was downward from 2012 to 2050 and such trend was sharper in coal controlling scenarios.

### Conclusions

Coal fired PM2.5 emission was mainly contributed to excess mortalities of exposed population in China, and it could be much reduced under the coal control policy scenarios in near future.

# **SYM05: Climate change adaptation and mitigation**

**104, September 26, 2017, 10:30 - 12:00**

The tri-benefits of green infrastructure – health, environment and economic

**Kathryn Bowen\*, School of Population Health, Australian National University, Canberra, Australia**

## Background/Aim

Green infrastructure (GI) has been identified as an effective adaptation strategy for climate change and is particularly relevant to urban areas. Green infrastructure is the “interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations”. It provides multiple benefits from an adaptation perspective including cooling, air quality and reduced flooding, and also provides multiple ecosystem services, which benefit human health and wellbeing, thereby increasing the liveability of cities. Despite significant research on the multiple benefits provided by green infrastructure, it has not been widely embraced as a critical infrastructure element for cities. Progress towards understanding the role of GI and its health and economic benefits will be outlined in this presentation.

## Methods

The paper highlights the international move to understanding the importance of green infrastructure, using case studies from Melbourne, Australia. The paper also outlines ways in which economic theory has been used to develop business cases to support the increase of green infrastructure.

## Results

Green infrastructure has been embraced in many urban locations, however much remains to be done. Melbourne has some very good examples of effective green infrastructure projects, which have been well supported by policy makers and the community. Green infrastructure is currently not seen as a core component of planning processes, partly because business cases are not being developed to support its implementation.

## Conclusions

It is imperative that researchers develop consistent and measurable methods of evaluating the economic benefits of green infrastructure in order for it to be better integrated in our rapidly urbanising settings.

# SYM12: Environmental health in indigenous populations

024, September 26, 2017, 10:30 - 12:00

## Oil extraction in the Amazon basin and exposure to metals in indigenous populations

**Cristina O'Callaghan-Gordo\***, ISGlobal, Centre for Research in Environmental Epidemiology (CREAL), Barcelona, Spain

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### Background/Aim

Two-thirds of oil extraction areas in the Peruvian Amazon are within indigenous territories. Poor environmental practices and oil spills have contaminated the environment and exposed the indigenous population to metals, PAHs and other contaminants. Moreover, unplanned and rapid economic growth has led to rapid changes in traditional life-style (i.e diet and alcohol consumption) with further unexpected impacts on health. We present results of a health survey conducted 13 to 16 months after the occurrence of two major oil spills from the Northern Peruvian pipeline that passes through the indigenous Kukama communities of Cuninico and San Pedro.

### Methods

In January 2016, the Peruvian National Institute of Health (CENSOPAS-INS) tested blood for lead and urine for arsenic, cadmium and mercury from the inhabitants of these communities. Concentrations of metals were determined using atomic absorption spectrophotometry.

### Results

Nine percent of the population (129/1400) participated in the survey. Median (interquartile range) blood lead levels were 2.4 µg/dL (1.6). Median urine levels creatinine corrected were 3.1 (3.0) µg/g for arsenic, 1.8 (1.0) µg/g for cadmium and 5.1 (5.3) µg/g for mercury. 17% and 50% of the study population had levels of cadmium and mercury higher than those recommended by the Peruvian Ministry of Health (2 µg cadmium/g creatinine and 5 µg mercury/g creatinine). The highest levels of mercury were observed in children <10 years (median 6.9 µg/g). Among working-age men (n=26), participation in cleaning-up activities after the oil spills seemed to be associated with higher blood lead and urine cadmium and mercury levels although these increases were not marked. Life-style related exposures could not be evaluated.

### Conclusions

High levels of metals were observed in indigenous populations living in oil extraction areas on the Peruvian Amazon. Future studies should focus on the evaluation of health effects of environmental contamination in combination with health effects of rapid life-style changes.

# SYM12: Environmental health in indigenous populations

024, September 26, 2017, 10:30 - 12:00

## Environmental improvements to Aboriginal Health in Australia

Author information; Jeff Standen, Manager Aboriginal Environmental Health Unit, New South Wales Ministry of Health, ; PhD Candidate, School of Public Health, University of Sydney, New South Wales, Australia.

This presentation will provide an overview of indigenous health status in Australia and describe one environmental initiative that has demonstrated improvements to environmentally related diseases.

Numerous studies and government reports over many decades have documented poorer socio-economic and health outcomes for Aboriginal people in Australia compared to the mainstream population.

Despite this evidence and ongoing government commitments to decrease this disparity, many health indicators have shown little improvement including environmentally related infectious diseases such as skin, gastrointestinal and respiratory conditions.

The NSW Housing for Health program has been working with Aboriginal communities for 18 years to identify and improve specific items in over 3500 houses to ensure they function to support healthy living practices. All work on the houses is prioritised to achieve nine evidence-based criteria.

An evaluation of the program linked geocoded hospital separations data to participating houses over a 10 year period. Before and after hospital separation rate ratios for residents of houses receiving the program were compared with a control group over the same time period.

Rates of hospital separations for residents of the participating houses decreased significantly ( $RR = 0.62$ ) whilst the rates in the control group were increasing ( $RR=1.03$ ) over the same time period. The study concluded residents of the houses that received the Housing for Health program had a 40% reduction in infectious disease hospitalisations compared to those in the control group.

# SYM12: Environmental health in indigenous populations

024, September 26, 2017, 10:30 - 12:00

## Climate change and the right to health for Māori in Aotearoa/New Zealand

**Rhys Jones\***, Te Kupenga Hauora Māori, University of Auckland, Auckland, New Zealand  
Hayley Bennett, c/- Department of Anaesthetics, Rotorua Hospital, Rotorua, New Zealand  
Gay Keating, University of Otago, Wellington, New Zealand  
Alison Blaiklock, Department of Public Health, University of Otago, Wellington, New Zealand

### Background/Aim

Climate change threatens to exacerbate existing inequities in health between Māori and non-Māori in Aotearoa/New Zealand. Yet the challenges posed by climate change are accompanied by considerable opportunities to advance indigenous rights and reduce health disparities. New Zealand, having ratified human rights treaties that include the right to health, must be accountable to its obligations relating to climate change and Māori health. We used a human rights perspective to elucidate relationships between climate change and Māori health and identify New Zealand's obligations to act justly.

### Methods

We examined issues related to climate change and Māori health using a right-to-health analytical framework. The scope for this analysis included the effects of climate change itself, approaches to minimise climate change by limiting greenhouse gas emissions (mitigation) and future adaptations to a warmer climate (adaptation).

### Results

Climate change, if allowed to continue unchecked, is incompatible with progressive realisation of the right to health for Māori in Aotearoa/New Zealand. Strategies to mitigate and adapt to climate change pose serious threats to the right to health for Māori unless equity is prioritised.

### Conclusions

Our analysis identified several important areas in which the government is currently failing to meet its obligations arising from the right to health for Māori. Based on the findings of this work, there is a clear obligation on the New Zealand government to dramatically and urgently reduce domestic greenhouse gas emissions. Climate change mitigation strategies with clear health and equity co-benefits should be adopted immediately, with other interventions designed, implemented and evaluated carefully in partnership with Māori. Action should be underpinned by a commitment to self-determination for Māori communities, respect for indigenous philosophies and knowledges, and recognition that indigenous ways of knowing can contribute to mitigation and adaptation strategies that benefit all people.

# SYM12: Environmental health in indigenous populations

024, September 26, 2017, 10:30 - 12:00

## Environmental and Socio-economic Challenges of Indigenous Population in Nigeria

**Adetoun Mustapha\***, Department of Epidemiology and Biostatistics, MRC-PHE Centre for Environment and Health, Imperial College London, London, United Kingdom

### Background/Aim

With over five hundred different ethnic groups, Nigeria is a deeply divided society on the basis of the plurality of ethnic, religious and regional characteristics. The United Nations report on Nigeria's Common Country Analysis, describe Nigeria as one of the most unequal countries in the world. This presentation will evaluate environmental and socio-economics episodes among indigenous people in Nigeria and opportunities to promote environmental justice.

### Methods

Case study of three purposely selected indigenous populations from published literature and content analysis of relevant publications of government and international organizations agencies was carried out. Informal interview of members of the population was conducted to understand local issues that may not normally be contained in published documents.

### Results

Criteria for identifying indigenous peoples are open-ended. The concept adopted in this study is that certain groups are discriminated in particular ways because of their particular culture, mode of production and marginalized in a way that other groups within the state do not suffer from. On this basis, the Ogonis, the nomadic Fulanis and the Southern Kaduna communities are selected for study. These three groups have concerns about land and natural resource rights, provision of basic infrastructure, economic empowerment and environmental degradation.

Oil and gas exploration has produced environmental damage in the Niger Delta region where the Ogonis who traditionally depend of farming and fishing live. The nomadic Fulani pastoralists are often alienated from their host community's natural resources and now compete for access to wetland areas with famers. The Southern Kaduna Christian minorities have claimed discrimination over leadership in governance and distribution of resources by the mostly Hausa, Muslim majority in Northern Nigeria.

### Conclusion

Enumeration of Nigerian indigenous population is needed as several minorities meet most of the criteria for indigeneity. Further research on the Nigerian indigenous populations is equally required to address their concerns and socio-economic development.

# SYM12: Environmental health in indigenous populations

024, September 26, 2017, 10:30 - 12:00

Indigenous peoples and environmental problems - challenges and opportunities

**\*Professor Helen E Moewaka Barnes, SHORE & Whariki Research Centre, College of Health, Massey University, Auckland, New Zealand**

**Background/Aim:** In Aotearoa New Zealand, Maori - the indigenous peoples - are driving multiple environmental projects. Many involve collaborations between researchers, local people and local, regional and national agencies. Increasingly, indigenous peoples are communicating globally, sharing many similar concerns as well as solutions. The presentation will explore collaborative projects with Maori communities involving a range of issues related to land and water: potable water and climate change, environmental degradation, Treaty settlements and the return of highly modified lands. The work covers issues of policy, land use, restoration, local, regional, national and international collaborations, 'social movements' and the role that social science can play in bringing these together.

**Methods:** Drawing on multiple collaborative projects with Maori communities the broader research explores relationships between people and land and the challenges and opportunities presented. Using Maori driven projects as case studies, this presentation will discuss the evidence and actions that are occurring and are needed to improve wellbeing.

**Results:** Local projects often do not aspire to, nor can they remain local if they are to achieve their goals. Working from local to national to global realms, networks of projects are able to see results on multiple levels and across the interrelated domains of human and environmental wellbeing.

**Conclusions:** Much is occurring in response to the alienation and degradation of environments and, in Aotearoa New Zealand, Maori often lead the way. Although specific initiatives may be localised, groups are increasingly coming together to address shared concerns; influencing and setting policy is a key area where increased connections enable opportunities for greater voice.

## TUC01: Built Environment Methods & Other

026, September 26, 2017, 10:30 - 12:00

### Using Mobile Monitoring to Develop Hourly Land Use Regression Models of Particle Number and Black Carbon Concentrations

**Steve Hankey\***, School of Public and International Affairs, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA

Peter Sforza, Center for Geospatial Information Technology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA

Brian Farrell, Center for Geospatial Information Technology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA

Matt Pierson, Center for Geospatial Information Technology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA

**Background/Aim:** Land Use Regression (LUR) is primarily used to develop long-term (i.e., annual-average) concentration estimates from fixed-site measurements. Adding temporal (e.g., hourly) information to LUR may allow for more reliable exposure assessment. We test the feasibility of using mobile monitoring data to develop hourly LURs of Particle Number (PN) and Black Carbon (BC) concentrations.

**Methods:** We used a bicycle-based, mobile monitoring platform to collect ~130 hours of PN (CPC 3007, TSI Inc.) and BC (AE51, Aethlabs) measurements in Blacksburg, VA. We repeatedly cycled two routes (~12 miles per route) during the summer and fall of 2016; each route was cycled 5 times per hour-of-day (i.e., 12 daylight hours; 7am-7pm). We deployed a reference site located at the beginning of each route to adjust for day-to-day differences in background concentrations. All mobile measurements were adjusted for known artifacts of sampling and aggregated at 100m intervals along the sampling routes to obtain concentration estimates for LUR modeling.

**Results:** We developed 12 separate hourly LUR models for PN and BC using stepwise regression. Model adj-R<sup>2</sup> ranged from ~0.2-0.8 among hours and pollutants. Generally, adj-R<sup>2</sup> was highest for the morning and evening models; model fit was worst during early- to mid-afternoon hours (1-4pm). When pooling measurements across all hours, we observed relatively high adj-R<sup>2</sup> (PN: 0.81; BC: 0.58). During model development, we offered 22 variables at 15 buffer sizes; variables that were significant across models included those related to traffic (heavy-duty vehicle volume, functional class), land use (industrial or retail area, employment density), and land cover (tree cover, water).

**Conclusions:** Our work shows how prescribed mobile monitoring campaigns can be used to develop temporally-resolved (e.g., hourly) LUR models. Our approach may be useful in refining exposure assessment (i.e., matching concentrations with time-activity patterns) or developing cost-effective monitoring campaigns for pollutants that are traditionally cost-prohibitive.

# TUC01: Built Environment Methods & Other

026, September 26, 2017, 10:30 - 12:00

## Test Results of a Non-Toxic Home

Carl E Grimes\*, Managing Director, Hayward Healthy Home Institute, Monterey, CA, USA

### Background/Aim

People are exposed to the indoor environment of homes for as much as 90% of each day. Yet few epidemiological studies include homes. Could a “tight” house (low air changes per hour) built with routine methods – except for careful selection of low toxicity materials and systems – result in pollutants below the various recommended thresholds, as verified by routine industry test methods? Would a continuous ventilation system reduce any excess levels to below the recommended thresholds?

### Methods

Low toxicity building materials were selected according to manufacturer supplied information from specifications, product labels, and Safety Data Sheets. More sophisticated selection methods were not included. Measurements were after construction, 48 hours of ventilation, and then 48 hours with the house closed. Routine industrial testing occurred before occupancy. Pollutants focused on VOCs, CO<sub>2</sub>, and particle counts. Plus, professional sensors with data logging continued for 5 days. After the first 24 hours, the ventilation was turned off. After another 48 hours, the ventilation was turned on.

### Results

When the ventilation was off formaldehyde exceeded the recommended levels by 5 times. Several VOCs were above thresholds with one notably 29 times higher. Of the 28 possible chemicals, 22 were detected - only 2 of which were included in the manufacturer supplied information. All levels quickly dropped to below suggested thresholds when the ventilation was turned on.

### Conclusions

Careful selection of building materials did not result in pollutant levels below recommended thresholds. Information supplied by manufacturers were not always accurate or inclusive.

It is therefore unlikely that lower exposure houses can be built simply by controlling building materials.

Mechanical ventilation reduced the pollutants to below recommended thresholds.

Additional studies of multiple houses of both controlled houses and uncontrolled houses, over time is needed for a more detailed profile.

# TUC01: Built Environment Methods & Other

026, September 26, 2017, 10:30 - 12:00

## Reducing household air pollution and improving health in Nairobi's informal settlements: a participatory system dynamics approach

**James Milner\***, Department of Social & Environmental Health Research, London School of Hygiene & Tropical Medicine, London, UK

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Nici Zimmermann, UCL Institute for Environmental Design & Engineering, University College London, London, UK

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Catherine Kyobutungi, African Population & Health Research Center, Nairobi, Kenya

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Paul Wilkinson, Department of Social & Environmental Health Research, London School of Hygiene & Tropical Medicine, London, UK

Mike Davies, UCL Institute for Environmental Design & Engineering, University College London, London, UK

### Background/Aim

Rapid growth and unequal development has resulted in more than 60% of Nairobi's population living in informal settlements. Household air pollution (HAP), primarily fine particulate matter (PM<sub>2.5</sub>), is a major contributor to the large environmental burdens of disease and mortality in these areas, but actions to reduce HAP exposure have so far had limited success. This pilot study is attempting to understand the problem as a complex, interconnected system and to assess the potential implications of different policy options.

### Methods

We used a participatory system dynamics approach to map the drivers and effects of HAP pollution in Nairobi's informal settlements. The model was developed through a series of workshops with stakeholders (including community members, policymakers, NGOs, and academics), refined and calibrated to the Korogocho area of the city using available data, including recent trends in key variables. Expected impacts of changes in PM<sub>2.5</sub> exposure on life expectancy were estimated within the model using life tables.

### Results

The system dynamics process identified key drivers of HAP exposure, such as outdoor air pollution levels, household ventilation and the proportion of households using clean stoves/lighting. Subsequent modelling revealed how these drivers interact and form important feedback loops in the system. Analysis of policy options suggests that combinations of policies may be more effective than single policies for reducing HAP exposure and improving health. In particular, the model highlighted the importance of awareness raising and investment in monitoring and health impact assessment, which can trigger reinforcing mechanisms to create synergies among policies.

### Conclusions

Despite limitations of the available data in this setting, the pilot study demonstrates the value that participatory system dynamics brings to understanding complex urban systems. It also indicates the importance of developing evidence-based health policy.

# TUC01: Built Environment Methods & Other

026, September 26, 2017, 10:30 - 12:00

The associations between neighborhood social cohesion and objective (GIS-based) and perceived built environments using a latent profile approach in seniors from two US regions

Jenna Hua\*, Stanford Prevention Research Center, School of Medicine, Stanford University, Stanford, California, USA  
Benjamin Chrisinger; Stanford Prevention Research Center, School of Medicine, Stanford University, Stanford, California, USA  
Terry Conway; University of California, San Diego, San Diego, California, USA  
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Brian Saelens; Seattle Children's Hospital, Seattle, Washington, USA  
Lawrence Frank; University of British Columbia, Vancouver, British Columbia, Canada  
Abby King; Health Policy and Research, School of Medicine, Stanford University, Stanford, California, USA

## Background/Aim

Healthy aging increases seniors' quality of life and reduces society's healthcare costs, but requires support from both built and social environments. Prior studies often focused on a few built environment features without considering the complexity and multi-dimensionality of the built environment (BE). Using latent profile analysis (LPA), this study aims to examine the relations between objective (GIS-based) and perceived BE profiles and neighborhood social cohesion, and potential moderators (sociodemographic characteristics), that may exist between BE and neighborhood social cohesion in a regionally-derived cohort of seniors from two US locales.

## Methods

As part of the Senior Neighborhood Quality of Life Study (SNQLS), 693 participants aged 66-97 years (52.2% female, 30% racial minority) were sampled from Seattle-King County, WA and Baltimore, MD-Washington, DC regions in 2005-2008. Two previously published papers on SNQLS derived three objective and four perceived BE profiles. Participants' sociodemographic information and social cohesion were assessed using validated surveys. Mixed-effect models were used to examine the main and interaction effects of different BE profiles and sociodemographic characteristics in relation to social cohesion.

## Results

Objective BE profiles included 62.7% low, 29.3% mean and 5.8% high walkability/transit/recreation. Perceived profiles included three for Seattle [20.4% low walkable, transit and recreation (LWTR); 32.1% moderately walkable/moderately recreational (MWMR); and 47.2% high walkable/recreationally dense (HWRD)] and four for Baltimore [18.8% LWTR, 28.5% low walkable/recreationally sparse (LWRS), 37.4% MWMR and 15.3% HWRD]. No association was found between objective BE profiles and social cohesion; however, better perceived BE profiles were associated with higher social cohesion. Moderating effects were observed between race, gender, education and marital status and BE profiles, and varied by region.

## Conclusions

LPA offered a more comprehensive approach to assessing the built environment. Seniors living in high walkable and recreationally dense neighborhoods experienced higher neighborhood social cohesion, which may set the stage for more active lifestyles and healthy aging.

# TUC01: Built Environment Methods & Other

026, September 26, 2017, 10:30 - 12:00

## Ranking of Homes by Attributes

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### Background/Aim

People are exposed to the indoor environment of homes for as much as 90% daily. Despite an increase in chronic disease with suspected environmental exposures, few epidemiological studies include homes. The complexity of houses combined with the complications of individual susceptibility present a formidable obstacle to well-structured research.

### Methods

An algorithm was developed to rank houses from 1 to 100 based on physical attributes and behaviours as reported by occupants in an Internet accessed survey. The initial algorithm was subsequently calibrated to the experience of multiple assessors. Additional questions included a list of symptom complaints, plus whether occupants felt better when they left the house only to recur upon re-entry. Basic statistical analysis was conducted to identify combinations of attributes plus associations between those attributes and behaviours, and occupant reports of their experience.

### Results

Cascading of the effects of attributes frequently resulted in lower scores than were evident from singular attributes. Occupant responses to house attributes ranged from one extreme to the other due to individual variability (Bell curve). However, expected trends were identified showing that houses with cleanable surfaces, appropriate ventilation, moisture control, and current maintenance, for example, tended to have the fewest complaints. Houses that had difficult to clean surfaces, uncontrolled ventilation, dampness, and poor maintenance tended to have the greatest complaints. However, significant clusters indicated that some individuals reported multiple complaints in high scoring houses and some individuals reported few complaints in low scoring houses.

### Conclusion

Attributes of houses are complex with many individual characteristics. Individual differences of occupant experience in houses are also complex with frequent outliers. However, initial patterns of both apparent uniformity and clusters of anomalies have been identified. With a sufficiently large database, additional associations and definition should be possible, which could stimulate research questions for, and contribute to, epidemiological investigations.

# TUC02: Effects of Climate Change & Temperature

020, September 26, 2017, 10:30 - 12:00

## Assessment of heatwave impacts on cause-specific emergency department attendances in Queensland, Australia

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**Objectives:** To examine the impacts of heatwaves on emergency department attendances (EDAs) in Queensland, Australia.

**Methods:** A quasi-Poisson generalized additive model was used to quantify the effects of heatwaves on cause-specific EDAs in eight cities of Queensland, Australia, including Brisbane, Cairns, Longreach, Mackay, Mount Isa, Rockhampton, Toowoomba and Townsville. The study period was from 01/01/2013 to 31/12/2015. Possible confounders including seasonality and long-term trend, day of week, and relative humidity were controlled in the model. The city-specific results were meta-analyzed to get the pooled result for the whole Queensland. Based on the findings of our previous work, heatwave was defined as three or more consecutive days when the mean temperature was  $\geq 95^{\text{th}}$  percentile of the mean temperature across the whole study period.

**Results:** During heatwave periods, EDAs for a wide range of diseases increased appreciably in Queensland, including nutritional and metabolic diseases (RR:1.181, 95% CI:1.040, 1.342), injury, poisoning and certain other consequences of external causes (RR:1.092, 95% CI:1.039,1.147), diseases of the nervous system (RR:1.091, 95% CI:1.021, 1.166), diseases of the skin and subcutaneous tissue (RR:1.079, 95% CI:1.002, 1.162), diseases of the musculoskeletal system and connective tissue (RR:1.069, 95% CI:1.004, 1.140), endocrine, mental and behavioral disorders (RR:1.062, 95% CI:1.006, 1.120), certain infectious and parasitic diseases (RR:1.058, 95% CI:1.011, 1.108), diseases of the circulatory system (RR:1.055, 95% CI:1.014,1.097), diseases of the genitourinary system (RR:1.046, 95% CI:1.004, 1.090), and diseases of the ear and mastoid process (RR:1.041, 95% CI:1.006,1.077). Heatwave effects on total EDAs varied across different cities, and the greatest effect was observed in Townsville (RR:1.082, 95% CI:1.026, 1.140), followed by Rockhampton (RR:1.071, 95% CI: 1.024, 1.120), Mount Isa (RR:1.056, 95% CI: 0.975, 1.144), Toowoomba (RR:1.031, 95% CI:0.974, 1.092), Cairns (RR:1.029, 95% CI:0.991, 1.069), Brisbane (RR:1.018, 95% CI:0.999, 1.038), Mackay (RR:1.016, 95% CI:0.970, 1.063), and Longreach (RR:0.977, 95% CI:0.851, 1.121). The effect of heatwaves on total EDAs in the rural region (RR:1.039, 95% CI:1.010, 1.069) was similar to that in the urban region (RR:1.035, 95% CI:1.003, 1.068).

**Conclusions:** EDAs for a wide range of diseases increased during heatwave periods. As climate change progresses, EDAs in Queensland may increase in the future, requiring the Queensland Government to develop effective public health strategies to adapt to climate change.

# TUC02: Effects of Climate Change & Temperature

020, September 26, 2017, 10:30 - 12:00

Effects of heatwaves on emergency department attendances in Mount Isa, Australia

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**Background:** People living near industrial areas may be vulnerable to environmental hazards due to their compromised immune and hematological systems. This study aimed at assessing the impacts of heatwaves on the health of residents living nearby a mining area.

**Methods:** Poisson generalized additive model allowing for over-dispersion was used to quantify the effects of heatwaves on cause-specific emergency department attendances from January 1<sup>st</sup> 2013 to 31<sup>st</sup> December 2015 in Mount Isa, a town where a mining industry (copper, lead, zinc, and silver) is located. Seasonality, long-term trend, day of week, and relative humidity were controlled for as possible confounders. Based on the findings of our previous work, heatwave was defined as three or more consecutive days when mean temperature was  $\geq 95^{\text{th}}$  percentile of mean temperature across the whole study period.

**Results:** Heatwaves had significant effects on the emergency department attendances for blood related diseases (i.e., diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism, ICD 10: D50-D89) (RR: 2.14; 95% CI: 1.16, 3.95), and pregnancy related diseases (i.e., conditions related to or aggravated by the pregnancy, childbirth or by the puerperium, ICD 10: O00-O99) (RR: 2.41; 95% CI: 1.28, 4.53). These results were robust to the different definitions of heatwave.

**Conclusions:** Heatwaves might trigger blood related diseases and pregnancy related diseases in Mount Isa residents, and the biological mechanisms behind these effects should be further explored.

# TUC02: Effects of Climate Change & Temperature

020, September 26, 2017, 10:30 - 12:00

Changing susceptibility to temperature over time and the associated climate, demographic and socio-economic factors in Japan for 1972 - 2012

Author information; Arial 8pt (please overtype this)

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## Background/Aim

Previous studies have shown that the temperature-related mortality risk has changed over time, but little is known about the related factors that have driven such changes. We investigated the changing susceptibility to non-optimal temperature in 47 prefectures in Japan for 1972-2012 in three aspects: the minimum mortality temperature (MMT), the heat- and cold-related mortality risks. Moreover, we examined how the changes in the three aspects are associated with climate, demographic, health service, and socio-economic factors and air conditioner (AC) prevalence.

## Methods

We used a two-stage design. In the first stage, we used a time-varying distributed lag nonlinear model to estimate the temperature-mortality association smoothly changing over time in each prefecture. In the second stage, we performed a multivariate meta-analysis to combine prefecture-specific associations and estimated the time-varying MMT and the time-varying heat/cold risks. We applied linear mixed effects models to investigate to which extent the temporal variations in the three aspects are explained by the time-varying factors with adjustment of prefecture-specific time trends.

## Results

The MMT increased (from 18.4-27.5 to 23-31.5 °C) and the heat risk decreased (from 1.10-1.33 to 0.99-1.16 in relative risk (RR)) in almost all prefectures in Japan. The cold risk decreased (from 1.12-1.78 to 1.21-1.59 in RR) overall in Japan though it increased in several eastern prefectures. Higher levels of temperature, population age, health service, socio-economic status, and AC prevalence were strongly associated with higher MMT, and lower heat/cold risks.

## Conclusions

Our findings suggest that population's susceptibility to non-optimal temperature has decreased over the past 4 decades in Japan. A variety of factors seem to have contributed to such decrease; temperature warming, improved healthcare and socio-economic status, and increased AC prevalence. Interestingly, population aging has also contributed to the decrease possibly because the health status of elderly population has improved.

# TUC02: Effects of Climate Change & Temperature

020, September 26, 2017, 10:30 - 12:00

## Can Temperature Affect Maternal Stress During Pregnancy?

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### Background/Aim

Maternal psychological stress during pregnancy has essentially been conceptualized as a teratogen. However, little is known about the effect of temperature on maternal stress during pregnancy. The aim of this study is to investigate the relationship between temperature and maternal stress during pregnancy.

### Methods

In 2010, a total of 1931 eligible pregnant women were enrolled across Shanghai from four prenatal care clinics during their mid-to-late pregnancy. Maternal life-event stress and emotional stress levels during pregnancy were assessed by the "Life Event Scale for Pregnant Women" (LESPW) and "Symptom Checklist-90-Revised Scale" (SCL-90-R), respectively. Multivariate binary logistic regression models were used to evaluate the relationship between temperature and maternal stress. Stratified analyses were conducted to identify the modifying effects of complications of pregnancy and sunlight duration on the association between temperature and maternal stress.

### Results

After adjusting for relevant confounders, an U-shaped relationship was observed between the daily average temperature and maternal Global-Severity-Index (GSI) of the SCL-90-R. The risk of high GSI (P75-P100) increased when the women were exposed to extreme low temperatures (P1-P5) (OR=1.7, 95% CI: 1.1-2.7) and extreme high temperatures (P95-P100) (OR=1.6, 95% CI: 1.1-2.4) compared to the risk when they were exposed to an optimal temperature range (20-25°C). High temperatures induced acute stress (lasted for 1 day), whereas low temperatures induced long-term stress (lasted for 14 days). Women without complications of pregnancy were more susceptible to extreme low or high temperatures than those with complications of pregnancy. When exposed to extreme low or high temperatures, women experiencing short (vs. long) sunlight duration were more likely to develop high GSI (P75-P100).

### Conclusions

In conclusion, extreme low (P1-P5) and high (P95-P100) temperatures may induce acute and long-term emotional stress during pregnancy, respectively. Complications of pregnancy and sunlight duration may modify the relationship between temperature and maternal stress during pregnancy.

# TUC02: Effects of Climate Change & Temperature

020, September 26, 2017, 10:30 - 12:00

## Temperature-related mortality impacts under climate change scenarios consistent with the Paris Agreement: a multi-country analysis

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On behalf of the MCC Collaborative Research Network

### Background/Aim

The recent international agreement reached in Paris aims at keeping the increase in global mean temperature (GMT) below 2°C, and it pursues efforts to limit it below 1.5°C. Here we provide evidence on temperature-related direct mortality impacts under these and more extreme climate change scenarios, using a worldwide multi-country dataset.

### Methods

Two-stage time series analysis using distributed lag non-linear models and multivariate meta-analysis to estimate temperature-mortality relationships for 412 locations within 20 countries in 1985-2012. Future impacts, quantified as attributable risks for non-optimal temperature and for cold and heat separately, were computed under scenarios consistent with 1.5°C, 2°C, 3°C, and 4°C increase in GMT, defined by corresponding 20-year windows identified in temperature series projected along the 21<sup>st</sup> century using four global climate models.

### Results

Across different regions of the world, a rise from 1.5°C to 2°C in GMT would generate 0.20%-1.40% increases in heat-related and 0.30%-0.67% decreases in cold-related mortality. Mild temperate areas such as North Europe and Australia would experience a small but significant net decrease (0.28% and 0.47%, respectively), while hotter places such as South Europe and South-East Asia would face a larger significant net increase (0.61% and 0.73%). Changes are close to null in areas characterized by diverse climatic conditions, such as North and South America and East Asia. More extreme scenarios with GMT rising to 3°C-4°C would present more dramatic heat-related impacts, especially in hotter places, with net increases up to 7.10% in some tropical areas.

### Conclusions

This large worldwide assessment provides evidence of potential health benefits of enforcing mitigation strategies to reduce global warming. Compliance with the limits set by the Paris Agreement (2°C) would prevent dramatic increases in mortality projected in many regions, while more ambitious targets (1.5°C) would be beneficial for hotter tropical areas where a large proportion of world population lives.

## TUC02: Effects of Climate Change & Temperature

020, September 26, 2017, 10:30 - 12:00

A discussion of the challenges of uncertainty around linking climate change to health events

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Climate change and global warming have been the focus of physical scientists for decades in predicting the level of warming based on CO<sub>2</sub> emissions in relation to their greenhouse gas effects. However, measuring the impact of global warming on health is more recent. The methodological challenges of measuring the association between climate change and any health outcome generates uncertainty in the face of this major public health problem. The inability to fully adjust for confounders of mortality or emergency room visits when using ecological data based on meteorological measures of temperature is one major challenge resulting in uncertainty. The data from these studies are focused on emergency room visits or on mortality, while morbidity and physician's outpatient office visits related to climate change might be neglected or more difficult to assess. These uncertainties provide a philosophical argument about the ethical implications of such uncertainties when reporting to the public on the impact of climate change on health in general. Is this the reason we have objections to the notion that climate change can impact health, particularly among the deniers of climate change? In this discussion session, we will address some of these questions and how we might act in the face of uncertainty.

# TUC03: Effects of prenatal exposure to solvents, food chemicals, and other risk factors on child development

022, September 26, 2017, 10:30 - 12:00

Prenatal solvent exposure and motor inhibition function at the age of 10 – 12 in the PELAGIE mother-child cohort.

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## Background/Aim

Epidemiological studies reported that prenatal solvent exposure was associated with higher frequency of attention deficit and higher levels of hyperactivity or impulsivity in exposed children which suggest impaired motor inhibition function. The purpose of the present work is to investigate the effect of prenatal exposure to solvents on the motor inhibition function measured by neuropsychological test performed in children of 10-12 years old.

## Methods

Ninety nine children from the PELAGIE mother-child cohort (France; from 2002) underwent functional Magnetic Resonance Imaging (fMRI) during which motor inhibition function was assessed with the go/no-go task during 10 minutes: children were asked to press a button as quickly as possible in response to a green smiley but not press the button when seeing a red smiley. Task performance was assessed by the average reaction time (RT) and the commission rate (incorrect answer to a red smiley). Solvent exposure was assessed at the beginning of pregnancy (<19 WG) by self-reported questionnaire (n=89) and oxygenated, chlorinated and petroleum solvent job-exposure matrices (JEM; n=92). Multiple linear regression including confounders allowed to estimate association between exposures and performance.

## Results

Petroleum and chlorinated solvent JEM-based exposures were associated with a longer RT. No association was observed between RT and oxygenated solvents JEM-based exposures and self-reported exposure. Concerning commission rate, no association was observed with any of the exposures assessments.

## Conclusions

Prenatal solvent exposures seem associated with performance to the go/no-go task. This result needs to be linked to the functional MRI analyses on cerebral activations.

# TUC03: Effects of prenatal exposure to solvents, food chemicals, and other risk factors on child development

022, September 26, 2017, 10:30 - 12:00

Prenatal solvent exposure association with motor inhibition functional MRI at the age of 10-12 in the PELAGIE mother-child cohort

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## Background/Aim

Epidemiological studies reported that prenatal solvent exposure was associated with adverse neurobehavioral outcomes that suggest impaired motor inhibition function. Using functional Magnetic Resonance Imaging (fMRI) among children aged 10-12 years old, we aimed at investigating the effect of prenatal exposure to solvents on the activation of cerebral regions involved in the motor inhibition function.

## Methods

Fifty-three children from the PELAGIE mother-child cohort (France, from 2002) underwent a 10-minutes fMRI go/no-go task using an event-related design. Children were asked to press a button as quickly as possible in response to a green smiley ('go') but not press the button when seeing a red smiley ('no-go': inhibition event). Solvent exposure was assessed at the beginning of pregnancy (<19 WG) by measuring three glycol ether metabolites in maternal urine and defined as 'unexposed' (1<sup>st</sup> tercile) or 'exposed' (2<sup>nd</sup> and 3<sup>rd</sup> tercile) for each solvent. Go and no-go cerebral activations at individual and group levels were assessed using SPM. T-test with p-value corrected for multiple testing was used to estimate difference of brain activations between differentially exposed children. Confounders as tobacco smoke and alcohol consumption at the beginning of pregnancy were taken into account by restriction.

## Results

'No-go' cerebral activations were larger in middle and inferior frontal regions of the right hemisphere among children unexposed to methoxyacetic acid as compared to exposed ones. No differential activations were found with ethoxyacetic acid and phenoxyacetic acid.

## Conclusions

The present study suggests association between prenatal solvent exposure and larger activations in cerebral regions involved in motor inhibition function at the age of 10-12 years old. Analysis will be extended to a bigger sample (on-going urinary measurements) to confirm and refine these results.

## TUC03: Effects of prenatal exposure to solvents, food chemicals, and other risk factors on child development

022, September 26, 2017, 10:30 - 12:00

Prenatal exposure to food chemicals and cognitive development in pre-school aged children from the EDEN mother-child cohort

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**Background/Aim:** Cognitive development is influenced by many factors, including nutritional and environmental ones. Food brings essential nutrients but can also carry contaminants. Our aim was to study the association of prenatal exposure to food chemicals with child intelligence quotient (IQ).

**Methods:** This study was based on 844 mother-child pairs of the French EDEN cohort. Individual food consumption during pregnancy assessed by a 137-item food frequency questionnaire was combined with food chemical data from the second French Total Diet Study. Contaminant variables (including pesticides, polychlorinated biphenyls (PCBs), metals, polycyclic aromatic hydrocarbons (PAHs), mycotoxins, brominated flame retardants (BFR) and bisphenol A (BPA)) were log-transformed to the base 2 allowing expressing the change in outcome for a doubling of exposure. IQ was assessed at age 5-6 years with the WPPSI-III. Associations between exposure to 99 contaminants selected as being not collinear with intake of one specific food item and IQ scores were tested individually by multivariable linear regression adjusted for potential confounders (child's age and sex, maternal age, socio-demographical characteristics, breastfeeding, dietary profile, smoking, HOME score, caretaker and recruitment center).

**Results:** We found 11 contaminants positively associated with IQ score at 5-6 years, mainly among pesticides (e.g. Bifenthrin, Procymidone) and mycotoxins (e.g. Ochratoxin A and B). The strongest association was found between Ochratoxin A and total IQ ( $\beta=2.21$ ; 95%CI[0.84 - 3.58]). Associations were observed particularly for verbal IQ, while performance IQ was positively associated only with a few pesticides. The main contributors of pesticides (fruits and vegetables) and mycotoxins intake (cereal products) were positively associated with IQ. No significant associations were found between IQ and PCBs, PAHs, metals, BFR, BPA.

**Conclusions:** Our results suggest that, for some specific diets, despite the intake of associated food contaminants during pregnancy, benefits of nutrients may outweigh potential risk from exposure to contaminants.

# TUC03: Effects of prenatal exposure to solvents, food chemicals, and other risk factors on child development

022, September 26, 2017, 10:30 - 12:00

## Dietary acrylamide intake during pregnancy and postnatal growth and obesity: results from the Norwegian mother and child cohort study (MoBa)

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**Background/Aim:** Acrylamide exposure during pregnancy has been negatively associated with foetal growth in previous epidemiological studies; however, long-term associations with the child's postnatal growth are unknown. We aimed to study the association between dietary acrylamide exposure during pregnancy and child's postnatal growth up to 8 years in a large cohort study in Norway.

**Methods:** In 51,952 mother-child pairs from MoBa, acrylamide intake during pregnancy was assessed by combining maternal food intake with concentration of acrylamide in food. Mothers reported their child's weight and length/height 11 times between 6 weeks and 8 years. Weight and height growth were modelled separately using Jenss-Bayley's growth curve and then BMI was calculated. Overweight and obese children were identified using the International Obesity Task Force cut-offs. Logistic regression models were used to analyse the relationship between acrylamide intake in quartiles and being overweight/obese at 3, 5 and 8 years.

**Results:** Median of maternal acrylamide intake was 24.7µg/day (interquartile range: 18.4, 33.2). Prenatal dietary acrylamide intake was associated with an increased risk of being overweight/obese at 3, 5 and 8 years in a dose response manner. At 3 years, the adjusted odds ratio (aOR) of being overweight/obese for the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> quartile were 1.10 (95%Confidence Interval (CI): 1.02 – 1.20), 1.12 (95%CI: 1.04 – 1.22) and 1.21 (95%CI: 1.11 – 1.31). These results were similar at 5 years. At 8 years, although the results were not significant they remained within the same magnitude. Maternal acrylamide at the highest level of intake was associated with increased risk for obesity at 3 years 1.35 (95%CI=1.06 – 1.73).

**Conclusions:** Dietary acrylamide intake during pregnancy was associated with an increased risk of being overweight/obese. Our study need to be replicated as it is the first one to link acrylamide exposure and postnatal growth.

# TUC03: Effects of prenatal exposure to solvents, food chemicals, and other risk factors on child development

022, September 26, 2017, 10:30 - 12:00

## Exposure to Formaldehyde and Associations with Asthma Outcomes: A Systematic Review and Meta-Analysis

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### Background/Aim

Formaldehyde is a commonly used adhesive and known human carcinogen. Human exposure to formaldehyde in commercial and household products is widespread. We conducted a systematic review of human evidence regarding exposure to formaldehyde and the risk of asthma development, asthma symptoms and exacerbations.

### Methods

We conducted a comprehensive search of articles published up to March 15, 2016. We included original studies that investigated indoor or ambient sources of airborne inhalation exposure to formaldehyde incurred any time prior or concurrent to diagnosis or exacerbation of asthma outcomes. We developed and registered a protocol in PROSPERO (CRD#42016038766), evaluated risk of bias across nine domains for each included study, identified a subset of studies that were combinable in a meta-analysis, and rated the quality and strength of the overall body of evidence according to the Navigation Guide systematic review methodology.

### Results

We screened 4,482 total articles and identified 148 human studies that met our inclusion criteria; of these, 81 reported on asthma status of participants that provided the most direct evidence for outcomes related to our study question. 10 studies were combinable in a meta-analysis for the risk of childhood asthma development; we also evaluated evidence for risk of childhood asthma exacerbation (wheezing and shortness of breath) as well as adult asthma outcomes. Studies generally had “low” to “probably low” risk of bias across most domains. A 10-fold increase in formaldehyde exposure was associated with an increased risk of childhood asthma development for indoor formaldehyde exposure (OR= 2.27, 95% CI: [1.26, 4.09]) and ambient exposures (OR=1.03, 95% CI: [1.02, 1.04]).

### Conclusions

Our research supports the need for health protective actions by clinicians and policy makers to reduce people’s exposures to formaldehyde to prevent asthma and demonstrates opportunities for optimizing the design of future research studies.

# TUC03: Effects of prenatal exposure to solvents, food chemicals, and other risk factors on child development

022, September 26, 2017, 10:30 - 12:00

## Vitamin D Levels during Pregnancy in Relation to Autism Spectrum Disorders (ASD) in Offspring; the Early Markers for Autism (EMA) Study in California

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**Background/Aim:** Recent research supports the importance of environmental factors in the etiology of ASD. Vitamin D deficiency has increased concurrently with ASD prevalence and evidence for vitamin D's role in brain and immune function has led to interest in associations with ASD. Generally, prior studies have examined surrogates of vitamin D or levels after ASD diagnosis, not during critical fetal developmental periods. Our goal is to address these gaps.

**Methods:** We conducted a case-control study among children born 2000-2003 in Southern California who had banked biospecimens available from routine screening. Autism cases (N=563) were identified through the CA Department of Developmental Services and controls (N=436) were selected from general population births. 25-Hydroxyvitamin D (25OHD) was measured in maternal serum collected at 14-20 weeks gestation and newborn blood spots. Vitamin D levels were categorized as deficient (<50nmol/L), insufficient (50-74nmol/L) and sufficient ( $\geq$ 75nmol/L, referent category). Crude and adjusted odds ratios (AOR) and 95% confidence intervals (CI) were calculated.

**Results:** 25OHD was deficient in 9.5% and insufficient in 26% of mothers. 25OHD levels were lower during winter and among mothers of non-White race/ethnicity, but were similar between cases and controls. The AOR (95%CI) for maternal deficiency was 0.79 (0.49-1.3) and for insufficiency was 0.94 (0.68-1.3). Stratifying by parity or maternal race/ethnicity did not yield meaningful differences. By sex, female children of 25OHD-deficient mothers had lower ASD risk, based on small numbers.

**Conclusions:** In this first large study to examine prenatal vitamin D levels in relation to clinical ASD, we saw no association, in contrast to the hypothesis. Our findings with newborn 25OHD levels and ASD were similarly null. Prior studies reporting lower Vitamin D levels in children already diagnosed with ASD may reflect current lifestyle and diet. Future analyses will examine vitamin D's role in protecting against environmental exposure effects on ASD risk

## TUC04: Exposure Assessment Other ambient

100, September 26, 2017, 10:30 - 12:00

### Long-term exposure to environmental pollution based on tree rings

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**Background/Aim:** Citizens of megacities are exposed to heterogeneous environments where pollution varies in time and space. Accessing such variability is a complex task since environmental pollution measurements are sparse in most cities, not covering most of the urban spatial variability. Data availability for earlier periods is rarer, most of them covering the last two decades at best. Tree-ring data has the potential to reconstruct past variability of environmental pollution in different parts of the city. The aim of this work is to use the elemental composition of different cell types of wood to create a reliable time series of environmental pollution in São Paulo city, in order to understand the effects of long-term exposures on humans health.

**Methods:** We measured the elemental composition in tree rings of *Tipuana tipu*, an abundant species in São Paulo. Elemental analysis was performed using the Laser Ablation coupled to an ICP-MS. This high-resolution approach allows the semi-quantitative analysis of elemental composition of fibers, cells with a fast-programed cell death, and axial parenchyma that are long-lived storage cells in the wood. Since fibers are short-lived, they are likely the ones that will hold the most reliable information about the environmental pollution in the year of tree-ring formation.

**Results:** The preliminary results show that Hg, Pd, Rh are not found in the analysed samples, whereas Cu, Zn, Pb, Cd are abundant. Out of these elements, Pb and Cd do not seem to be constitutive elements of the wood, probably representing the environmental variability of these elements. This analysis confirms that the concentration of these elements is cell type dependent, and the highest concentrations are found in the storage cells of wood.

**Conclusions** We expect that the elemental analysis of fibers will produce a reliable reconstruction of the environmental pollution in São Paulo over the last four decades.

# TUC04: Exposure Assessment Other ambient

100, September 26, 2017, 10:30 - 12:00

## Mapping population exposure to urban air pollution at local scales

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### Background/Aim

Increased physical activity has been shown to significantly reduce the risk of non-communicable diseases, and promoting both physical health and mental wellbeing. However, for many urban dwellers, the choices of convenient outdoor locations for engaging in physical activity may be limited to polluted urban microenvironments (often during peak commute times). Thus there is increasing concern that exercise in these environments may lead to increased exposure to air pollution which could partially offset the health benefits associated with increased levels of exercise. However, recent studies designed to quantify this risk to urban populations have failed to take into consideration the large microscale variability in pollution concentrations observed in urban areas. Similarly, whilst recent studies of individual personal exposure to air pollution have demonstrated the importance of time spent in the commuter microenvironment in determining total daily exposure, sample sizes are typically small, leading to limited applicability. The present study addresses this gap using novel pollution measurement, modelling and mapping techniques to combine air quality and population movement data.

### Methods

Air pollution concentrations were measured using a novel network of low-cost sensors to provide detailed local-scale air quality data. People were tracked moving through the urban area using a combination of blue tooth, wifi and video camera technologies. Land-use regression models were employed to provide hourly estimates of both population movement and air quality which were over-laid to produce exposure maps for a suburban area in central Auckland.

### Results

Results show that, when used together, these techniques provide unique insights into areas of the city where population exposure to air pollution is significant thereby enabling the development of targeted air quality management strategies.

### Conclusions

This pilot study demonstrates the potential of the technique to provide accurate estimates of exposure to air pollution at community scales within any urban environment.

## TUC04: Exposure Assessment Other ambient

100, September 26, 2017, 10:30 - 12:00

### Seasonal ambient particulate matter and population health outcomes among communities impacted by road dust in British Columbia, Canada

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**Background/Aim:** In recent years, many air quality monitoring programs have favoured measurement of particles less than 2.5 microns ( $PM_{2.5}$ ) over particles less than 10 microns ( $PM_{10}$ ) in light of evidence that health impacts are mostly from the fine fraction. However, the coarse fraction ( $PM_{10-2.5}$ ) may have independent health impacts that support continued measurement of  $PM_{10}$  in some areas, such as those affected by road dust. The objective of this study was to evaluate the associations between different measures of daily PM exposure and two daily indicators of population health in seven communities in British Columbia, Canada, where road dust is an ongoing concern.

**Methods:** The measures of exposure were  $PM_{10}$ ,  $PM_{2.5}$ ,  $PM_{10-2.5}$ ,  $PM_{2.5}$  adjusted for  $PM_{10-2.5}$ , and  $PM_{10-2.5}$  adjusted for  $PM_{2.5}$ . The indicators of population health were dispensations of the respiratory reliever medication salbutamol sulfate and non-accidental mortality. This study followed a time-series design using Poisson regression over a 2003-2015 study period, with analyses stratified by three seasons: residential woodsmoke in winter; road dust in spring; and wildfire smoke in summer. A random effects meta-analysis was conducted to establish a pooled estimate.

**Results:** Overall, an interquartile range increase in daily  $PM_{10-2.5}$  was associated with a 3.6% [1.6, 5.6] increase in non-accidental mortality during the road dust season, which was reduced to 3.1% [0.8, 5.4] after adjustment for  $PM_{2.5}$ . The adjusted coarse fraction had no effect on salbutamol dispensations in any season. However, an interquartile range increase in  $PM_{2.5}$  was associated with a 2.7% [2.0, 3.4] increase in dispensations during the wildfire season.

**Conclusions:** These analyses suggest different impacts of different PM fractions by season, with a robust association between the coarse fraction and non-accidental mortality in communities and periods affected by road dust. We recommend that  $PM_{10}$  monitoring networks be maintained in these communities to provide feedback for future dust mitigation programs.

## TUC04: Exposure Assessment Other ambient

100, September 26, 2017, 10:30 - 12:00

### Land Use Regression of ambient endotoxin concentrations in a livestock dense area: robustness of model predictions at residential addresses of health study participants

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#### Background/Aim

Endotoxin is an inflammatory agent of bacterial origin that is known to be emitted from livestock farms. However concentrations and associated effects for neighboring residents are largely unknown. The Livestock Farming and Neighboring Residents' Health study, a large-scale population-based epidemiological study was performed in the Netherlands. Land Use Regression (LUR) models for endotoxin were developed based on spatially dense measurements of ambient endotoxin concentrations within the research area. We aimed to evaluate robustness of endotoxin LUR model predictions for the residential addresses of a sample of the 2,494 health study participants.

#### Methods

Ambient endotoxin was measured repeatedly at 61 sites to obtain annual average concentrations to develop LUR models based on livestock-related GIS variables. Based on all monitoring sites an overall LUR model was built by supervised stepwise variable selection. Model robustness was assessed by 10-fold Hold-out Validation (HV), using random selections of 90% of the measurement sites resulting in 10 models. Consistency in selected variables was evaluated and robustness of endotoxin predictions at 419 residential addresses was assessed using the Intraclass Correlation Coefficient (ICC) and Pearson correlation.

#### Results

Explained spatial variation of the ten HV-models ranged from 53.1% to 71.5% (overall model R-squared 63.9%). Selected predictors showed high consistency between models and HV R-squared over the HV-models was 32.0%. Predictions of endotoxin concentrations at home addresses showed to be robust (ICC 0.81 for HV-models) and predictions of single HV models showed high agreement to the overall model (Pearson correlations ranging from 0.82-0.99).

#### Conclusions

In conclusion, robust endotoxin LUR models were developed which seem suitable for predicting ambient endotoxin concentrations in a livestock dense area. Next step will be evaluating associations between predicted endotoxin exposure concentrations and respiratory health outcomes in our population-based health study.

## TUC04: Exposure Assessment Other ambient

100, September 26, 2017, 10:30 - 12:00

### Particulate Exposures in Asthmatic Kids (PEAK): Differences between ultrafine and fine particle exposures in Baltimore, USA

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**Background/Aim:** Particulate matter (PM) air pollution is known to exacerbate asthma symptoms in children; however, it is still unclear which metric (particle size, morphology or chemical composition) of PM is most relevant to respiratory health. Most studies have focused on the health impacts of fine PM (PM<sub>2.5</sub>, particles with diameter less than 2.5 µm), yet recent toxicological evidence suggests that respiratory health effects may be more strongly related to the ultrafine portion of PM exposure. Due to complexities of exposure assessment and the lack of a regulatory monitoring network for UFP, few epidemiologic studies have evaluated the relationship between UFP and respiratory health. The aim of this work is to determine which potentially modifiable factors of fine PM, including UFP, microenvironment, and peak exposure, are associated with respiratory effects in 15 inner-city children with asthma.

**Methods:** We have conducted personal exposure assessment to ultrafine and fine PM exposures in a panel of children with asthma, each of whom were followed for 7 days with 4 days of continuous monitoring of PM (10-s resolution), geographic location via GPS, biomarkers (urinary LTE4), and asthma symptoms. Ultrafine PM was measured using a Partector (expressed as lung deposited surface area; CH Technologies) and fine PM mass was measured with a MicroPEM (RTI International).

**Results:** Inner-city children are exposed to levels of PM mass often exceeding WHO recommendations for PM<sub>2.5</sub> in indoor air on all sampling days (24-hr mean: 7.2 µg/m<sup>3</sup>; range: 0.3-32.8 µg/m<sup>3</sup>). Ultrafine particle exposures (24-hr mean: 39 µg<sup>2</sup>/cm<sup>3</sup>; range: 5-202 µg<sup>2</sup>/cm<sup>3</sup>) typically varied over 2 orders of magnitude within 24-hours. Exposures to ultrafine particles tended to be highest at home during exposure to secondhand smoke and cooking events and while commuting.

**Conclusions:** Large day-to-day and within-day variability was observed for both ultrafine and fine PM. Ultrafine PM was only weakly correlated with fine PM exposure due to differences in sources and lifetime.

## TUC04: Exposure Assessment Other ambient

100, September 26, 2017, 10:30 - 12:00

### City-to-city variations in air pollution in relation to key determinants for cities in the Sustainable Healthy Urban Environments (SHUE) database

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On behalf of the SHUE project partners

#### Background/Aim

Reducing urban air pollution is a key target for public health policy, but some cities have made substantially more progress than others with similar characteristics. This work examined the degree to which variations in fine particulate matter (PM<sub>2.5</sub>) between cities can be explained by selected city-level determinants.

#### Methods

We assessed variations in air pollution levels for 118 global cities in the Sustainable Healthy Urban Environments (SHUE) database using annual average PM<sub>2.5</sub> concentrations taken from the WHO air pollution in cities dataset. Variation in PM<sub>2.5</sub> was examined in relation to level of socio-economic development (*per capita* GDP), city size (population), and regional PM<sub>2.5</sub> emissions from the 500 km areas around the cities using data from the EDGAR global emissions inventory.

#### Results

PM<sub>2.5</sub> concentrations were strongly related to each determinant. On average, in mutually-adjusted models, PM<sub>2.5</sub> levels were 12.1 µg/m<sup>3</sup> lower in cities with *per capita* GDP of US\$30,000 compared with those of US\$10,000, and 24.2 µg/m<sup>3</sup> lower at US\$50,000. Concentrations increased approximately linearly with city size (~1.6 µg/m<sup>3</sup> per million population) and with regional PM<sub>2.5</sub> emissions within 500 km (~13.0 µg/m<sup>3</sup> per Mt emissions). Cities with higher-than-expected PM<sub>2.5</sub> for their level of wealth, population, and regional emissions are predominantly in Asia and the Middle East.

#### Conclusions

Comparative analyses in a global sample of cities suggests that air pollution levels are strongly related to socio-economic development, city size, and emissions from beyond the city boundaries. There is large unrealised potential for reducing air pollution and improving health in urban areas, but actions are more likely to succeed if cities work with their regional neighbours.

# TUC05: Other cardiovascular effects of Ambient air pollution

102, September 26, 2017, 10:30 - 12:00

## Physical Activity, Ambient Air Pollution and the Risk of Incident Cardiovascular Disease: A Cohort Study

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### *Background/Aim*

Physical activity (PA) has preventive effects on cardiovascular disease (CVD). Outdoor PA enhances the uptake of air pollutants, possibly modifying these beneficial effects. The aim of this study was to examine whether benefits of PA on the risk of cardiovascular events are moderated by long-term air pollution exposure in an urban setting.

### *Methods*

Data from 57,053 participants (50-65 years) of the Danish Diet, Cancer, and Health cohort with information on PA at baseline (1993-97) was linked to the National Patient Register to obtain information on incident (first-ever) hospital contacts (emergency, in- and outpatient) for CVD (WHO ICD-10, I00-I99; ICD-8 39-45 ) until 2016. Annual mean nitrogen dioxide (NO<sub>2</sub>) levels were estimated at participants' residences at baseline. We used adjusted Cox regression to associate physical activity (sports, walking, cycling, gardening) and incident CVD, and tested potential interaction by levels of NO<sub>2</sub> (high: >20.9 µg/m<sup>3</sup>; medium: 14.3-20.9 µg/m<sup>3</sup>; low: <14.3 µg/m<sup>3</sup>)

### *Results*

Preliminary analysis shows that of 45,218 participants without CVD history at baseline, 19,198 had CVD events during a mean follow-up of 15.4 years (SD: ±6.4). Mean NO<sub>2</sub> concentration was 18.7 µg/m<sup>3</sup> at the baseline (years 1993-1997). We found inverse associations of participation in sports (hazard ratio, 95% CI: 0.88; 0.85-0.91), cycling (0.96; 0.93-0.99), gardening (0.93; 0.90-0.97), walking (0.94; 0.89-0.99) with incident CVD for the entire cohort. There was no statistically significant interaction between PA and NO<sub>2</sub>.

### *Conclusions*

Preliminary results suggest that PA has a preventive effect on the incidence of CVD and this effect is not modified by exposure to high levels of NO<sub>2</sub>.

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# TUC05: Other cardiovascular effects of Ambient air pollution

102, September 26, 2017, 10:30 - 12:00

## Association between Children's Blood Pressure and Long-term Exposure to Local PM<sub>10</sub> in China: A national cross-sectional study

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### Background/Aim:

To examine the relationship between children's blood pressure and long-term exposure to particulate matter with aerodynamic diameter  $\leq 10 \mu\text{m}$  (PM<sub>10</sub>) in China.

### Methods

We collected the data of systolic and diastolic blood pressure (SBP and DBP) for 71,763 children aged 7 to 18 from 30 cities from 2010 Chinese National Survey on Students' Construction and Health (CNSSCH). We also collected the data of local annual average concentration of PM<sub>10</sub>, ambient temperature, relative humidity and other air pollutants (SO<sub>2</sub> and NO<sub>2</sub>) from China Meteorological Administration and Ministry of Environment Protection of China. We used the generalized additive model (GAM) to examine the associations between PM<sub>10</sub> and children's SBP and DBP.

### Results

The obvious geographic variation in the annual average concentration of PM<sub>10</sub> was found, ranging from 40  $\mu\text{g}/\text{m}^3$  in Haikou to 155  $\mu\text{g}/\text{m}^3$  in Lanzhou. We found the increase of PM<sub>10</sub> was associated with increase of both SBP and DBP in Chinese children after adjusting for individual characteristics, socioeconomic conditions, ambient temperature, relative humidity and other air pollutants (NO<sub>2</sub> and SO<sub>2</sub>). A 100  $\mu\text{g}/\text{m}^3$  increase of PM<sub>10</sub> was associated with 0.88 mmHg (95% CI: 0.71, 1.05) higher SBP and 0.91 mmHg (95% CI: 0.77, 1.06) higher DBP ( $p < 0.001$ ). We also found the larger effect estimate of PM<sub>10</sub> on SBP in physically inactive children than that in active ones. Consistent associations of SBP or DBP with PM<sub>10</sub> were found in both girls and boys.

### Conclusions

There are associations between long-term exposure to higher local PM<sub>10</sub> and increases of children's blood pressure. Public health policy for improving the air quality could be helpful to protect children's cardiovascular health.

## TUC05: Other cardiovascular effects of Ambient air pollution

102, September 26, 2017, 10:30 - 12:00

### The cardio-respiratory health impacts of particulate ambient air pollution (AAP) exposure in adults within low and/or middle income countries (LMIC's): a systematic review and meta-analysis

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**Background/Aim;** Research on the health effects of particulate ambient air pollution (AAP) exposure is mainly performed within developed regions with results extrapolated to LMIC's. Such generalisation fails to accurately capture the health impacts of AAP in LMIC's. The aim of this systematic review and meta-analysis is to examine the cardiorespiratory health impacts of particulate AAP exposure in LMIC's exclusively.

**Methods;** Systematic electronic searching plus hand searching of the relevant literature was performed locating studies examining the cardiorespiratory health impacts of particulate AAP exposure in LMIC's. Estimates were pooled by pollutant (PM<sub>2.5</sub>, PM<sub>10</sub>), lag and outcome, and presented as excess relative risk per 10µg/m<sup>3</sup> increase in particulate AAP. Further sub-group analysis was performed examining estimates pooled by specific outcomes, region, and city.

**Results;** 1553 abstracts were identified, 97 studies met the pre-specified inclusion criteria incorporating roughly 1 million events. A 10µg/m<sup>3</sup> increase in same day PM<sub>2.5</sub> was associated with a 0.50% (95% CI 0.40, 0.70) and 0.47% (95% CI 0.36, 0.57) increase in cardiovascular and respiratory mortality respectively. For respiratory morbidity, the association was greatest at moving average lags of 0-1 days, with a 0.33% (95% CI 0.07, 0.6) and 0.76% (95% CI 0.52, 1.01) increase for PM<sub>10</sub> and PM<sub>2.5</sub> respectively. Risk of cardiovascular morbidity was lower at 0.16% (0.06, 0.27%) for PM<sub>10</sub>. Estimates also varied by region, in East Asia and Pacific a 10µg/m<sup>3</sup> increase in same day PM<sub>2.5</sub> was associated with a 0.12% (95% CI 0.8, 0.16) increase in respiratory mortality, while in Latin America and the Caribbean this association was greater at 1.32% (95% CI 0.89, 1.74).

**Conclusions;** Short term exposure to particulate AAP was associated with increases in morbidity and mortality in LMIC's with variations in regional specific estimates apparent. Stronger associations were found for both morbidity and mortality in Latin America and the Caribbean than East Asia and Pacific.

## TUC05: Other cardiovascular effects of Ambient air pollution

102, September 26, 2017, 10:30 - 12:00

Why air pollution may not increase, and might decrease, the prevalence of cardiovascular morbidity

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**Background/Aim:** It is commonly assumed that air pollution increases disease prevalence and thus health service costs. We explored the impact of air pollution (AP) on cardiovascular morbidity and mortality as a prelude to the implementation of a microsimulation model of AP and cardiovascular disease (CVD) in the UK.

**Methods:** Use of a simplified 'bathtub' model to examine the evolution of CVD prevalence and mortality over a 30 year period under realistic estimates of the relative risk (RR) for disease incidence, case fatality and mortality. In this model, mortality among those who develop clinically-diagnosed CVD is assumed to be proportional to the number of people with ever-diagnosed CVD, to be independent of time since first diagnosis, and to be a function of CVD incidence and case fatality.

**Results:** The RR for the AP-mortality relationship is dominantly determined by the coefficient for AP-CVD incidence and rapidly approximates the same numerical value irrespective of the effect of AP on case fatality. Disease prevalence (proportion of people with ever-diagnosed CVD) on the other hand is heavily influenced by the AP RR for case fatality, which determines the duration lived with illness and life expectancy. A preliminary literature review suggests that the AP RR for fatality may be similar to, or even greater than, that for disease incidence, which would suggest that AP reduces or largely leaves unchanged the prevalence of CVD.

**Conclusions:** Although AP-related mortality rapidly reflects the effects of AP on disease incidence, the adverse effect of AP on case fatality diminishes the effect of increasing incidence to increase disease prevalence and may be so great as to diminish overall prevalence, though with additional life shortening. AP is therefore unlikely substantially to increase the burden of CVD on health services despite its important impact in increasing years of life lost.

# TUC05: Other cardiovascular effects of Ambient air pollution

102, September 26, 2017, 10:30 - 12:00

## Long-term exposure to ultrafine particles and type 2 diabetes prevalence

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**Background/Aim.** Recent studies suggested an association between long-term exposure to air pollution and diabetes. However, evidence is still limited, especially for ultrafine particles (UFP, diameter  $<0.1\mu\text{m}$ ) which have a high toxic potential due to their small size but comparably large surface.

**Methods.** We conducted a cross-sectional analysis based on data of the second follow-up (KORA FF4) of the KORA S4 study in Augsburg and two adjacent rural counties, Germany (2013-2014). Long-term exposure to particle number concentration (PNC) as indicator for UFP, ozone, particulate matter with diameters  $<10\mu\text{m}$  ( $\text{PM}_{10}$ ),  $<2.5\mu\text{m}$  ( $\text{PM}_{2.5}$ ) and  $2.5-10\mu\text{m}$  ( $\text{PM}_{\text{coarse}}$ ), absorbance of  $\text{PM}_{2.5}$  ( $\text{PM}_{2.5\text{abs}}$ ), nitrogen dioxide and oxides ( $\text{NO}_2$ ,  $\text{NO}_x$ ) was measured in 2013/14 and individual concentrations at the participants' residences were estimated by land-use regression. We used logistic regression adjusting for socio-demographic, lifestyle and clinical covariates to assess the association between annual air pollution concentration and prevalence of type 2 diabetes in 2,268 participants. Effect modifications were tested by the inclusion of interaction terms.

**Results.** Our results indicated a positive association for all air pollutants except for ozone. Significant effect estimates were seen for PNC [odds ratio: 1.18 (95%-confidence interval: 1.01;1.39)] per 2,000 particles/ $\text{cm}^3$  (interquartile range) increase and for  $\text{PM}_{2.5\text{abs}}$  [1.26 (1.01;1.57)] per  $3 \cdot 10^{-6}/\text{m}$  increase. The estimates however decreased after additional adjustment for the percentage of households with low income within a  $1\text{km}^2$  grid to 1.10 (0.91;1.33) for PNC and 1.10 (0.81;1.49) for  $\text{PM}_{2.5\text{abs}}$ . Effect estimates were higher for men, smokers, residents of the rural counties and physically inactive participants whereas age, low education, obesity and a history of cardiovascular disease did not modify the estimates significantly.

**Conclusions.** As one of the first studies investigating chronic exposure to ultrafine particles and type 2 diabetes our results point towards a positive association highlighting the role of ultrafine particles within the complex mixture of ambient air pollution.

## TUC05: Other cardiovascular effects of Ambient air pollution

102, September 26, 2017, 10:30 - 12:00

Long-term exposure to fine particulate matter air pollution is associated with increased platelet count in Taiwanese adults

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### Background

The prothrombotic effects of particulate matter (PM) are a possible biological mechanism linking PM air pollution and increased risk of cardiovascular disease. We investigated the associations of long-term exposure to PM with an aerodynamic diameter  $\leq 2.5 \mu\text{m}$  ( $\text{PM}_{2.5}$ ) and platelet count, a marker of hematologic and hemostatic changes, in a Taiwanese population.

### Methods

We studied participants who took part in a standard medical examination program between 2001 and 2014 with repeated measurements of platelet count. A spatio-temporal model based on satellite-derived aerosol optical depth data was used to estimate 2-year average ambient  $\text{PM}_{2.5}$  concentration at each participant's address. Mixed-effects linear regression model was used to examine the associations between  $\text{PM}_{2.5}$  exposure and platelet count with adjustment for potential confounders.

### Results

A total of 362,395 participants (48.5% males; mean age:  $39.3 \pm 13.3$  years) with 794,125 observations were included in the data analysis. After adjustment for age, sex, educational level, smoking, drinking, exercise, season, occupational exposure to dust, body mass index (BMI), hypertension, diabetes, hyperlipidemia and history of cardiovascular disease, every  $10 \mu\text{g}/\text{m}^3$  increment in  $\text{PM}_{2.5}$  concentration was significantly associated with 0.30% increase in platelet count (95% confidence interval: 0.27%, 0.33%). Stronger associations were observed among older participants (age  $\geq 65$  years) and those with hypertension, diabetes or  $\text{BMI} \geq 25.0 \text{ kg}/\text{m}^2$  (all  $P$  values for interaction  $< 0.05$ ).

### Conclusions

Long-term  $\text{PM}_{2.5}$  exposure was associated with increased platelet count. Elderly and people with preexisting cardiometabolic risk factors were more vulnerable.

### Presentation preference:

Oral (General Sessions)

# TUC06: Sources, predictors and health effects of indoor environmental exposures

105, September 26, 2017, 10:30 - 12:00

## Surrounding residential greenness does not confound associations between pet ownership and endotoxins in Germany

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### Background/Aim

Pet ownership is consistently associated with higher indoor endotoxin concentrations. We examined whether surrounding residential greenness may confound or modify this association in homes in Munich, Germany, because pet ownership might be related to neighbourhood greenness.

### Methods

Pet ownership data were collected during participant recruitment in the LISA cohort. Endotoxin concentrations were measured in settled house dust sampled from mothers' mattresses and living room floors (N=1199). Residential greenness was defined as the mean Normalized Difference Vegetation Index in a 500m buffer around the home. Linear regression models assessed cross-sectional associations between log-transformed endotoxin concentrations and pet ownership, adjusted for known predictors of endotoxin concentrations. Confounding was assessed by additionally adjusting the models for residential greenness. Effect modification was assessed by including interaction terms between pet ownership and residential greenness, and stratifying the models by residential greenness tertiles.

### Results

In adjusted models, dog ownership (5.3%) was associated with higher endotoxin concentrations in mattresses (means ratio: 1.67 [95% confidence intervals: 1.17, 2.39]) and on floors (2.32 [1.60, 3.35]). Cat ownership (9.2%) was only associated with mattress concentrations (1.49 [1.14, 1.97]). No associations were found with the other pets considered (bunny, bird). Associations were robust to further adjustment for greenness. Associations were slightly stronger in the lower greenness tertile for endotoxin concentrations in mattresses (low: 2.10 [1.01, 4.35], medium: 1.55 [0.86, 2.77] and high: 1.43 [0.79, 2.59] for dogs, and low: 1.93 [1.13, 3.29], medium: 1.40 [0.92, 2.14] and high 1.48 [0.89, 2.44] for cats) but not on floors. Interaction terms were not significant.

### Conclusions

Residential greenness did not confound the associations between pet ownership and indoor endotoxin concentrations, and there was only limited evidence of effect modification. Studies should continue investigating how pets influence indoor endotoxin concentrations, either by their presence and/or by acting as transmission vectors of the outdoor environment.

# TUC06: Sources, predictors and health effects of indoor environmental exposures

105, September 26, 2017, 10:30 - 12:00

## Indoor green determinants: outdoor green and other home characteristics

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**Background/Aim.** Indoor green has been hypothesized to benefit human health and well-being similarly to residential green, which will likely be investigated in future studies. In this Germany-based study, we examined which home characteristics are associated with greater amount of indoor green and whether indoor and outdoor green are interrelated.

**Methods.** Plants units' number in a living room and a bedroom together with other home characteristics were collected within the INGA study which included 454 children homes from Zerbst, Bitterfeld and Hettstedt and 437 adult homes from Erfurt and Hamburg. Outdoor green was defined as the mean Normalized Difference Vegetation Index in 50- to 1000-m circular buffers around residences and was available for Erfurt only. Negative binomial regressions were employed to assess the association between indoor green and potential predictor factors, separately for children's and adult's homes.

**Results.** Besides area differences in indoor green, size of the apartment was strongest related to a number of plants indoors in both children's (count ratio: 1.06 [95% confidence intervals; 1.03, 1.09] per 10 m<sup>2</sup>) and adults' (1.08 [1.03, 1.13]) homes. Also in children's homes, newer houses, absence of mice and presence of mould or dampness were related to more plants units. In adults, indoor-green related factors were presence of a dog and a cat as well as fewer rooms in the apartment. Less green in visible neighbourhood (50- and 100-m buffers) was related to having more indoor plants (e.g. 0.71 [0.56, 0.92] in highest tertile of outdoor green compared to lowest tertile). However, for walkable neighbourhood (500- and 1000-m buffers), these associations were in opposite direction.

**Conclusions.** Future research on indoor green should preferably use number of plants per size of the apartment and also cautiously check for potential confounding by other co-factors.

# TUC06: Sources, predictors and health effects of indoor environmental exposures

105, September 26, 2017, 10:30 - 12:00

## Household cleaning sprays and asthma control among elderly women

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### Background/Aim

Asthma control is suboptimal in nearly half of adult patients. A better knowledge of environmental determinants of asthma control may help improve disease management. Exposure to cleaning products at home is common and has been associated with adverse respiratory effects, especially when used in a spray form. However, data on the association between domestic use of cleaning sprays and asthma control are scant. We investigated this issue in a large cohort of French elderly women.

### Methods

We used data from a case-control study on asthma (Asthma-E3N, 2011-2013) nested in the E3N cohort. Women with asthma were invited to complete a questionnaire regarding respiratory health and environmental exposures (92% response rate). Among 3,023 women with current asthma, we examined asthma control, as defined by the Asthma Control Test (ACT) in the last 4 weeks. We used a standardized questionnaire to assess the frequency of household cleaning tasks, including the use of sprays. Analyses were adjusted for age, smoking status, body mass index and educational level.

### Results

Data on ACT and use of cleaning sprays were available for 2,223 women (70±6 years old). Asthma was controlled (ACT=25), partly controlled (ACT=20-24) and poorly controlled (ACT≤19) in 29%, 46% and 25% of the participants, respectively. A positive association was suggested between the use of at least 2 sprays weekly (10%) and poorly controlled asthma, in all women (odds ratio [OR]: 1.42, 95%CI: 0.93-2.15; p=0.10) and in those without household help (n=1,038; OR: 1.84, 0.95-3.59; p=0.09). When examining specific products, weekly use of windows/mirror cleaning sprays (25%) was associated with poorly controlled asthma (OR: 1.68, 1.09-2.58); use of other types of sprays (eg, furniture, oven, floor) was not.

### Conclusions

Regular use of cleaning sprays may contribute to poor asthma control in women. Limiting their use may help better achieving asthma control.

Funding: CENESA (IRES-2013)

# TUC06: Sources, predictors and health effects of indoor environmental exposures

105, September 26, 2017, 10:30 - 12:00

## Evaluation and control of nanoparticle emissions during 3D printing

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### Background/Aim

The 3D printer market continues to grow rapidly while health concerns are recently on the horizon. The aims of this study was to quantitate the emission rate of nanoparticle and to develop and compare several control methods to reduce the particle emission during fused deposition modelling (FDM) 3D printing.

### Methods

The emission rates of nanoparticle (#/min) were determined using seven different thermoplastic filaments (ABS1, ABS2, PLA, PVA, laywood, HIPS and nylon) during 3D printing using SMPS (scanning mobility particle sizer) and OPS (optical particle spectrometer). After that eight different control methods, as a combination of enclosure, suction fan with filter at the extruder, exhaust ventilation fan with filter at back side of the 3D printer housing, were invented and tested with ABS and HIPS filament.

### Results

The nanoparticle emission rates ranged from to according to the filament types and we could classify it into high emitter ( $> 10^{11}$  #/min, HIPS and Nylon), medium emitter ( $10^9$  #/min  $\sim 10^{11}$  #/min, ABS 1 and ABS 2), and low emitter ( $< 10^9$  #/min, PLA, PVA and Laywood). We found that emission rates depended on the types of filament and temperature of extruder head but not bed temperature.

Seven out of eight control methods were evaluated to have over 70% of removal efficiency except one method. The best method was to attach HEPA filter at the enclosure housing after installing enclosure housing of the 3D printer with 99.5 % of removal efficiency of nanoparticle.

### Conclusions

We confirmed that emission of nanoparticle was high and dependent on the types of thermoplastic materials and extruder temperature. We suggested the control method to reduce the particle emission. For example, appropriate filter such HEPA filter after enclosure housing could effectively reduce the nanoparticle emission into the air.

# TUC06: Sources, predictors and health effects of indoor environmental exposures

105, September 26, 2017, 10:30 - 12:00

## Exposure and Risk Assessment about Indoor Air Pollutants in Office Buildings for Workers

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### Background/Aim

Effects of indoor air quality have been received many attentions, especially about production workers in bad work environments and sensitive people. However, office staffs don't yet receive enough attention. According to the data from the National Statistical Office in Korea, the number of office workers is increasing year after year. This paper aimed to evaluate the exposures and risks about the office workers and attempt to propose air quality management plan in office buildings.

### Methods

Target air pollutants such as CO, CO<sub>2</sub>, O<sub>3</sub>, NO<sub>2</sub>, TVOCs, PM10 and HCHO were measured in three type's offices, which were divided into offices in metropolitans, national industrial complex and factories. Health effect perception and office characteristics were also measured by questionnaires.

### Results

A total of 328 employees from 31 offices participated in the survey. Significant differences were not found about the concentrations of measured pollutants in three type offices. The carcinogenic effects of formaldehyde, acetaldehyde and benzene were all exceeded the reference value  $1 \times 10^{-6}$ . By questionnaire, 47.4% employees advocate their reduced working capacity owing to ventilation deficiency, and 35% employees advocate their reduced working capacity owing to indoor pollutant sourced. Moreover, 30% employees answered that they had dry eye syndrome, and 33% employees had headaches.

### Conclusions

The office workers spent most of their time in office building. According to the results of this study, office staffs dissatisfied their indoor air qualities and some of them had health effects. Further researches focused on office staffs should be carried out in the future.

## TUC06: Sources, predictors and health effects of indoor environmental exposures

105, September 26, 2017, 10:30 - 12:00

Quantile Regression Analysis to predict effects of Outdoor Pollution and Human Activities on Indoor Air

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Background: Since people in developed countries tend to spend more than 85% of their time indoors, it is essential to quantify human exposure to inhalable pollutants indoors. In built environment, people are exposed to pollutants that are either emitted indoors or originate from outdoor sources and infiltrate indoors. While ambient concentrations are monitored by standard air-quality monitoring-networks, information on indoor pollutant concentrations is mostly unavailable. Our aim was studying contributions of airborne pollutants to indoor air.

Methods: Approximately 70,000 measurements of common urban criteria pollutants ( $PM_{10}$ , NO,  $NO_2$ ,  $O_3$ ) were recorded simultaneously every half-hour both indoor and outdoor in the headquarters of the Haifa-District-Municipalities Association for the Environment during years 2004-2007 (~17,500 time-periods per-year). Additionally, meteorological data, temperature, humidity, wind-speed, wind-direction, and precipitation were recorded. The headquarters are located on the second-floor of a two-story building. Inlets of indoor instruments were placed in the main hall. Inlets of outdoor instruments were located on the rooftop. The formally non-smoking office occupied 15 employees. The office had a central heating, ventilation and air-conditioning system, with a fixed inward drawn fresh-air. We used quantile regression analysis (for quantiles 10, 25, 50, 75, 90) to assess effects of outdoor pollution on indoor pollution, adjusted for seasonality, trend and meteorological-factors based on daily time-series.

Results: Peaks of both outdoor and indoor levels of  $PM_{10}$ ,  $NO_x$ , and  $NO_2$  were recorded during morning rush-hours. Lower measurements were recorded on Saturdays and holidays. Outdoor pollutants levels predicted indoor levels, with stronger associations in higher quantiles (For  $PM_{10}$   $q_{90}$ -coefficient=0.2, $p<0.01$ ). For  $NO_2$ , in addition to outdoor  $NO_2$ , both temperature ( $q_{75}$ -coefficient=0.3, $p<0.01$ ) and weekday ( $q_{75}$ -coefficient=0.7, $p=0.003$ ) predicted indoor  $NO_2$  levels.

Conclusions: This extensive dataset allows studying the interplay between outdoor and indoor pollution levels and the effects of human activity on indoor air. On heavily polluted days, indoor levels are high as well.

# SYM07: Climate Change: Heat, Mortality and Climate Action

101, September 26, 2017, 14:00 - 15:30

## Moving from adapting to climate variability to adapting to climate change

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**Background/Aim:** Many adaptation policies and measures focus on reducing vulnerability to current climate variability. Although these have the potential to improve health and well-being in the short term, they may not be robust to a changing climate. For example, extreme heat is the leading weather-related cause of morbidity and mortality, with exposures becoming more widespread, frequent, and intense with climate change. Heat early warning and response systems (HEWS) that integrate weather forecasts with risk assessment, communication, and reduction activities, are increasingly widespread. HEWS are frequently touted as an adaptation to climate change, but little attention has been paid to the question of how best to ensure the effectiveness of HEWS with additional climate change.

**Methods:** Review the challenges that climate change poses to HEWS and identify strategies for modifying HEWS so they remain adaptive in a world with more and more intense heatwaves.

**Results:** HEWS satisfy the tenets of an intervention that facilitates adaptation, but climate change poses challenges infrequently addressed in HEWS, particularly planning for adjustments in the onset, duration, and intensity of dangerously warm temperatures; the magnitude and pattern of acclimatization; and planning for changes over time in the relationships between temperature and health outcomes.

**Conclusions:** Iterative management should be central to a HEWS. Climate change adaptation and implementation science research frameworks can be used to identify HEWS modifications to improve effectiveness as temperatures continue to rise, incorporating new scientific insights and lessons learned on promoting and protecting population health.

# SYM07: Climate Change: Heat, Mortality and Climate Action

101, September 26, 2017, 14:00 - 15:30

## Global patterns of temperature-related mortality

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**Background:** Patterns of temperature-related mortality vary with space and time, and it is important to evaluate this issue at a global scale.

**Methods:** We critically review the epidemiological evidence on global patterns of temperature-related mortality, and discuss key issues in the assessment of mortality impacts of temperature extremes.

**Results:** We assess the empirical evidence on the mortality impacts of both hot and cold temperatures, and explore how these patterns will alter as climate change proceeds. We found that, in many countries, cold temperature plays a greater role than hot temperature in the occurrence of deaths, but in some countries, this pattern is opposite. We also observed that population adaptability to hot temperature has been increasing over the time so that heat-related mortality has been declining in many parts of the world. However, population adaptability to cold temperature has had no apparent alterations. As climate change progresses, the heat-related mortality will increase while cold-related mortality will decrease, but the magnitude of such a change may vary with region and over the time.

**Conclusions:** Accruing evidence reveals that the patterns of temperature-related mortality vary with space and time, which may be due to different exposure and population adaptation. Additionally, social and technological development may also play a role. Future research needs to focus on these issues in the assessment of temperature-related mortality. Improved understanding of temperature-related mortality is one of the major tasks for quantification of the public health impacts of climate change.

# SYM07: Climate Change: Heat, Mortality and Climate Action

101, September 26, 2017, 14:00 - 15:30

## Long-term changes in temperature-related mortality in a changing climate

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Projections of future temperature-related mortality in a changing climate have proliferated over the past decade. Most such studies make the simplifying assumption that the exposure-response function (ERF) linking mortality risk to hot and cold temperatures will remain constant in the future as the climate warms. This approach increasingly appears unrealistic in light of emerging empirical evidence that consistently showing declines in the ERF for heat in recent decades in locations around the world. These decreasing heat ERFs may reflect increasing air conditioning prevalence, but appear also to reflect improvements in economic and health conditions. In addition, cross-sectional evidence indicates that ERFs for both heat and cold differ markedly across locations in the current climate depending on prevailing temperatures. In the US, warmer cities show steeper cold ERFs, flatter heat ERFs, and higher minimum mortality temperatures (MMT) than cooler cities. If this evidence is informative about the impact of future climate change, it suggests that ERFs in a future, warmer climate, may shift from the typical cool city shape to the typical warm city shape, resulting in changes in both cold and hot ERFs as well as the position of the ERF over the distribution of temperature. While some studies have incorporated adaptation trends in the heat ERF for future projection, no attention has been paid to changes in cold-related ERFs in a warming climate. Here, we review the literature on differential exposure-response functions over time and space, and then explore the sensitivity of future projections in selected US cities to a range of assumptions about the evolution of both hot and cold ERFs over time. We show that projections of temperature-related mortality are highly sensitive to alternative assumptions about future adaptation, and suggest that future projection studies take these uncertainties into account when reporting results.

# SYM07: Climate Change: Heat, Mortality and Climate Action

101, September 26, 2017, 14:00 - 15:30

A global perspective to temperature, climate and health: results from the MCC Project

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## Background/Aim

Epidemiological associations between non-optimal temperature and human health are markedly heterogeneous across populations living in different regions of the world, and so are the future health impact projected in a changing climate. We present here the findings from a comprehensive assessment performed by the Multi-City Multi-Country (MCC) network, an international collaboration of research teams working on a program aiming to produce evidence on associations between weather, climate and health.

## Methods

The MCC Project has gathered daily time series data on temperature and mortality counts for several outcomes from 455 locations in 24 countries between 1972 and 2012. These data were analysed using state-of-the-art analytical methods based on two-stage designs using distributed lag non-linear models and multivariate meta-analysis, to obtain location-specific estimates of temperature-mortality associations and to pool them across countries, regions, and globally.

## Results

Separate analyses have investigated different aspects of the association, such as the relative and attributable risk for heat and cold compared across locations, the factors responsible for these heterogeneous relationships, the temporal variation in risk and related adaptation patterns, the effects associated to extreme weather events and to day-to-day and within-day temperature changes, the variation in minimum mortality (optimal) temperature, and the projected impact under climate change scenarios, among others.

## Conclusions

The MCC Study represents by far the largest epidemiological investigation on temperature, climate, and human health. Results from this international project provides important information for planning local and global public health and climate policies and adaptation strategies to attenuate current and future health burden associated to non-optimal temperature.

# SYM07: Climate Change: Heat, Mortality and Climate Action

101, September 26, 2017, 14:00 - 15:30

Addressing the heat disease: a pilot study of trade unions and climate heat in the workplace

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## Background/Aim

Growing heat under climate change is having major social impacts, signalling a 'heat disease' of epidemic proportions. The issue is under-researched: in 2016 the UN report, 'Climate Change and Labour: Impacts of Heat in the Workplace', stressed threats to livelihood and health, stating research was 'urgently required' (UNDP 2016). How can the experience of rising heat be translated into effective policies to address impacts and injustices, and enable effective climate policy? Climate policy, as a socio-political process, is set in the bio-physical context of climate change: how can the two be related to address the experience of 'heat disease'?

## Methods

The paper reports on a pilot for a citizen science program designed to expose the experience of workplace heat under climate change. It posits the need to link big-data climate science with the affective experience of climate change, to deepen climate policy debates. The pilot is conducted with relevant trade unions and focuses initially on construction and agri-business in Australia, sectors particularly exposed to climate heat.

## Results

Interviews will be analysed in the light of project aims and with a view to developing future research agendas in this area.

## Conclusions

The paper aims to enable the emergence of new research agendas, refining research questions. There will be a special focus on addressing the methodological challenges of engaging the social sciences in epidemiological studies of climate change.

# SYM07: Climate Change: Heat, Mortality and Climate Action

101, September 26, 2017, 14:00 - 15:30

## Adapting to climate change to minimise mortality and morbidity in the workplace

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Dave Briggs, Department of Epidemiology and Biostatistics, Imperial College, London, UK

Tord Kjellstrom, School of Demography, Australian National University, Canberra, Australia

### Background

The impact of climate change on worker mortality and morbidity can be minimised by reducing work intensity during hot parts of the day as measured by the thermal work limit (TWL). However, effective self-paced work reduces worker output especially in the agricultural sector.

### Methods

Using an approximation to calculate hourly heat stress in each 0.5x0.5 degree grid cell we calculate the work hours lost per person working at 200W, 300W and 400W. Then using population data, we calculate person hours lost for that grid cell.

### Results

The data of all grid cells in a country or region can then be summed to give percentage of work hours lost for the country or region for each month in 1995, 2025, 2055 and 2085. Data from two regions will be presented as examples: South East USA and Northern India.

### Conclusions

One way to avoid the detrimental health effects of heat stress as climate change progresses is for the worker can reduce their work output. This poster shows a method of calculating this productivity loss. Further studies of the impact of work in the heat on the health of workers is needed to compare this cost with that of productivity loss.

## SYM14: Epidemiology of exposure to mixtures

024, September 26, 2017, 14:00 - 15:30

### Testing the capabilities of methods for mixtures epidemiology with simulated data: Or How I Learned to Start Worrying and Love the DAG

**Thomas F. Webster\***, Boston University School of Public Health, Boston, USA  
Marc Weisskopf, Harvard T.H. Chan School of Public Health, Boston, USA

#### Background/Aim

Methods for mixtures epidemiology tend to focus on variable selection and colinearity. Methods are often tested and compared using simulated, benchmark data sets. For causal inference (vs. prediction), interpretation of results requires assumptions about causal structure, even for simulated data.

#### Methods

We illustrate the issue by contrasting two approaches used for simulating data with varying degrees of correlation between exposures. Method 1: Suppose exposures  $X_1$  and  $X_2$  are multivariate normal with correlation  $r_{12}$ ; construct outcome  $Y$  using an equation (e.g.,  $Y=b_0+b_1*X_1+b_2*X_2+error$ ). To generate data for situations differing only in exposure correlation, change  $r_{12}$  and reapply the same equation. Method 2: Assume  $X_1$ ,  $X_2$  and  $Y$  are multivariate normal with bivariate correlations  $r_{12}$ ,  $r_{1Y}$ ,  $r_{2Y}$ . To generate data for situations differing only in the exposure correlation, repeat changing only  $r_{12}$ . We interpret regression results by constructing Directed Acyclic Graphs (DAGs) consistent with the two methods.

#### Results

Method 1 is consistent with the following casual structure:  $X_1$  and  $X_2$  are caused by a shared, unmeasured source  $U$ ; both exposures cause outcome  $Y$ ; there are no other variables of concern. Crude regression results are confounded by co-exposure; bias increases as  $r_{12}$  increases. Mutual adjustment produces unbiased results. Method 2 is consistent with a hexagonal DAG where unknown variables ( $U_{12}$ ,  $U_{1Y}$ ,  $U_{2Y}$ ) cause each pair of variables. Crude regression results are unbiased; mutual adjustment biases results as it conditions on colliders. Under some circumstances both methods can produce the same data for any given  $r_{12}$ . More complicated statistical methods are likely to be subject to similar types of biases.

#### Conclusions

For mixtures epidemiology, explicit causal assumptions are needed for interpretation of results of regression and more sophisticated analytic methods. They are also needed for construction of simulated data used to compare methods. Failure to do so can lead to misleading results.

# SYM14: Epidemiology of exposure to mixtures

024, September 26, 2017, 14:00 - 15:30

## Co-exposure (Z) amplification bias: A threat to the validity of mixtures epidemiology

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### Background/Aim

The analysis of health effects of exposure mixtures is a critically important issue in human epidemiology, and increasing effort is being devoted to establishing methods to analyze exposure mixtures in epidemiological studies. We previously presented on a recently described amplification of uncontrolled confounding resulting from conditioning on additional variables that is referred to as Z-amplification bias. This is particularly problematic in the context of mixtures analyses as co-exposures can cause this amplification: hence, the term co-exposure amplification bias. Understanding the properties of this bias amplification is critical for mixtures epidemiology. Here we expand on effects of this bias under different co-exposure scenarios likely to be found in mixtures epidemiology.

### Methods

Through the use of Directed Acyclic Graphs (DAGs) we describe data structures underlying different reasons for correlated mixtures of exposures. From these we deduce the potential for bias amplification when including multiple exposures together in analytic models.

### Results

When correlation between co-exposures is caused by a variable that is unrelated to the outcome of interest, then the possibility of co-exposure amplification bias is high when the exposures are considered together in analytic models. When correlation between co-exposures is caused by a variable that is also related to the outcome of interest, then adjustment for both exposures helps reduce confounding. When both reasons for co-exposure correlation are present, the effects on co-exposure bias become more complicated and can go in both directions. In this case, the distribution of sources of exposure to the contaminants will influence which direction the bias is likely to go.

### Conclusions

Co-exposure amplification bias poses an important potential problem to the analysis of health effects of exposure mixtures. Careful consideration of the structure giving rise to correlated exposures is critical and may have implications for statistical approaches to analyzing the data

# TUC07: Other Effects of Climate Change

026, September 26, 2017, 14:00 - 15:30

## Temperature Variation, Transitional Season, and Human Health

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**Background/Aim:** Although an increase in recent research evaluated the impacts of extreme weather on human health, few assessed the health effects of large temperature variation and of extreme weather in transitional seasons compared to typical summer and winter. This presentation will describe our studies in New York State (NYS) aimed at evaluating how large temperature variation affected respiratory hospitalization in summer, and whether extreme cold had different impacts on cardiovascular (CVD) or respiratory admissions in transitional months than in winter.

**Methods:** Case-crossover design was used to address the aims using respiratory/CVD hospitalization obtained from the state-wide discharge data. Daily and weekly temperature range (maximum temperature – minimum temperature) were used as temperature variation indicator. The effects in transitional months (November, March and April) were evaluated and compared to those in summer and winter. Conditional logistic regression was conducted adjusting for daily mean temperature and air pollution. The modifying effects of socio-demographic were assessed in stratified analysis.

**Results:** We found that excess risks of respiratory hospitalization significantly increased per 1 °C change of daily temperature (range from 0.26% - 1.18%) with lag 3 in most regions, but health risks associated with weekly temperature change were higher (0.35% – 1.64%) with the delayed lags from 5-7 days. Furthermore, we found that asthma admission in NYS did not increase during cold spell, but increased after cold spell, which only showed up in November and early spring (March and April). The increases were only observed in warmer areas than in cold areas. A similar trend was found for CVD.

**Conclusions:** We found that large temperature variation and extreme weather in transitional seasons would have stronger and larger human health burden due to lack of adaptability. Future warning or prevention effort against extreme weather should consider large temperature change and have early warning issued in transitional months.

## TUC07: Other Effects of Climate Change

026, September 26, 2017, 14:00 - 15:30

### Different spatiotemporal features of the seasonal influenza A and B in six different climatic zones, Australia

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#### Background/Aim

Few studies investigate the different spatiotemporal characteristics of seasonal influenza A and B in different climatic zone. This study aims to assess the spatiotemporal patterns of seasonal influenza A and B based on postal area (PA) level in different climatic zones in Australia.

#### Methods

Geographic Information System and spatiotemporal analyses were used to explore the differences of the seasonal influenza A and B under six climatic zones (i.e., tropical, subtropical, hot dry summer and mild winter zone (HDSMW), hot dry summer and cold winter zone (HDSCW), temperature with mild/warm summer and cold winter zone (TMSCW) and temperature with warm summer and cool winter zone (TWSCW) across Australia.

#### Results

The highest annual incidences were observed in HDSMW, with 166.1 and 82.9 per 100,000 population between 1<sup>st</sup> January 2011 and 31<sup>st</sup> December 2013, for influenza A and B, respectively. The smallest annual incidences occurred in TMSCW, with 84.4 and 24.6 per 100,000 population for both influenza A and B, respectively. The highest monthly incidences for both influenza A and B occurred in August in tropical, subtropical, HDSMW and HDSCW, excepted for TMSCW and TWSCW for influenza A (in July). The smallest average monthly incidences of influenza B presented in February, except for TWSCW (in March). The smallest average monthly incidences of influenza A occurred in February for HDSCW and TWSCW and in April for HDSMW and in November for tropical and subtropical. Overall, 76.6% of PA had greater averages of annual incidences for influenza A than those for influenza B, in which 60.8% of PA were observed in TMSCW and TWSCW.

#### Conclusions

There were great differences in the epidemics of influenza A and B under the six climatic zones in Australia. This study could be useful to develop an influenza early warning system based on weather factors in Australia.

# TUC07: Other Effects of Climate Change

026, September 26, 2017, 14:00 - 15:30

## Projection of ozone-related mortality with climate and population changes in urban China

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### Background/Aim

China is experiencing rising ozone pollution in urban areas, but its potential future health impacts under both climate and population changes remain unclear. We examine future annual and seasonal ozone-related mortality in 347 urban counties of China under three climate and emission scenarios and six population scenarios.

### Methods

Ozone projections were statistically downscaled from a global chemistry-climate model to a fine spatial resolution (0.25° × 0.25°) using newly available ambient ozone monitoring data across China from 2013-2015. The attributable fraction method was then applied to estimate the daily ozone-related premature mortality in the 2010s, 2030s, 2040s, and 2050s, respectively.

### Results

Higher ground-level ozone occurs under an extreme warming scenario in which air pollutant emissions are held at 2005 levels (RCP8.5\_WMGG), leading to an excess 4296 (95% CI: 3415 to 5169), 5181 (4213 to 6228), and 5134 (4086 to 6171) non-accidental deaths per year in 2033-2035, 2043-2045, and 2053-2055 relative to 2013-2015. Estimates of future changes in ozone-related mortality are sensitive to the choice of climate and emissions scenario, decreasing under RCP4.5 but increasing under RCP8.5 by 2043-2045 and 2053-2055 relative to 2013-2015. Population increases amplify the adverse impacts of climate change on ozone-related mortality. Deteriorating ozone air quality in colder months contributes to excess ozone-related mortality.

### Conclusions

Our analysis suggests that more stringent air pollution control measures will be needed, including beyond the warm season, to prevent a rising health burden of climate change via ozone pollution in urban China.

# TUC07: Other Effects of Climate Change

026, September 26, 2017, 14:00 - 15:30

Health impact of low crop yield in rural Burkina Faso in the context of weather variability

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## Background/Aim

We have previously shown that low crop harvests are associated with negative child nutritional and health outcomes in subsistence farming populations in Burkina Faso. Such impacts are likely to increase under climate change. We quantified the health burden associated with low crop yields, and their weather-attributable components, to inform health protection policies.

## Methods

We used data on annual variation in crop yields and a previously-derived relationship between crop yield in the year of birth and child mortality <5 years of age, to compute changes in Years of Life Lost (YLL) using life table method. Age-specific mortality rates were derived from the Nouna Health and Demographic Surveillance System, 1984–2012. We estimated the contribution of weather variation to low crop yields using a statistical crop model. We used global circulation model climate projections in the crop model to estimate future risk of low crop yield under the 1.5°C target scenario.

## Results

Over the period 1984–2012, crop yield in two years was <70% and in further six years 71–90% of the period average. Over these eight years, yield deficit translated into an average deficit of 58 kg of millet per person per year and was estimated to contribute to a total of 2,853 YLL per 100,000 population over the same period, of which 2,024 YLL (71%) could be attributed to adverse weather effect on crop production. Under the 1.5°C warming scenario, we projected an increase in the risk of annual yield decline <90% by 60% in the year 2100, compared to 2015.

## Conclusions

Low crop yields have an appreciable impact on child survival and YLL, much of which appears to be related to weather factors, suggesting the need for integrated interventions to protect against the effects of low crop yields and/or the adverse impact of weather on crop production.

## TUC07: Other Effects of Climate Change

026, September 26, 2017, 14:00 - 15:30

### The Impacts of Climate Change on Food and Waterborne Diseases in Malaysia

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**Background:** Food and waterborne diseases (FWBD) in this study refer to food poisoning, typhoid, cholera, hepatitis A and dysentery. Total FWBD is the cumulative of all the 5 diseases listed. This study is an attempt to quantify climate-induced increases in the morbidity rates of FWBD.

**Methods:** Monthly FWBD cases and average monthly meteorological data between the years of 2004 to 2014 were obtained from the Ministry of Health Malaysia and Malaysian Meteorological Department, respectively. Population projections in Malaysia up to 2040 were retrieved from the Department of Statistics Malaysia and projected to the year 2100 based on the mean percentage increase of 40 years. The PRECIS model was used to project future climatic variables up to 2100 under the A1B scenario. Poisson generalized linear models and overdispersed Poisson were developed to quantify the relationship between climatic parameters and number of reported FWBD cases in the future.

**Results:** The findings revealed that the total FWBD cases in Malaysia was 145562 cases with 118 deaths. The overall mean age of the patients varied between 19 and 26 years old. Temperature gave a significant impact on total FWBD and food poisoning cases in Selangor ( $p < 0.001$ ), Melaka ( $p < 0.001$ ), and Kelantan ( $p < 0.001$ ), while temperature in Sabah was significantly associated with total FWBD ( $p < 0.004$ ) and cholera cases ( $p < 0.001$ ). Precipitation was only associated with cholera cases in Sabah ( $P = 0.022$ ). For every 1 °C increase in temperature, the excess risks of total FWBD, food poisoning, and cholera cases in every state will increase up to 54.7%, 56.4%, and 58.7%, respectively. However, the contribution of rainfall was very mild, whereby every increase of 1 mm in precipitation will increase the excess risk of cholera by 0.03%.

**Conclusion:** The study concludes that climate does affect the distribution of FWBD cases in Selangor, Melaka, Kelantan, and Sabah.

## TUC08: Occupational and Environmental Metal Exposure and Health

020, September 26, 2017, 14:00 - 15:30

### Temporal and Spatial Variation of Urinary Lead, Cadmium, Cobalt, and Copper Levels in the General Taiwanese: NAHSIT 1993–1996 and 2005–2008 Periods

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**Background/Aim:** The increasing episodes of hazardous metal contamination in soil, water, or agriculture products are a public health concern. We aim to evaluate the temporal and spatial variations in urinary levels of lead (Pb), cadmium (Cd), cobalt (Co), and copper (Cu) in the general Taiwanese population.

**Methods:** We randomly selected 1601 participants aged older than 7 years from the Nutrition and Health Survey in Taiwan (NAHSIT) conducted during 1993–1996 and 2005–2008. We measured the concentrations of the four metals in the participants' first morning void urine sample using inductively coupled plasma mass spectrometry. We used principal component analysis to identify the potential factors related to exposure profiles of above hazardous metals in our participants.

**Results:** The geometric mean (GM) levels of urinary Pb, Cd, Co, and Cu in participants from NAHSIT 1993-1996 (N=821) and 2005-2008 (N=780, parenthesis) were 2.21 (0.90), 0.54 (0.69), 0.95 (1.07), and 16.67 (13.81) µg/L, respectively. We found that GM level of urinary Pb in our participants was significantly decreased from NAHSIT 93-96 to 05-08, whereas those of urinary Co and Cd were increased regardless of age. However, GM levels of Pb, Co and Cu in children or adolescent were significantly higher than those in adults at two periods, except for Cd. Our data indicated that exposure profiles of above four metals were obviously categorized by two principal components (PC), included PC1 (male) and PC2 (female), regardless of age and periods. Besides, our results revealed that GM levels of Pb, Cd, Co, Cu in participants lived in rural area were higher than those in urban and other areas in NAHSIT 05-08.

**Conclusions:** We concluded that urinary Pb, Cd, Co, and Cu levels in the general Taiwanese varied by gender, age, place of resident and periods.

# TUC08: Occupational and Environmental Metal Exposure and Health

020, September 26, 2017, 14:00 - 15:30

## Abrupt increase of allergic disease incidence in local community after opening of ferronickel manufacturing factory: An interrupted time series study

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### Background/Aim

The first ferronickel manufacturing factory of Korea opened at Gwangyang city on October 23<sup>th</sup> 2008. There has been public concerns regarding adverse health effects of scattered ferronickel slags from waste landfill since the opening of the factory. Therefore, to evaluate the immediate and gradual health effects of ferronickel factory on local residents of Gwangyang city, we conducted interrupted time series analysis using health insurance data.

### Methods

Using standard methods of interrupted time series analysis, we analysed monthly incidence and hospital visits of allergic disease [asthma (J45), vasomotor and allergic rhinitis (J30), dermatitis and eczema (L20-L30)] in Gwangyang city between 2004 to 2014. Data were gathered from national health insurance service database which covers all the hospital use data of entire Gwangyang city residents. Seasonality adjusted segmented quasi-Poisson regression analysis was used to evaluate whether the opening of the ferronickel factory was associated with immediate and gradual changes in allergic disease incidence and hospital visits. We also assessed the association in comparison cities (Yeosu and Suncheon city) near Gwangyang city and control outcomes [Forearm fracture (S52), Osteoporosis (M81)].

### Results

After opening of the ferronickel factory, there was an abrupt and sustained increase in the monthly allergic disease incidence [relative risk (RR), (95% confidence interval): pruritus: 1.277, (1.104-1.477); atopic dermatitis: 1.272, (1.151-1.406); seborrheic dermatitis: 1.088, (1.006-1.176); irritant dermatitis: 1.112, (1.011-1.224); unspecified dermatitis: 1.880, (1.444-2.448)]. Effects were greater in young children (aged 0 to 9) and similar results were observed in analysis with monthly number of hospital visits. No significant changes were observed in control outcomes and analysis in comparison cities.

### Conclusions

The opening of ferronickel factory in Gwangyang city was associated with a significant increase of allergic disease in local residents.

# TUC08: Occupational and Environmental Metal Exposure and Health

020, September 26, 2017, 14:00 - 15:30

## Blood metals and cognitive function in Chinese workers

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**Background/Aim.** The relationship of co-exposure to manganese, aluminum, and copper on neurotoxicity is still unclear. Therefore, our aim was to determine the association of these metals with learning and memory.

**Methods.** We completed a cross-sectional study of 60 Chinese male workers from a ferroalloy or manufacturing factory. Whole blood samples were analyzed for metals using inductively coupled plasma-mass spectrometry. Animal naming, fruit naming, and WHO/UCLA-Auditory Verbal Learning Tests (AVLT) assessed learning and memory. Additional information was obtained via questionnaire. Linear regression models were constructed for each metal with each test, adjusting for age, education, smoking, and alcohol use; a final model included all three metals. Blood lead was assessed, but was not associated with any cognitive tests.

**Results.** Geometric mean blood manganese was 14.0 µg/L (95% confidence interval (CI): 13.0, 15.0), aluminum was 306.1 µg/L (286.2, 327.5), and mean copper was 78.6 µg/dL (76.4, 80.7). Ferroalloy factory workers had significantly higher blood aluminum and manganese, but not higher copper, compared to manufacturing workers. In adjusted models, manganese was significantly associated with poorer AVLT first 5 trial average ( $\beta=-1.93$ ; 95% CI: -3.82, -0.03), but was not significant after adjustment for other metals ( $\beta=-1.27$ ; -3.10, 0.55). There was a similar pattern for aluminum with AVLT. Aluminum was significantly associated with improved performance on the fruit naming test in adjusted models including manganese, and copper. In models adjusting for covariates, manganese and aluminum, an increase in copper was associated with significantly poorer performance on animal naming ( $\beta=-0.238$ ; -0.377, -0.099) and AVLT ( $\beta=-0.070$ ; -0.128, -0.013). There was a non-significant association for copper with fruit naming ( $\beta=-0.102$ ; -0.207, 0.003).

**Conclusions.** Blood copper was consistently associated with decreased performance on cognitive function testing even after adjustment for manganese and aluminum; this should be verified with studies using metal biomarkers reflecting cumulative exposure.

# TUC08: Occupational and Environmental Metal Exposure and Health

020, September 26, 2017, 14:00 - 15:30

## Lead exposures and osteoarthritis in Korean adult men and women

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### Background/Aim

Lead (Pb) has been reported to affect bone and cartilage in animal models and human studies. However, few studies evaluated the association between Pb exposures and osteoarthritis in population. The aim of our study was to analyse the relationship between Pb exposures and osteoarthritis in Korean population.

### Methods

In this study, we used the data from Korean National Health and Nutrition Examination survey V (2010-2012). We evaluated subjects who were  $\geq 50$  years of age with radiological examinations on knees. The radiologic grade of osteoarthritis was assessed by Kellgren & Lawrence system. The blood Pb was analysed in 2388 subjects. The relationships between Pb and osteoarthritis was investigated using multiple logistic regression adjusting age, BMI, house income, education, smoking, alcohol drinking, physical activity, and occupation after stratification of sex.

### Results

For men, the OR for the third and highest quartile compared to the lowest of Pb was 2.34 (95% CI: 1.32, 4.14), and 1.90(95% CI: 1.09, 3.32) in men, and for women, the OR for the highest quartile compared to the lowest was 1.81(95% CI: 1.17, 2.77) after adjusting demographic factors.

### Conclusions

Our findings suggest that lead exposures were associated with radiological osteoarthritis in Korean adult men and women.

# TUC08: Occupational and Environmental Metal Exposure and Health

020, September 26, 2017, 14:00 - 15:30

## Cumulative Lead Exposure and Risk of Incident Open-Angle Glaucoma: the VA Normative Aging Study

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**Background:** Glaucoma is the leading cause of irreversible loss of vision, and open-angle glaucoma (OAG) is the major subtype in the U.S. Although the etiology of OAG is still unclear, increasing evidence suggests that oxidative stress may play an important role. Heavy metals, such as lead, have been associated with oxidative stress-related chronic disease. We investigated the association between cumulative lead exposure and incident OAG.

**Methods:** We examined 572 OAG free males from the Normative Aging Study who had tibia and patella lead measurements from 1991 to 1999 using K X-ray fluorescence and standard ocular evaluations from 1995 to 2015 (mean baseline age=66.3 years (range=49.9-98.1); median follow-up=12 years (range=1 to 23 years)). OAG cases were identified by consistent reports of enlarged or asymmetric cup-to-disc ratio together with vision field defect or existence of disc hemorrhage. We used Cox proportional hazards regressions to estimate hazard ratios (HRs) of incident OAG. Inverse probability weighting (IPW) was applied to reduce potential selection bias of the bone lead sub-study.

**Results:** We identified 57 incident OAG during follow-up (Overall incidence rate=85 per 10,000 person-years). After adjustment for age, education, body mass index and cumulative cigarette smoke (pack-years), a 10-fold increase in patella lead was significantly associated with a HR of 2.96 (95% CI: 1.08, 8.12). The HR comparing participants in the highest with the lowest quartiles of patella lead was 2.65 (95% CI: 1.11, 6.32) with a positive linear trend (p for trend=0.037). Further adjustment for intraocular hypertension, hypertension and diabetes mellitus did not change these findings. Non-significant positive associations were observed with tibia lead (HR=1.95 (95% CI: 0.64, 5.99) for a 10-fold increase in tibia lead).

**Conclusions:** This first epidemiologic study of cumulative lead exposure and incident OAG suggests that cumulative lead exposure may be an unidentified risk factor of OAG.

## TUC09: Child Health: phthalates, triclosan

022, September 26, 2017, 14:00 - 15:30

### Prenatal Urinary Triclosan Concentrations and Neurodevelopment

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**Background/Aim:** Triclosan, an antimicrobial chemical used in some consumer products, is ubiquitous among pregnant women. Gestational exposure may reduce the levels of thyroid hormones important for neurodevelopment. We examined the association between triclosan exposure during fetal development and children's neurobehavior at three years of age.

**Methods:** We measured triclosan in urine samples collected at ~12 weeks of gestation in 794 Canadian women enrolled in a prospective pregnancy and birth cohort study (MIREC) from 2008-2011. Around 3 years of age, children's cognitive abilities were assessed using the Wechsler Primary and Preschool Scale of Intelligence-III (WPPSI-III) and two scales of the Behavior Rating Inventory of Executive Function-Preschool (BRIEF-P). Parents reported children's behavior using the Behavior Assessment System for Children-2 (BASC-2) and Social Responsiveness Scale-2 (SRS-2). We used multivariable linear regression to estimate the covariate-adjusted associations between a 10-fold increase in prenatal urinary triclosan concentrations and neurobehavioral outcomes, as well as sex-specific associations.

**Results:** The median urinary triclosan was 8.8 ng/mL (range: <LOD-2,621 ng/mL). Triclosan was not associated with most neurobehavioral scores. Notably, increasing triclosan was weakly associated with better WPPSI-III picture completion scores ( $\beta$ : 0.2; 95% CI: 0, 0.5), BASC-2 externalizing problems ( $\beta$ : -0.5; 95% CI: -1.1, 0), and BASC-2 hyperactivity scores ( $\beta$ : -0.6; 95% CI: -1.2, -0.1). Child sex modified few of the associations between triclosan and neurobehavior (TCS x sex p-values  $\leq$  0.1). For example, a 10-fold increase in prenatal triclosan was associated with a 1-point (95% CI: -1.9, -0.2) better somatization score in girls, but no association among boys.

**Conclusions:** In this cohort, prenatal urinary triclosan concentrations were not associated with most measured aspects of neurobehavior and weakly associated with some, but not in the hypothesized direction.

## TUC09: Child Health: phthalates, triclosan

022, September 26, 2017, 14:00 - 15:30

The relationship between phthalate exposures and oxidative stress in school age children.

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**Background/Aim:** Phthalates are ubiquitous in the environment and are found in many household products. Phthalate exposures may increase oxidative stress in individuals via the formation of reactive oxygen species (ROS), potentially affecting respiratory outcomes, with children a vulnerable group. The aim of this study was to investigate the relationship between urinary measures of oxidative stress and urinary phthalate metabolites in school aged children and the identification of any activities or products that may increase measured exposure.

**Methods:** A spot urine sample was collected from children aged between 5 and 12, who lived on the outskirts of an industrial area and who were participating in a respiratory health study. Urinary phthalate metabolites were analysed using high-performance liquid chromatography/tandem mass spectrometry (LC-MS/MS) and 8-hydroxy-deoxyguanosine (8-OHdG) was measured using the Check ELISA method. All samples were adjusted for specific gravity measured using a hand held refractometer. Questionnaire information provided by parents was examined to determine potential sources of phthalate exposure.

**Results:** Median and range of specific gravity adjusted urinary phthalate metabolite concentrations ( $\mu\text{g/L}$ ) were MMP (4.7, 0.7-180); MCP (6.20, <0.50-180); MEP (41.0, 2.20-4700); MiBP (39.0, 3.30-1500); MBP (43.0, 3.00-1200); MEHHP (47.5, 3.20-670); MECPP (61.0, 3.30-900); MEOHP (31.5, 1.70-610); MBzP (11.0, 0.50 – 300) and MEHP (6.90, 0.60-140). MCHP, MOP, MNP, and MiDP were below the limit of detection. Spearman correlation coefficients for all metabolites were significantly correlated with 8-OHdG with the largest coefficients observed for MBP and MBzP ( $r_s = 0.305$ ). The presence of new carpet was associated with increased urinary MEP concentrations while MiBP was increased in those reporting the presence of bedroom and playroom carpet.

**Conclusions:** Phthalate metabolites were commonly detected, albeit at concentrations lower than in many other studies, and were associated with a urinary marker of oxidative stress, showing that even low level phthalate exposure may elicit oxidative stress responses in children.

## TUC09: Child Health: phthalates, triclosan

022, September 26, 2017, 14:00 - 15:30

### Identifying Vulnerable Neurodevelopment Windows of Triclosan Exposure in Children

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**Background/Aim:** Exposure to triclosan, an endocrine disrupting chemical, may decrease circulating thyroxine levels or interfere with thyroid hormone signaling during gestation or early childhood neurodevelopment. In this study, we investigated associations of prenatal and postnatal triclosan exposure with intellectual abilities among 199 children in the HOME Study birth cohort.

**Methods:** We quantified triclosan in up to three maternal urine samples collected during the second and third trimesters and within 48 hours of delivery. We also quantified triclosan in child urine samples collected up to six times between 1 and 8 years of age. At age 8 years, children's full scale IQ (FSIQ) was assessed using the Wechsler Intelligence Scale for children, 4<sup>th</sup> Edition (WISC-IV). We applied a multiple informant method to account for repeated triclosan measurements from the same individual at different visits, estimate covariate-adjusted triclosan-IQ associations at each visit, and test if triclosan-IQ associations at each visit differed from one another.

**Results:** Maternal triclosan concentrations during pregnancy were not associated with FSIQ scores. However, for each 10-fold increase in triclosan concentration at delivery, there was a 4.1-point decrease in child full scale IQ (95% CI: -6.5, -1.7) at age 8 years. Children's triclosan concentrations were not associated with FSIQ scores. The interaction p-value between triclosan and visit suggested that the association between repeated triclosan concentrations and child IQ varied by exposure timing (p-value=0.05). The pattern of associations between repeated triclosan concentration and child IQ was not modified by sex (p > 0.44).

**Conclusions:** Triclosan concentration at birth, but not at other exposure windows, was inversely associated with child IQ at age 8 years, suggesting a heightened window of vulnerability to triclosan exposure around delivery for children in this cohort. This association suggests a possible window of vulnerability that warrants further investigation.

## TUC09: Child Health: phthalates, triclosan

022, September 26, 2017, 14:00 - 15:30

### Association between phthalate exposure and thyroid stimulating hormone levels among preschool-age children

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#### Background/Aim

Despite its clinical importance, the associations between phthalate exposure and thyroid-stimulating hormone (TSH) levels have not been sufficiently investigated yet.

#### Methods

We used data from the Environment and Development of Children (EDC) study. Urinary levels of phthalate metabolites, such as mono-(2-ethyl-5-hydroxyhexyl) phthalate (MEHHP), mono-(2-ethyl-5-oxohexyl) phthalate (MEOHP), and mono-n-butyl phthalate (MnBP), were measured repeatedly using urine samples collected from mothers at pregnancy and children at 2 and 4 years of age. Thyroid-stimulating hormone (TSH) levels were measured repeatedly at 2 and 4 years of age. We evaluated the associations of urinary phthalate metabolite levels measured prenatally and after delivery with log-transformed TSH levels using linear mixed models adjusted for potential confounders.

#### Results

One-unit increase in creatinine-adjusted log-transformed prenatal MnBP levels were inversely associated with TSH levels measured repeatedly at 2 and 4 years of age ( $\beta = -0.055$ , 95% confidence interval [CI]: -0.108, -0.003). Urinary MnBP levels at 2 and 4 years of age were also inversely associated with TSH levels ( $\beta = -0.064$ , 95% confidence interval [CI]: -0.123, -0.006). Urinary MEHHP and MEOHP levels were not associated with TSH levels in this study population. We did not find any evidence of heterogeneity of the associations by sex (p-value for interaction > 0.10).

#### Conclusions

We found that urinary MnBP levels measured prenatally and at 2 and 4 years of age were associated with TSH levels among preschool-age children.

## TUC09: Child Health: phthalates, triclosan

022, September 26, 2017, 14:00 - 15:30

Are prenatal trimester-specific phthalates exposure related to metabolomics biomarkers during peripuberty?

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**Background:** Exposure to phthalates *in utero* may affect glycemia and adiposity-related hormones in adolescence in a sex-specific fashion, but not necessarily other clinical markers of metabolic risk, including serum lipids. Circulating metabolites afford the potential to characterize pre-clinical changes and biochemical pathways by which early life exposures influence the development of cardiometabolic risk in later life.

**Methods:** Among 242 mother-child dyads from the Early Life Exposure in Mexico to ENvironmental Toxicants (ELEMENT) birth cohort, we measured 9 phthalate metabolites in maternal spot urines obtained during each trimester, corrected for urinary specific gravity and natural-log-transformed. In 128 girls and 114 boys aged 8-14 years, we used a mass-spectrometry based untargeted metabolomics platform to measure fasting serum metabolites. The procedure yielded 938 unique chemical features including 332 known compounds. We estimated the associations between each urinary phthalate and each serum metabolite, stratified by sex and adjusting for child age, BMI z-score, and pubertal onset, defined as any pubic or genital/breast Tanner stage >1. We accounted for multiple comparisons using the false discovery rate approach (q-values) and a threshold of 10%.

**Results:** Among girls, 2<sup>nd</sup> trimester concentrations of monobenzyl and 3<sup>rd</sup> trimester mono(3-carboxypropyl) mono(2-ethyl-5-carboxypentyl) and mono(2-ethyl-5-hydroxyhexyl) (MEHHP) phthalates were associated with several known metabolites. For example, a log unit increase in 3<sup>rd</sup> trimester concentrations of MEHHP was significantly associated with diacylglycerol 16:0:16:0 (beta: -0.31) and dodecenedioic acid (0.34) – medium chain fatty acids implicated in metabolic risk in adult populations; monounsaturated fatty acids (11-cis-eicosenoic (0.34) and myristoleic acid (0.30)); choline (-0.31) and pyroglutamic acid (-0.34). Among boys, we observed a few associations of 2<sup>nd</sup> and 3<sup>rd</sup> trimester phthalates with unidentified metabolites.

**Conclusions:** Metabolomics biomarkers may reflect sex differences in response to *in utero* phthalate exposures during puberty that are not detected in clinical markers of cardiometabolic risk

# TUC10: How ambient air influences birth outcomes

100, September 26, 2017, 14:00 - 15:30

## Prenatal Exposure to Source-Specific Fine Particulate Matter and Term Low Birthweight in California

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### Background/Aim

Multiple studies have demonstrated associations between fine particulate matter (PM<sub>2.5</sub>) and term low birth weight (TLBW: birth weight <2,500g and gestational weeks ≥37weeks). However, it remains unclear which PM<sub>2.5</sub> sources contribute to these associations, and whether some regions or populations are susceptible to those associations. We investigated whether PM<sub>2.5</sub> and its sources were associated with TLBW, and effect modifications by region and maternal characteristics.

### Methods

We used California birth records and ambient PM<sub>2.5</sub> data from 2002 to 2009. Source apportionment method (Positive Matrix Factorization) identified five sources (secondary ammonium sulfate, secondary ammonium nitrate, vehicular emissions, biomass burning, and resuspended soil). Average gestational exposure was calculated for mothers residing within a 20km radius of monitors (N=1,050,330). Logistic regression was conducted adjusted by individual and neighbourhood characteristics. Interaction term was added to investigate whether risk differ by region or maternal characteristics.

### Results

PM<sub>2.5</sub> total mass and three PM<sub>2.5</sub> sources were associated with TLBW. Risk of TLBW associated with each interquartile range increase in exposure were 4.9% (95% confidence interval: 2.6-7.3) for total PM<sub>2.5</sub>, 7.7% (4.7-10.7) for secondary ammonium sulfate, 5.6% (3.5-7.7) for resuspended soil, and 3.1% (1.3-4.9) for secondary ammonium nitrate. Heterogeneous associations were found between inland and coastal regions, as well as northern and southern regions for several sources. We also found effect modification by maternal race/ethnicity and educational attainment, with higher risk of TLBW in mothers with less education and non-Asian mothers.

### Conclusions

Results suggest that some PM<sub>2.5</sub> sources may be more harmful than other sources. Investigating the relative toxicity of different PM<sub>2.5</sub> sources is useful from a regulatory standpoint by allowing targeting of emission sources. Furthermore, determining which populations are at highest risk from air pollution exposures is an important topic from an environmental justice perspective, and our study showed heterogeneous associations by region and by maternal characteristics.

# TUC10: How ambient air influences birth outcomes

100, September 26, 2017, 14:00 - 15:30

## Traffic-related Air and Noise Pollution, Preterm Birth and Stillbirth in London

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### Background/Aim

Evidence for associations between ambient air pollution and both preterm birth (PTB) and stillbirth is inconsistent. Road traffic pollution comprises potentially toxic air pollutants and noise, but only two studies of PTB have investigated these co-exposures together, with conflicting results, and none for stillbirth. This study investigates long-term exposure to both traffic-related air and noise pollution during pregnancy and risk of PTB and, for the first time also, stillbirth.

### Methods

The study population comprises 887664 singleton births across Greater London from 2003-2010. Monthly concentrations of NO<sub>2</sub>, NO<sub>x</sub>, source-specific traffic-related PM<sub>2.5</sub>, PM<sub>2.5</sub>, PM<sub>10</sub> and ozone were estimated at 20m x 20m resolution using a dispersion model, and time-weighted averages were calculated for pregnancy/trimesters at address-level. Annual road traffic noise levels were modelled at address-level using the TRAFFIC NOISE EXPOSURE (TRANEX) model. We analysed the relationship between air pollutant/noise exposures and PTB/stillbirth using logistic regression.

### Results

There were 5451 (0.6%) stillbirths in the study population, and 5.8% of live births were preterm. Mean pregnancy exposures were NO<sub>x</sub>: 75µg/m<sup>3</sup>, PM<sub>2.5</sub>: 15µg/m<sup>3</sup>, PM<sub>10</sub>: 24µg/m<sup>3</sup>, ozone: 32µg/m<sup>3</sup>, day-time noise: 58dB and night-time noise: 53dB. Preliminary results suggest increased pregnancy average ozone exposure is associated with increased risk of both PTB and stillbirth; and suggest possible associations between high road traffic noise and increased risk of PTB and stillbirth but only after adjustment for air pollution co-exposures - we are investigating these associations further.

### Conclusions

To our knowledge, this is the first epidemiological study to investigate risk of stillbirth and traffic noise, and also the largest to investigate air pollution and noise exposures jointly in relation to PTB. This study combines highly spatially refined address-level exposure assessment for both noise and air pollutants, and will improve understanding of the relative influences of these co-exposures upon adverse birth outcomes.

# TUC10: How ambient air influences birth outcomes

100, September 26, 2017, 14:00 - 15:30

Long-term Exposure to Air pollution and Pregnancy (LEAP) study: term low birth weight

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## Background/Aim

Birth weight is a determinant of health status in childhood and adulthood. The LEAP study is a multi-centric study aimed to analyse the association between air pollution exposure and adverse pregnancy outcomes. Here, our objective was to evaluate the association between particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>) and nitrogen oxides (NO<sub>2</sub> and NO<sub>x</sub>) and low birth weight (LBW) in term newborns in Rome.

## Methods

We selected all singleton livebirths delivered from 2002 to 2014 from women aged 15-49 years, living for the entire pregnancy in Rome. We assessed exposure at residential coordinates using land use regression models for all pollutants, performing an extrapolation using a background monitoring station to account for temporal variability. We used logistic regression to analyse low birth weight in term newborns, adjusting for maternal age, marital status, maternal education, parity, nationality, sex of the baby, gestational week, season of conception, and small area socioeconomic position.

## Results

We selected 237,563 term livebirths (5280 were weighting less than 2500 grams). Average exposure during pregnancy was 41ug/m<sup>3</sup> NO<sub>2</sub>, 81ug/m<sup>3</sup> NO<sub>x</sub>, 19ug/m<sup>3</sup> PM<sub>2.5</sub>, and 36 ug/m<sup>3</sup> PM<sub>10</sub>.

Air pollution exposure was associated to a higher risk of term LBW. For 10ug/m<sup>3</sup> increase in NO<sub>2</sub> the odds ratio (OR) was 1.07 (95%CI: 1.04-1.09), and for 20 ug/m<sup>3</sup> increase in NO<sub>x</sub> OR=1.06 (95%CI: 1.04-1.09). For 5 ug/m<sup>3</sup> increase in PM<sub>2.5</sub> we found an OR=1.08 (95%CI: 1.03-1.13), and for 10 ug/m<sup>3</sup> increase in PM<sub>10</sub> OR=1.06 (95%CI: 1.03-1.10). The results were stable to further adjustment (for occupation, paternal education, etc.).

## Conclusions

We found an association between exposure to air pollution and term low birth weight in Rome.

# TUC10: How ambient air influences birth outcomes

100, September 26, 2017, 14:00 - 15:30

## Air pollution and birth outcomes in China – A synthesis of Chinese and English language research

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### Background

Historically, the majority of research on air pollution and birth outcomes was undertaken on cohorts from western countries, with relatively lower levels of exposure. There is now a sufficient number of studies to warrant an assessment of effects in China, a higher exposure setting. This was the first systematic review of both Chinese and English language research on air pollution and birth outcomes in China.

### Methods

We conducted a systematic review, according to the PRISMA statement, of all Chinese and English language articles published between 1980 and 2015 on the association between ambient air pollution (NO<sub>2</sub>, SO<sub>2</sub>, CO, PM<sub>10</sub>, PM<sub>2.5</sub>, O<sub>3</sub>) and birth outcomes (low birth weight, preterm birth, stillbirth, congenital anomaly) in China. Of the 1,829 articles screened, 11 English language articles and 14 Chinese language articles were included for full review; 25 total.

### Results

Mean concentrations of PM<sub>10</sub>, NO<sub>2</sub> and SO<sub>2</sub> during the study period were 113 µg/m<sup>3</sup>, 50 µg/m<sup>3</sup> and 61 µg/m<sup>3</sup>, respectively, with maximum concentrations of 600, 468 and 630 µg/m<sup>3</sup>, respectively. Evidence of association with sulphur dioxide (SO<sub>2</sub>) was more consistently reported for reduced birth weight and preterm birth. Coarse particulate matter (PM<sub>10</sub>) was associated with congenital anomaly, notably cardiovascular defects. The adjusted odds ratio (95% CI) for pooled heart defects was 1.35 (1.15, 1.60) and ranged from 1.31 (1.07, 1.60) for patent ductus arteriosus to 1.44 (1.04, 1.99) for defects of the cardiac septa per 10 µg/m<sup>3</sup> of PM<sub>10</sub> over the entire pregnancy.

### Conclusions

Exposure levels and effects were generally greater in China. China has low incidence of some perinatal morbidities (e.g, preterm birth, 3%) but contributes substantially to global burden due to the large number of births (e.g., 1m preterm births per year), which might be addressed by reductions in sulphur dioxide and particulate matter.

## TUC10: How ambient air influences birth outcomes

100, September 26, 2017, 14:00 - 15:30

### Green space exposure and ultrasound measures of fetal growth: A Spanish birth cohort study

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**Background/Aim:** In recent years, the effect of greenness on birth weight has been studied in different analyses across multiple countries; however, the available evidence on such an effect on measures of fetal growth during the prenatal life is nonexistent. The aim of this study was to evaluate the association between exposure to residential surrounding greenness and fetal biometry in four birth cohorts included in the Spanish Infancia y Medio Ambiente (INMA) – Environment and Childhood– Study

**Methods:** Biparietal diameter (BPD), femur length (FL), abdominal circumference (AC), and estimated fetal weight (EFW) were evaluated for 2478 fetuses at 12, 20, and 34 weeks of gestation. The size and growth between these points were assessed by SD scores, derived using cohort-specific growth curves for each parameter, which were adjusted for constitutional factors known to affect fetal growth. Satellite-derived normalized difference vegetation index (NDVI) was used to quantify surrounding greenness (100 m, 300 m, and 500 m buffers) of participants' residential addresses during pregnancy. Associations between ultrasounds measurements and greenness variables were investigated using linear regression models, adjusted for socio-demographic and lifestyle-related variables. We also further adjusted the models for nitrogen dioxide exposure during pregnancy.

**Results:** Higher levels of surrounding greenness were associated with increased size at week 12 for BPD, AC and EFW and increased growth for BPD, AC and EFW in weeks 20-34. Less consistent associations were observed for FL. Adjusting for NO<sub>2</sub> attenuated the relation between greenness and ultrasounds, suggesting a mediator role for air pollution in our observed associations.

**Conclusions:** This is the first study to report on the impact green space exposure on fetal growth using ultrasound measurements. We found a positive association between this exposure and most of ultrasound measures of fetal growth.

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# TUC10: How ambient air influences birth outcomes

100, September 26, 2017, 14:00 - 15:30

## Maternal Exposure to Greenness during Pregnancy and Birth Weight

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### Background/Aim

Exposure to greenness in the residential neighbourhood, measured through the normalized difference vegetation index (NDVI), has been shown to affect human health. In this study, we study the association between maternal exposure to NDVI during pregnancy and birth weight with adjustment for air pollution as well as other individual and neighbourhood confounders.

### Methods

For 684,266 births between 2001 and 2012 in Massachusetts, each birth was assigned an average NDVI during pregnancy using the 250 \* 250 m grid cell for which the mother lived in. We regress birth weight against NDVI, particulate air pollution (PM<sub>2.5</sub> at 1 \* 1 km), and other covariates in generalized linear models. We adjust for nonlinearity in effect using splines. The full list of covariates are as follows: marital status, maternal education, government-supported prenatal care, maternal/paternal age and race, maternal cigarette smoking before/during pregnancy, parity, Kotelchuck Index for prenatal care, gestational/other diabetes and hypertension, mode of delivery, infant sex, clinical gestational age, and census-tract percent black population and median income.

### Results

In the linear model with NDVI and covariates, an interquartile range (IQR) increase in NDVI (0.225) was associated with a 13.87 (95% CI: 11.98, 15.75) gram increase in birth weight. After adjusting for PM<sub>2.5</sub>, an IQR increase in NDVI was associated with a 14.90 (12.91, 16.90) gram increase in birth weight. Including interactive terms between NDVI and each of government-supported prenatal care, maternal education, and infant sex did not significantly change the NDVI effect estimates.

### Conclusions

Maternal exposure to greenness measured through NDVI appears beneficial to newborn health as it is positively associated with birth weight, even after adjusting for highly-resolved particulate air pollution predictions and many individual / neighbourhood health and socioeconomic variables.

## TUC11: Challenges in risk assessment - from exposures to continents

102, September 26, 2017, 14:00 - 15:30

### Daily Intake Estimation and Cumulative Risk Assessment of 6 Phthalates in the General Taiwanese: Taiwan Environmental Trace Toxic Substances Survey (TESTs) 2013

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**Background/Aim:** In May 2011, a food scandal occurred in Taiwan because of the ill-legal use of the di-2-ethylhexyl phthalate (DEHP) in food products. We assessed the daily intakes (DIs) and cumulative risk of 6 phthalates in the general Taiwanese after the scandal.

**Methods:** We evaluated the DIs of 6 phthalates, such as di-n-butyl phthalate (DnBP), di-iso-butyl phthalate (DiBP), and di-2-ethylhexyl phthalate (DEHP), in a general Taiwanese using urinary phthalate metabolites. We assessed hazard quotients of phthalates included reproductive ( $HQ_{rep}$ ) and hepatic ( $HQ_{hep}$ ) effects. Cumulative risk assessment was applied to evaluate the synergistic effects of different phthalates exposure on reproductive and hepatic outcomes.

**Results:** The creatinine-based calculation model showed that the highest DI values in males and females  $\geq 7$ -to  $< 12$ -years-old were for DEHP (males: median: 4.79  $\mu\text{g}/\text{kg}$  bw/d; females: median: 2.62  $\mu\text{g}/\text{kg}$  bw/d). The 95<sup>th</sup> percentile (P95) of  $HQ_{rep}$  values were all  $> 1$  in the  $\geq 7$ - to  $< 12$ -year-old,  $\geq 18$ - to  $< 40$ -year-old, and  $\geq 65$ -year-old male groups, but they were  $< 1$  in all of the female groups. The P95 of  $HQ_{hep}$  values were all  $> 1$  in the  $\geq 7$ - to  $< 12$ -year-old and  $\geq 12$ - to  $< 18$ -year-old male groups, but they were  $< 1$  in all of the female groups. In general, most of the  $HQ_{rep}$  was attributable to the HQs of DnBP and DiBP (53.9-84.7%), and DEHP contributed most to  $HQ_{hep}$  (83.1-98.6%), which reveals that DnBP, DiBP and DEHP were the main risk of phthalate exposure for Taiwanese.

**Conclusions:** Taiwan's general population is widely exposed to phthalates, especially for DnBP, DiBP and DEHP. Additional studies are needed to clarify whether the contamination sources primarily food and personal care products. The TDI of DEHP to protect vulnerable residents, like children and reproductive-aged adults, should be lowered after considering the potential cumulative negative effects on reproduction.

# TUC11: Challenges in risk assessment - from exposures to continents

102, September 26, 2017, 14:00 - 15:30

## Cardiovascular Risk from Water Arsenic Exposure in Vietnam: Application of Systematic Review and Meta-Regression Analysis in Chemical Health Risk Assessment

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### Background/Aim

A systematic review (SR) and meta-analysis cannot provide the endpoint answer for a chemical risk assessment (CRA). The objective of this study was to apply SR and meta-regression (MR) analysis to address this limitation using a case study in cardiovascular risk from arsenic exposure in Vietnam.

### Methods

Published studies were searched from PubMed using the keywords of arsenic exposure and cardiovascular diseases (CVD). Random-effects meta-regression was applied to model the linear relationship between arsenic concentration in water and risk of CVD, and then the no-observable-adverse-effect level (NOAEL) were identified from the regression function. The probabilistic risk assessment (PRA) technique was applied to characterize risk of CVD due to arsenic exposure by estimating the overlapping coefficient between dose-response and exposure distribution curves. The risks were evaluated for groundwater, treated and drinking water.

### Results

A total of 8 high quality studies for dose-response and 12 studies for exposure data were included for final analyses. The results of MR suggested a NOAEL of 50 µg/L and a guideline of 5 µg/L for arsenic in water which valued as a half of NOAEL and guidelines recommended from previous studies and authorities. The results of PRA indicated that the observed exposure level with exceeding CVD risk was 52% for groundwater, 24% for treated water, and 10% for drinking water in Vietnam, respectively.

### Conclusions

The study found that systematic review and meta-regression can be considered as an ideal method to chemical risk assessment due to its advantages to bring the answer for the endpoint question of a CRA.

# TUC11: Challenges in risk assessment - from exposures to continents

102, September 26, 2017, 14:00 - 15:30

Exposure to dyed particulates and health effect when participating in a color run- a pilot study

## **Background**

Recently, running arrangement has emerged where dyed powder is thrown at the participants. The powder consists of corn starch with various additives to provide color. However there is a lack of risk assessment for this exposure. We therefore conducted a pilot study to investigate the exposure to particles and metals as well as health effects for participants in a color run.

## **Method**

11 healthy volunteers participated in color and reference runs with a distance of 5-6 km in the fall of 2015. Personal pumped sampling of particles of the inhalable fraction was measured and gravimetrically analyzed and via ICP-MS for metals. Lung function was examined using spirometry and nitric oxide in exhaled air as a inflammatory marker. Participants answered a questionnaire on symptoms from the eyes, nose, airways and skin. Health surveys were conducted before and after every run.

## **Results**

Levels of inhalable particles were statistically significant higher in the color runs, 10-279 mg /m<sup>3</sup> compared to the reference runs (all below LOQ, <0.06 mg /m<sup>3</sup>). Calculating a time weighted average for 8 hours (assuming zero exposure up to 8 hours) showed 6 of the values exceeding the Swedish OEL for flour dust, 3 mg /m<sup>3</sup> (0.75 -24 mg /m<sup>3</sup>). Metals identified including magnesium, aluminum and nickel showed levels significantly higher than in the reference run. At the reference runs no health problems were reported. In the color runs one participant with rosacea had worsened rash. No statistically significant differences in spirometry or level of inflammatory marker were seen between the runs.

## **Conclusion**

High levels of particulate matter were measured during the color runs and metals were identified. Lighter skin problems were reported but no significant effect on the airways was observed. The group is small and an extended study would be of interest.

# TUC11: Challenges in risk assessment - from exposures to continents

102, September 26, 2017, 14:00 - 15:30

Reducing mortality risk by targeting specific air pollution sources: Suva, Fiji

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## Background/Aim

Health implications of air pollution vary dependent upon pollutant sources. This work determines the value, in terms of reduced mortality, of reducing ambient PM<sub>2.5</sub> (atmospheric particulate matter less than 2.5µm aerodynamic diameter) concentration due to different emission sources. Suva, a Pacific Island city with substantial input from combustion sources, is used as a case-study.

## Methods

The sources of PM<sub>2.5</sub> in Suva have been quantified by positive matrix factorisation. A review of recent literature has been carried out to delineate the mortality risk associated with these sources. Risk factors have then been applied for Suva, to calculate the possible mortality reduction that may be achieved through reduction in pollutant levels.

## Results

Higher risk ratios for BC and S resulted in mortality predictions for PM<sub>2.5</sub> from fossil fuel combustion, road vehicle emissions and waste burning that surpass predictions for these sources based on health risk of PM<sub>2.5</sub> mass alone. Predicted mortality for Suva from fossil fuel smoke exceeds the national toll from road accidents in Fiji.

## Conclusions

The greatest benefit for Suva, in terms of reduced mortality, is likely to be accomplished by reducing fossil fuel combustion, emissions from vehicles and waste burning

# TUC11: Challenges in risk assessment - from exposures to continents

102, September 26, 2017, 14:00 - 15:30

## Global Burden of Disease from Environmental and Occupational Risk Factors: Southeast Asia, East Asia, and Oceania

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### Background/Aim

Environmental risk factors contribute to the burden of disease through a variety of pathways, including exposure to toxins via unsafe water, food, and air. This exposure can take place in the home, in the workplace, or almost anywhere outside through increased levels of ambient pollution. Quantifying this risk worldwide is paramount to understanding the problem in order to design effective interventions.

### Methods

Diverse methodology was applied across a range of environmental risks. First, the data landscape was scoured in order to create rich datasets across time and space for risk exposure. Then, Bayesian statistical methods and a database of covariates were used in order to predict for all risk factors, geographic locations, sexes, age groups, and time periods in order to create a comprehensive and comparable set of estimates. Risk information derived from established literature and updated review was used to estimate PAFs, which were then applied to the GBD2015 estimates of cause-specific deaths and DALYs in order to calculate burden attributable to environmental and occupational risks.

### Results

Over the past twenty five years - 1990 to 2015 - the proportion of burden attributable to environmental risks in the Southeast Asia, East Asia, and Oceania super-region has seen a modest reduction from 16.8% to 12.7%. Improvements to water and sanitation infrastructure in the region helped drive the effect, but environmental risks still present a significant challenge to local health. Ambient and household air pollution caused more than 2 million deaths in the super-region, with high rates seen in South Asia and mainland China.

### Conclusions

Development in the super-region is steadily improving infrastructure critical to healthcare provision and mitigation of environmental risk exposure. The epidemiologic transition indicated by this work provides an important roadmap for the increasing relevance of NCDs that are strongly linked to chronic exposure to environmental pollutants.

# TUC12: Environmental exposure and health in elderly populations

105, September 26, 2017, 14:00 - 15:30

Eczema, allergic sensitization and exposure to air pollution in the elderly

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(299/300 words)

**Background/Aim:** Most people develop eczema early in life, however, there is some evidence that it can develop during adulthood. Only a few studies have investigated the incidence of eczema in elderly. Eczema is a complex disease whereby environmental factors act in concert with immune reactions. In the current project, we investigated the incidence of eczema, the associated atopic conditions and the possible role of air pollution in a cohort of elderly women from the Ruhr area in Germany.

**Methods:** We studied 830 women (mean age 73.5 years) to investigate incidence of eczema and allergic sensitization. We used an adapted version of the ISAAC Symptom questionnaire for adults to assess the incidence of eczema after the age of 55 years. Long-term exposure to particulate matter (PM<sub>2.5</sub>), PM<sub>2.5</sub>absorbance, and long-term exposure to nitrogen dioxide (NO<sub>2</sub>) was assessed at residential addresses using geographic information systems based regression models and air pollution measurements. Total serum Immunoglobulin E (IgE) concentrations were assessed at baseline and specific IgE was assessed at follow-up.

**Results:** 15.8% of women had ever eczema and incidence of eczema symptoms after the age of 55 was 8.2%. Incident cases of eczema symptoms remained high (6.2%) after exclusion of women with high IgE levels and rhinitis at baseline. For incidence of eczema statistically significant effects were found with all investigated exposures: odds ratio (OR) per interquartile range (IQR) PM<sub>2.5</sub> 1.44 (95%CI:1.06;1.97), per IQR PM<sub>2.5</sub>absorbance 1.45 (1.08;1.95), and per IQR NO<sub>2</sub> 1.49 (CI:1.04;2.15). Associations were stronger when excluding women with allergic sensitization and rhinitis at baseline (e.g. with NO<sub>2</sub>: OR=1.73 (95%CI:1.16;2.57)). Total and specific IgE levels were not associated with air pollution.

**Conclusion:** This study provides evidence that adults can develop eczema when exposed to elevated levels of air pollution and that eczema in the elderly is probably not related to atopy.

# TUC12: Environmental exposure and health in elderly populations

105, September 26, 2017, 14:00 - 15:30

## Eczema in the elderly – The impact of genetics and air pollution

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(300/300 words)

**Background/Aim:** Eczema is caused by an interplay of genes and environment. Genetic risk factors for eczema have mainly been identified in children and their role in adult eczema is not clear. We have recently reported an association of air pollution with eczema in elderly women. Animal studies suggest that the arylhydrocarbon receptor (AHR) may mediate this association. In the present study we investigated (i) the role of genetic risk factors, identified in children, for eczema in elderly and (ii) the gene-environment interaction (GxE) between *AHR* polymorphisms and air pollution on eczema, using 462 elderly German women from the SALIA cohort.

**Methods:** Incident eczema after the age of 55 years was assessed by an adapted version of the ISAAC symptom questionnaire. Long-term residential concentrations of  $\text{NO}_2$ ,  $\text{NO}_x$ ,  $\text{PM}_{2.5}$ ,  $\text{PM}_{10}$ ,  $\text{PM}_{2.5}$  absorbance were determined with land-use-regression models. Genotyping was performed with the Affymetrix Axiom™ Precision Medicine Research Array. We focused the main genetic association analysis on five single nucleotide polymorphisms (SNPs) that met genome-wide significance for eczema in children and the loss-of-function null mutation R501X in the filaggrin gene. We tested the associations for each SNP separately and combined to a weighted genetic risk score. We performed the GxE analysis using nine SNPs genotyped in the *AHR* region.

**Results:** The incidence of eczema was 7.6%. Genetic risk factors identified in children were not associated with eczema in elderly. The GxE analysis revealed that minor allele carriers of *AHR* polymorphisms were more susceptible to air pollution-induced eczema. The strongest GxE was found with the functional *AHR* polymorphism rs2066853: e.g. OR with  $\text{NO}_x$  per  $39.5\mu\text{g}/\text{m}^3$  was 5.06 ( $p=0.011$ ) for carriers and 1.09 ( $p=0.782$ ) for non-carriers (interaction  $p=0.034$ ).

**Conclusions:** We showed that *AHR* polymorphisms modify the risk to air pollution-induced eczema. Our results also indicate different genetic risk factors for eczema in children vs. elderly.

# TUC12: Environmental exposure and health in elderly populations

105, September 26, 2017, 14:00 - 15:30

## Air pollution and performance-based physical functioning in Dutch older adults

### Author information

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### Background/Aim

Functional limitations are a major cause for needing care and institutionalization among older adults. It has been suggested that exposure to air pollution is associated with increased functional limitations in older people. We assessed the association between air pollution and physical functioning in Dutch older adults.

### Methods

We analyzed data on performance-based and self-reported physical functioning for 1,735 participants of the Longitudinal Aging Study Amsterdam, who participated in at least one of three measurement cycles performed in 2005/2006, 2008/2009 and 2011/2012. Annual average outdoor air pollution concentrations [nitrogen dioxide (NO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), particulate matter with diameters ≤ 2.5 μm (PM<sub>2.5</sub>), ≤ 10 μm (PM<sub>10</sub>), and 2.5-10 μm (PM<sub>coarse</sub>), and PM<sub>2.5</sub> absorbance] at the home address at the start of the first measurement cycle were estimated using land-use regression models. Analyses were performed using mixed models with random subject intercept accounting for correlation between repeated measurements within subjects, and adjusting for potential confounders.

### Results

Exposure to most air pollutants was associated with reduced performance-based physical functioning, e.g. an inter-quartile range increase in NO<sub>2</sub> exposure was associated with a 0.35 (95 confidence interval: 0.20-0.51) lower performance test score, equivalent to the effect on performance of a 1-year increase in age. Exposure to air pollution was generally not associated with self-reported functional limitations, and not associated with the decline in performance-based physical functioning over the study period.

### Conclusions

This study suggests an adverse effect of exposure to air pollution on performance-based physical functioning of older adults in the Netherlands.

# TUC12: Environmental exposure and health in elderly populations

105, September 26, 2017, 14:00 - 15:30

High air pollution and extrinsic skin aging: results from a population-based cohort

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## Background/Aim

Episodes of high air pollution remain an unresolved problem even in countries with low pollution levels. Following the recent evidence that ambient air pollution can aggravate signs of extrinsic skin aging, we investigated the contribution of high air pollution episodes to skin aging in elderly.

## Methods

We used a cohort of 1,431 adults aged 60–84 years of the population-based Berlin Aging Study II (BASE-II). The SCINEXA™ score was employed to assess extrinsic skin aging: (1) coarse wrinkles on the face and (2) pigment spots on the face and on the back of the hand. Daily concentrations of particulate matter (PM<sub>10</sub>) and ozone (O<sub>3</sub>) were obtained with the Optimal Interpolation method (Umweltbundesamt FGII4.2), combining the chemistry transport model with routine monitoring data (resolution 7km×8km). We counted the days when modeled pollutants' concentrations exceeded the maximum allowed values in the European Union (>50 µg/m<sup>3</sup> PM<sub>10</sub>, >120 µg/m<sup>3</sup> O<sub>3</sub>). The mean over the study period (2009–2014) was used as exposure. We employed linear regression models, adjusting for relevant confounders. Regression coefficients were converted to mean ratios and presented as %-change.

## Results

Participants were on average exposed to 19 days of exceeded PM<sub>10</sub> and 17 days of exceeded O<sub>3</sub>, which correlated moderately ( $\rho=0.39$ ). Two-week O<sub>3</sub> exceedance per year was associated with more coarse wrinkles in the crow's feet area (24% higher score on average; 95%-CI: 1%, 46%) and on the upper lip (42%; 95%-CI: 0%, 83%). PM<sub>10</sub> was weakly related to more pigment spots on cheeks (26%; 95%-CI: -8, 71%). These results were mutually independent in two-pollutant models.

## Conclusions

High air pollution episodes were related to signs of extrinsic skin aging. PM<sub>10</sub> and O<sub>3</sub> correlated with different outcomes, which might be either due to co-exposure to solar radiation for O<sub>3</sub>, or to different pathophysiological mechanisms for particles and gases.

298 words

# SYM18: Why health policy matters and what is the role of epidemiologists?

104, September 26, 2017, 16:00 - 17:30

Epidemiology guiding health policy to influence behaviour: bans on cigarettes in public places

**Wael K Al-Delaimy, Department of Family Medicine and Public Health, University of California San Diego, Chair of the International Joint Policy Committee of Societies of Epidemiology.**

## Background/Aim

Secondhand smoke (SHS) was documented as a carcinogen but there were challenges in measuring SHS in real life situations compared to controlled chambers. The understanding of human risk from SHS came as a result of a handful of epidemiology studies documenting its relationship with lung cancer among nonsmokers. The aim of this presentation is to highlight how epidemiology evidence helped develop policies across the globe that in turn influenced human population behaviour.

## Methods

The presentation will provide data on studies that had direct policy impact through smoking ban policies and the justification for such policies. The studies focus on the use of more accurate measures of exposure to determine and quantify SHS exposure compared to active smoking. Examples of such policies from New Zealand and the United States will be presented.

## Results

The policies that were put in place to ban smoking in public places in California in 1994 and in New Zealand in 1990 and 2003 were guided by epidemiology data of the risks of SHS on nonsmokers. This is demonstrated at the local level in citing specific studies that quantitatively demonstrate the levels of SHS exposure to help support smoking bans. These smoking ban policies are credited for changing behaviour and social norms regarding smoking among both nonsmokers and smokers. Further, this positive impact was extended to new products such as e-cigarettes.

## Conclusions

Health policy has the most cost-effective impact on public health if properly developed and enforced. Evidence based-policies regarding SHS relied on epidemiology data to help prevent disease and protect the health of thousands in the public. Epidemiologists have the responsibility to be involved in developing policies through the evidence that their studies generate for the benefit of public health.

# SYM18: Why health policy matters and what is the role of epidemiologists?

104, September 26, 2017, 16:00 - 17:30

Making a real world impact: epidemiology and the sunbed ban policy

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## Background/Aim

Regular use of sunbeds (tanning beds) is common among adolescents and young adults, particularly women, in many countries with people of European origin. Yet, exposure to ultraviolet (UV) radiation from the sunbeds is associated with increased risk of melanoma and non-melanoma skin cancer, and younger people appear to be particularly susceptible to its carcinogenic effects. The International Agency for Research on Cancer have classified sunbeds as a Class 1 carcinogen. This presentation will describe the epidemiological research and the subsequent 'behind-the-scenes' translation efforts that made a significant impact on health policy in Australia, leading to a national ban on commercial solarium, and on changes to tanning bed policy internationally.

## Methods

Several systematic reviews have summarised the evidence for an association of sunbeds with skin cancer risk. We also investigated the association between sunbed use and risk of early-onset cutaneous melanoma using data from the Australian Melanoma Family Study, a multi-centre, population-based, case-control-family study with 604 cases diagnosed between ages 18 and 39 years and 479 controls. Drivers of policy change included advocacy by melanoma consumer advocates and prominent academics, epidemiological modelling to estimate the number of melanoma cases that could be avoided each year by banning sunbeds, media coverage, and support from government, NGOs, and health professionals. Challenges included changes in government, resistance by commercial solarium, and attempts to discredit the epidemiological studies.

## Results

In February 2012, the NSW government announced a complete ban on commercial solarium in NSW, effective 31st Dec 2014. Our Australian epidemiological research and modelled estimates were cited in the media release of the ban. This has led to all other Australian States adopting the same ban, and helped to influence policy changes in other countries.

## Conclusions

Epidemiology played an important role in the decision to ban all commercial sunbeds in Australia.

# SYM18: Why health policy matters and what is the role of epidemiologists?

104, September 26, 2017, 16:00 - 17:30

Six years after Fukushima disaster – lessons learned

Yasushi Honda, Faculty of Health and Sport Sciences, University of Tsukuba, Tsukuba, Japan

## Background/Aim

Fukushima nuclear plant accident occurred on March 11, 2011. After the accident, people were concerned about the risk due to the exposure to radioactive agents. Unfortunately, it was not possible to give them what their risk would be, because of the problems with the initial action. Here, I would discuss the problems for future policy implication.

## Methods

Mostly narrative, collected from newspapers, web sites and personal communications.

## Results

It was obvious that I131 exposure to children would have been the most serious problem. An epidemiologist should have collected the exposure information from those children who had been regarded as heavily exposed to radioactive agents, and, considering only 8 days of half-life of I131, s/he should have conducted the first exposure assessment as soon as possible. Just after the accident, nobody was certain whether the accidents would have become uncontrollable, and even researchers would not want to visit heavily polluted area. Still, Professor Tokonami at Hirosaki University Institute of Radiation Emergency Medicine and his colleagues tried to measure I131 at heavily polluted areas. They actually measured the I131 level of 62 people on 12 – 16 April, about 1 month after the accident. They tried to measure more and planned to follow up the victims. However, Fukushima Prefecture side (FP) asked them to stop measuring. FP may have been sorry for the victims and did not want to bother them, and/or they may have been more concerned about reputable damage. FP was not responsible for the accident itself, and it was unlikely FP tried to avoid the epidemiological studies that could be the basis of risk assessment and trials from the victims.

Another problem in disseminating the information on radiation risk was misinterpretation of epidemiological evidence; even a national institute showed in its web that cancer mortality risk was not observed if the exposure was < 100mSV. This was shown soon after the disaster, and I speculate that they tried to calm down the panic.

## Conclusions

Good intention could result in unfavourable consequence.

# SYM18: Why health policy matters and what is the role of epidemiologists?

104, September 26, 2017, 16:00 - 17:30

## Public policy on climate change – what can epidemiology contribute?

Author information; **Alistair Woodward, School of Population Health, University of Auckland, New Zealand**

### Background/Aim

Climate change is a severe challenge to long-term human health and well-being. Dealing with this challenge demands difficult trade-offs and radical social change. Unsurprisingly policy is fraught and contested. I will explore the contributions that epidemiology can make to effective public policy to mitigate and adapt to climate change.

### Methods

A review of the findings of the most recent Assessment Report of the Intergovernmental Panel on Climate Change, and scientific and political developments in the three years following AR5.

### Results

Analysis of media reports shows that climate change is seldom framed as a health issue, and one might conclude that health has had relatively little influence on climate policy. Is this because epidemiologists have not broadcast their work effectively, or they have focussed on questions that have little policy salience, or is damage to health a late-developing, well-buffered and extraordinarily difficult outcome to track over a long time-span? I suggest there is some truth in each case. Some important questions about climate change, such as “how much climate-related death and illness is currently attributable to anthropogenic climate change?” are well-suited for epidemiological reasoning. Others, such as “should the world accept warming of 2 degrees C above pre-industrial levels, or should we strive to restrict warming to no more than 1.5 degrees on average?” require social judgements on a broad scale. But epidemiologists can assist by providing robust information that is directly relevant (an example: recent work on deaths due to hunger and under-nutrition for low versus high emissions pathways). Limits to adaptation and co-benefits of wise mitigation are also policy-rich topics ripe for epidemiological analysis.

### Conclusion

Epidemiology can and should play a bigger role in shaping climate policy.

# TUC13: Temperature, climate change & related topics

024, September 26, 2017, 16:00 - 17:30

## Future health impact of higher ambient temperatures in Stockholm, Sweden

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### Background/Aim

Excess mortality attributed to high ambient temperatures is considered one of the greatest weather related health burdens today. This is likely to change as climate change will increase mean temperatures and the frequency of temperature extremes. Along climate change there are other factors, likely to affect the health burdens from heat that will change as well.

This study aims to quantify how changing mortality rates, prevalence of chronic and non-communicable diseases and vulnerability to heat will change the health burden from high temperatures between a baseline period (1981-2010) and a future period (2035-2065).

### Methods

We used exposure-response relationships from a study on older adults in Stockholm. The study calculated the exposure-response for different age-groups and persons diagnosed with different diseases. We used projections in mortality rates, hospitalization rates and assumptions on vulnerability to assess the future mortality attributable to heat in Stockholm.

### Results

Climate change is the factor that will alter the number deaths attributable to heat the most. The transition to a more elderly demographic was estimated to have smaller, but similar impacts. An expected lowering of mortality rates in Stockholm was estimated to lower heat related deaths by more than 30%. In the most positive of scenarios with lower mortality, less people hospitalized with cardiovascular disease and lower risk for the oldest part of the population, we still estimate an increase in the number of deaths attributable to heat of 173%.

### Conclusions

The increase of the population above 50, both as part of the population and in individuals, will increase the number of deaths attributable to heat. A decline in people diagnosed with cardiovascular disease would also lower the future health burden significantly. Lowering the vulnerability for people aged above 75 however, may be the intervention with greatest potential to lower the future deaths attributable to heat.

## TUC13: Temperature, climate change & related topics

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### The Heat Exposure Integrated Deprivation Index (HEIDI): a data-driven approach to mapping extreme hot weather risk

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**Background/Aim:** Extreme hot weather events are increasing in intensity, frequency, and duration as a consequence of climate change. As a result, hot weather mortality is a growing concern in many urban environments, and different strategies are being explored to protect public health. A commonly implemented approach is the construction of spatial heat vulnerability indexes to identify areas at relatively higher and lower risk.

**Methods:** Different approaches were used to generate three different indices for greater Vancouver, Canada using a pool of variables chosen to reflect social vulnerability, population density, temperature exposure, and urban form. The three different indices were: (1) unweighted; (2) weighted; and (3) the data-driven Heat Exposure Integrated Deprivation Index (HEIDI) approach. The performance of each index was assessed using mortality data from 1998-2014, and the maps were compared with respect to spatial patterns identified.

**Results:** The spatial variables most strongly associated with mortality were the deprivation index, the density of the senior population, estimated apparent temperatures on a very hot day, and distance to the nearest major road. The population-weighted spatial correlation between the three indices ranged from 0.64-0.78. The HEIDI approach successfully detected areas of very high heat vulnerability, whereas vulnerability was more spatially smoothed by the other approaches. All indices performed best under extreme temperatures, but HEIDI provided more useful delineation of risk at lower thresholds.

**Conclusions:** Each of the indices in isolation provides useful information for risk communication and public health protection. However, combining the HEIDI approach with standard unweighted or weighted methods provides richer information about the most vulnerable areas and populations. The methods we describe can be replicated in any other large urban environment where mortality data are available and can be georeferenced with relatively good accuracy.

# TUC13: Temperature, climate change & related topics

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## Adaptation to heat and cold in the context of a changing climate: a multi-country analysis

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On behalf of the MCC Collaborative Research Network

**Background and objectives:** The net impact of global warming will depend on the extent to which adaptation overcomes the effect of gradual changes in temperature. Disentangling the two processes is critical to provide accurate projections of future temperature-related impacts under climate change scenarios. We present evidence from a multi-country investigation that assessed temporal trends in mortality attributed to both heat and cold, and adaptation.

**Methods:** We collected data from 305 locations in 10 countries between 1985 and 2012. Temporal trends in country-specific attributable mortality fractions (AF) for heat/cold (temperatures above/below minimum mortality temperature) were estimated using a two-stage time series design with time-varying distributed lag non-linear models and multivariate meta-analysis. To disentangle the contribution of adaptation from changes in attributable mortality due to gradual increases in temperature, we compared yearly AF with those predicted assuming either temperature distribution or exposure-response relationships as constant across the study period, respectively.

**Results:** Heat-AF decreased in all countries except Australia and UK, from 0.45-1.39% in the first to 0.15-0.93% in the last 5-year periods, respectively. Different patterns were found for cold, with ranges from 5.56-15.43% to 2.17-8.54%, showing either decreasing (Japan, Spain, Australia, Ireland), increasing (US), or stable trends (Canada, South Korea, UK). We found inconsistent patterns in Brazil and Switzerland and a null heat-impact in Ireland. Long-term trends were mostly captured by temporal variation in exposure-response associations (interpreted as adaptation), while year-to-year fluctuations were driven by changes in temperature distribution.

**Conclusions:** Our findings indicate that heat-mortality impacts decreased in most countries consistent with previous studies, whereas cold-mortality exhibited heterogeneous trends. In addition, the pace of adaptation has been faster than the observed warming, suggesting there is scope for the implementation of effective public health policies under climate change. Further investigations should focus on identification of the factors responsible for these adaptation trends.

# TUC13: Temperature, climate change & related topics

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Comparing heat-mortality relation between central area and outer area within a mega city of Vietnam

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## Background/Aim

City population is expected to increase and assessment of urban heat island (UHI) impact on heat-related mortality has become more important. Although some studies made UHI impact assessment with assumption that the heat-mortality relation is consistent across the city sub-regions, the assumption has not been tested. In this study, we evaluated heat-mortality relations for 24 districts of Ho Chi Minh (HCM) City, which were further divided into central districts (central area) and outer districts (outer area), and the assumption was examined.

## Methods

We estimated district-specific meteorological conditions using dynamic downscaling model, and the heat-mortality relation of central and outer area was examined following two-stages analysis. Firstly, we used a standard time series quasi-Poisson regression linking daily mortality with daily average temperature to produce the overall cumulative exposure-response curve for each district. Secondly, we reduced and pooled the estimated district-specific overall cumulative exposure-response curves using a multivariate meta-analytical model, separating into central districts and outer districts.

## Results

The temperature-mortality relation was almost identical between the central and outer areas. The difference in mortality attributable fraction (AF) due to heat between central and outer districts was 0.42%, which contributed most by the difference in temperature distribution between the two areas. This difference can be defined as AF due to the UHI in Ho Chi Minh City.

## Conclusions

This is the first comprehensive study that examined the heat-mortality relation of city sub-regions that used both district-specific temperature and mortality data. Our findings reveal that though the heat-mortality relation was identical between central area and outer area; it was the difference in temperature distribution induced the difference in the mortality AF. It is therefore reasonable to choose the same heat slope for different districts within a city, but this necessitates district-specific temperature measurements for each district in the global heat-related mortality projection model.

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# TUC14: Evaluation of Exposure to Chemical and Metal Mixtures and Health Effects

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Bayesian varying coefficient kernel machine regression to assess cognitive trajectories associated with exposure to complex mixtures

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**Background/Aim:** Exposure to heavy metal mixtures during early life may exert wide-ranging effects on children's neurodevelopment and cognitive growth trajectories. However, there is a lack of statistical methods that can simultaneously accommodate the complex exposure-response relationship between metal mixtures and neurodevelopment, while estimating cognitive trajectories.

**Methods:** We introduce Bayesian Varying Coefficient Kernel Machine Regression (BVCKMR), a hierarchical model that estimates how mixture exposures at a given time point are associated with baseline cognition and cognitive trajectories. BVCKMR flexibly captures the exposure-response relationship, incorporates prior knowledge, and accounts for non-linear and non-additive effects of individual exposures. Using contour plots and cross-sectional plots, BVCKMR provides information about interaction and effect modification between complex mixture components. BVCKMR was applied to data from PROGRESS, a prospective birth cohort study in Mexico City on metal mixture exposures and temporal changes in neurodevelopment. The metal mixture exposures included manganese, arsenic, cobalt, chromium, cesium, copper, lead, cadmium and antimony.

**Results:** The simulation study considered three exposure-response relationship scenarios: linear additive, linear with interaction, and quadratic with interaction. Under each scenario, the baseline cognition and cognitive trajectories for each individual were estimated. A regression comparing the true exposure-response function terms and the predicted estimates using BVCKMR yielded  $R^2$  values of 0.74 – 0.97. Results from a subset of PROGRESS ( $N = 665$ ) provide evidence of significant negative associations between second trimester lead and Bayley Scales of Infant and Toddler Development trajectories across 6 - 24 months (effect size -0.10 [-0.16, -0.04] per interquartile range increase in Pb exposure). We detected an interaction effect between second trimester lead and manganese exposures with 24-month Bayley.

**Conclusions:** BVCKMR is a promising statistical approach for investigating the effects of exposure to complex mixtures on cognitive growth trajectories.

# TUC14: Evaluation of Exposure to Chemical and Metal Mixtures and Health Effects

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Causal mediation analysis for estimating direct and indirect effects of an environmental mixture on child neurodevelopment

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## Background/Aim

Current research suggests exposure to chemical mixtures has detrimental effects on health. New statistical methodology is needed to formalize the natural direct effect (NDE), natural indirect effect (NIE), and controlled direct effect (CDE) of a mixture of exposures on an outcome through an intermediate variable.

## Methods

We implemented Monte Carlo methods to estimate the NDE, NIE and CDE, through simulation of counterfactuals. This method allows for nonlinear effects and interactions between the co-exposures, mediator and covariates. Confidence intervals are obtained via bootstrapping. We applied this methodology to quantify the contribution of birth length as a mediator between *in utero* co-exposure of arsenic, manganese and lead, and children's neurodevelopment, in a prospective birth cohort in rural Bangladesh.

## Results

We found nonlinear associations of arsenic and lead with birth length, and of manganese with neurodevelopment, and a significant interaction between arsenic and manganese on neurodevelopment. There was a significant negative association between the metal mixture and neurodevelopment, independent of birth length, comparing the co-exposure of metals at their 75<sup>th</sup> percentiles to their 25<sup>th</sup> percentiles (NDE: -0.06, 95% CI: -0.12, -0.01). The percent mediated through fetal growth was estimated to be 70%, although, the indirect effect of birth length was marginally significant (NIE: -0.13, 95% CI: -0.34, 0.08). Upon hypothetical intervention to fix birth length at the 75<sup>th</sup> percentile value of 48cm, the direct effect was no longer significant, suggesting, targeted interventions on fetal growth can block part of the adverse effect of metals on neurodevelopment (CDE: -0.07, 95% CI: -0.28, 0.15).

## Conclusions

Our extension of causal mediation methodology that allows for a mixture of exposures is important for environmental health applications. Applying these methods, we found a negative association of co-exposure to lead, arsenic, and manganese on neurodevelopment, independent of *in utero* growth, and suggestive evidence growth partially mediates the mixture.

# TUC14: Evaluation of Exposure to Chemical and Metal Mixtures and Health Effects

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Mediating and Interacting effects of birth outcomes on the relationship between prenatal manganese exposure and cognitive outcome among 2-3 years-old Bangladeshi children

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**Background/Aim:** We investigated the mediating and interacting influence of physical measurements at birth on the relationship between prenatal exposure to manganese and cognitive status among 2-3 years-old Bangladeshi children.

**Methods:** Pregnant mothers were enrolled in a prospective birth cohort in rural Bangladesh between 2008-2011 and children followed longitudinally. Manganese was measured in umbilical cord blood metal by ICP-MS. Anthropometric measurements (weight, length, head circumference) were assessed at delivery. Cognitive status of the children was assessed by translated and culturally appropriate version of the Bayley Scales of Infant and Toddler Development Third Edition at age 20-40 months. We assessed the effect of cord blood manganese on neurodevelopment considering whether physical measures at birth mediated the association with cognitive score or whether these measures modified the association between cord blood manganese and cognitive score. Recently developed statistical approaches allow for estimating mediation and effect modification effects simultaneously.

**Results:** 764 mother-child pairs were included. Higher cord blood manganese concentration was associated with lower cognitive score [ $\beta=-0.31$ , standard error (SE)=0.12,  $p=0.008$ ]. Among the birth measures, mediating and modifying effects of birth length were identified. We found a significant mediation effect through birth length ( $\beta =-0.08$ , SE=0.03). We found evidence of interaction between manganese and birth length ( $\beta =0.11$ , SE=0.03) and of mediated interaction (both mediation and interaction)( $\beta =-0.04$ , SE=0.01)(all  $p\leq 0.01$ ). The overall proportion mediated by birth length was 38.2% and the proportion attributed to interaction was 21.7%.

**Conclusions:** Our findings confirm that birth length significantly contributes to the overall effect of manganese exposure on child's cognitive score. This suggests that manganese may have effects on global nutritional status that contributes to neurotoxicity, as opposed to effects that are specific to brain development. In addition, our analysis suggests that birth length (a marker of growth stunting) also partly modifies the effect of manganese on neurodevelopment.

# TUC14: Evaluation of Exposure to Chemical and Metal Mixtures and Health Effects

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Heavy metal components in atmospheric fine particulate matter before and after the coal-fired power plants shut down in Beijing, China

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**Background/Aim** Many studies have indicated that some heavy metal components in fine particulate matter (PM<sub>2.5</sub>) could cause adverse effects on human health. To reduce the atmospheric particle pollution and improve the air quality, four of the five coal-fired power plants (CFPP) in Beijing, which is an important source of ambient PM<sub>2.5</sub>, have been shut down. The aim of this study was to compare the difference of heavy metal components in atmospheric PM<sub>2.5</sub> before and after the CFPP were shut down during the winter heating season in Beijing, China.

**Methods** The ambient sampling site was set in a main district of Beijing. December 2012 to January 2013 and December 2015 to January 2016 were chosen as two sampling periods, in which at least 15 days were selected for the PM<sub>2.5</sub> continuous sampling before and after the CFPP were shut down respectively. The membrane weighing method was used to determine the PM<sub>2.5</sub> mass concentration and the Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was used for the measurement of the heavy metal components of the samples.

**Results** The average daily concentration of PM<sub>2.5</sub> was 133.75µg/m<sup>3</sup> and 110.64µg/m<sup>3</sup> before and after the CFPP were shut down, respectively. After the CFPP were shut down, the concentrations of arsenic, cadmium, plumbum and zinc reduced by 90.4%, 66.7%, 66.7% and 62.5%, and the mass percentage in PM<sub>2.5</sub> decreased by 85.9%, 40.7%, 48.9% and 30.0%, respectively. The proportion of days with concentration of PM<sub>2.5</sub> less than 75 µg/m<sup>3</sup> (WHO Interim target-1) increased from 38.7% to 46.8% and days with high levels of pollution (PM<sub>2.5</sub> ≥150 µg/m<sup>3</sup>) decreased from 37.1% to 29.0%.

**Conclusions** The heavy metal contents in PM<sub>2.5</sub>, especially arsenic, could be obviously reduced by shutting down the CFPP, which is meaningful for the residents because of the reduction of health risk.

# TUC14: Evaluation of Exposure to Chemical and Metal Mixtures and Health Effects

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## Characteristic of chemical use in the semiconductor manufacturing industry

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### Background/Aim

The semiconductor industry is known to use a variety of chemicals, but it is difficult to know chemical information on chemical ingredients, content, health hazards because of trade secrets. The aim of this study was to analyze a material safety data sheet (MSDS) focus on health hazards and trade secret ingredients, in a semiconductor manufacturing facility.

### Methods

MSDS information and a chemical inventory were provided by large market share of the worldwide semiconductor company, which operated two factories (A and B) at different sites. Descriptive statistics were obtained on the number of chemical products and ingredients, photoresists, and carcinogens, classified by the International Agency for Research on Cancer (IARC), as well as trade secret ingredients. The total chemical use per year was estimated from chemical inventories after unifying the amount used into mass (kg).

### Results

A total of 428 and 432 chemical products were used in factories A and B, respectively. The number of pure chemical ingredients, after removing both trade secret ingredients and multiple counting, was 189 (A) and 157 (B). The number of products containing carcinogens, such as sulfuric acid, catechol, and carbon black was 47 (11%) and 28 (6%) in factories A and B, respectively. The total chemical use per year was 46,850 tons in factory A and 45,627 tons in factory B. More than 97% chemical products used in photolithography included trade secret ingredients.

### Conclusions

This is the first study of chemical use in a modern semiconductor manufacturing factory; it was found that more than 45,000 ton/year, of more than 420 chemical products with more than 150 pure chemical ingredients, was used, with about 40% of products containing trade secret ingredients. Photolithography used many chemicals, with more than 97% of them containing trade secret ingredients.

# TUC14: Evaluation of Exposure to Chemical and Metal Mixtures and Health Effects

026, September 26, 2017, 16:00 - 17:30

## Acute health effects related to non-occupational exposure to insect repellents

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### Background/Aim

Emerging and resurging vector-borne diseases in the U.S. contribute to the public health burden of morbidity and mortality. Insect repellents applied on the skin or clothes, prevent mosquito and tick bites, and help reduce the transmission of vector-borne diseases. With the use of insect repellents becoming more important, information on the magnitude and characteristics of illnesses from insect repellent exposure can help with identifying pesticide exposure problems and designing interventions for disease prevention. Since 1998, the Sentinel Event Notification System for Occupational Risks (SENSOR)-Pesticides Program has been tracking cases of acute pesticide-related illness and injury in the U.S., including those related to insect repellent exposures. Seven (Florida, Louisiana, Michigan, North Carolina, New York, Oregon and Washington) of 13 SENSOR-Pesticides Program states routinely report cases on acute non-occupational pesticide related illness or injury.

### Methods

Health effects due to acute non-occupational illnesses related to insect repellent exposures reported to the SENSOR-Pesticides Program in 7 U.S. states during the period 2007-2013 were identified and characterized according to related pesticide, signs or symptoms, severity, and age.

### Results

We identified 582 cases of acute non-occupational illnesses related to insect repellent exposures, and 42% of these were in children  $\leq 5$  years of age. For all cases, 93% were of low severity, 1% with high severity, and no fatalities. Exposure in 68% of all cases and 84% of children  $\leq 5$  years of age occurred through the ocular route. About 69% of cases in children  $\leq 5$  years of age occurred as a result of using the insect repellent contrary to instructions on the product label.

### Conclusions

The severity of illness from acute exposure to insect repellents was low, though a sizable percentage of cases was in children  $\leq 5$  years of age. A majority of illnesses due to insect repellent use in children can be prevented by following recommendations on product use.

# TUC15: East to West - topics in spatial epidemiology

020, September 26, 2017, 16:00 - 17:30

## Geospatial distribution of giardiasis in NSW, Australia

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### Background/Aim

Giardiasis is a common cause of gastrointestinal illness notifiable in New South Wales. However, little is known about the distribution of risk factors for giardiasis in Australia. Despite routine notification, little is known about the geographical distribution of cases and associated risk factors in NSW. This study seeks to identify the determinants of geospatial distribution of giardiasis in New South Wales, Australia

### Methods

Confirmed (de-identified) giardiasis cases notified to the Notifiable Conditions Information Management System in NSW for January 2011 to July 2016 will be analysed. Spatial cluster analyses will be implemented to delineate areas with high rates of giardiasis. Hypothesis around potentially modifiable risk factors for giardiasis such as use of tank water, well water supply, onsite septic and exposure to wildlife will be explored using geo-spatial tools.

### Results

Results revealed significant age-specific clusters among 0-4 year olds, 5-14 year olds and 15-64 year olds predominantly along the Eastern Seaboard of the NSW State. A significant clustering of cases occurred in statistical areas (localities) with a high socio-economic status, suggesting a higher incidence of cases amongst higher socio-economic groups across the State. There were no significant differences in the monthly elevation in relative risk (ref: Jan) nor between long term and short term trends/seasonality when clusters were compared with non-clusters

### Conclusions

The application of advanced geospatial analysis to the investigation of confirmed cases of giardiasis in New South Wales has improved our understanding of the epidemiology and geographical distribution of this parasitic disease. This is important to assist with identification of high risk locations and modifiable risk factors not detected through routine surveillance measures in order to inform disease prevention and control strategies at the State and Health District levels.

# TUC15: East to West - topics in spatial epidemiology

020, September 26, 2017, 16:00 - 17:30

## Geospatial examination of chemical mixtures in drinking water and mortality in women in the Nurses' Health Study

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### Background/Aim

Recent health crises related to chemical exposures from drinking water in the United States highlight the challenge posed by frequent detection of pollutants associated with adverse health outcomes. However, for most chemical pollutants, there are no direct links between drinking water exposures and long-term health. We investigated whether spatial variability in mortality can be linked to spatial variability in drinking water chemical pollutants among women in the Nurses' Health Study (NHS), a large US based cohort study

### Methods

Our analysis included 28,452 U.S. women who provided a residential drinking water sample in 1989-1990. We measured concentrations of drinking water contaminants in a subset of archived water samples, including metals (lead, arsenic and cadmium) and emerging contaminants (poly- and perfluoroalkyl substances, PFASs) from geographically diverse areas. We evaluated the relationship between mortality risk 1990-2010 and residential location using a generalized additive model. Analyses were adjusted for demographics, health behaviors including smoking and alcohol consumption, disease comorbidities and socioeconomic factors. The spatial patterns of adjusted mortality odds were then compared to spatial distribution of drinking water contamination and the locations of known major point sources.

### Results

During follow-up, 6499 women died from non-accidental causes. Statistically significant geographical variability in crude mortality odds (range: 0.84-1.54) was observed. Spatial variability in mortality was not fully explained by known risk factors. Distinct spatial patterns in concentrations of trace metals and PFASs in drinking water, detected in more than 95% and 60% of the archived samples, suggest these exposures may be useful for explaining additional variability in mortality.

### Conclusions

Results suggest drinking water exposures may contribute to spatial variability in mortality in the NHS cohort and a comprehensive epidemiological study examining the relationship between chemical contaminants in drinking water and mortality risks is warranted.

# TUC15: East to West - topics in spatial epidemiology

020, September 26, 2017, 16:00 - 17:30

## Spatial point pattern analysis of congenital heart defects in Lanzhou, China

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### Background/Aim

Analysis of spatial point processes has been used to investigate spatial variation of disease risks, and their relationships with environmental factors; however, few studies have been conducted in China, where emissions from industries and heavy traffic pose serious public health concerns. The objective of this work is to investigate the impacts of major point sources and road networks on congenital heart defects (CHD) risks in Lanzhou, China, where maternal exposure to ambient air pollution was linked to increased risks of CHD.

### Methods

From a Lanzhou birth cohort during 2010-2012, 8,227 singleton live births with home addresses in the city urban area were included in this study. K, L, and Kcross functions were used to detect clustering tendency of the CHD (n=65) and healthy infants (n=8162). Kernel density ratio was used to identify potential clusters of CHD cases adjusting for the distribution of healthy infants. Poisson point process model was used to model intensity of CHD cases as a function of emission-weighted distance to major point sources (power plants and cement factories), road length density within 100m buffers, intensity of healthy infants, maternal income and education.

### Results

Similar significant clustering patterns were identified for CHD cases and healthy infants. Adjusting for the distribution of healthy infants, maternal income and education, CHD risks were significantly associated with increased road length density within 100 m buffer (RR: 1.07) and decreased emission-weighted distance from major point sources (RR: 0.07). Chi-square test with quadrat counts and Kolmogorov-Smirnov test validated the model and showed no spatial clustering in residuals.

### Conclusions

Results indicate proximity to major point sources and road network have adverse impacts on newborn's health in Lanzhou, China. The identified clusters of CHD cases might allow policy makers or future mothers to make informed decisions regarding exposure control and risk management.

# TUC15: East to West - topics in spatial epidemiology

020, September 26, 2017, 16:00 - 17:30

## Greenness and Depressive Symptoms of 7 major cities in Korea

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### Background/Aim

Greenness is expected to affect mental health through stress reduction, cognitive restoration, increased physical activity, increased social interaction, noise mitigation. Some studies have suggested the association between greenness and mental health, however, evidence remains limited. The objective of this study is to examine the association between greenness and depressive symptoms in 7 major cities of Korea.

### Methods

This study included a total of 64,909 individuals from Community Health Survey 2009. Individuals with Center for Epidemiological Studies Depression (CES-D) score  $\geq 16$  were classified as having depressive symptoms. District-level of greenness was measured by Normalized Difference Vegetation Index (NDVI). Logistic regression was used to analyse the association between greenness and depressive symptoms.

### Results

Compared to the lowest quartile (1<sup>st</sup> quartile), odds ratio (OR) of having depressive symptoms was 0.795 (95% confidence interval (CI): 0.730, 0.867) in the highest quartile of NDVI (4<sup>th</sup> quartile), 0.870 (95% CI: 0.804, 0.941) in the 3<sup>rd</sup> quartile and 0.805 (95% CI: 0.748, 0.867) in the 2<sup>nd</sup> quartile. When NDVI was treated as continuous variable, OR of having depressive symptoms was 0.859 (95%CI: 0.820, 0.900) with an interquartile range (17.61) increase of NDVI.

### Conclusions

This study showed that a lower greenness level was associated with depressive symptoms in 7 major cities of Korea. Further studies are needed to understand the effect of greenness on mental health.

## TUC15: East to West - topics in spatial epidemiology

020, September 26, 2017, 16:00 - 17:30

### Geographic Disparities of Cervical Cancer Survival in California, USA

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**Background/Aim:** Mapping crude and adjusted geographic distributions of disease outcomes is a useful tool for identifying risk factors of public health concern. The crude spatial pattern of disease is often what is observed by public health practitioners, but these patterns may be due to important spatially-varying predictors such as socioeconomic status, race/ethnicity, or environmental exposures. Individual-level spatial analyses can provide insight regarding geographic disparities in disease risk by adjusting for these variables without aggregation bias.

**Methods:** We conducted a spatial analysis of cervical cancer survival among 17,541 cases diagnosed throughout California USA from 1995-2009 using MapGAM, an R package that estimates spatial hazard ratios (HR) and corresponding 95% confidence intervals (CI) in a generalized additive model framework with a non-parametric bivariate smooth term of location. Survival models were adjusted for patient age, tumor characteristics, race, socioeconomic status, care at a high-volume hospital (HVH), non-adherence to treatment guidelines, distance to receive care, and distance to closest HVH. Results were mapped in R also using MapGAM.

**Results:** After controlling for patient and tumor characteristics, we observed significant areas of low HR in the San Francisco Bay area, Ventura and Los Angeles Counties. When distance and quality care variables were included in the model, HR northeast of Sacramento became elevated and significant due to reverse spatial confounding. Living within 30 miles of a HVH was protective [HR:0.86, 95% CI:0.77,0.97]. The fully adjusted spatial analysis reveals geographic disparities not due to quality of care.

**Conclusions:** Quality of care indicators were the most influential on geographic disparities, but areas of poorer cervical cancer survival may be related to spatially-varying social or environmental stressors that warrant further investigation. The use of a bivariate smoother of location within the survival model allows for more advanced spatial analyses for exploring potential predictors of geographic disparities.

# TUC16: Air pollution plays a role in family planning

022, September 26, 2017, 16:00 - 17:30

## Associations of Prenatal Exposures to PM<sub>2.5</sub> Chemical Constituents and Sources with Stillbirth

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### Background/Aim

The stillbirth rate in the United States is relatively high among developed countries, and it has remained almost unchanged since 2006. Evidence is limited and inconsistent concerning associations between stillbirth and fine particulate matter (PM<sub>2.5</sub>), its chemical constituents and sources. We estimated the risk of stillbirth associated with prenatal exposures to PM<sub>2.5</sub> total mass, chemical constituents and sources.

### Methods

PM<sub>2.5</sub> total mass and twenty chemical constituents were collected from ambient monitors, and five PM<sub>2.5</sub> sources were quantified using Positive Matrix Factorization. A case-control study (N=32,262), matched by fetal sex and maternal characteristics (race/ethnicity, age, educational attainment), was conducted using records of livebirths and stillbirths collected from eight locations throughout California from 2002 to 2009. Gestational age-adjusted exposure levels were calculated for each pollutant. Conditional logistic regression was applied to estimate the risk of stillbirth associated with pollutants. As sensitivity analysis, we explored models stratified by gestational length of stillbirth: 20 to 27 weeks (intermediate fetal death) and after 28 weeks (late fetal death).

### Results

An interquartile range increase in gestational exposure to PM<sub>2.5</sub> total mass was associated with an odds ratio (OR) of 1.06 (95% confidence interval: 1.01-1.11) times higher risk of stillbirth. Similarly, associations were found with secondary ammonium sulfate [OR: 1.13 (1.06-1.21)], resuspended soil [OR: 1.11 (1.06-1.15)], and vehicular emissions [OR: 1.06 (1.01-1.12)]. Associations were also found with PM<sub>2.5</sub> aluminum, elemental carbon, iron, ammonium ion, nitrate ion, silicon, sulfate ion, titanium, vanadium, and zinc. The results were similar when stillbirths were categorized as intermediate fetal death or late fetal death.

### Conclusions

Stillbirth was associated with some PM<sub>2.5</sub> sources and/or chemical constituents. The findings suggest that certain PM<sub>2.5</sub> sources and/or constituents are more toxic than others. Our findings will aid further understanding of chemical constituents and regulating specific emissions sources to prevent stillbirths.

## TUC16: Air pollution plays a role in family planning

022, September 26, 2017, 16:00 - 17:30

### Residential Proximity to Major Roadways and In Vitro Fertilization Outcomes

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**Background/Aim:** Emerging human data suggest that air pollution adversely affects early pregnancy outcomes, particularly pregnancy loss; however the evidence is limited. The objective of this study was to examine whether residential proximity to major roadways, as a proxy for traffic-related exposures, is associated with in vitro fertilization (IVF) outcomes.

**Methods:** This analysis included 441 women enrolled in the Environment and Reproductive Health (EARTH) Study, a prospective cohort study, who underwent 670 IVF cycles (2004-2016). Using geocoded residential addresses collected at entry, we used ArcGIS to calculate the Euclidean distance to the nearest Class A major roadway (including major interstate, US and state highways). IVF outcomes were abstracted from electronic medical records. We used multivariable generalized linear mixed models to evaluate the association between residential proximity to major roadways and IVF outcomes adjusting for maternal age, race, body mass index, and smoking status.

**Results:** Closer residential proximity to major roadways was statistically significantly associated with lower probability of live birth following IVF. The adjusted percentage of IVF cycles resulting in live birth for women living  $\geq 1000$  m from a major roadway was 47% (95% CI 38, 57) compared to 33% (95% CI 27, 40) for women living  $< 200$  m (p-for-comparison, 0.02). This association was fairly linear with the odds of live birth increasing by 17% (19% CI 2, 33) for every 500 m increase in the distance from major roadways. While there was no association between residential proximity to major roadways and implantation or clinical pregnancy, the odds of pregnancy loss was 2.72 (95% CI 1.24, 5.96) times higher for women living within 200 m compared to women living  $\geq 1000$  m of a major roadway.

**Conclusion:** Closer residential proximity to major roadways during IVF may be related to reduced likelihood of live birth, particularly due to increased risk of pregnancy loss.

# TUC16: Air pollution plays a role in family planning

022, September 26, 2017, 16:00 - 17:30

## Short- and long-term exposure to ambient fine particulate matter and semen quality in Taiwan

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### Background/Aim

Environmental exposure to chemicals has been considered as a potential factor contributing to deteriorated semen quality. However, there is limited information on exposure to air pollution and semen quality. We therefore investigated the health effects of short- and long-term exposure to fine particulate matter (PM<sub>2.5</sub>) on semen quality in a large Taiwanese population.

### Methods

We studied 6,475 male participants aged 15-49 years who participated in a standard medical examination program in Taiwan between 2001 and 2014. Semen quality measurements included sperm concentration, total motility, progressive motility and morphology. We estimated PM<sub>2.5</sub> exposure at each participant's residential address using a spatio-temporal model based on satellite-derived aerosol optical depth data. A spermatogenic cycle average concentration (based on the concentrations of the month of the semen examination and the two months before the examination) was used as an indicator of short-term exposure. A 2-year average concentration (based on the concentrations of the year of the semen examination and the year before the examination) was used as an indicator of long-term exposure. Multivariable linear regression models were used to investigate the associations between PM<sub>2.5</sub> and semen parameters.

### Results

The 3-month and the 2-year PM<sub>2.5</sub> concentration were highly correlated (correlation coefficient = 0.81,  $P < 0.001$ ). An increment of 5  $\mu\text{g}/\text{m}^3$  in PM<sub>2.5</sub> was associated with a decrease in normal morphology (0.83% for short-term exposure and 1.29% for long-term exposure). In contrast, an increment of 5  $\mu\text{g}/\text{m}^3$  in PM<sub>2.5</sub> was associated with an increase in sperm concentration ( $1.02 \times 10^6/\text{ml}$  for short-term exposure or  $1.03 \times 10^6/\text{ml}$  for long-term exposure) and total motility (0.20% for short-term exposure or 0.34% for long-term exposure).

### Conclusions

Long-term exposure to PM<sub>2.5</sub> air pollution decreases the percentage of sperm with normal morphology. We speculate the positive associations between PM<sub>2.5</sub> and sperm concentrations/motility may due to the compensation mechanism.

# TUC16: Air pollution plays a role in family planning

022, September 26, 2017, 16:00 - 17:30

## Preconception exposure to fine particulate matter and spontaneous abortion among Chinese females aged 20-49 years: a prospective cohort study

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### Background/Aim

Association between preconception exposure to fine particulate matter (PM<sub>2.5</sub>) and spontaneous abortion (SA) remains unexplored. This study aims to evaluate the association between preconception PM<sub>2.5</sub> exposure and SA.

### Methods

697016 couples participated in the National Free Pre-pregnancy Check-ups Project, and subsequently conceived successfully with self-reported last menstrual period (LMP) between May 13<sup>th</sup> and Dec 31<sup>st</sup> 2015 were included. City-daily-scaled data of PM<sub>2.5</sub> were obtained from National Urban Air Quality Real-time Publishing Platform. Individual PM<sub>2.5</sub> exposure was measured across the preconception and pregnancy period, which started from the 360<sup>th</sup> day before LMP to the time-point of delivery or onset of SA. Average PM<sub>2.5</sub>, accumulated days with PM<sub>2.5</sub>≥75-µg/m<sup>3</sup> and PM<sub>2.5</sub>≥150-µg/m<sup>3</sup> were calculated respectively for different assessment windows, including the last 7-days (1 week) and each 30-days (1 month) during the last 360 days, before LMP. Multivariate-adjusted logistic regression was used to estimate the association, especially adjusted for previous and post PM<sub>2.5</sub> exposure of corresponding assessment window.

### Results

For PM<sub>2.5</sub> exposure in the last week, a 10-µg/m<sup>3</sup> increase in average showed no statistical association with SA, one day increase of accumulated days with PM<sub>2.5</sub>≥75-µg/m<sup>3</sup> [adjusted odds ratio (aOR)=1.11, 95% confidence interval (95%CI): 1.08-1.13] and PM<sub>2.5</sub>≥150-µg/m<sup>3</sup> [aOR =1.32, 95%CI: 1.28-1.36] were associated with increased risk of SA. For PM<sub>2.5</sub> exposure in the last month before LMP, a 10-µg/m<sup>3</sup> increase in average could increase the risk of SA by 1.2% [95%CI: 0.3%, 2.2%]; one day increase of accumulated days with PM<sub>2.5</sub>≥75-µg/m<sup>3</sup> and PM<sub>2.5</sub>≥150-µg/m<sup>3</sup> could increase the risk SA by 5.1% [95%CI: 4.3%-5.9%] and 24.6% [95%CI: 23.0%-26.3%] respectively. Our study also resulted that during the last 12 months before LMP, the third month before LMP had the highest OR with SA.

### Conclusions

Preconception exposure to PM<sub>2.5</sub> could increase the risk of SA, which peaked at the third month before LMP in the one-year preconception period.

## TUC16: Air pollution plays a role in family planning

022, September 26, 2017, 16:00 - 17:30

### Preterm birth before and after power plant retirements in California, 2001-2011

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**Background/Aim:** Many studies have identified increased air pollution as a risk factor for preterm birth. However, given the multifactorial etiology of preterm birth, systematic differences—e.g., lower socioeconomic status—among women exposed to higher levels of air pollution may explain part of this association. We aimed to use a quasi-experimental design to address unmeasured confounding and to evaluate the implications of coal and oil power plant retirements in California for preterm birth.

**Methods:** We utilized California 2001-2011 birth record data and U.S. Energy Information Administration power plant data to identify births to women living within 20km of power plants ( $n = 57153$  births). Unexposed mothers were those who had their last menstrual period (LMP) in the year after power plant retirement; exposed mothers had their LMP in the year period two years prior to power plant retirement. We defined three levels of proximity to power plants: 0-5km; 5-10km; and 10-20km. We used a difference-in-differences design to estimate associations of distance, power plant exposure, and preterm birth, controlling for power plant, neonate sex, maternal age, race/ethnicity, and education. In falsification tests, we used U.S. Census data to evaluate compositional changes in the population living near power plants over time and used active coal plants as a negative control.

**Results:** Between 2001-2011 two coal and six oil power plants were retired. In the study population, 6.5% of births were preterm and overall rates did not differ by distance from power plants. We found significant reductions in the risk of preterm birth for mothers living within 5km (-0.017, 95% CI: -0.029, -0.006) and between 5-10km (-0.15, 95% CI: -0.025, -0.006) after controlling for secular trends using data on mothers living 10-20km away.

**Conclusions:** Retiring or transitioning coal and oil power plants to natural gas may improve birth outcomes for nearby populations.

# TUC16: Air pollution plays a role in family planning

022, September 26, 2017, 16:00 - 17:30

## Prenatal exposure to PM<sub>2.5</sub> and Congenital Heart Disease in Taiwan

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### Background/Aim

Exposure to ambient air pollution during early pregnancy has been linked to congenital heart disease (CHD). However, only a few studies have investigated the effect of PM<sub>2.5</sub> but with conflicting results. This study aimed to evaluate the association between prenatal exposure to PM<sub>2.5</sub> and occurrence of CHD in Taiwan.

### Methods

We enrolled 782 births with major CHD from the Taiwanese Birth Registry during 2007–14, and randomly selected 5,033 controls without any birth defect using a population-based case-control design. Exposure to PM<sub>2.5</sub>, as well as PM<sub>10</sub>, PM<sub>2.5-10</sub>, CO, SO<sub>2</sub>, NO<sub>2</sub> and O<sub>3</sub>, during 3–8 weeks of pregnancy was retrieved from air quality monitoring stations, and interpolated to every township using ordinary kriging. We applied unconditional logistic regression models adjusted for potential confounders to evaluate the association.

### Results

The results revealed a positive correlation between exposure to PM<sub>2.5</sub> (aOR = 1.18, 95% CI = 1.01–1.38, per IQR = 15.1 µg/m<sup>3</sup>) during early pregnancy and occurrence of CHD. The observed association remained robust in two-pollutant models when adjusted for the second air pollutant. In subgroup analysis, we found that the endocardial cushion defect (aOR = 2.30, 95% CI = 1.04–5.06) and pulmonary artery and valve stenosis (aOR = 1.66, 95% CI = 1.01–2.76) were significantly correlated with PM<sub>2.5</sub> exposure. No similar effect was observed for the other air pollutants.

### Conclusions

The study demonstrated an increased risk of PM<sub>2.5</sub> exposure during critical window of embryogenesis on CHD occurrence, and certain subgroups were most affected.

# TUC17: Re-examining public health impacts from a range of radiation exposures

100, September 26, 2017, 16:00 - 17:30

## Assessment of personal radiofrequency electromagnetic field exposure considering body shadowing effect in children and parents, Korea

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### Background/Aim

We aimed to assess the personal RF-EMF exposure levels of children and adults by their activities, with consideration of body shadowing (BS) effect.

### Methods

We recruited 50 child-adult pairs, who were 6-9 years old children and their parents, living in the cities of Seoul, Cheonan and Ulsan (South-Korea). RF-EMF measurements were performed for 2016.09 – 2016.12 using a portable device (ExpoM-RF®, Fields at Work GmbH, Zürich, Switzerland), tailored to capture 14 Korean RF bands ranging from 87.5 to 5875MHz. Participants carried the device for 48 hours and kept a time-activity diary using a smartphone application. BS effect was compensated by applying BS factors to the measured electric-field strength. Generalized linear mixed model was used to analyse the summarized data.

### Results

The arithmetic (geometric) means of the total power density were 174.9 (36.6)  $\mu\text{W}/\text{m}^2$  for all: 116.2 (30.1) for children and 235.1 (44.7)  $\mu\text{W}/\text{m}^2$  for parents. The contribution of each frequency bands was 71.6%, 2.7%, 12.2%, 6.2%, 4.5%, and 2.8% in children and 79.2%, 2.3%, 8.8%, 4.4%, 2.8% and 2.5% in parents, for down-link, up-link, total WiFi, FM Radio, TV, and WiBro2300, respectively. Among activities, predicted marginal mean of total power density ( $\mu\text{W}/\text{m}^2(95\%CI)$ ) was highest when travelling by metro, followed by shopping, moving on foot/bicycle and travelling by bus: 910.3(390.8, 2,120.6), 345.3(151.2, 788.7), 328.4(208.1, 518.4), and 306.4(142.9, 656.9), respectively. BS-compensated geometric mean of total power density was 6.3% and 12.4% significantly higher in children and parents, respectively, than not compensated one. However, the degree of BS effects between children and parents was not significantly different ( $p$  for interaction=0.52).

### Conclusions

The contribution of base-station exposure was the highest both in parents and children. Total and base-station RF-EMF exposure levels in Korea were higher than those reported in European countries. BS attenuated personal measurement values more in adults than children with no significance.

# TUC17: Re-examining public health impacts from a range of radiation exposures

100, September 26, 2017, 16:00 - 17:30

Decreases in adolescents' figural memory performance associated with cumulative individual radiowave brain dose over one year.

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## Background/Aim

The potential impact of microwave radiofrequency electromagnetic fields (RF-EMF) emitted by wireless communication devices on neurocognitive functions of adolescents is still discussed. In a previous longitudinal analysis we found changes in figural memory scores associated with higher cumulative RF-EMF brain dose in adolescents. This study aimed on following up these results using a new study population and a new approach to control for confounding from media usage itself.

## Methods

Individual RF-EMF brain dose for each participant (n=842) was modelled using objective data from mobile phone operators, personal RF-EMF measurements, questionnaire data and geospatial modelling. Multivariable linear regression models were fitted on memory score changes over one year and cumulative RF-EMF brain dose as well as media usage either related or unrelated (negative exposure controls) to RF-EMF exposure. An additional laterality analysis for right ear vs. left ear/no preference phone callers was conducted since memory functions are known to be lateralized in brain hemispheres. To control for confounding of media use behaviours a stratified analysis for different media use patterns was conducted.

## Results

We found decreased figural memory scores with higher cumulative RF-EMF dose score change (-0.22, 95% CI: -0.47 to 0.03) per IQR in the whole sample and in a network operator recorded sample (-0.26, 95% CI: -0.42 to -0.10). No association was seen with media usage unrelated to RF-EMF. RF-EMF brain dose was negatively correlated with figural memory in right side users (-0.39, 95% CI: -0.67 to -0.10). Using operator recorded data, verbal memory score was impaired in left side users.

## Conclusions

The results support a potential adverse effect of RF-EMF brain dose on adolescents' cognitive functions. Results of the laterality analysis are compatible with the involved brain hemispheres for figural (right side) and verbal (left side) memory.

# TUC17: Re-examining public health impacts from a range of radiation exposures

100, September 26, 2017, 16:00 - 17:30

## *In-Utero* Exposure to High Magnetic Fields and the Risk of Abnormal Thyroid Hormone Levels in Offspring: A prospective cohort study with up to 20 years of follow-up

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**Background/Aim:** Exposure to magnetic fields (MF) and hypothyroidism in children have been increasing in parallel. Animal studies have shown that MF exposure could impact thyroid hormone levels.

**Methods:** The impact of maternal MF exposure during pregnancy on thyroid hormones in offspring was examined in a prospective cohort study among members of the Kaiser Permanente Northern California (KPNC) healthcare system. Pregnant women were asked to carry an EMDEX meter for 24 hours during early pregnancy to capture MF exposure from all sources. Confounders were ascertained during in-person interviews. Among 1,063 participants, 734 had both a live-born child and valid MF measurements, thus were included in the current study. During 20 years of follow-up, 96 children had laboratory test results for TSH and free T4 thyroid hormones. Those whose TSH and T4 levels were both below the median level were classified as having lower thyroid function.

**Results:** After controlling for multiple confounders using Cox survival analysis using all 734 participating children, those with high *in-utero* MF exposure [95<sup>th</sup> percentile MF  $\geq$  2 milligauss (mG)] had an increased risk of having low thyroid hormone levels [hazard ratio (HR)=2.7, 95% confidence interval (CI): 0.9-7.8] compared to children with lower *in-utero* MF exposure ( $<$  2 mG). When restricting the analysis to the children who had both TSH and T4 test results, the association was stronger and statistically significant (HR=3.1, 95%CI: 1.1-9.0). There was also a dose-response relationship: HR=2.3 for *in-utero* MF level 2-4 mG, and HR=5.0 for *in-utero* MF level  $>$  4 mG).

**Conclusions:** *In-Utero* exposure to high MF level is associated with increased risk of low thyroid hormone levels, mostly due to low TSH levels. These results indicate a possible adverse impact of MF on the pituitary gland during *in-utero* fetal brain development. This important novel finding needs be further examined in future studies.

# TUC17: Re-examining public health impacts from a range of radiation exposures

100, September 26, 2017, 16:00 - 17:30

## Estimated lifetime effective dose to hunters and their families in Sweden after the Chernobyl accident in 1986 – a pilot study

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### Background/Aim

Hunters and their families, with an over average consumption of food from the forest ecosystem, belong to the most exposed subpopulations in Sweden after the Chernobyl nuclear power plant accident in 1986. Using registry data and results from whole-body measurements algorithms were developed to calculate lifetime effective doses and collective doses to hunters.

### Methods

Ten hunters and their family members were randomly selected from each of the three counties with the highest fallout in Sweden (Västernorrland, Uppsala, Gävleborg) using the register for hunting weapons from the Police Authority in 1985. Statistics Sweden matched these individuals ( $n=85$ ), using dwelling coordinates, onto the digital map produced by the Swedish Radiation Safety Authority after aerial measurements of ground deposition of  $^{137}\text{Cs}$  ( $\text{kBq m}^{-2}$ ). Internal effective doses were estimated with aggregated transfer factors from ground deposition to in-vivo body concentration for  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$  in hunters ( $\text{Bq kg}^{-1}$ ). External effective doses were also calculated on these dwelling coordinates for  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$  and short-lived nuclides, respectively. Annual effective doses for external and internal doses were then cumulated up to a life expectancy of 80 years for men and 84 years for women, respectively.

### Results

The total lifetime effective doses, from the Chernobyl fallout, to the members of the hunter families in this cohort were on average 8.0 mSv in Västernorrland, 4.5 mSv in Uppsala and 3.9 mSv in Gävleborg. The effective dose to males were about 40% higher than in females. In all counties the internal dose was about 75% of the total lifetime effective dose. The collective dose for all hunters with family members ( $n=44,000$  in total) in these three counties could be approximated at about 250 manSv.

### Conclusions

This pilot study shows it is possible to use register data to develop algorithms for calculating life-time effective dose commitments for hunters.

# TUC17: Re-examining public health impacts from a range of radiation exposures

100, September 26, 2017, 16:00 - 17:30

## Validity of self-reported mobile phone use in the COSMOS study

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### Background/Aim

Possible health effects of mobile phone use are of considerable public and scientific interest, but previous epidemiological research has been limited by problems associated with (differential) recall bias and cross-sectional health analyses. The COSMOS cohort study, comprising almost 300,000 adult mobile phone users across Europe, has the advantages of a prospective study design and objective mobile phone use data from operator records. We assess validity of self-reported mobile phone use in a sub-population (N=75993) of the COSMOS study, and examine, for the first time, if validity differs according to experience of symptoms during mobile phone use or concerns related to mobile phones.

### Methods

We used Cohen's weighted Kappa to assess agreement between self-reported and operator-derived mobile call frequency and duration for a 3-month period. We evaluated sensitivity of both self-reported high ( $\geq 10$  calls/day or  $\geq 4$  hours/week) and low ( $\leq 6$  calls/week or  $< 30$  minutes/week) mobile phone use, against the gold standard operator data.

### Results

We observed stronger agreement between self-reported and operator-derived estimates of mobile phone use for call duration compared to call frequency. Self-reported low mobile call frequency and duration demonstrated high sensitivity, however for self-reported high mobile call frequency and duration sensitivity was considerably lower. Self-reported call frequency validity was lower in younger age strata and women. Validity of self-reported call duration was lower in those who reported symptoms during or shortly after mobile phone use, compared to those who reported no symptoms.

### Conclusions

In contrast to previous validation studies, we observed better agreement overall, but a tendency for greater underestimation than overestimation in self-reporting of mobile phone use. This is most likely due to our use of a pre-defined categorical scale, rather than continuous scale, for self-reporting of mobile phone use.

# TUC17: Re-examining public health impacts from a range of radiation exposures

100, September 26, 2017, 16:00 - 17:30

## Lifetime UVB and risk of Osteoporosis in a British Population

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### Background/Aim

Vitamin D derived through solar irradiation is an important pathway to bone health. Many populations have been found to be vitamin D deficient cross-sectionally but little longitudinal data exist. We propose to examine lifetime UVB exposure by using lifetime solar irradiation and comparing populations with differing exposures.

### Methods

Participants of the UK Biobank study (age 40-69 at baseline) were geolocated. UVB were calculated for each residence (n=437,986, missing 64,696) for the period 2000-2015 using JAXA satellite data at 5x5 km monthly resolution and linked to residence using GIS. Life time exposure was calculated combining birth and baseline residence location exposures for UVA/UVB at each. Outcomes of bone health (e.g. fractures; bone density measured with heel sonograph; osteoporosis medication; self-reported osteoporosis) were obtained at baseline of the UK Biobank cohort. Associations were adjusted for a variety of risk factors and potential confounders. A positive control of skin cancer was used to examine validity.

### Results

Increased lifetime ambient UVB decreased the risk of fractures in the last 5 years (adjusted Odds Ratio [OR] 0.86; 95% Confidence Intervals 0.8-0.9) and osteoporosis medication use (OR 0.53; 0.4-0.7). No association was found between lifetime UVB exposure and bone mineral density, heel fractures or any fractures and breaks. Increased ambient UVB exposure increased the risk of non-melanoma skin cancers (OR 1.54; 1.3-1.90).

### Conclusions

Measured by place of residence, higher UVB exposures were associated with lower risk of fractures in the last 5 years, but not for lower bone mineral density or osteoporosis. Lifetime exposure to sufficient vitamin D may influence bone health and other diseases in older people.

# TUC17: Re-examining public health impacts from a range of radiation exposures

100, September 26, 2017, 16:00 - 17:30

## Ethical aspects in epidemiological studies of radiation health effects

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People are exposed to radiation from low frequency electromagnetic fields (ELF); radiofrequency fields (RF); visual light, ultraviolet light (UV); and, ionizing radiation (IR). Sources are electrical appliances (ELF); mobile phones/base stations (RF); solar radiation and solariums (UV); and, radon and terrestrial gamma radiation (IR). Some health outcomes have a latency period and longitudinal studies are desirable for understanding causation. This session includes papers discussing post-natal thyroid hormone levels after ELF exposure in utero, UV-exposure and risk of osteoporosis, mobile phone use and cognitive function, validity of self-reported mobile phone use, and body shadowing of RF exposure. Protecting the most vulnerable, including the fetus and children not able to advocate for themselves, is a first-order principle of biomedical ethics. Another cornerstone in ethics is informed consent. In research on children, informed consent is provided by care givers, usually parent(s). Is there an ethical dilemma in a longitudinal study if the parents provided informed consent and the outcome is collected when the individual has reached lawful age? Should the results be reported back both to the person(s) providing the informed consent and to the person at lawful age? The dose-response relationship is fundamental in radiation research; for solar radiation dose-response is U-shaped; the linear non-threshold hypothesis is widely accepted for cancer from IR; and, scientific debate persists for ELF/RF, depending on the outcome studied. Therefore, special ethical considerations are needed when designing and interpreting studies of radiation under these different models. Challenges are faced in preparing a risk communication plan under different models. Validity of exposure assessment is critical in environmental epidemiology for interpreting results and should precede risk communication to the public. To avoid harm to the study population, ethical considerations must be considered before communicating results from validation studies. These ethical dimensions will be discussed.

## TUC18: Exposome

102, September 26, 2017, 16:00 - 17:30

### Use of plasma metabolomics to identify potential metabolic pathways associated with traffic-related air pollutants

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#### Background/Aim

High-resolution metabolomics (HRM) has recently emerged as a sensitive tool for measuring environmental exposures and corresponding biological response. Use of HRM in air pollution epidemiologic studies holds promise to improve internal exposure estimation to complex air pollution mixtures, including primary traffic emissions.

#### Methods

The Dorm Room Inhalation to Vehicle Emission (DRIVE) study was conducted to measure an extensive suite of pollutants at multiple ambient and indoor sites along a major highway artery. In this panel-based study, 54 students living in dormitories either near (20 m) or far (1.4 km) from the highway conducted personal sampling and contributed bio samples (plasma and saliva). Untargeted HRM were used to identify potential metabolic pathways associated with traffic-related air pollutants in the panel.

#### Results

Weekly levels of traffic pollutants were significantly higher at the near dorm compared to the far dorm ( $p < 0.05$ ). 20,766 metabolites were reliably extracted from plasma samples using two technical columns on four monthly bio sample collections. A total of 847 metabolic features in HILIC plasma metric and 444 features in C18 plasma metric were significantly associated with at least one or more of the single traffic indicators, including black carbon, carbon monoxide, nitrogen oxides and particulate matter ( $p < 0.05$ ), when controlling for covariates and false discovery rate. Pathway analysis reveal the potential association between these significant metabolic features and several inflammatory pathways, including leukotriene metabolism and anti-inflammatory metabolites formation from EPA. In particular, 15 features were putatively matched with leukotriene B4 and 6 were matched with leukotriene E4, all of which exhibited significant alternation of intensity associated with traffic air pollutant level.

#### Conclusions

HRM is a sensitive, powerful tool for air pollution epidemiologic studies to examine the metabolic response to complex traffic exposures, but may require comprehensive chemical validation to further develop the biomarker of observed traffic pollution health effects.

## TUC18: Exposome

102, September 26, 2017, 16:00 - 17:30

### Diet and the exposome: dietary determinants of children's body burden of environmental contaminants

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**for the HELIX consortium**

#### Background/Aim

Our aim was to investigate the association between dietary habits and measured concentrations of several environmental contaminants in blood and urine samples of 1,280 children at 6-8 years.

#### Methods

Our study is conducted within the HELIX project that draws resources from six ongoing European birth cohorts: France, Greece, Lithuania, Norway, Spain and the United Kingdom. We used linear regression to investigate the association between measured blood/urine concentrations of 40 contaminants and consumption of 11 food groups, after adjusting for cohort, maternal education, child's sex, age, year of birth, and siblings (yes/no). The association with the KIDMED score, assessing adherence to the Mediterranean diet for children and adolescents, was also studied. We only report associations with  $p\text{-value} \leq 0.05$  after correction for multiple testing by the false discovery rate. Since the dependent variables were log-transformed and food intakes are expressed in times/week, the derived beta coefficients are interpreted as percentage change per one time increase in weekly food consumption.

#### Results

Fish consumption was positively associated with serum perfluorononanoate ( $\beta=3.5\%$ , 95%CI= 1.6,5.3), perfluoroundecanoate ( $\beta=8.7\%$ , 95%CI, 5.9,11.4), perfluorooctane sulfonate ( $\beta=5.7\%$ , 95%CI, 3.9,7.5), arsenic ( $\beta=14.7\%$ , 95%CI, 8.8,20.6) and mercury ( $\beta=14.1\%$ , 95%CI, 11.6,16.6) levels. One time per week increase in fruit intake was associated with an increase of 2.4% (95%CI, 0.9,4) in urinary diethyl phosphate and 3.8% (95%CI, 2,5.6) in urinary diethyl thiophosphate. Weekly dairy consumption was negatively associated with lead levels. One unit increase in the KIDMED score was associated with higher concentrations of polychlorinated biphenyls and mercury and lower concentrations of lead. High (3-7 times/week) versus no organic food consumption was associated with lower urinary phthalate metabolites and diethyl phosphate.

#### Conclusions

Fish consumption in childhood was positively associated with exposure to perfluorinated compounds, mercury and arsenic. Exposure to organophosphorus pesticides was positively associated with fruit consumption and negatively associated with the choice of organic food.

# TUC18: Exposome

102, September 26, 2017, 16:00 - 17:30

Construction of Environmental Risk Score Beyond Standard Linear Models:  
Application to Metal Mixtures, Oxidative Stress and Cardiovascular Disease in NHANES

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## Background/Aim

There is growing concern of potential health effects of exposure to pollutant mixtures. We initially proposed an Environmental Risk Score (ERS) as a summary measure to examine the risk of exposure to multiple pollutants in epidemiologic research considering only pollutant main effects (Park et al., 2014). We expand the ERS by consideration of pollutant-pollutant interactions using modern machine learning methods. We illustrate the multi-pollutant approaches to predicting a marker of oxidative stress (gamma-glutamyl transferase (GGT)), a common disease pathway linking environmental exposure and numerous health endpoints.

**Methods:** We examined 20 metal biomarkers measured in urine or whole blood from 6 cycles of the National Health and Nutrition Examination Survey (NHANES 2003-2004 to 2013-2014, n=9664). We randomly split the full data evenly into training and testing sets and constructed ERS's of metal mixtures for GGT using adaptive elastic-net with main effects and pairwise interactions (AENET-I), Bayesian additive regression tree (BART), Bayesian kernel machine regression, and SuperLearner in the training set and evaluated their performances in the testing set. We evaluated the concordance of various ERS and the associations between ERS and cardiovascular endpoints.

## Results

ERS based on AENET-I performed better than other approaches in terms of prediction errors in the testing set. Important metals identified in relation to GGT include lead, cadmium, dimethylarsonic acid, mercury, cobalt, tungsten, and barium. All ERS's showed significant associations with systolic and diastolic blood pressure and hypertension. For hypertension, one standard deviation increase in each ERS from AENET-I, BART and SuperLearner were associated with odds ratios of 1.50 (95% CI, 1.15, 1.94), 1.38 (1.09, 1.76), and 1.31 (1.02, 1.66), respectively. ERS's showed non-significant positive associations with mortality outcomes.

## Conclusions

ERS is a useful tool for characterizing cumulative risk from pollutant mixtures, with accounting for statistical challenges such as high degrees of correlations and pollutant-pollutant interactions.

## TUC18: Exposome

102, September 26, 2017, 16:00 - 17:30

### Diet and the exposome: dietary determinants of environmental contaminants measured in pregnant women

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#### for the HELIX consortium

#### **Background/Aim**

Diet is the main source of exposure to several environmental contaminants, but the relative magnitude of various food groups is unknown. Our aim was to identify dietary determinants of environmental contaminants in a sample of pregnant women.

#### **Methods**

This study is conducted within the HELIX project, an EU project including pregnancy cohorts from six countries. Maternal diet was assessed during pregnancy when also 54 environmental contaminants were measured in blood or urine collected (n~818). We performed linear regressions after log-transforming all the contaminants concentrations. Thus, beta coefficients are interpreted as percent change in times per week increase of the weekly food consumption. We report only significant associations after adjustment for false discovery rate, after adjustment for maternal age, education, parity, gestational weight gain, pre-pregnancy body mass index, year of delivery, passive and active smoking during pregnancy.

#### **Results**

Meat consumption was positively associated with urinary bisphenol(A) (beta=2%, 95% CI, 1-3). Fish consumption was positively associated with PFDA, HCB, arsenic, MEP, 5-OH-MEHP, bisphenol(A) and all parabens. One time per week increase in fruit intake during pregnancy was associated with 2% increase in dimethyl phosphate (95%CI, 1-3), and in vegetable intake with 2% increase in DDE and PFNA. Cereal intake was positively associated with blood PFOS and urinary bisphenol(A) and butylparaben concentrations. Legume intake was positively associated with several persistent organic pollutants, lead, and phthalate and organophosphorus pesticides metabolites. Dairy food intake was not associated with increased concentrations of any contaminant.

#### **Conclusion**

Within this multi-country population, we have identified several dietary pathways of exposure to legacy and emerging contaminants.

## TUC18: Exposome

102, September 26, 2017, 16:00 - 17:30

### Correlations of exposure variables in mixtures epidemiology: methods and implications

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#### Background/Aim

Exposure science is generating increasing amounts of exposure data and is crucial for investigating the health effects of mixtures. Epidemiologists need to understand patterns of co-exposures to consider confounding, colinearity and other issues, including the similarity between populations.

#### Methods

Exposure correlations can be readily portrayed using heat maps and dendrograms. We construct the latter using the average linkage of the distance defined as one minus the absolute value of the Spearman correlation coefficients. We compare correlation matrices between populations using the Mantel statistic: the Spearman correlation of the elements in the lower triangular forms of the correlation or dissimilarity matrices (with p-values computed using permutations). We illustrate these methods using exposure biomarkers measured in NHANES and a Boston cohort.

#### Results

In the Boston cohort, serum concentrations of persistent organic compounds showed two major clusters: PentaBDEs and other compounds: organochlorine pesticides (OCs) and PCBs. The latter contained two main subclusters, lower and higher molecular weight PCBs. NHANES 2003-4 group B samples also showed a roughly block diagonal correlation structure, with blocks for PBDEs, OCs, PAH metabolites and phthalate metabolites. The comparison between the two studies was restricted to common compounds. The Mantel test yielded an overall correlation of 0.7 ( $p=0.002$ ), indicating a moderately strong similarity between the two.

#### Conclusions

The approximately block diagonal correlation structure may be partly due to common sources, exposure routes, physical chemistry, persistence and parent compounds. The low correlation between persistent and non-persistent compounds may be real or an artifact of differences in persistence and the use of cross-sectional data. The approximately block diagonal correlation structure suggests that confounding within groups may be more important than confounding between groups. Interactions can still occur between blocks if there is joint exposure. Hierarchical variable selection may be appropriate for mixtures epidemiology.

# TUC19: New insights on water and human health

105, September 26, 2017, 16:00 - 17:30

## Hospital visits for gastrointestinal illness after a major water main break

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### Background/Aim

Water main breaks can occur due to the stresses of an aging infrastructure and changing climate. Water main breaks are a public health concern because they can cause abrupt decreases in water pressure in the pipeline and lead to the intrusion of contaminants. In May 2010, a major water main break affected approximately 2 million residents in the Greater Boston area and an order to boil water was issued in 30 communities. This study examines the association between the water main break and subsequent hospital visits for gastrointestinal illness.

### Methods

A case-crossover study design was used to assess emergency room (ER) and hospital outpatient visits for gastrointestinal (GI) illness in Massachusetts following the water main break in 2010. GI illness was defined using ICD-9-CM diagnosis codes. Controls were selected using a time-stratified bi-directional approach and matched on day of week. Exposure status was determined according to the case/control date and town of residence. Fixed-effects logistic regression models estimated risk of hospital visit during the 0-3 and 4-7 days following the main break.

### Results

In 2010, there were 46,420 ER and hospital outpatient visits for GI illness in Massachusetts, of which 10,859 occurred among residents of communities affected by the main break. Main break exposure was positively associated with ER and hospital outpatient visits during the first 0-3 days (Odds Ratio, OR: 1.47; 95% Confidence Interval, CI: 1.14-1.89) and subsequent 4-7 days (OR: 1.58; 95% CI: 1.20-2.07). These associations were particularly strong among young children ( $\leq 5$  years).

### Conclusions

A major water main break in 2010 was associated with an increased risk for ER and hospital outpatient visits for GI illness. Future analyses will consider negative control exposures and also examine historical records of less severe main breaks assigned according to service zone. This abstract does not necessarily reflect EPA policy.

# TUC19: New insights on water and human health

105, September 26, 2017, 16:00 - 17:30

## Water quality and diarrhoeal diseases among children in informal settlements in Cape Town, South Africa.

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### *Background/Aim*

The true burden of childhood diarrhoea and water quality in informal settlements in Cape Town is not accurately known where more than 20% of the city households are located. Water pollution is suspected to be among major causes for diarrhea in particular. This exploratory study aims at investigating diarrhoea among children under five years and drinking water quality at household level.

### *Methods*

The study took place in the Lotus River catchment area, where 24% of the 380,000 inhabitants reside in informal settlements. A cross-sectional study was conducted during winter season (April – July) with a household questionnaire-based survey and drinking water samplings. The questionnaire was administered to 543 randomly selected households in six settlements with a main focus on water and sanitation factors as well as on 1- and 2-week self-reported childhood diarrhoea prevalence. Water samples were collected from 91 study households and 6 public taps and analysed for faecal and heavy metal contamination.

### *Results*

The one- and two-week prevalence of diarrhoea in under-five children was found 13.2% and 16.9% respectively. Among the diarrhoea risk factors, hand-washing showed a significant preventing effect (OR=0.40; 0.17, 0.91). Almost all the samples from both household and public taps have been found free of any bacteriological contamination. About 10 to 15% of the household water samples contained a level of heavy metal (arsenic, lead and mercury) above maximum allowable limits while in two out of the six public taps the level of arsenic was found above.

### *Conclusions*

The study brought new insights on diarrhoea prevalence in informal settlements and showed its significant association with hygiene conditions. Heavy metal contamination found in drinking water at household level is alerting and could be linked to conditions of transport from the tap or storage. Further investigations are therefore needed on chemical pollutions of water, one important challenge of Sustainable Development Goals.

# TUC19: New insights on water and human health

105, September 26, 2017, 16:00 - 17:30

## Latitudinal variation in childhood diarrhoea is associated with local rainfall and population density

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### Background/Aim

Scientists have long predicted the impacts of climate-related infectious disease emergence, and yet the extent to which local socioeconomic and demographic drivers can mask the influence of weather variation and environmental settings on child health is widely debated. Models that couple weather and environmental conditions with demographic factors offer a potentially improved approach for estimating shifts in disease distribution and risk under climate change.

### Methods

With a focus on childhood diarrhoea caused by the parasite *Cryptosporidium* spp., - an infection easily controlled by public health interventions but also strongly linked to environmental conditions through waterborne spread, we systematically review and empirically model the effects of local weather and flooding history on cryptosporidiosis, after controlling for seasonality, publication bias, access to improved sanitation, health resources and population density at a global scale.

### Results

We examined 1588 papers on childhood cryptosporidiosis and identified 36 studies representing a range of geographic locations and climatic, environmental and socio-economic conditions. Generalized linear mixed effects models for equatorial, sub-tropical and temperate climates found local rainfall and population density were the most important determinants of childhood cryptosporidiosis across all regions. In lower latitudes, local rainfall and population density were significant and positively associated with childhood cryptosporidiosis. In temperate latitudes there was a significant negative association of disease with rainfall and a positive association with population density.

### Conclusions

This global empirical analysis indicates that climate and demographic change can affect childhood cryptosporidiosis, with differential patterns between low and high latitude regions. These findings underscore the need to consider locality specific environmental and demographic factors when assessing disease distributional shifts and risks due to climate change. These results may have implications for developing environment-focused public health policies to manage health risks of climate change for future generations.

## TUC19: New insights on water and human health

105, September 26, 2017, 16:00 - 17:30

### Residential proximity to unconventional oil and gas wells, drinking water contaminants, and health symptoms in the Ohio Utica shale formation

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**Background/Aim:** More than 9 million Americans live  $\leq 1$  mile from an unconventional oil and gas (UO&G) (“fracking”) well, potentially placing their drinking water at risk of contamination. We conducted a community-based, cross-sectional study in Ohio to evaluate relationships between residential proximity to UO&G wells and (1) drinking water contaminants and (2) health symptoms.

**Methods:** We collected drinking water samples and interviewer-administered questionnaires from 66 participants. We analyzed water samples for 16 volatile organic compounds (VOCs) and gasoline-range organic compounds (GRO). We calculated residential proximity to UO&G wells using well locations obtained from the Ohio Department of Natural Resources and geocoded addresses for study homes. We used parametric and non-parametric tests to assess relationships between residential proximity to UO&G wells and (1) contaminant detection rates and concentrations and (2) self-reported health symptoms in participants living  $< 2$  km versus  $\geq 2$  km from UO&G wells.

**Results:** Commonly detected VOCs included BTEX compounds (benzene, toluene, ethylbenzene, xylenes) and trihalomethanes (bromoform, bromodichloromethane, chloroform, dibromochloromethane). Detection rates of benzene, bromodichloromethane, bromoform, and dibromochloromethane were 2.3-4.8 times as high among homes  $< 2$  km versus  $\geq 2$  km from UO&G wells ( $p < 0.1$ ). Observed concentrations of these 4 contaminants and GRO were 1.7-6.2 times as high among homes  $< 2$  km versus  $\geq 2$  km from UO&G wells ( $p < 0.05$ ). The proportion of any self-reported existing health symptoms, neurologic symptoms, and respiratory symptoms were 1.2-1.7 times as high among those  $< 2$  km versus  $\geq 2$  km from UO&G wells ( $p < 0.1$ ).

**Conclusions:** We observed correlations between residential proximity to UO&G wells and (1) detection and concentration of toxic organic compounds in drinking water, and (2) reported health symptoms. Though we cannot definitively link these compounds and symptoms to UO&G wells, our findings underscore the need for further investigation into exposures and health impacts of UO&G development.

## TUC19: New insights on water and human health

105, September 26, 2017, 16:00 - 17:30

### Assessing global endocrine disrupting activity in drinking water with bioassays: a possible tool for population-level exposure assessment

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**Background/Aim:** Some natural and anthropogenic substances in drinking water sources are known or suspected endocrine disrupting chemicals (EDC), but few are regulated or routinely measured in U.S. public water supplies (PWS). Compared to measuring single analytes, bioassays that assess activity levels may better quantify population-level exposure to a variety of EDC.

**Methods:** We conducted a pilot study of 10 PWS in Iowa, where agriculture-associated water contaminants (e.g., pesticides, nitrate) are suspected EDC. Source (untreated) water samples and finished (treated) drinking water samples were collected in spring and fall and concentrated 200x via a U.S. Geological Survey protocol. We assessed global EDC activity (aryl hydrocarbon [Ah], androgenic [AR], thyroid hormones [Ty], estrogenic [ER], and corticosteroid [CS]) with novel assays that express nuclear steroid receptor constructs in mammalian cell lines. We quantified statistically significant activity relative to negative controls and used bivariate and multivariate methods to compare activity overall, by season, and by utility/sample characteristics.

**Results:** Among 62 samples (31 per season), 69% had significant Ah activity, 52% AR, 5% Ty, 2% ER and 2% CS. The percentage of samples with Ah activity was higher in the spring (84% versus 55%;  $\chi^2 p=0.01$ ), and more common in utilities with  $\geq$  median ( $\geq 3.19$  mg/L) nitrate levels ( $p=0.04$ ) or that were served by surface versus groundwater sources ( $p=0.02$ ). AR activity was more common in spring versus fall samples ( $p<0.001$ ), and we found non-significant within-season contrasts in activity across strata of treatment and regulated contaminants. Multivariable analyses were imprecise, but suggested that surface waters and untreated samples had greater levels of Ah and AR activity after adjusting for other factors.

**Conclusions:** Our pilot results indicate that specific types of EDC activities in PWS vary by season and utility characteristics. This holistic approach to measuring EDC may hold promise for characterizing population-level EDC exposures through drinking water.

# WP01: Environmental issues in Asia Pacific Region

Seymour Centre, September 27, 2017, 08:30 - 10:00

## Air Pollution and Human Health in China

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The air pollution situation in China is complex. Coal combustion, automobile and industrial emissions, and biomass and waste incineration constitute major sources of air pollution. Moreover, since 2013, haze pollution weather has occurred in many regions of China. To address the current air pollution problem, in recent years China has implemented a series of regulations, including the Air Pollution Law as well as the Air Pollution Control and Action Plan. The government has also developed environmental air quality standards.

Public health risks caused by air pollution have been a serious concern for governments and the public. Many current time-series and case-crossover studies have focused on the health effects caused by short-term exposure on air pollution. In these studies, the air pollutants include O<sub>3</sub>, PM, NO<sub>2</sub> and SO<sub>2</sub>, and the health outcomes range from the biomarkers to disease incidence and mortality. Furthermore, China has carried out panel studies and intervention studies. Panel studies in Beijing, Shanghai, and other large cities focused on the association between air pollution and biomarkers. Additionally, during the 2008 Beijing Olympics and other pollution control events, studies were carried out to estimate the association between the interventions and the functional index and inflammation biomarkers. In addition, a few studies focused on the chronic effects of air pollution. These studies discussed the association between air pollutants, including PM, SO<sub>2</sub>, NO<sub>2</sub> and O<sub>3</sub>, and the outcomes blood pressure and mortality. Nevertheless, long-term studies remain limited. To date, only two representative studies are concerned with PM<sub>2.5</sub>, with blood pressure as the only studied outcome.

To further and systematically study the impact of air pollution on the health of the population, the Chinese government funded two large multi-center studies, one is the Short-term Health Effects of Air Pollution Study in China (China SHEAP Study) and the other is Long-term Effect of Air Pollution in China (China LEAP Study). The projects will obtain the acute and chronic exposure-response relationship between air pollution and mortality, disease incidences, symptoms, functional indexes and biomarkers by conducting time-series, case-crossover, panel, and cohort studies national wide.

## WP01: Environmental issues in Asia Pacific Region

Seymour Centre, September 27, 2017, 08:30 - 10:00

### The Global Burden of and Public Health Action for Asbestos-Related Diseases

**Ken Takahashi**

The World Health Organization (WHO) has repeatedly called on countries (<http://www.who.int/mediacentre/factsheets/fs343/en/>) to eliminate asbestos-related diseases (ARDs). Australia is historically a major producer and user of asbestos, adopted a total ban on asbestos in 2003, and currently suffers one of the world's highest mortality rates of ARDs. The quantification of the burden of ARDs is warranted for public health action, but hampered particularly in developing countries, due to the lack of awareness in general and difficulty in diagnosing ARDs. We recently collated relevant data from the WHO Mortality Database and published literature. Many developing countries, including those which now consume high volumes of asbestos, lack any meaningful data on ARDs. In countries where data are available, the burden of ARDs is drastically skewed towards countries that historically consumed high volumes of asbestos. These are the most economically developed countries of today, *e.g.*, the USA, Australia, the Western European countries and Japan. Regarding the annual number of mesothelioma deaths, the ten leading countries accounted for 83% of the world's total.

Reasonable estimations can be done for countries which do not have data on the ARD burden, based on, for example, the known correlation between the historical level of asbestos use and subsequent rates of ARDs at the national level. Consequently, a range of countries with no available data, mostly of economically developing status, emerged as countries already having missed a substantial "hidden" burden of ARDs. Moreover the "future" burden of ARDs is reasonably predictable from the "current" status of asbestos use. The WHO emphasizes that the best way to eliminate ARDs is for countries to stop using asbestos. However, since the turn of the century, 12 (17) countries have been consuming asbestos at a level exceeding 1.0 (0.5) kilograms per capita per year. Although a good number of countries have adopted a total ban on asbestos, they are generally limited to countries that have actually recorded a significant burden of ARDs (as aforementioned). Countries that have not adopted a ban and continue to use high volumes of asbestos, lack such records as well as awareness and the relevant expertise.

This contrastive panorama of national situations underscores the need for more and improved international collaboration on public health action in the asbestos/ARD arena.

# SYM04: Air pollution, climate change and population health in China

024, September 27, 2017, 10:00 - 12:00

A county-level estimate of PM<sub>2.5</sub> related chronic mortality risk in China based on multi-model exposure data

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## Background/Aim

Ambient fine particulate matter (PM<sub>2.5</sub>) pollution is currently a serious environmental problem in China, but evidence of health effects with higher resolution and spatial coverage is insufficient. This study aims to provide a better overall understanding of long-term mortality effects of PM<sub>2.5</sub> pollution in China and a county-level spatial map for estimating PM<sub>2.5</sub> related premature deaths of the entire country.

## Methods

Using five sets of satellite-derived PM<sub>2.5</sub> concentration data and the integrated exposure-response model which has been employed by the Global Burden of Disease (GBD) to estimate global mortality of ambient and household air pollution in 2010, we estimated PM<sub>2.5</sub> related premature mortality for five endpoints across China in 2010.

## Results

Premature deaths attributed to PM<sub>2.5</sub> nationwide amounted to 1.24 million in total, and 114,602, 81,079, 383,896, 657,005 for adult chronic obstructive pulmonary disease, lung cancer, ischemic heart disease, and stroke, respectively; 3,798 deaths for acute lower respiratory infections were estimated in children under the age of 5. About half of the premature deaths were from counties with annual average PM<sub>2.5</sub> concentrations above 60.75 µg/m<sup>3</sup>, which cover 13.09% of the Chinese territory. These counties were largely located in the Beijing-Tianjin-Hebei region and the North China Plain. High population density and high pollution areas exhibited the highest health risks attributed to air pollution. On a per capita basis, the highest values were mostly located in heavily polluted industrial regions.

## Conclusions

PM<sub>2.5</sub>-attributable health risk is closely associated with high population density and high levels of pollution in China. Further estimates using long-term historical exposure data and concentration-response (C-R) relationships should be completed in the future to investigate longer-term trends in the effects of PM<sub>2.5</sub>.

# SYM04: Air pollution, climate change and population health in China

024, September 27, 2017, 10:00 - 12:00

Personal exposure to ambient ozone and airway inflammatory response: a panel study in healthy adults

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**Background/Aim:** Ambient ozone concentrations can vary spatio-temporally. Few health studies of ozone were based on personal direct measurements. We therefore aimed to evaluate the acute effects of personal ozone exposure on airway inflammatory response and the potential epigenetic modifications.

**Methods:** This is a longitudinal panel study with four follow-ups among healthy young adults in Shanghai, China from May to October 2016. For each visit, personal exposure to ozone was measured from 10 a.m. to 6 p.m. in 3 consecutive days. At the end of each visit, we collected buccal samples, and measured fractional exhaled nitric oxide (FeNO), an established biomarker of airway inflammation. We measured interleukin-4, interleukin-13, inducible nitric oxide synthase (iNOS) and DNA methylation of nitric oxide synthase isoform 2A (NOS2A). Linear mixed-effect models were used to evaluate the acute effects of personal ozone exposure on the above indicators relevant to respiratory inflammation. Mediation analyses were conducted to explore the modulation roles of interleukins and NOS2A methylation in changes of FeNO induced by ozone.

**Results:** On average, the 8-hr mean exposure to personal ozone was 22  $\mu\text{g}/\text{m}^3$ , much lower than that monitored at a nearby site (107  $\mu\text{g}/\text{m}^3$ ). Only the present-day ozone at individual level was statistically associated with respiratory inflammatory indicators. A 10  $\mu\text{g}/\text{m}^3$  increase in personal exposure to ozone was associated with increments of 3.73% (95%CI: 0.25%, 7.21%) in FeNO. We observed similar increases in interleukins and iNOS, as well as decreases in NOS2A methylation. Interleukins and NOS2A methylation showed some mediation in the associations between ozone and FeNO.

**Conclusions:** Our results provided robust human evidence that personal ozone exposure could induce rapid airway inflammation and further this process may be modulated by immune reaction and DNA methylation in respiratory tissue.

# SYM04: Air pollution, climate change and population health in China

024, September 27, 2017, 10:00 - 12:00

## Long-term Exposure to Fine Particulate Matter Air Pollution and Type 2 Diabetes Mellitus in Elderly: a Cohort Study in Hong Kong

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**Background/Aim:** Air pollution has been proposed as an emerging global risk factor for diabetes. However, evidence for the link between long-term air pollution exposure and occurrence of diabetes is limited, and the results are mixed. We aimed to assess the association of long-term residential exposure to fine particulate matter with aerodynamic diameter less than 2.5 microns (PM<sub>2.5</sub>) with the prevalence and incidence of type 2 diabetes mellitus (DM), respectively.

**Methods:** This is a prospective cohort study. We studied 61,447 participants of the Chinese Elderly Health Services cohort in Hong Kong at baseline (1998-2001) and followed participants without DM at baseline to 31 December 2010 to ascertain the first emergency hospital admission for type 2 DM. Yearly mean residential PM<sub>2.5</sub> exposure was predicted based on satellite data. Binary logistic regression and time-varying Cox proportional hazard model were used to evaluate the prevalence and incidence risk of DM associated with PM<sub>2.5</sub> respectively while adjusting for potential individual and neighbourhood confounders.

**Results:** There were 7,542 participants reported prevalent DM and 53,905 without DM at baseline in whom we studied incident type 2 DM. Over a mean follow-up of 9.8 years, we ascertained 512 patients as incident type 2 DM cases. After adjusting for the potential confounders, the odds ratio (OR) for every 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> concentration was 1.19 (95% confidence interval (CI): 1.03 – 1.38) for prevalent DM, while the corresponding hazard ratio (HR) was 1.48 (95% CI: 1.06 – 2.08) for incident type 2 DM. The associations of PM<sub>2.5</sub> with DM were only statistically significant in women.

**Conclusions:** Long-term exposure to PM<sub>2.5</sub> was associated with higher risk of both prevalence and incidence of diabetes mellitus in Hong Kong elderly population. Women may exhibit higher vulnerability than men to pollution exposure.

# **SYM04: Air pollution, climate change and population health in China**

**024, September 27, 2017, 10:00 - 12:00**

Years of life lost attributable to extremely cold and hot temperatures in metropolitan areas of four cities, China

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## **Background/Aim**

This study aimed to examine the years of life lost (YLL) attributable to extreme temperatures in four cities with different climatic characteristics in China by a time-series research.

## **Methods**

Cause-specific years of life lost attributable to both extreme heat and cold were evaluated after considering the lag and cumulative effects by a double threshold B-spline distributed lag non-linear model (DLNM).

## **Results**

The yearly average YLLs due to all-cause deaths attributable to extreme heat and cold were 0.148 and 0.561, 0.070 and 0.207, 0.263 and 0.197, 0.246 and 1.368 per thousand persons, respectively for Harbin, Nanjing, Shenzhen and Chongqing. The extreme-temperature attributed YLLs in Chongqing were the highest, and then were the YLLs in Harbin. All the cause-specific YLLs attributable to extremely cold temperatures were higher than YLLs attributable to extremely hot temperatures in Harbin, Nanjing and Chongqing, but it had the inverse results in Shenzhen that all the cause-specific YLLs attributable to extremely cold temperatures were lower than those YLLs attributable to extremely hot temperatures. In all the four study areas, the extreme-temperatures attributed YLLs of cardiovascular diseases were greater than the YLLs of respiratory diseases.

## **Conclusions**

The results indicated that both extremely cold and hot temperatures increase mortality and cause attributed YLLs in different manners in four cities. Our study offers a platform to improve and extend predictions of the effects of climate change in China, and a reference for local health policy making.

# **SYM04: Air pollution, climate change and population health in China**

**024, September 27, 2017, 10:00 - 12:00**

**Ambient temperature may interact with air pollution to alter blood pressure in healthy adults: a panel study in Beijing, China**

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## **Background/Aim**

Both low temperature and high air pollution have been associated with increased risk of cardiovascular events, which could be predicted by increased arterial blood pressure (BP) within short periods. However, whether exposures to temperature and air pollution simultaneously may have interactive effects on BP has been unknown. We investigated this potential interaction during 460 repeated visits in 39 healthy university students in the context of traffic-related air pollution.

## **Methods**

Study participants underwent repeated BP measurements for 12 occasions under three exposure scenarios in Beijing, China in 2010-2011. We used generalized linear mixed-effects models to estimate exposure effects controlling for potential confounders.

## **Results**

Decreasing temperature was associated with significant increases in BP. There were significant interactions between temperature and traffic-related air pollutants (particulate matter with an aerodynamic diameter  $\leq 2.5 \mu\text{m}$ , organic carbon, elemental carbon and nitrogen dioxide) on BP ( $P < 0.05$  for all interaction tests). The estimated increases in systolic and diastolic BP were 4.9 mmHg [95% confidence interval (CI): 2.9, 6.8] and 3.7 mmHg (95%CI: 2.3, 5.1) at high elemental carbon level ( $\geq$ median), and were -1.3 mmHg (95%CI: -6.3, 3.6) and 0.7 mmHg (95%CI: -2.8, 4.2) at low elemental carbon level ( $<$ median) per  $10^\circ\text{C}$  decrease in daily minimum temperature. We also found stronger air pollution effects on BP at low temperature levels ( $<$ median) than at high temperature levels ( $\geq$ median).

## **Conclusions**

Low temperature and high air pollution may act synergistically to increase BP in healthy adults. Our findings may have potential implications for prevention of cardiovascular events associated with increased BP among high-risk individuals.

# SYM16: Is Bigger Always Better? Promises and Pitfalls Studying Air Pollution Effects in Very Large Populations

024, September 27, 2017, 10:30 - 12:00

Modelling temporal and spatial variability in the mortality effects of air pollution in the USA

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## Background/Aim

Whilst the adverse health effects of air pollution on individuals have been well established, its effects at the population level are yet to be thoroughly understood<sup>1-2</sup>. The spatial variability of the adverse health effects across an entire country also remain uncertain. In this study we investigate the effects of air pollution on death rates, and how these effects vary by age-group and in different regions of the USA, where there is a wide range of socioeconomic features, climates and air pollution compositions.

## Methods

We used death records for 1982-2013 from the U.S. National Center for Health Statistics (NCHS). Each record contains information on the county of residence, and the decedent's age, sex and race along with underlying and multiple contributing causes of death. Corresponding age-sex population counts were from the U.S. Census Bureau (USCB) and the NCHS. Air pollution exposure estimates for the corresponding period will be made by incorporating a combination of remotely-sensed and in-situ observations of pollution concentrations along with outputs from chemical transport models, into a land-use regression (LUR) model. The estimates will primarily be annual average exposures of pollutants such as NO<sub>2</sub>, CO, O<sub>3</sub>, PM<sub>2.5</sub> (particulate matter with diameter less than 2.5µm), PM<sub>2.5</sub> subspecies (elemental carbon, organic carbon, nitrate sulfate and ammonium) and PM<sub>2.5</sub> by source. The estimates will be available at a high horizontal resolution of 100m in urban areas and 1km in rural areas across the entire U.S.

We will describe a Bayesian hierarchical model which will include effects that share information across ages, counties, causes of death and air pollution constituents, and measure their variation over age and space.

## Results/Conclusions

Results and conclusions will be forthcoming.

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# **SYM16: Is Bigger Always Better? Promises and Pitfalls Studying Air Pollution Effects in Very Large Populations**

**024, September 27, 2017, 10:30 - 12:00**

Assessing air pollution exposures in large cohort studies: A critical review

**Michael Jerrett**, Fielding School of Public Health, UCLA, Los Angeles USA

Large cohort studies offer the promise of detecting relatively subtle health effects from air pollution exposures. Exposure assessment for large studies can be challenging because the exposure estimates often lack key details, which may increase exposure measurement error and subsequently bias risk estimates. In this presentation, I will review the available and emerging approaches to estimating air pollution exposures for large cohort studies.

In the literature, several methods are used for exposure assessment in large cohorts, including: (1) remote sensing, (2) atmospheric chemistry models, (3) land use regression models, (4) geostatistical models, and (5) hybrid models that combine two or more of the first four methods. I will also draw upon a recent systematic evaluation of these methods, which compared health effects from each class of model in the American Cancer Society Cancer Prevention Study (CPS II) with N ~ 670,000.

Remote sensing models can be applied virtually globally and as such have great appeal for large cohort studies. Recent advances have downscaled estimates for particulate matter to 1 km. In a new study, we systematically assessed the mortality risks. Models that included some ground-based monitoring data typically detected larger risks than those remote-sensing estimates that did not include ground data.

Numerous recent develops – in atmospheric chemistry models, machine-learning algorithms and remote sensing – have substantially improved exposure estimates for cohort studies. Major limitations still exist, including: lack of retrospective estimates with validity for studies on diseases with long-term latency; little information on personal mobility of study participants to account for critical micro-environments such as “in transit” exposures; and limited information infiltration rates that often determine indoor exposures to pollutants of ambient origin.

# **SYM16: Is Bigger Always Better? Promises and Pitfalls Studying Air Pollution Effects in Very Large Populations**

**024, September 27, 2017, 10:30 - 12:00**

## **Is Exposure Measurement Error the Elephant in the Room?**

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Adam Szpiro, School of Public Health, University of Washington, Seattle, USA

### **Background**

Inference in air pollution cohort studies targets the association between exposure and a disease outcome. Exposure is typically predicted from monitoring data from locations that are most often not where the participants live. The resulting measurement error affects health effect estimates and their confidence intervals. We address conditions when this matters.

### **Methods**

We review recently developed methods for measurement error correction and discuss the practical implications of the theory. We show through simulations and applications that measurement error can affect inference by causing bias and incorrect confidence interval coverage.

### **Results**

The exposure model with the best prediction accuracy won't necessarily produce the best inference about health effects. Measurement error induced from predicted exposures has both Berkson-like and classical-like components. Both components can induce bias in either direction. Their relative importance and correctability depend upon the exposure assessment design and the adherence of the exposure assessment to the two compatibility conditions: spatial compatibility and covariate compatibility. When violated, these compatibility conditions can still affect the inference, no matter how large the cohort study. Finally, a non-parametric bootstrap correction is needed to obtain valid standard error estimates that account for both types of measurement error.

### **Conclusions**

Measurement error in air pollution cohort studies can be more important than is appreciated in many applications. This has implications for study design, for development and application of post-hoc correction methods, and for interpretation of the published literature.

# **SYM16: Is Bigger Always Better? Promises and Pitfalls Studying Air Pollution Effects in Very Large Populations**

**024, September 27, 2017, 10:30 - 12:00**

## **Big: Better, or just Big? The ELAPSE Study**

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### **Background/Aim**

In recent years, health effects of air pollution are being studied at ever lower concentration levels. Such studies need to be able to establish exceedingly small effects on population health attributable to small contrasts in air pollution exposure. In order to meet these challenges, investigators are increasingly using so-called administrative databases as sources of exposure and/or health outcome data. The advantage of using such databases is that they are often available at low cost and contain data on millions of subjects which increases study power. A disadvantage is that data on important potential confounders of the relationship between air pollution and health (such as smoking and diet) are often lacking. Investigators have turned to using various strategies for indirect confounder control to alleviate these problems.

### **Methods**

The ELAPSE study is a European collaboration that merges traditional cohorts with administrative databases in an attempt to identify health effects of low-level air pollution in Europe. Data from more than 10 traditional cohorts are pooled in a central database containing rich data on individual level potential confounders of the association between air pollution and health effects such as education, occupation, diet and smoking. In addition, seven administrative database studies are included which jointly contain data on about 35 million study subjects. Each administrative database is linked to smaller scale population surveys which serve as a source of data on potential confounders and as a source to establish correlations between these confounders and air pollution levels in the study areas. These data are then used to develop indirect confounder control using the method developed by Shin et al. (Environmental Research 2014).

### **Results**

Preliminary results of indirect confounder control were recently published by Strak et al. (Environmental Research 2017). Despite weak associations between individual lifestyle-related risk factors and air pollution, indirect adjustment substantially affected air pollution mortality risk estimates. The adjustment, however, differed by population subgroup.

### **Conclusions**

These results suggest that the population surveys and administrative databases need to be very carefully aligned for this method to work properly.

# **SYM16: Is Bigger Always Better? Promises and Pitfalls Studying Air Pollution Effects in Very Large Populations**

**024, September 27, 2017, 10:30 - 12:00**

## Combining and pooling of data – Lessons learned from the NCI Cohort Consortium

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### Background/Aim

The National Cancer Institute (NCI) Cohort Consortium was formed in 2000 to pool a large amount of data and biospecimens to address the need for large-scale collaborations for the conduct of a wide range of cancer studies. We aim to describe the NCI Cohort Consortium as a resource for collaborative research projects that would be difficult to address with a single study.

### Methods

The Cohort Consortium is one of the largest research consortia supported by the NCI. It is composed of investigators responsible for more than 50 U.S. and international cohorts containing more than 7 million individuals from diverse populations with high-quality risk factor data as well as biospecimen data for more than 2 million individuals collected at baseline. The NCI Cohort Consortium has been used as a rich resource for pooling data to investigate gene-gene and gene-environment interactions in the etiology of cancer.

### Results

Several projects utilizing pooled resources from the NCI Cohort Consortium have been conducted. Examples include, but are not limited to, the Breast and Prostate Cancer Cohort Consortium (BPC3); African American BMI and Mortality Pooling Project; and the Vitamin D Pooling Project Rarer Cancer Consortium (VDPP). Demographic information and findings from these studies as well as information on participating in the NCI Cohort Consortium will be presented.

### Conclusions

Collaboration in the cohort consortium enables investigators to share data and resources, expand study populations and create opportunities to answer unique research studies

# WC01: Basic time series analyses of Temperature

026, September 27, 2017, 10:30 - 12:00

The influence of weather on *Salmonella* cases in Singapore - a time series analysis

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## Background/Aim

Non-typhoidal *Salmonella* (NTS) is an important cause of gastroenteritis globally, with more than 93.8 million cases reported annually. In the absence of adequate food protection measures, weather may influence the survival of *Salmonella* and thus transmission. Studies documenting this relationship in tropical settings are limited. We investigated the association between NTS cases and weather in the tropical city state of Singapore.

## Methods

We obtained surveillance data on NTS cases reported between 2005–2015 to the Ministry of Health and contemporaneous meteorological data from the National Environment Agency. Short term associations between NTS cases and meteorological factors were assessed using time-series analysis, controlling for season, long term trend, delayed weather effects and autocorrelation. We also accounted for the period where NTS case notifications were legally mandated.

## Results

A 1°C increase in mean ambient air temperature was associated with a 4.3% increase (IRR: 1.043, 95% CI 1.003 – 1.084,  $p=0.035$ ) in NTS cases in the same week and a 6.3% increase (IRR: 1.063, 95% CI 1.022 – 1.105,  $p=0.002$ ) in cases three weeks later. A 1% increase in mean relative humidity was associated with a 1.3% decrease (IRR: 0.987, 95% CI 0.981 – 0.994),  $p<0.001$  in cases six weeks later, while a 10mm increase in weekly cumulative rainfall was associated with a 0.8% increase (IRR: 1.008, 95% CI 1.002 – 1.015,  $p=0.012$ ) in cases 2 weeks later but a 0.9% decrease (IRR: 0.991, 95% CI 0.984 – 0.998,  $p=0.008$ ) 5 weeks later. No thresholds for these weather effects were detected. The period where NTS was legally notifiable was associated with a 60.3% (IRR: 1.603, 95% CI 1.382 – 1.860,  $p<0.001$ ) increase in cases.

## Conclusions

This study confirms the influence of weather on NTS cases in Singapore. The findings inform the review and implementation of food safety interventions aimed at reducing NTS cases during warmer weather.

# WC01: Basic time series analyses of Temperature

026, September 27, 2017, 10:30 - 12:00

Time-Series Analysis of Heat Waves and Emergency Department Visits in Atlanta, USA,  
1993 to 2012

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## Background/Aim

Heat waves are extreme weather events that have been associated with adverse health outcomes. However, there is limited knowledge of heat waves' impact on population morbidity such as emergency department (ED) visits. We investigated associations between heat waves and ED visits for 17 outcomes in Atlanta over a 20-year period.

## Methods

Associations were estimated using Poisson log-linear models controlling for continuous air temperature, dew-point temperature, day-of-week, holidays, and time trends. We defined heat waves as periods of  $\geq 2$  consecutive days with temperatures beyond the 98th percentile of the temperature distribution over the period 1945-2012. We considered 6 heat wave definitions using maximum, minimum, and average air temperature and apparent temperature. Associations by heat wave characteristics (duration, timing, and intensity), age stratification (<18, 18-65, >65), and race were also examined.

## Results

Among all outcome-heat wave combinations, associations were strongest between ED visits for acute renal failure and heat waves defined by maximum apparent temperature at lag 0 [relative risk (RR): 1.15, 95% confidence interval (CI): 1.03-1.29], ED visits for ischemic stroke and heat waves defined by minimum temperature at lag 0 (RR: 1.09, 95% CI: 1.02-1.17), and ED visits for intestinal infection and heat waves defined by average temperature at lag 1 (RR: 1.10, 95% CI: 1.00-1.21). ED visits for all internal causes were associated with heat waves defined by maximum temperature at lag 1 (RR: 1.02, CI: 1.00, 1.04).

## Conclusions

Heat waves can confer additional risks of ED visits beyond those of daily air temperature, even in a region with high air conditioning prevalence. Associations of heat waves with ED visits can be sensitive to heat wave definitions and we found stronger and more frequent associations when heat waves are defined using minimum or maximum temperature compared to average temperature.

# WC01: Basic time series analyses of Temperature

026, September 27, 2017, 10:30 - 12:00

Association between meteorological variables and hospitalizations for cardiac arrest in Hong Kong.

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## Background/Aim

Many studies have examined the associations between meteorological conditions and hospitalization or mortality for cardiovascular diseases (CVD) and most have found increases in CVD mortality/morbidity during periods of extreme hot or cold temperatures. Few studies have specifically examined associations between cardiac arrest (CA) and weather.

## Methods

For this retrospective time-series study we used daily data on hospitalizations for CA from 2002-2011 for public hospitals in Hong Kong, a large city with a subtropical climate. Daily counts on CA were regression on mean daily temperature and relative humidity (RH), and pollutants using distributed lag non-linear models, controlling for trend, seasonality, day of the week and holidays

## Results

The total number of CA hospitalizations during the study period was 6774 and 91% of hospitalizations ended with the death of the patient. Both high and low temperatures were strongly association with more CA hospitalizations. The excess risk was strongest on the same day but lagged effects persisted for 24 days. Relative to the minimum morbidity temperature of 27°C, a day with mean temperature = 12°C was associated with a relative risk (RR) (95% confidence interval (CI) for CA hospitalization = 2.02 (1.56, 2.61) while a day with mean temperature = 31°C was associated with an RR = 1.72 (1.22, 2.43). Hospitalizations among patients with diabetes were more sensitive to extreme temperatures. Other meteorological and pollutant variables were not associated with CA hospitalizations.

## Conclusions

Extreme temperatures are a very strong risk factor for CA hospitalization. Measures to reduce exposure to hot and cold ambient temperatures for individuals at risk of CA may have the potential to reduce morbidity and mortality from this condition.

# WC01: Basic time series analyses of Temperature

026, September 27, 2017, 10:30 - 12:00

## Heatwave and infants' hospital admissions under different heatwave definitions

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**Background:** Data on the health impacts of heatwaves in infants are limited, and this study aimed to examine how heatwaves affect hospital admissions in infants.

**Methods:** A quasi-Poisson generalized additive model was used to assess the effects of heatwaves on hospital admissions in infants from 1st January 2005 to 31st December 2015 in Brisbane, Australia, using a series of heatwave definitions after controlling for possible confounders. A case-only analysis was conducted to examine the possible modification effects of personal and community characteristics on the heatwaves effects on infants' hospital admissions.

**Results:** There was no significant increase in infants' hospital admissions when heatwave intensity was defined as mean temperature  $\geq$  90th percentile or  $\geq$  95th percentile of the mean temperature across the study period. When heatwave intensity increased to  $\geq$  97th percentile, infants' hospital admissions increased significantly (RR: 1.05, 95% CI: 1.01, 1.10), and this increase raised with the increase of heatwave duration. No modification effect of gender, indigenous status, or Socio-Economic Indexes for Areas (SEIFA) level on heatwave effect was observed.

**Conclusions:** Infants in Brisbane were sensitive to intense heatwaves, and future heat early warning system based on a scientifically solid heatwave definition incorporating evidence-based heatwave intensity and duration is needed to protect infants in the face of heatwaves. Community-based heatwave adaptation programs aiming at raising the awareness of the adverse health impacts of intense heatwaves among infants' caregivers may also relieve the health care demand in infants.

# WC01: Basic time series analyses of Temperature

026, September 27, 2017, 10:30 - 12:00

Are hospital emergency department visits due to dog bites associated with ambient temperature? A time-series study in Beijing, China

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## Background/aims

It is well documented that suboptimal ambient temperature is associated with cardiovascular and respiratory diseases. However, no evidence has been available with regard to the potential impacts of ambient temperature on dog bites. This study aims to examine the association between ambient temperature and daily hospital emergency department visits due to dog bites (EDVDBs) in Beijing, China; and to explore whether the temperature-EDVDB association varies by sex and age.

## Methods

Daily EDVDBs were collected from a hospital appointed for dog bites in Beijing during 2012-2014. A quasi-Poisson regression with distributed lag non-linear model (DLNM) was employed to estimate the impact of temperature on daily EDVDBs. Stratified analysis was performed to examine the temperature-EDVDB association by sex and age-groups. Sensitivity analysis was performed to check the robustness of the results by adjusting other meteorological variables and air pollutants.

## Results

A total of 42,481 EDVDBs were collected, with daily cases ranged from 15 to 71. The association between temperature and EDVDBs was U-shaped, with extreme cold temperature showing a weaker, delayed and shorter effect on the risk of dog bites while the effect of extreme hot temperature being stronger, more immediate and lasting longer. Cold temperature had a greater impact on female whereas male was more sensitive to hot temperature. The temperature-EDVDB association was unapparent in the 15-21 years group. The cold effect was only significant in the 0-14 years group whereas all age-groups suffered from the similar heat effect except those aged 22-45 years. Adjusting other meteorological variables and air pollutants did not change the results.

## Conclusions

The impact of temperature on EDVDBs is U-shaped in Beijing, China which varies by sex and age. The temperature effect is independent from other meteorological variables and air pollutants.

# WC01: Basic time series analyses of Temperature

026, September 27, 2017, 10:30 - 12:00

Socioeconomic and environmental contextual factors modifying the association between ambient temperature and mortality: a multi-country analysis

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on behalf of the MCC Collaborative Research Network

## Background/Aim

Previous studies have shown that temperature-health associations are highly heterogeneous across populations living in different parts of the world. However, little is known about the factors responsible for these differences. In this contribution, we used data from a multi-country study to identify contextual factors that modify temperature-mortality associations.

## Methods

We collected ambient temperature and mortality time-series for 378 locations in 21 countries, in periods between 1985 and 2014. Standardized measures of demographic, socioeconomic, infrastructural, and environmental indicators were derived from the OECD Regional and Metropolitan Database. We used a two-stage approach with distributed lag non-linear models to estimate temperature-mortality associations, and a multivariate meta-regression to evaluate the effect modification of each indicator. To summarise effects, we calculated fractions of mortality attributable to temperatures above (heat) or below (cold) the 90<sup>th</sup> and 10<sup>th</sup> temperature percentiles. The modifier effects are reported as percentage changes predicted for the 95<sup>th</sup> vs 5<sup>th</sup> percentiles of the indicator distribution.

## Results

Overall observed attributable fractions were 0.27% and 0.41% for heat and cold, respectively. Several factors modified the impact, although in a larger extent for heat than for cold. Significant percentage changes of the figures above were found for PM2.5 (+63% for heat and +7.3% for cold), unemployment (+93% and +36%), urban vs rural (+52% and +15%), pro-capita hospital beds (-74% and -11%), Gini index (+111% and +15%), and poverty rate (+51% and +25%).

## Conclusions

This represents by far the largest study assessing effect modification of temperature-mortality relationships, performed by comparing different populations across the world and using standardized contextual indicators. Preliminary findings suggest larger effects of non-optimal temperature on mortality, in particular heat, in communities characterised by a higher level of inequalities and worse socio-economic conditions, higher pollution exposure, urban landscape, and lower availability of health services

## WC02: Potentially endocrine disrupting chemicals and reproductive health

020, September 27, 2017, 10:30 - 12:00

### Urinary triclosan concentrations and diminished ovarian reserve among women from a fertility clinic

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**Background/Aim:** Triclosan, an endocrine disrupting chemical used as an antibacterial in personal care and consumer products, has shown estrogenic activity in experimental studies. There are limited human studies on reproductive health effects of triclosan. The objective of this study was to prospectively investigate the association between urinary triclosan concentrations and antral follicle count (AFC), a well-accepted marker of ovarian reserve, among women from a fertility center.

**Methods:** This analysis included 109 women in the Environmental and Reproductive Health (EARTH) Study who provided at least one urine sample prior to the measurement of AFC, between 2007 and 2016. We quantified urinary triclosan concentrations by tandem mass spectrometry and measured AFC through transvaginal ultrasonography on the 3rd day of an unstimulated menstrual cycle or on the 3rd day of a progesterone withdrawal bleed. Poisson regression models were used to estimate the associations of specific gravity (SG)-adjusted urinary triclosan concentrations (as continuous in  $\log_e$  scale) with AFC adjusted for age, body mass index (BMI), year of sample collection, physical activity and baseline infertility diagnosis.

**Results:** The median (interquartile range, IQR) of the SG-adjusted urinary triclosan concentrations for the 225 samples provided by the 109 women was 7.9 (3.0, 33.6)  $\mu\text{g/L}$ . Women had median (IQR) AFC of 13 (8, 18). In unadjusted models, one  $\log_e$  unit increase in SG-adjusted urinary triclosan concentrations was associated with a 3% decrease (95% CI= -5%, -2%) in AFC (p-value=0.04). This association strengthened after adjustment for covariates (-4%, 95% CI= -7%, -1%, p-value=0.009). Specifically, women in the 75<sup>th</sup> percentile of exposure (33.6  $\mu\text{g/L}$ ) had a 6.6% decrease in AFC compared with women in the 25<sup>th</sup> percentile (3.0  $\mu\text{g/L}$ ).

**Conclusion:** SG-adjusted urinary triclosan concentrations were inversely associated with AFC in women seeking care at a fertility center.

## WC02: Potentially endocrine disrupting chemicals and reproductive health

020, September 27, 2017, 10:30 - 12:00

Serum perfluorinated alkyl acids (PFAAs) in UK women undergoing fertility treatment

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**Background/Aim:** Perfluorinated alkyl acids (PFAAs) are used widely as surfactants in household and industrial applications such as textile treatments and food packaging, and can be persistent and bioaccumulative. Human exposure occurs primarily through diet, and has been associated with adverse effects on fertility, birth outcomes, and neurodevelopment. Polycystic ovarian syndrome (PCOS) is an endocrine disorder characterised by hyperandrogenism, ovarian cysts, and irregular menses, and often results in infertility. There is interest in the potential contribution of endocrine disrupting chemicals in the environment, such as PFAAs, to the disease. The aim of this study was to (1) characterise PFAA exposure in women undergoing fertility treatment in the UK; and (2) examine the association of PFAAs in PCOS and non-PCOS patients with clinical measurements of fertility.

**Methods:** PCOS (n=29) and non-PCOS (n=30) participants 20-45 years were recruited from the IVF Unit at the Women and Children's Hospital, Hull. Serum was analysed for 13 PFAAs including perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorohexane sulfonate (PFHxS) using isotope-dilution liquid chromatography-tandem mass spectrometry.

**Results:** Mean concentrations of PFOS, PFOA and PFHxS were 3.71, 2.74 and 1.29 ng/mL, respectively. PFOS and PFOA ( $p=0.279$ ), and PFOS and PFHxS ( $p=0.490$ ) were significantly correlated. Mean PFOS concentrations were lower than reported values from general populations in Canada, Hong Kong, Taiwan, Denmark, and most pregnancy cohorts globally. Conversely, PFOA and PFHxS were higher. PFOS was significantly higher in PCOS than non-PCOS patients (4.12/3.37 ng/mL,  $p=0.021$ ), but there was no difference for PFOA or PFHxS. There was a significant linear relationship between PFOS, age ( $p=0.008$ ) and menstrual cycle regularity ( $p=0.003$ ,  $R^2=0.210$ ), with higher PFOS in patients with irregular cycles.

**Conclusions:** We present preliminary data suggesting increased PFOS concentrations in PCOS patients, and a unique PFAA exposure profile for women of reproductive age in the UK relative to comparative populations globally.

## WC02: Potentially endocrine disrupting chemicals and reproductive health

020, September 27, 2017, 10:30 - 12:00

### Environmental phenol associations with repeated fetal growth measures exhibit sex differences

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**Background/aim:** Phenols are used ubiquitously in consumer products including pesticides, plastics, and personal care products, and exposure in pregnant women is common. Bisphenol-A has been associated with reduced fetal growth but other phenols have been explored minimally. The objective of our analysis was to examine repeated measures of urinary phenols during pregnancy to test associations with ultrasound and delivery parameters of fetal growth.

**Methods:** Pregnant women were recruited early in gestation as part of the LIFECODES birth cohort and provided urine samples at up to 4 study visits (median 10, 18, 26, and 35 weeks gestation). Abdominal and head circumference, femur length, and estimated fetal weight were recorded at up to 3 time points per subject, as was birth weight. All measures were standardized to gestational age specific z-scores. Using linear mixed effects models we examined associations between repeated growth measures and a subject-specific average of each phenol, including: 2,4-dichlorophenol (2,4-DCP); 2,5-dichlorophenol (2,5-DCP); benzophenone-3 (BP3); butyl, ethyl, methyl, and propyl parabens; triclosan; triclocarban; and bisphenol-S (BPS).

**Results:** Most phenols were highly detectable in urine samples from the study population (>70%). In males fetuses, 2,4-DCP and 2,5-DCP were inversely associated repeated measures of estimated or actual fetal weight z-scores ( $\beta=-0.15$ , 95% CI=-0.31, 0.02;  $\beta=-0.20$ , 95%CI=-0.39, -0.01, respectively). BP3 and each of the parabens were not associated with weight z-scores but were associated with decreased abdominal circumference. No clear associations were observed in males for triclosan, triclocarban, or BPS. In female fetuses, associations were generally null. However, detection of BPS was associated with lower estimated or actual fetal weight z-scores in repeated measures models ( $\beta=-0.25$ , 95%CI=-0.49, -0.02).

**Conclusions:** These results suggest an important sexually dimorphic role of environmental phenol exposure in fetal development.

## WC02: Potentially endocrine disrupting chemicals and reproductive health

020, September 27, 2017, 10:30 - 12:00

Repeated plasma measurements of maternal inflammatory markers during pregnancy in relation to urinary phenols and parabens

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**Background:** During gestation, the regulation of inflammation is critical for the progression of a healthy pregnancy and fetal development. Previous human and animal studies suggest that exposure to toxicants designated as phenols and parabens is related to the inflammatory process. Few studies have investigated this relationship during pregnancy. Our main objective was to characterize the longitudinal relationship between plasma inflammatory markers and individual maternal urinary phenols and parabens across pregnancy.

**Methods:** The present study was conducted on data from a nested case-control study of preterm birth, including 129 cases and 352 controls. We measured 7 phenols and 4 parabens in urine samples, as well as 5 inflammatory markers in plasma at up to four study visits from each participant during pregnancy. We used linear mixed models to analyse repeated measurements, and multivariate linear regression to explore cross-sectional relationships by individual study visits.

**Results:** In our repeated measures analyses, we observed that some phenols had significant positive relationships with the inflammatory markers C-reactive protein, Interleukin-6, and tumor necrosis factor- $\alpha$ , and the anti-inflammatory molecule interleukin-10. The greatest magnitude among these associations indicated that an interquartile range increase in triclosan was associated with a 12.8% (95% CI: 3.83, 22.4) increase in C-reactive protein. We also found that an interquartile range increase in ethylparaben was associated with a 7.6% (95%CI: -13.9, -0.7) decrease in interleukin-1 $\beta$ . Many of these longitudinal relationships differed in direction and magnitude by study visit, indicating potential mechanistic variations across gestation.

**Conclusions:** The results of our study provide evidence suggesting that exposure to phenols and parabens is associated with circulating levels of inflammatory markers. These relationships may have implications for fetal development and birth outcomes.

## WC02: Potentially endocrine disrupting chemicals and reproductive health

020, September 27, 2017, 10:30 - 12:00

### Concentrations of perfluoroalkyl substances in pregnancy and breastfeeding duration

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**Background/Aim:** Animal studies suggest that exposure to perfluoroalkyl substances (PFAS) can disrupt mammary gland development, potentially impacting lactation. Prior epidemiological studies report shorter breastfeeding duration among mothers with higher PFAS concentrations in pregnancy. In a United States cohort, we examined pregnancy PFAS concentrations in relation to duration of breastfeeding.

**Methods:** We studied 1,154 mother-child pairs from Project Viva, a longitudinal pre-birth cohort enrolled 1999-2002. We measured concentrations of four PFASs in maternal plasma from early pregnancy (median 9.6 weeks gestation): perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), and perfluorononanoate (PFNA). Mothers reported duration of any breastfeeding through 12 months. Using linear regression models, we estimated associations of PFAS concentrations with duration of breastfeeding, adjusted for relevant covariates including maternal age, body mass index, race/ethnicity, education, household income, and pregnancy hemodynamics. Primary analyses were restricted to nulliparous mothers (n=555) to avoid bias resulting from the strong relationship of prior breastfeeding with PFAS concentrations among parous women.

**Results:** Median (25-75th percentile) PFAS concentrations (in ng/mL) were 5.8 (4.1-7.9) (PFOA), 25.0 (18.6-34.0) (PFOS), 2.4 (1.6-3.7) (PFHxS), and 0.7 (0.5-0.9) (PFNA), and median breastfeeding duration was 5 months (1-11). Among nulliparous women, pregnancy PFOA concentrations were inversely associated with breastfeeding duration (fourth quartile (Q4) vs. Q1: -1.5 months, 95% confidence interval (CI): -2.5, -0.4, Q3: -0.8, 95% CI: -1.8, 0.3, Q2: -1.1, 95% CI: -2.1, -0.1); associations were not observed for other PFASs. In analyses including parous and nulliparous women, associations with breastfeeding were considerably stronger for all four PFASs.

**Conclusions:** Breastfeeding duration was shorter among mothers with higher pregnancy PFOA, associations that were attenuated but still present among nulliparous women, a subset not subject to bias due to previous breastfeeding. Future analyses will examine other measures of breastfeeding success in Project Viva to better characterize potential impacts of PFAS exposure on lactation.

## WC02: Potentially endocrine disrupting chemicals and reproductive health

020, September 27, 2017, 10:30 - 12:00

Prenatal exposure to phthalates and neurodevelopment in 48 month children of Mexico City

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**Background/Aim:** Pregnancy is a critical window of exposure to toxicants that can affect the developing fetal brain. Exposure to phthalates is ubiquitous among pregnant women, nevertheless longitudinal effects on neurodevelopment remain controversial.

**Methods:** Nine phthalate metabolites were measured in spot urines from each trimester of pregnancy in 218 pregnant women participating in the Mexico City ELEMENT cohort, and corrected for urine dilution by specific gravity. Geometric means (GM) and molar sum of DEHP (i.e., MEHP, MEOHP, MEHHP, MECPP), DBP (i.e., MBP, MiBP), high (HMWP) and low (LMWP) molecular weight phthalate metabolites were calculated. General Cognitive Index (GCI) and Motor Index (MI) were measured at 48 months using McCarthy Scales of Children's Abilities (MSCA). Linear regression models were performed with log transformed GM phthalates and were adjusted for sex, gestational age, breastfeeding, maternal education and maternal IQ.

**Results:** Among 218 mother-child pairs, GM were as follows: LMWP= 1.82 ng/L, HMWP=0.3 ng/L, DEHP=0.30 ng/L and DBP=0.40 ng/L. MSCA mean scores were: GCI= 97.4, MI =46.0. A negative association was found in unadjusted models of HMWP with GCI ( $\beta$ -3.19, 95% CI -6.31, -0.06), and MI ( $\beta$ -1.91, 95% CI -4.09, 0.26). In adjusted models of GCI and HMWP, all HMWP individual metabolites had the same negative association, but MBzP and MEOHP metabolites had a marginal statistical significance. Likewise, in adjusted models of MI and HMWP we found a significant negative association ( $\beta$  -2.80, 95% CI -5.09, -0.51), and the adjusted model of MI and DEHP metabolites showed a negative significant association ( $\beta$  -2.77, 95% CI -5.04, -0.51), which remained for MEHHP, MEOHP and MECPP. No significant associations were found between LMWP and MSCA scores and DBP and MSCA scores.

**Conclusions:** Our results strengthen the evidence for stricter regulations to reduce phthalates exposures in pregnant women and their children.

# WC03: Occupational Health: cancer & heat

022, September 27, 2017, 10:30 - 12:00

## Occupation and relative squamous cell carcinoma risk: Solar UV dose estimates of Swedish workers

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### Background/Aim

Ultraviolet (UV) radiation emitted by the sun is the main causal factor for cutaneous malignant melanoma and non-melanoma skin cancer (NMSC). Squamous cell carcinoma (SCC) is the second most common NMSC and prevalingly induced by cumulative solar UV exposure, leaving outdoor workers and elderly people at greater risk. Less lethal than melanoma, NMSC is the most common cancer in fair-skinned populations and at a constant rise worldwide. However, high inter- and intra-individual variations make UV exposure assessment challenging. Data on received long-term solar UV doses is scarce. This study aims at ranking occupational activity risk for SCC and at estimating cumulative UV doses received for various occupational activities.

### Methods

Solar UV dose potentially received by various anatomical zones, at different geographical location in Sweden and specific occupational postures have been estimated by modelling(1, 2). These UV doses were combined with SCC incidence ratios of various occupational activities of Swedish workers. Activity exposure matrices have been built up to better assess the solar UV exposure for various occupational activities. The Swedish data source is the extensive Nordic Occupational Cancer (NOCCA) project, undertaken as a cohort study with linkage of individual record based on personal identity codes used in all five Nordic countries, including job history in four points in time.

### Results

The dose estimated for anatomical zones of the lip, eyelid, external ear, scalp and neck and upper limb are high for outdoor workers. Their potentially UV doses received vary by season and latitudes of their Swedish geolocation. Indoor occupational activities received lower UV doses; however the doses illustrated a different anatomical distribution.

### Conclusion

The suggested activity exposure matrix supports a dose-response relationship between chronic solar UV doses estimated and SCC in Sweden and provides cumulative UV doses received during various occupational activities.

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## WC03: Occupational Health: cancer & heat

022, September 27, 2017, 10:30 - 12:00

Is there a link between occupational silica or asbestos exposure and kidney cancer? A case-control study in Canadian men

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### Background/Aim

Asbestos and crystalline silica are prevalent workplace exposures and are recognized human carcinogens. As few studies have investigated their associations with kidney cancer, we sought to address this gap using a Canadian case-control study

### Methods

Incident cancer cases were identified by provincial cancer registries and self-reported questionnaires were used to obtain information on cancer risk factors and lifetime occupational history as part of the National Enhanced Cancer Surveillance System (NECSS). The NECSS is a population-based case-control study conducted from 1994-1997 in eight Canadian provinces. Occupational hygienists coded occupational histories for asbestos and silica exposure using concentration, frequency, and reliability, enabling the development of several exposure metrics. Logistic regression was used to estimate, separately by exposure, odds ratios (OR) and 95% confidence intervals. Models were adjusted for age, province, BMI, and cigarette smoking.

### Results

Complete occupational data were available for 652 cancer cases and 2,368 controls. Overall, 33% and 44% of workers were ever occupationally exposed to asbestos and silica, respectively. Obesity and older age were positively associated with kidney cancer, however smoking was not. Workers who had ever been exposed to asbestos were significantly more likely to have kidney cancer than those who were never exposed (OR 1.2, 95% CI 1.0 – 1.5). Ever-exposure to silica was not related to a significantly elevated risk of kidney cancer (OR 1.1, 95%CI 0.9 – 1.4). When examining duration of exposure as well as tertiles of cumulative asbestos exposure, calculated by multiplying relative frequency and concentration by duration, exposure was linked to an increased risk of kidney cancer, but only significantly so in the lowest tertile (OR 1.4, 1.0 – 1.9). In similar analyses for silica, no significant relationships were observed when comparing exposed to unexposed workers.

### Conclusions

We found evidence that occupational exposure to asbestos, but not silica, is positively associated with kidney cancer.

## WC03: Occupational Health: cancer & heat

022, September 27, 2017, 10:30 - 12:00

### Occupational herbicide exposure may induce Kidney injury molecule I (KIM I) and Neutrophil Gelatinase-Associated Lipocalin (NGAL) levels in sugarcane farmers in rural Sri Lanka

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Extensive use of herbicides is common among agriculture workers in Sri Lanka (SL). Recent studies hypothesized the role of agrochemicals in the development of mysterious chronic kidney disease termed as CKDu. Paraquat and Glyphosate were leading herbicides among sugarcane farmers (SF) hence occupational exposure is inevitable. This study reports detection of urinary Paraquat and Glyphosate residues among SF residing in CKDu emerging regions (Uva province; Warunagama and Rahathangama) of SL along with tubular injury biomarkers KIM I and NGAL. Collected urine samples were compared with non-endemic controls (CN) (Southern province; Matara). Paraquat, Glyphosate, KIM I and NGAL levels (Warunagama, n = 66; Rahathangama, n = 69; Matara, n = 66) were estimated using Enzyme Linked Immunosorbent Assays. Urinary creatinine, microalbumin and albumin creatinine ratio (ACR) were also assessed for kidney function. Generally herbicide residues and injury biomarkers were higher in SF with compared to CN. Creatinine adjusted urinary glyphosate and paraquat levels were significantly higher in Warunagama ( $271.3 \pm 23.7 \mu\text{g/g Cr}$ ,  $2.08 \pm 0.33 \mu\text{g/g Cr}$ ;  $p < 0.001$ ) but not in Rahathangama ( $250.4 \pm 18.8 \mu\text{g/g Cr}$ ,  $0.79 \pm 0.12 \mu\text{g/g Cr}$ ;  $p > 0.05$ ) when compared with CN ( $191.2 \pm 14.2 \mu\text{g/g Cr}$ ,  $0.67 \pm 0.05 \mu\text{g/g Cr}$ ). Urinary NGAL levels were significantly higher ( $12.4 \pm 4.7 \text{ ng/mg Cr}$   $p < 0.0001$ ,  $12.0 \pm 2.8 \text{ ng/mg Cr}$ ;  $p < 0.0001$ ) in both Warunagama and Rahathangama. However, urinary KIM I levels were not significant ( $101.6 \pm 25.0 \text{ ng/g Cr}$ ,  $114.6 \pm 25.5 \text{ ng/g Cr}$ ;  $P > 0.05$ ) with compared to CN ( $34.9 \pm 20.1 \text{ ng/g Cr}$ ,  $1.8 \pm 0.4 \text{ ng/g Cr}$ ). In conclusion, current study confirms higher urinary herbicides levels in SF, potentially due to occupational exposure. Similarly, higher urinary KIM I and NGAL levels were also reported in both CKDu emerging locations and could be link with elevated herbicide residue levels. However, low but detectable levels of urinary herbicide, KIM I and NGAL in non-endemic controls may support dietary exposure and warrants further studies.

Keyword: chronic kidney disease, Glyphosate, herbicide exposure, kidney injury, KIM I, Paraquat, NGAL

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## WC03: Occupational Health: cancer & heat

022, September 27, 2017, 10:30 - 12:00

### Geographic area impacts of climate change on peoples' work capacity

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#### Background

Increasing environmental heat is the most predictable effect of climate change. In already hot areas this increase will create health risks, particularly for people who carry out physically demanding jobs. Excessive heat exposures will occur outdoors and indoors (without air conditioning). Low income people in tropical countries will be at the highest risk. The physiological evidence concerning heat impacts on workers is extensive, but epidemiological evidence is limited.

#### Methods

Using climate and population data for 67,000 geographic grid cells (size = 0.5 x 0.5 degrees) based on internationally approved sources, we produced heat stress maps for different years. We applied exposure-response relationships for work capacity effects of heat stress to estimate impacts at area level.

#### Results

The number of people subjected to extremely high average heat levels (Wet Bulb Globe Temperature > 30°C) in the hottest month will rise from current estimates of less than 1 million to 400 million in 2085. At country level, up to 2-4% of current daylight work hours are too hot for physical activity at moderate intensity, e.g. in Cambodia, India, Pakistan, and Nigeria. Maintaining this degree of physical activity substantially increases the risk of clinical health effects. By 2085 the physically unsafe work hours increases to 7-11% if current global climate policies are enforced, and to half these losses if the most ambitious climate change policies are implemented.

#### Conclusions

Workplace heat exposure will increase for millions of people as climate change progresses. Our model estimates area impacts incorporating climate conditions, location of work (in sun, in shade or indoors), effects of different work intensity, night time heat stress and age distribution of the local population. Further studies of health and performance impacts of heat in the working age group are needed to validate and improve these risk health assessments due to climate change.

## WC03: Occupational Health: cancer & heat

022, September 27, 2017, 10:30 - 12:00

### Volumetric bone mineral density increases following a period of heightened physical activity in female U.S. Army Soldiers

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**Disclaimer:** The views expressed are those of the authors and do not reflect the official policy of the Army, Department of Defense, or the US Government.

**Background/Aims:** Basic combat training (BCT) for military recruits is a time of heightened physical activity when stress fracture risk is increased. Animal studies demonstrate that bones can mount an anabolic response to physical activity, which confers mechanical benefits that may offset risk of injury. During BCT, this anabolic response may be more robust in those with lower bone density at the start of training, where a greater loading stimulus is perceived by the skeleton. We hypothesized that the BCT setting would result in increases in volumetric bone mineral density (vBMD; suggesting bone anabolism) and that individuals with lowest baseline vBMD would see the greatest change.

**Methods:** We quantified the tibia vBMD of 90 female recruits before and after BCT, using a high-resolution peripheral quantitative computed tomography (XtremeCTII, Scanco Medical). Using a linear mixed model, we estimated the mean change in vBMD following BCT. To evaluate the effect of baseline vBMD on the change in vBMD we used a generalized additive model, applying a naturalized spline to baseline vBMD. We adjusted for baseline 25-hydroxyvitamin D and serum calcium, exercise prior to BCT, and race/ethnicity.

**Results:** Tibial vBMD increased following BCT (Effect Estimate: 1.79%, 95% CI: 1.32, 2.25). The relationship between the change in vBMD and baseline vBMD was significantly non-linear ( $p < 0.001$ ). Individuals with the lowest baseline values for vBMD saw the greatest increases in vBMD where the slope of this effect diminished as baseline vBMD increased.

**Conclusions:** BCT results in new bone formation, as suggested by increased vBMD. This anabolic response to training was most evident in Soldiers with lowest baseline bone density. These findings suggest that Soldiers with less dense bones at BCT entry are capable of bone anabolism—a biological process that can be targeted for stress fracture mitigation.

## WC04: Ambient air pollution & childhood asthma

100, September 27, 2017, 10:30 - 12:00

Chronic social stressors and susceptibility to short-term variation in urban ozone: A case-crossover analysis of childhood asthma exacerbations in NYC

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Growing evidence suggests that chronic social stressors (e.g., poverty, violence exposures) may modify associations between chronic air pollution exposures and health. Relatively few studies, however, have examined whether the effects of acute air pollution exposures vary by social or socioeconomic factors, or how these spatial modifiers influence the apparent effects of spatio-temporal pollution exposure estimates.

In this study, we estimate residence- and day-specific ozone exposure estimates for multiple lag days, by combining highly spatially-resolved intra-urban concentration surfaces with regulatory monitoring data. Applying conditional logistic regression (Cox Proportional Hazard) models in a case-crossover design, adjusting for temperature and co-pollutant exposures, we examined associations with asthma exacerbations. Outcome data was limited to citywide hospital records for children aged 5 to 17 years, during the warm season (June - August) asthma hospitalizations (n = 2,353) and Emergency Department (ED) visits (n = 11,719), from 2005-2011.

In keeping with our prior studies, we found elevated associations between ozone and exacerbation risk for lag days 1 through 3. Risks associated with ozone exposure were consistently lowest in communities with the lowest violent crime rates, and increased with increasing community violence. Similarly, we found that ozone conferred lesser risk in communities with lesser socioeconomic deprivation, and that risks increased in a roughly dose-response manner.

Subsequent analyses will develop cross-stratified models, using both modifiers, to compare and contrast modification attributable to each social factor.

## WC04: Ambient air pollution & childhood asthma

100, September 27, 2017, 10:30 - 12:00

### Methods for predicting asthma exacerbations using personal sensor monitoring systems

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**Background/Aim:** The Pediatric Research using Integrated Sensor Monitoring Systems (PRISMS) program was launched by the US National Institute of Biomedical Imaging and Bioengineering to develop wearable, sensor-based, integrated health monitoring systems for measuring environmental (e.g., personal air pollution exposure), physiological, and behavioral factors in epidemiological studies of pediatric asthma. Continuous, real-time sensor data pose unique opportunities and challenges compared to typical environmental epidemiology data from cohort or panel studies. To extract meaningful information from heterogeneous sensors, a data integration framework and new statistical approaches that apply over large historical and streaming data are required. While many scientific questions are of interest, a common goal is to identify important triggers of asthma exacerbations. The aim of our study is to develop, apply, and evaluate a statistical analysis framework for predicting asthma exacerbations from sensor data.

**Methods:** Our basic framework consists of a population-level machine learning model (e.g., generalized boosted model) updated to a personalized prediction model on top of a novel data integration and analysis architecture. We evaluate our framework using simulated data and pilot data.

**Results:** Key statistical challenges include effective summarization of sensor data streams ("feature engineering"), the development of independent training and test data sets for model evaluation that appropriately account for temporally and spatially autocorrelated data, feature selection, and interpretation of resultant models. Recent symptoms are typically an important predictor of future exacerbation. Population-level triggers may differ from individual-level triggers.

**Conclusions:** Data arising from sensor-based monitoring systems require modern statistical analysis approaches, but offer an exciting new paradigm for clinical and epidemiological studies.

## WC04: Ambient air pollution & childhood asthma

100, September 27, 2017, 10:30 - 12:00

### Early-life Exposure to PM<sub>2.5</sub> and Risk of Acute Asthma Clinical Encounters among Children in Massachusetts: A Case-Crossover Analysis

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**Background/Aim:** Associations between ambient particulate matter <2.5µm (PM<sub>2.5</sub>) and asthma morbidity have been suggested in previous epidemiologic studies. We estimated the associations between early-life short-term PM<sub>2.5</sub> exposure and the risk of asthma clinical encounters among Massachusetts children in the novel Pregnancy to Early Life Longitudinal (PELL) cohort data linkage system.

**Methods:** We used a semi-bidirectional case-crossover study design with short-term exposure lags for asthma exacerbation using information from the PELL data system. Cases included children up to 9 years of age who had a hospitalization, observational stay, or emergency department visit for asthma or wheeze between January 2001 and September 2009 (n=33,387). Daily PM<sub>2.5</sub> concentrations were estimated at a 4-km resolution using satellite remote sensing, land use, and meteorological data. We applied conditional logistic regression models to estimate adjusted odds ratios (ORs) and 95% confidence intervals (CI). We stratified asthma clinical encounters by potential effect modifiers.

**Results:** Overall, associations between PM<sub>2.5</sub> exposure and asthma clinical encounters among children at lags 0, 1 and 2 were close to the null value of OR=1.0. Evidence of effect modification was observed by birthweight for lags 0, 1 and 2 (p<0.05), and season of clinical encounter for lags 0 and 1 (p<0.05). Children with low birthweight (<2500g) had increased odds of having an asthma clinical encounter due to higher PM<sub>2.5</sub> exposure for lag 1 (OR: 1.14 per 10-µg/m<sup>3</sup> increase in PM<sub>2.5</sub>; 95% CI: 1.01, 1.27).

**Conclusion:** Asthma or wheeze exacerbations among low birthweight children were associated with short-term increases in PM<sub>2.5</sub> concentrations.

## WC04: Ambient air pollution & childhood asthma

100, September 27, 2017, 10:30 - 12:00

### Risk effects of near-roadway air pollutants on bronchitic symptoms in asthmatic and non-asthmatic children

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**Background/Aim:** Research indicates that exposures to ambient criteria air pollutants affect bronchitic symptoms, especially in asthmatics, but less is known about the importance of exposures to the near-roadway air pollutant mixture. In the current study, we investigated whether exposure to near-roadway air pollutants was associated with increased risk of bronchitic symptoms among asthmatic and non-asthmatic children. Given previous studies' findings of associations between regional air pollution and bronchitic symptoms, we also tested whether near-roadway effects differed across communities with high and low regional pollution.

**Methods:** Longitudinal data from 3 cohorts of children (N=7224) participating in the southern California Children's Health Study were analyzed. Presence of bronchitic symptoms in the past 12 months was assessed over an 8 to 9 year period within each cohort. Residential exposure to the near-roadway air pollution mixture from freeways and non-freeways (with NO<sub>x</sub> as an indicator) was estimated using the CALINE4 line-source dispersion model. Mixed-effects logistic regression models were used to test the association between near-roadway air pollutants and bronchitic symptoms, allowing for potentially different associations by asthma status and regional air pollution levels.

**Results:** Among asthmatic children, a 2 SD (11.2 ppb) increase in exposure to non-freeway NO<sub>x</sub> was associated with a 35% increase in the odds of reporting bronchitic symptoms (OR: 1.35; 95% CI: 1.13-1.63), while a 2 SD (37.1 ppb) increase in exposure to freeway NO<sub>x</sub> was associated with a 24% increase in odds (OR: 1.24; 95% CI: 1.04-1.49). Among non-asthmatic children, only non-freeway NO<sub>x</sub> was statistically significantly associated with bronchitic symptoms (OR: 1.12; 95% CI: 1.01-1.25 per 2 SD increase). Associations between near-roadway pollutants and bronchitic symptoms were generally strongest among asthmatics living in communities with lower regional PM<sub>2.5</sub>.

**Conclusions:** Near-roadway air pollution was associated with bronchitic symptoms, and the association varied by asthma status and by regional air pollution.

# WC04: Ambient air pollution & childhood asthma

100, September 27, 2017, 10:30 - 12:00

## Short-term Association between Ambient Temperature and Asthma Hospitalization in Children: First Admissions vs. Repeated Admissions

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### Background/Aim

Asthma can be triggered by various factors such as low temperature (Turner, Barnett, Connell, & Tong, 2012) and food allergies due to different etiologies. Compare to ambient exposures, behavioural triggers such as food allergy may be easier to avoid once sources of allergy are identified. Therefore repeated asthma admissions may be more likely to be environmental-factors-associated or the more severe cases. Including first admission cases in asthma-temperature association study may bias the association.

This study investigated whether the associations with ambient temperature are comparable between first asthma admissions and repeated admissions among young children.

### Methods

Daily number of asthma hospitalization among children <6 year-old in a subtropical Asian urban city during 2007-2011 was regressed on daily mean temperature using distributed lagged nonlinear models with other environmental factors adjusted. The analyses were stratified by season and type of admissions (first admission and repeated admission).

### Results

The total number of first admissions was 1 time more than that of repeated admissions during the study period (8113 vs. 4171 cases). Repeated admissions were shown to be more sensitive to temperature in both seasons. In hot season, number of repeated admissions increased with higher temperature (>29 °C) while no significant association was found for first admissions. The cumulative relative risks (cumRR) (95% confidence interval) at high temperature (31 vs. 29°C; lag0-17) for repeated admissions and first admission were 1.75(1.2, 2.72) and 0.86(0.58, 1.28), respectively. In cold season, both admissions increased with warmer temperature (>15°C) with stronger association for repeated admissions. The respective cumRRs for repeated and first admissions at warm temperature (21 vs. 15°C; lag0-7(repeated)/ lag0-5(first)) were 1.88(1.03, 3.43) and 1.43(0.97, 2.13).

### Conclusions

Repeated asthma admissions among young children showed stronger association with ambient temperature which possibly reflected their higher sensitivity to ambient conditions and severity. Future asthma-temperature studies may consider analysing the two groups separately.

## **WC04: Ambient air pollution & childhood asthma**

**100, September 27, 2017, 10:30 - 12:00**

### Ethical considerations in respiratory health effects of air pollution

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Abundant scientific evidence has demonstrated various health effects from air pollution in different populations around the world. Recently, traffic-related emissions are pollutants that have been associated with adverse respiratory health especially in young children. All studies presented in the Ambient air pollution and childhood asthma session of the 1SEE 2017 conference were unequivocal in finding associations between regional air pollution and increased health risk such as respiratory symptoms, asthma or wheeze exacerbations resulting in hospital admissions for respiratory diseases.

A core value of environmental epidemiology includes advancing the health and welfare of the public and protecting the most vulnerable. Objectively communicating research findings is often not enough to bring about needful commitment to improve ambient air quality. Environmental health policy is usually the result of a negotiation between stakeholders with different ethical worldviews and interests. Considering that children cannot advocate for themselves, do environmental epidemiologists have a duty to go beyond objectively communicating facts or should they become policy advocates? Should the role of environmental epidemiologists expand with time so that researchers are better positioned to respond to the challenges of this era? Should funding of activities that will facilitate informed, evidence-based discussion among these stakeholders and intervention programs in affected populations be of higher priority than repeating causal analyses of ambient air pollution and childhood asthma? In what ways, can environmental epidemiologists work to ensure the long-term policy decisions taken today will protect the future health of children? The discussion will address these questions and the role of environmental epidemiologists in the context of changing socio-political landscapes around the world.

## WC05: Nutrition during the cycle of life

102, September 27, 2017, 10:30 - 12:00

### Extended spectrum $\beta$ -lactamase-producing Enterobacteriaceae among meat, fish, and healthy mothers in Phnom Penh, Cambodia

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**Background/Aim.** Human colonization with extended spectrum  $\beta$ -lactamase-producing Enterobacteriaceae (ESBL-PE) is prevalent in Southeast Asia. Few studies have examined whether food may be a possible reservoir for exposure. We conducted a meat sampling study in Phnom Penh in collaboration with the BIRDY program (<http://www.birdyprogram.org/>), an ongoing study of neonatal health in low-income countries. We assessed ESBL-PE contamination among meat and fish, evaluated risk factors for contamination, and compared ESBL genes between meat and mothers participating in BIRDY.

**Methods.** From September-November, 2016, pork, fish, and chicken samples from two markets in Phnom Penh were analysed for ESBL-PE. We assessed stall hygiene, storage practices, and animal origins for each sample. We used logistic regression to evaluate potential risk factors for meat contamination. We performed whole genome sequencing on ESBL-PE recovered from meat and fish and from BIRDY mothers who had provided faecal swabs less than one year prior.

**Results.** Among 60 pork, 60 fish, and 30 chicken, 75% (113/150) were positive for ESBL-PE. Pork was most commonly contaminated ( $p < 0.01$ ). ESBL-PE from 8/150 samples demonstrated *mcr-1*-mediated colistin resistance, and *E. coli* from 2/150 samples were carbapenem-resistant (OXA-48 and OXA-181-mediated, respectively). Meat and fish raised on large-scale farms versus other husbandry schemes were more likely to be contaminated with ESBL-P *E. coli* (OR: 1.4, 95% CI: 1.1, 1.7). Pork and chicken fed medicine even when healthy versus those not were 2.8 times as likely (95% CI: 1.1, 7.3) to be contaminated with multidrug-resistant ESBL-PE. Most ESBLs among meat and humans were CTX-M-type; ESBLs belonging to the CTX-M-3 group (e.g. CTX-M-3, M-15, M-55) predominated across all hosts.

**Conclusions.** A high proportion of meat and fish in Phnom Penh are contaminated with ESBL-PE, and similar ESBL-types can be detected among healthy humans. This work highlights the need for improved regulation of food-animal farming in Southeast Asia.

## WC05: Nutrition during the cycle of life

102, September 27, 2017, 10:30 - 12:00

### Annual Crop Yield Variation, Child Survival and Nutrition among Subsistence Farmers in Burkina Faso

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#### Background/Aim

Year to year variation in crop yields may adversely affect nutrition, health, and survival of subsistence farming populations, particularly under climate change. However, empirical evidence linking crop yield variations with health and nutrition is limited. We aimed to examine the association of children's survival with inter-annual variation in food crop yield and nutritional status in a subsistence farming population in rural Burkina Faso.

#### Methods

We studied the survival of 44,616 children <5 years of age, 1992–2012, in the Nouna Health and Demographic Surveillance System in relation to (i) the food crop yield in the year of birth (expressed as a percent of the period average) and (ii) middle-upper arm circumference (MUAC) using shared frailty Cox proportional hazards models.

#### Results

Child survival was appreciably worse in children born in years with low crop yields and in children with small MUAC: after adjustment for individual and village characteristics a decrease from the 90th to 10th centile in annual crop yield was associated with a hazard ratio of 1.11 (95% CI 1.02, 1.20) for all-cause mortality and a 90th to 10th centile decrease in MUAC with a hazard ratio of 2.72 (95% CI 2.15, 3.45).

#### Conclusions

Children's survival is strongly associated with inter-annual food crop yield variability and nutritional status in the rural subsistence farming population in Burkina Faso. This and similar populations are likely to be vulnerable to low crop yields caused by droughts and other adverse weather conditions, whose frequency is likely to increase under climate change

# WC05: Nutrition during the cycle of life

102, September 27, 2017, 10:30 - 12:00

The nexus of climate change, food and nutrition security and diet-related non-communicable diseases in Pacific Island Countries and Territories

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## Background/Aim

Climate change and non-communicable diseases (NCDs) have both been described as some of the most important global health and development challenges of this century. Pacific Island Countries and Territories (PICTs) are disproportionately affected by the adverse impacts of climate change and have some of the highest rates of NCDs in the world.

The aim of this project is to explore the links between climate change, food and nutrition security (FNS) and diet-related NCDs in the Pacific and the possible implications of these relationships on the health of communities in the region. This review synthesises the existing literature on the nexus between climate change, FNS and NCDs in PICTs and explores the significance of this for the region.

## Methods

A systematic search was performed on the global databases PubMed, Web of Science, SCOPUS, Global Health Library, Science Direct, ProQuest and EMBASE. 1076 records were identified, 82 full papers screened, 16 papers added from a grey literature search and a total of 35 papers were included in the review.

## Results

Several links between climate change, FNS and diet-related NCDs in the Pacific were found with the potential for significant adverse consequences. The effects of climate change on agriculture, food production, fisheries, migration and disaster response are adversely affecting FNS in the region and reducing diet quality and diversity. A reduced of availability of, and access to, local nutritious foods is driving an increasing dependence on energy-dense, imported foods contributing to increasingly high rates of NCDs.

## Conclusions

Further research is required to strengthen the evidence of the links between climate change, FNS and NCDs, however, it is clear that climate change is likely to reduce FNS and exacerbate the existing high rates of NCDs in the Pacific region and collaborative and integrated efforts are required to address these two important challenges.

## WC05: Nutrition during the cycle of life

102, September 27, 2017, 10:30 - 12:00

### Effect of Wine on Carotid Atherosclerosis in Type 2 Diabetes: A Two-Year Randomized Controlled Trial

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**Background/Aim:** Progression of carotid plaque volume in type 2 diabetes is common, but observational studies suggest that moderate alcohol can reduce risk of coronary disease. We evaluated whether initiating moderate wine consumption affects the progression of carotid-atherosclerosis in adults with type 2 diabetes.

**Methods:** In the randomized controlled CASCADE (CArdiovaSCuLAR Diabetes & Ethanol) trial, abstainers with type 2 diabetes were randomly assigned to drink either 150 mL of provided water, white-wine, or red-wine, for two-years and were instructed to follow a Mediterranean-diet. We followed changes in carotid-total-plaque-volume (carotid-TPV) and vessel-wall-volume (VWV), using three-dimensional ultrasound.

**Results:** High-quality paired carotid images from baseline and two-years were available from 174 participants (age = 59 years; 67% men; HbA1C = 6.8%). Detectable plaque at baseline was found in 45%. After two-years, there was no significant progression in carotid-TPV in any group [water;  $-1.4(17.0)$  mm<sup>3</sup>, CI (-2.7, 5.5), (p = 0.5), white-wine;  $-1.2(16.9)$  mm<sup>3</sup>, CI (-3.8, 6.2), (p = 0.6), red wine;  $-1.3(17.6)$  mm<sup>3</sup>, CI (-3.4, 6.0), (p = 0.5)] (p = 0.9 between groups). In post-hoc analysis among 58 participants with highest baseline-TPV, red-wine group showed a non-significant trend towards greater TPV regression (water:  $-4.6\pm 27.7$  mm<sup>3</sup>, white-wine:  $-7.1\pm 25.7$  mm<sup>3</sup>, red-wine:  $-10.5\pm 27.16$  mm<sup>3</sup>, p of trend = 0.09). Two-year reductions in Apo(B)/Apo(A) ratio ( $\beta = 0.34$ ; p = 0.003) were independently associated with regression in carotid-TPV. Two-year decreases in systolic-blood-pressure were independently associated with regression in VWV ( $\beta = 0.2$ ; p = 0.03). **Conclusions:** Consumption of a Mediterranean diet was associated with no progression of carotid atherosclerosis during the two-year intervention. There was a non-significant trend in the red-wine group towards carotid-TPV reduction in patients with highest plaque burden. This possibility should be tested in additional larger randomized trials. [ClinicalTrials.gov:NCT00784433](https://clinicaltrials.gov/ct2/show/study/NCT00784433)

## WC05: Nutrition during the cycle of life

102, September 27, 2017, 10:30 - 12:00

### Air Pollution, Diet, and Mortality in the NIH-AARP Cohort

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#### Background/Aim:

Oxidative stress and systemic inflammation are suggested pathways for air pollution-mediated adverse health outcomes. Recent evidence from dietary supplementation intervention studies suggests that foods rich in antioxidant and anti-inflammatory nutritional content offer protection against air pollution exposures.

#### Methods:

Potential interactive effects of long-term air pollution ( $PM_{2.5}$ ,  $NO_2$ , and  $O_3$ ) exposures and dietary habits (daily total fat, meat, fruit, vegetable, dairy, fish, and grain consumption) on mortality risks were evaluated in the NIH-AARP Diet and Health Study, a cohort of approximately half million subjects across the contiguous US. The cohort was linked to census tract estimates for  $PM_{2.5}$  and  $NO_2$  for 1999-2008, and  $O_3$  (8-hr daily maximum) for 2007-2011. Associations between air pollutants and risk of cause-related mortality were evaluated using multivariate Cox proportional hazards models, adjusted for both individual (age, sex, race, education, marital status, smoking history, BMI, diet, and alcohol consumption) and census-level contextual covariates (median census tract household income, % of census tract population with less than a high school level education), and effect modification by diet was assessed by evaluating statistical significance of air pollution-dietary variable interaction terms and conducting stratified analyses.

#### Results:

Associations between  $PM_{2.5}$  and  $NO_2$  exposures and total cardiovascular disease, ischemic heart disease, and diabetes mortality were found to be significantly reduced ( $p$  interaction  $< 0.05$ ) among those who consumed higher levels of fruits, while associations between  $O_3$  and total respiratory disease and COPD mortality were observed to be significantly reduced among those who consumed higher levels of vegetables.

#### Conclusions:

The results from this analysis reveal that increased intake of natural antioxidants found in fruits and vegetables attenuate mortality risks associated with long-term air pollution exposure, suggesting that promotion of healthy dietary habits can potentially provide an alternative, cost-efficient public health strategy to ameliorate the considerable health and economic burdens imposed by ambient air pollution.

# WC06: From assessing established exposures in new settings to new methods for establishing exposures

105, September 27, 2017, 10:30 - 12:00

## Residential Lead Paint Exposure Risk in Jakarta, Indonesia

Author information; Arial 8pt (please overtype this)

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### Background/Aim

Lead has been used as a paint additive since antiquity. Adverse toxicological effects of lead paint exposure were first identified in Brisbane, Australia in the late 19<sup>th</sup> century, where it is was eventually banned. However these paints continued to be used extensively around the world throughout the 20<sup>th</sup> century. In 1971, the United States banned the use of residential lead-based paints, followed by similar legislation in other high-income countries. By contrast, lead is still widely used as an additive in enamel paints in many low- and middle-income countries, including Indonesia. Despite this high prevalence, little is known about resulting exposures. This study endeavored to assess the severity of residential lead exposure resulting from paint.

### Methods

55 homes, 13 kindergartens and 10 playgrounds were assessed in 6 Jakarta neighborhoods. Of the homes, 12 were high income, 26 were middle income and 17 were low income. Wall, furniture and playground paints were analyzed in-situ with a handheld portable X-Ray Fluorescence instrument (pXRF). Dust samples were collected and analyzed in the US with Flame Atomic Absorption Spectrometry (FAAS).

### Results

Of the 1013 paint samples analyzed at all locations with the pXRF 3.6% (n=37) were found to be in excess of the USEPA action level of 1 mg/cm<sup>2</sup> (range=1.01-7.25; median=2.38). No soil samples exceeded the USEPA recommended level of 400 mg/kg for bare residential soil were children play. At the time of writing, dust samples were being analyzed with FAAS.

### Conclusions

Preliminary results indicate that despite a high prevalence of lead use in decorative enamel paints in Indonesia, exposures are likely limited

# WC06: From assessing established exposures in new settings to new methods for establishing exposures

105, September 27, 2017, 10:30 - 12:00

## High blood lead levels in Brazilian preschool children: investigation of exposure sources

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### Background/Aim

Lead is known as one of the most dangerous environmental pollutants. In 2013, a previous study showed high blood lead levels (BLL) in preschool children attending Day Care Centers (DCC), in São Paulo, Brazil. The objective of this study was to analyze the main sources of lead exposure, considering the home and school environments, previously studied by questionnaires.

### Methods

This cross-sectional study included 4 DCC (NR, PS, PF, VA), which presented 1-4-year-old children with higher BLLs among the 50 DCC participants in 2013. Children (n=54) were sorted out into "high exposure" ( $\geq 13.9\mu\text{g}/\text{dL}$  - 97.5 percentile of the 2013 sample) and "low exposure" ( $< 5\mu\text{g}/\text{dL}$ ). The X-ray fluorescence portable analyzer was used for the lead direct analysis in the environment. Screenings were performed to evaluate the lead concentrations in DCC's building and playgrounds and children's households, including wall paints, toys, floors, doors, windows, tableware items, among others.

### Results

There was found a significant difference in the  $\text{BLL} > 5\mu\text{g}/\text{dL}$  percentage among the DCCs. The highest BLL percentage was found in the "NR" DCC (69.6%), and the lower was found in the "PS" DCC (20%). In "NR" DCC building, 28.2% of the measurements were positive ( $> 600\text{ ppm}$ ), while 72.2% were positive in playground. Positive measurements in "PS" DCC building were 32% and 50% in playgrounds. A significant association was found between high BLL and lead found in households and DCC ( $p < 0.001$ ). Most of the positives measurements were found on tiles, painted iron window structures, doors and playground equipment.

### Conclusions

The results showed that the lead exposure estimated from the DCCs, where children spend about 10 hours/day can be as relevant as their household exposure. Therefore, public authorities should render efforts to provide a rigorous surveillance for lead-free supplies painting and all objects offered to children.

This study was funded by FAPESP and CNPq.

## WC06: From assessing established exposures in new settings to new methods for establishing exposures

105, September 27, 2017, 10:30 - 12:00

### Contemporary Flame Retardants Exposure in the United States

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#### Background/Aim

Because of the phase-out of polybrominated diphenyl ethers (PBDEs), flame retardant formulations containing mixtures of chlorinated and non-chlorinated organophosphates as well as other non-BDE brominated flame retardant chemicals have entered consumers markets in many countries. Understanding exposure to these contemporary flame retardants is of public health interest as components of these formulations are frequently detected in many products common to human environments

#### Methods

We assessed exposure to nine contemporary flame retardants by measuring the following urinary biomarkers: diphenyl phosphate (DPhP), bis(1,3-dichloro-2-propyl) phosphate (BDCPP), bis(1-chloro-2-propyl) phosphate (BCPP), bis(2-chloroethyl) phosphate (BCEtP), di-p-cresylphosphate (DpCP), di-o-cresylphosphate (DoCP), dibutyl phosphate (DBuP), dibenzyl phosphate (DBzP), and 2,3,4,5-tetrabromobenzoic acid (TBBA). We measured the concentrations of these metabolites in 76 urine samples collected in Atlanta in 2015 from adults with no known occupational exposure to flame retardants and compared them to those from a group of 146 firefighters collected in 2010-2011 after performing structural firefighting while wearing full protective clothing and a SCBA respirator.

#### Results

DPhP (median: 0.89; range: 0.26–5.6 ng/mL) and BDCPP (median: 0.69; range: 0.31–6.8 ng/mL) were detected in all of the non-occupationally exposed adult samples and all of the firefighters samples (DPhP [median: 2.9; range: 0.24–28 ng/mL], BDCPP [median: 3.4; range: 0.30–44 ng/mL]) with median concentrations of BDCPP and DPhP approximately five and three times higher, respectively, in the firefighters group. DBzP and DoCP were not detected in any of the samples.

#### Conclusions

These results suggest exposure to several contemporary flame retardants in the general population. The higher concentrations in the firefighters group indicate occupational exposures may be higher than background exposures. We plan to obtain reference range concentrations of these biomarkers for large scale general-population studies such as the National Health and Nutrition Examination Survey.

## WC06: From assessing established exposures in new settings to new methods for establishing exposures

105, September 27, 2017, 10:30 - 12:00

### Hair versus urine for the biomonitoring of pesticide exposure - Results from a pilot study on pregnant women

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#### Background/Aim

The quantitative assessment of human exposure to contaminants such as pesticides is a crucial step in the characterization of exposure-associated risk. For this purpose, biomonitoring is often privileged as it presents the advantage of integrating all the possible sources and routes of exposure and of being representative of the internal dose resulting from exposure. Although biological fluids such as urine and blood have been used to date for this purpose, increasing interest has also been observed over the past decade for hair analysis. The present work aimed at comparing the information obtained from the analysis of urine versus hair regarding exposure to pesticides in a cohort of pregnant women.

#### Methods

In nineteen pregnant women included in the pilot of the French cohort ELFE, one urine and one hair sample were collected simultaneously from each subject at the maternity. Samples were analyzed using analytical methods allowing for the detection of both parent pesticides and metabolites, and designed to be as similar as possible between urine and hair for reliable inter-matrix comparison. Forty-nine compounds were targeted, including parents and metabolites of organochlorines, organophosphates, pyrethroids, carbamates, phenylpyrazoles and other pesticides.

#### Results

The number of different compounds present at concentration above the limit of quantification ranged from 10 to 24 (median = 18, mean =  $17 \pm 3$ ) in hair, and from 1 to 13 (median = 9, mean =  $9 \pm 2$ ) in urine. In hair, 22 compounds were found in >40% of the individuals, whereas only 10 compounds presented the same frequency of detection in urine.

#### Conclusions

The present results highlight the cumulative exposure of the pregnant women included in this cohort and suggest that hair provides more comprehensive information on exposure than urine analysis. This study thus supports the relevance of hair analysis in future epidemiological studies investigating association between exposure and adverse health effects.

# WC06: From assessing established exposures in new settings to new methods for establishing exposures

105, September 27, 2017, 10:30 - 12:00

## Detection and differentiation of botulinum neurotoxins

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### Background/Aim

Evaluating sources and disease progression of natural toxin exposures is becoming increasingly mainstream in environmental epidemiology. Botulinum neurotoxins (BoNTs) are the most poisonous substances known and cause the disease botulism. The analysis of trace amounts of protein toxins in highly complex matrices is an exposure assessment challenge. We have developed and implemented a sensitive method that uses the enzymatic amplification of products with mass spectrometry to allow detection and serotyping of BoNT at low attomole/mL levels. Furthermore, we have performed detailed proteomics analysis to aid epidemiologic investigations discovering sources of intoxication and commonality/differences between concurrent botulism outbreaks.

### Methods

This method has three levels of selectivity including immunomagnetic extraction with monoclonal antibodies, enzymatic activity of the toxin on a peptide substrate, and specific detection of product peptides with MALDI TOF MS. The subtype and variant are then identified by digesting the bead mixture with trypsin/chymotrypsin followed by LC-MS/MS on a high-resolution mass spectrometer.

### Results

Our MS-based BoNT analysis can detect and differentiate all seven serotypes more rapidly than the traditional mouse bioassay. The detection limits are less than 0.1 mouse LD50 (low attomole/mL) in stool, serum, and food. The method has been used to investigate many botulism outbreaks and has confirmed foodborne, infant, adult colonization, and wound botulism. By subtyping the toxins, we derive an added layer of information that has been used in several outbreaks across the United States.

### Conclusions

The new BoNT method has allowed for more sensitive and rapid confirmation of botulism. Serum now is routinely tested and we are now able to routinely detect BoNT in wound botulism cases. The subtyping has provided rapid information for botulism investigations and has provided a deeper understanding to the diversity of subtypes that are causing human botulism in the United States.

## WC06: From assessing established exposures in new settings to new methods for establishing exposures

105, September 27, 2017, 10:30 - 12:00

Exposure to mobile phones and brain neoplasms. A meta-analysis of observational studies from 2010 to 2016

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**Background/Aim:** Carcinogenesis of electromagnetic fields due to mobile phone exposure is still a matter of controversy. IARC has considered electromagnetic fields in the group 2B as possibly carcinogenic to humans. Aim of this study was to analytically review the recent observational studies that tested the association between mobile phones and brain neoplasms.

**Methods:** Studies from 2010 to 2016 in 9 electronic databases were searched with the following syntax: “electromagnetic fields” OR “mobile phone” AND “brain neoplasm” OR “brain cancer” OR “brain tumours. A total of 6316 abstracts were extracted and after removing duplicates and those that did not fulfill the inclusion criteria seven case-control studies were selected; only one cohort study that filled the criteria but was not included because is still ongoing. Assessment criteria were frequency (once a week for at least 6 months), intensity (cumulative exposure >1000 hours), duration (>5 years) and laterality of tumour (ipsilateral o contralateral to the phone’s use). Odds ratio was used as a summary measure of association and was represented by forest plots. Heterogeneity was assessed by Q test. Publication bias was tested by Egger and Begg tests. Statistical analysis was carried out in Epidat 3.1.

**Results:** From assessment criteria only the intensity (OR=1.59 UI 95% 1.17-2.16) was statistically significant. Frequency (OR=1.08 UI 95% 0.93-1.26), duration (OR=1.10 UI 95% 0.78-1.56) and ipsilateral phone’s use (OR=1.33 UI 95% 0.91-1.91) were not associated to an increased risk of brain tumours. High heterogeneity and publication bias both were observed except for intensity (Q=0.09 p=0.76; Egger=-0.09 p=0.92).

**Conclusions:** The results of this study suggest an increased risk of brain tumours in users with high intensity of use (>1000 hours). However taking into account that our meta-analysis included only case-control studies and due to the complexity of defining the mobile’s phone exposure, future meta-analysis must include cohort studies to accurately assess the risk of mobile phones and brain carcinogenesis

# **SYM06: Addressing Environmental Determinants of Health in South Asia**

**101, September 27, 2017, 14:00 - 15:30**

## **Air Quality Landscape in India - Short and Long Term Outlooks**

**Sarath K. Guttikunda\***, Urban Emissions, New Delhi, India

Traditionally, air quality management is based on a “top-down” approach with data coming from a wide network of reliable, representative, and continuous monitoring stations. In India, continuous monitoring activities and information dissemination platforms are limited and under development, and needs a complete overhaul, to reach the level of transparency and accuracy required for implementing an air quality and health alert system.

While the top-down capacity is developing, the monitoring data trends present a deteriorating picture of air quality and public health. For example, recent comparative studies have highlighted Delhi as the city with the worst air quality in the world and the number of districts not complying with the national annual ambient standard for PM<sub>2.5</sub> went up from 40% to 60% between 1998 and 2014. The comparisons are not justified because of the lack reliable (and enough) monitoring data from cities other than Delhi – which means there are cities in India, which could be as bad as Delhi and yet not documented.

This presentation will focus on delivering an overview of these public portals <http://www.indiaairquality.info> and <http://www.delhiarquality.info>, data feeds, and policy linkages for short and long term air quality management planning for Indian cities. These portals support air quality information collation and dissemination in India, using a “bottom-up” approach; with forward linkages to data coming from the monitoring stations to validate, calibrate, and authenticate, as much as possible. The program utilizes state of the art meteorology and dispersion modelling platforms, with improved and dynamic emission feeds (estimated based on local surveys, measurements, and satellite feeds, as and when the data is available), and disseminating air quality forecasts for the next 3 days, at the district level in India and at 1 km resolution for Delhi, including hour-by-hour and day-by-day assessment of likely source contributions.

**Presentation preference (Select one checkbox)**

- Oral (Symposium): *Title Symposium (Addressing Environmental Determinants of Health in South Asia)*

# **SYM06: Addressing Environmental Determinants of Health in South Asia**

**101, September 27, 2017, 14:00 - 15:30**

## **Epidemic of chronic kidney disease in rural Sri Lanka: An overview of issues and research opportunities**

Author information; **Saroj Jayasinghe\***, Chair Professor of Medicine, University of Colombo, Sri Lanka  
Second Author; **Inoka Suraweera**, Consultant Community Physician, Environmental and Occupational Health Directorate, Ministry of Health, Sri Lanka

### **Background**

Epidemics of chronic kidney disease of unknown aetiology (CKDu) have emerged as major public health problems in rural Sri Lanka, Central America, India and Egypt. Their relationships to occupations have led to a new name: chronic interstitial nephritis in agricultural communities (CINAC).

In Sri Lanka the predominantly affected areas are in rural farmlands of North Central Province. However, recent studies on urinary biomarkers (KIM-1) indicate that wider areas are affected. Several hypotheses have been advanced to explain the epidemic: fluoride and hard water, heavy metal toxicity, agrochemicals, algae toxins, ionicity, and heat stress. This paper reviews some of the issues facing the country, and proposes opportunities for future research.

### **Issues**

Precise data of numbers affected are unavailable. CINAC with microalbuminuria is estimated to affect at least 70,000 with about 21,000 deaths so far. Households and communities are devastated because middle-aged males (i.e. breadwinners) are predominantly affected. This has led to severe socio-economic consequences (e.g. loss of livelihoods, stigmatization, young widows and orphans). The uncertainty in aetiology has led to several initiatives (e.g. provision of 'safe' water, restrictions to pesticides). However, their effectiveness is not well known. Large numbers of patients has spiralled costs and strained the public health sector. Implicit rationing has led to ethical issues in access to care.

### **Research opportunities**

Research opportunities include robust longitudinal cohort studies; analyses for environmental toxins; tissue analyses for heavy metals; genetic studies, therapeutic interventions; and quantifying and mitigating socio-economic costs. Novel approaches are also required: spatial analyses of combined environmental and population data, mathematical modelling, systems science approaches, and exposomics to assess cumulative risk exposures.

### **Conclusions**

A devastating epidemic of chronic kidney disease in rural Sri Lanka has led to the emergence of several research opportunities. Tackling the epidemic would require widening collaborations, interdisciplinary approaches and use of novel approaches.

# **SYM06: Addressing Environmental Determinants of Health in South Asia**

**101, September 27, 2017, 14:00 - 15:30**

## **Pesticide exposure in northern Thailand**

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**Background/Aim:** Pesticide usage in agriculture is common practice in Thailand. Though organic farming is a new trend globally, this share is still minor. In 1990s, persistent organochlorine pesticides i.e. dichlorodiphenyltrichloroethane (DDT) was used in malaria endemic areas in northern Thailand. Non-persistent pesticides, organophosphate and synthetic pyrethroids in particular, have been widely used in present agriculture. Here, we aim to present exposure assessment via environmental and biological monitoring.

**Methods:** This presentation gathers data mostly from our studies conducted in northern Thailand. Participants included multi-sectors namely school pupils and parents, university students, farmers, farmworkers, and consumers. Pesticide residues in vegetables and fruits are detected by chromatographic-based methods. Exposure screening rapid test, an enzyme-based method, has been widely used due to quick and cheap. Urinary biomarkers of exposure are chromatographic-based methods such as urinary dialkylphosphates (DAPs), 3-phenoxybenzoic acid (3-PBA).

**Results:** The exposure to DDT in 1990s, we found the associations between concentrations of DDT and its metabolites and thyroid/sex hormones in blood among those living in former DDT-spray area. DDT detection was gradually decreased since its ban in 2000. Exposure to non-persistent pesticides, vegetables and fruits are the main route of exposure. Screening rapid test among various groups showed high exposure to organophosphates and carbamate pesticides. Urinary DAPs were detected with high frequency and concentrations among farmers, farm workers, and some consumer groups with the levels greater than those reported by the US National Health and Nutrition Examination Survey (NHANES) for several folds.

**Conclusions:** Pesticide exposure in northern Thailand inherits from the use of organophosphate pesticides greater than others. For the immediate approach, cooperative research work will enable to identify some unexpected pesticides that spread over via imported vegetables and fruits in the region.

# SYM06: Addressing Environmental Determinants of Health in South Asia

101, September 27, 2017, 14:00 - 15:30

## Arsenic Crisis in Bangladesh: Past, Present and Future

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10. Richard Wilson, Harvard University, Cambridge, MA 02138, USA

**Background:** Arsenic contamination in Bangladesh is reported to be the biggest arsenic calamity in the world in terms of the affected population. Estimated 70 to 80 million people in the country have been chronically exposed to arsenic in their drinking water in what has been described as the largest mass poisoning in history. A large number of populations in Bangladesh are suffering from melanosis, keratosis, gangrene and skin cancer. The arsenic contamination is not only a health hazard for the people.

**Methods:** DCH Trust installed A River Sand Filter (RSF), selecting the areas we consider that the villages located on the bank of the river, where the water is available throughout the year, the villagers probably had a high arsenic exposure. We formed a management committee for the maintenance of RSFs and provided a custodian responsible for supervision and maintenance of the system. The core of the system is the use of four filters in series. Each of the filter tanks is filled with gravel or sand with steadily finer granularity to filter out the fine bacteria. Then, the water is pumped into a storage tank on top of a tower, using PVC pipe by 30-60 taps to supply water in the villages.

**Results:** With our experience in Sirajdikhan, River Sand Filters could be an excellent source of safe water supply for the rural community of Bangladesh. The RSF is a very simple technology with very high efficiency and low turbidity bacterial removal procedure.

**Conclusion:** DCH Trust successfully collaborating with Harvard School of Public Health (HSPH), Boston Children's Hospital and Oregon State University-USA. The consultation process develops trust and co-operation. We recommend RSF filters to the policy makers, researchers, donors, and investors who are now engaged in providing arsenic-free drinking water to the millions of people affected in Bangladesh.

# **SYM19: Air pollution impact in Asia**

**024, September 27, 2017, 14:00 - 15:30**

## Chronic exposure effect of PM on health in Asia

Author information; Arial 8pt (please overtype this)

**Takashi Yorifuji \***, Department of Human Ecology, Graduate School of Environmental and Life Science, Okayama University, Okayama, Japan

### Background/Aim

Number of epidemiological studies that evaluated long-term exposure to air pollution is still limited in Asian countries compared to western countries. Given a larger public health impact owing to long-term exposure rather than short-term exposure, more research is needed in Asian countries. In this presentation, I summarize the current evidence on effects of long-term exposure on health in Asian countries and discuss how to extend air pollution studies on this issue in this region.

### Methods/Results

First, I briefly introduce our previous study based on a cohort study (n=14,001) in Shizuoka, Japan (Yorifuji et al., Sci Total Environ. 2013). In the study, we evaluated the association between long-term exposure to traffic-related air pollution and cause-specific mortality and found an adverse effect of traffic-related air pollution on all-cause, cardiopulmonary disease, and lung cancer mortality. Second, I introduce other studies in Asian countries that evaluated the long-term exposure to air pollution on health outcomes and summarize the findings. Finally, I compare those findings from Asian countries with those from western countries.

### Conclusions

I highlight gaps in current knowledge and discuss future possible research in Asian countries.

# **SYM19: Air pollution impact in Asia**

**024, September 27, 2017, 14:00 - 15:30**

## Air pollution intervention studies in Asia

Author information;

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### Background/Aim

Asia is now facing the worst air pollution problem in the world. There is increasing interest in air pollution intervention studies in Asia to evaluate whether actions to improve air quality will benefit public health.

### Methods

We systemically reviewed up-to-date epidemiologic evidence of air pollution intervention studies in Asia.

### Results

Air pollution interventions studies were conducted on both population-level and individual-level in Asia. Population-level intervention studies provide clear evidence regarding the health benefits from specific intervention-induced reduction in air pollution (e.g. Beijing Olympics Games in 2008, Busan Asian Games in 2002). Individual-level intervention, such as the uses of air purifiers, facial masks and omega-3 fish oil, also demonstrated cardiopulmonary benefits.

### Conclusions

Air pollution intervention studies in Asia show that reduced exposure to air pollution lead to better public health.

## WC07: Biomass burning

026, September 27, 2017, 14:00 - 15:30

Outdoor pollution sources modify the impact of improved cookstoves on indoor particulate matter levels: findings from rural India

**\*Wael K Al-Delaimy, School of Medicine, University of California San Diego, USA**

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### Background/Aim

Improved cookstoves that decrease biomass fuel pollutants have had mixed results in rural areas of developing countries. Ambient air pollution is usually not taken into consideration when measuring the impact of improved cookstoves. Our aim was to determine the impact of improved cookstoves on particulate matter (PM) levels in two different areas in rural India with different ambient PM levels (PM10, PM2.5 and PM1) and their impact on indoor exposure.

### Methods

The sample of 105 households from an intervention that provided clean cooking and lighting energy options (Integrated Domestic Energy System (IDES)) and 75 control groups of houses that used traditional mud cookstove (TM). Mean outdoor and indoor air quality (IAQ) of each household was measured for concentrations of PM10, PM2.5, and PM1.

### Results.

Regression analyses of the association between IDES and indoor PM10, PM2.5 and PM1 reduction was only significant in the village with high ambient PM and there was no effect of IDES in the low ambient PM village. After adjusting for level of ambient PM in a multivariate model, IDES was associated with a statistically significant reduction ranging between 14-31% in all indoor PM levels during cooking time and 24-hr average levels.

### Conclusions

Ambient PM is an effect modifier of the impact of improved cookstoves on reduction of indoor PM. Future analyses of indoor air pollution reduction from cookstoves must take into consideration the effect modification of ambient PM to provide better estimates of the risk reduction from using such cookstoves.

## WC07: Biomass burning

026, September 27, 2017, 14:00 - 15:30

### Modeling Household Air Pollution Exposures on a Global Scale

Author information:

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**Background/Aim:** Approximately three billion individuals across Asia, Africa, and Central/South America cook with solid fuels. While exposure studies indicate that household air pollution (HAP) exposures vary within and between countries, there is an absence of quantitative exposure measurements in many countries with populations affected by HAP. To overcome the scarcity of exposure data, The Global Burden of Disease (GBD) has modeled summary HAP measurements from the literature to estimate national-level exposures. This analysis will update GBD exposure estimates with a model offering enhanced spatial heterogeneity.

**Methods:** HAP exposure levels were extracted from 45 more recent (2012-2016) peer-reviewed studies to update the World Health Organization HAP exposure database. A mixed-effect model was built to relate 24-hour mean  $PM_{2.5}$  concentrations from the database to cooking environment characteristics, including stove and fuel type, and geographic characteristics, including urban/rural identifier and altitude.

**Results:** The updated model added fuel-specific  $PM_{2.5}$  concentration coefficients, absent from previous models, and explained 14% of variability in mean 24-hour  $PM_{2.5}$  concentrations between studies. Predicted values showed significant regional variation in exposures for the same fuel type; average  $PM_{2.5}$  exposures for traditional wood and coal-fuelled stoves ranged from 153  $\mu g/m^3$  and 109  $\mu g/m^3$  (Andean Latin America) to 983  $\mu g/m^3$  and 700  $\mu g/m^3$  (South Asia), respectively. Having a 'clean' gas stove reduced exposures from wood stoves by 72% (East Asia) to 91% (Eastern Sub-Saharan Africa). Model results were combined with proportion of fuel use data from national/sub-national surveys for possible use in future GBD analyses.

**Conclusions:** The level of specificity with which  $PM_{2.5}$  exposures are assigned in the GBD was enhanced by incorporating region-specific fuel type estimates to account for geographical factors associated with HAP exposures. With future studies strategically conducted in countries currently lacking  $PM_{2.5}$  measurements, additional spatial heterogeneity in exposure estimates can be included to more accurately estimate HAP risks.

## WC07: Biomass burning

026, September 27, 2017, 14:00 - 15:30

### Household cookstoves: A comprehensive assessment of health-relevant emissions

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**Background/Aim:** Air pollution from biomass and liquid-fuel cookstoves is a leading cause of disease globally. There is a limited understanding, however, of the toxic pollutants emitted by cookstove technologies beyond particulate matter (PM<sub>2.5</sub>) and carbon monoxide (CO) emissions. The aim of this work was to develop a comprehensive inventory of health-relevant emissions, which will aid in the interpretation of the health impacts from cookstove smoke.

**Methods:** Over 100 gas- and particle-phase emissions from 30 stove-fuel combinations representing both traditional and cleanest-available technologies were measured in the laboratory. The pollutants that were characterized included: CO, black carbon (BC), organic carbon (OC), PM<sub>2.5</sub>, volatile organic compounds (including BTEX), carbonyls, ultrafine particles, and polycyclic aromatic hydrocarbons (PAHs). Descriptive and statistical analyses were conducted to compare pollutant emissions across stoves and fuels.

**Results:** PM<sub>2.5</sub> emissions from traditional wood stoves were consistently the highest (16.5-116.6 mg/MJ), while liquid-fuel stoves were the lowest (kerosene: 0.99-25.3 mg/MJ; LPG: 2.41-5.40 mg/MJ). Higher than expected PM<sub>2.5</sub> emissions were also seen from charcoal stoves (12.9-84.4 mg/MJ); we suspect this was due to refueling events. Emissions of known carcinogens varied greatly between stoves. The wick-kerosene stove, which reduced PM<sub>2.5</sub> emissions by 80% compared to a three-stone-fire, had the highest average emissions of benzene (107.5 mg/MJ), formaldehyde (34.6 mg/MJ) and acetaldehyde (12.6 mg/MJ), as well as a 380% increase in total BTEX emissions. The gasifier stove had a 65% reduction in PM<sub>2.5</sub> and reduced total BTEX emissions by >90%.

**Conclusions:** In the largest cookstove emissions characterization study reported to date, we observed that cookstoves touted as 'cleaner' because of their lower PM<sub>2.5</sub> emissions may be emitting higher concentrations of other harmful compounds than traditional stoves. We anticipate that the results of this study will inform future health studies, since cookstoves may not be comprehensively evaluated before they are disseminated to users.

## WC07: Biomass burning

026, September 27, 2017, 14:00 - 15:30

### Closing the gap between laboratory and in-situ biomass cookstove emissions measurements

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**Background/Aim:** Air pollution from residential biomass burning is estimated to lead to 3.5 million premature deaths annually. Evaluating the technology interventions proposed to address this public health crisis is complicated by the costs and logistical challenges of coupling exposure and health measurements in the field. Thus, health studies typically rely on laboratory emissions measurements, which often underestimate real-world emissions and exposures. This work developed and validated an improved method for laboratory characterization of cookstove emissions.

**Methods:** The Firepower Sweep Test (FST) was developed to examine cookstove emissions by systematically driving the stove through multiple firepowers, or operating points. The FST was validated by comparing emissions of black carbon (BC), organic carbon (OC), particulate matter (PM<sub>2.5</sub>), carbon monoxide (CO), and particle size from laboratory-based tests to emissions from cooking events measured in-situ in China, Honduras, Uganda, and India.

**Results:** Using the FST, we observed variability in stove emissions that was representative of field observations. For example, on a fuel-energy basis, the FST for wood stoves captured the range of emissions measured in India for both PM<sub>2.5</sub> (FST: 4.13-1519 mg/MJ, India: 81.0-560 mg/MJ) and CO (FST: 0.526-14.8 g/MJ, India: 1.72-5.25 g/MJ). Additionally, the FST provides information on emissions profiles during transition events (which are not captured in other laboratory protocols); PM<sub>2.5</sub> and CO emissions increased dramatically during refueling events for batch-fed charcoal stoves under the FST and in the field. Preliminary analyses suggest that firepower (a metric quantifiable in the field) can be used to predict in-home emissions.

**Conclusions:** By systematically varying firepower, the FST can improve estimates of real-world cookstove emissions in laboratory settings. Application of the FST could inform more accurate health-impact assessments. Outputs from this protocol may prove valuable for choosing truly cleaner cookstoves for interventions and interpreting results from epidemiological studies.

## WC07: Biomass burning

026, September 27, 2017, 14:00 - 15:30

### Risk of Cataract among Users of Bio Mass Fuel in Rural Nepal: A Case-Control Study

#### Background/Aim

The aim of this study is to investigate whether the use of biomass fuel is associated with cataract among adults in rural Nepal.

#### Methods

This is an 1:1 matched case-control study. We recruited 168 physician-confirmed cataract cases from eye camps and 168 non-cataract controls from Nepal, matched on age, sex and residential areas. The data were collected through interviews in ten different areas surrounding Kathmandu, Nepal and analyzed using multivariate conditional logistic regression. Factors like education level, socioeconomic status, diet, use of mosquito coils and kerosene lamps, smoking status, and kitchen location and ventilation were considered as possible confounders and effect modifiers in the initial analysis.

#### Results

Non-cooking related factors like smoking, use of mosquito coil and kerosene lamp, and low vegetable intake was associated with increased odds of cataract. After controlling for those factors, compared to clean-fuel stoves (such as gas, electricity and solar), use of BMF was associated with more than two-fold increased risk of developing cataract ( $p$ -value $<0.03$ ). Having kitchen within the living space was associated with 1.9 (95% CI 1.2-3.0) folds increased odds of developing cataract compared to kitchen located outside the living space. Compared to highly ventilated kitchen, kitchen with minimum ventilation (no windows) was associated with 3.3 (95% CI 1.9-5.7) folds increased odds of developing cataract. A three-way interaction was observed for type of stoves (improved or unimproved), type of fuel (clean or unclean) and location of kitchen (inside or outside of living area) ( $p$ -value $<0.05$ ). Compared to the users of improved stove with clean fuel that was located outside the living space, the odds of developing cataract was 10.1 fold (95%CI 2.30, 44.8) for users of unimproved stove with unclean fuel located inside living space.

#### Conclusions

This case-control study showed further evidence of cataractogenic effect of biomass fuel exposure among rural Nepalese population.

## WC07: Biomass burning

026, September 27, 2017, 14:00 - 15:30

Is remaining indoors an effective way of reducing exposure to PM<sub>2.5</sub> during biomass burning events?

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### Background/Aim

Bushfires, prescribed burns and residential wood burning are a significant source of fine particulates (PM<sub>2.5</sub>) affecting the health and well-being of thousands of Australians. Despite the lack of evidence, a common public health recommendation is to remain indoors assuming that the home provides a protective barrier against ambient PM<sub>2.5</sub>. The effectiveness of this strategy was evaluated by conducting simultaneous measurements of indoor and outdoor PM<sub>2.5</sub>. The study also investigated how well housing characteristics can be used to model infiltration in Australian homes impacted by smoke emissions.

### Methods

Week-long indoor and outdoor measurements of PM<sub>2.5</sub> were completed at 21 residences in regional areas of Victoria to assess the influence of smoke plumes on indoor air quality. The data was used to evaluate how well a mass-balance infiltration model performs to determine infiltration of outdoor PM<sub>2.5</sub> under a range of different ventilation scenarios.

### Results

The indoor and outdoor PM<sub>2.5</sub> measurements indicate approximately 50% of households had significant indoor sources of PM<sub>2.5</sub> mainly as a result of cooking activities, smoking and burning candles or incense. By remaining indoors residents were protected from peak outdoor PM<sub>2.5</sub> concentrations, but the level of protection was highly variable ranging from 12-76%. Housing stock (e.g. age of the house) and ventilation (e.g. having windows/doors open or closed) played a significant role in the infiltration of outdoor PM<sub>2.5</sub> indoors. The mass-balance infiltration model performed well when including house age and ventilation status predictors during smoke plume events.

### Conclusions

Sheltering indoors with windows and doors closed will provide some protection against outdoor PM<sub>2.5</sub> during smoke plume events, but the level of protection can be much lower for older homes. Furthermore, leaving windows and doors closed once the smoke plume event has abated can significantly increase indoor exposure to PM<sub>2.5</sub> as particles can be trapped within the home.

## WC08: Emerging environmental exposures in the study of reproduction and child development

020, September 27, 2017, 14:00 - 15:30

### The association of single nucleotide polymorphisms of the iodothyronine deiodinase gene in neural tube defects: a case control study

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#### Background

Although adequate folic acid or multivitamins can prevent up to 70% of neural tube defects (NTDs), the cause of NTDs in some cases remains unknown. Other risk factors are thought to be involved. Maternal thyroid hormone influences the development of the fetal brain at an early stage of pregnancy. In our previous study, we found that the serum free L-thyroxine (FT4) level epidemiologically modified the effect of the serum total homocysteine level on the risk of NTDs. Iodothyronine deiodinase (DIO) also influenced the balance of thyroid hormone. Therefore, we investigated the impact of single nucleotide polymorphisms (SNPs) of the DIO gene on the risk of NTDs.

#### Methods

We conducted a case control study. The subjects were pregnant women (99 controls and 93 cases) living in a county of Shanxi Province, China. Frozen blood samples were shipped to Beijing and analysed. The statistical analysis was performed using SAS software. All the participants provided signed informed consent. Ethical approval was obtained in both China and Japan.

#### Results

Of the 9 known SNPs of DIO, 2 SNPs in the control group and 3 other SNPs in the case group were not in Hardy-Weinberg equilibrium, while the other SNPs were in Hardy-Weinberg equilibrium. According to the results of a Cochran-Armitage trend test, no associations between the genotypes and NTDs were seen. However, among the participants with FT4 levels  $\leq 15.2$  pmol/L (median in control group), the genotypes of 4 SNPs were associated with NTDs; one SNP (rs11206237) was associated with NTDs after adjustments for age and gestational weeks.

#### Conclusions

The results of Hardy-Weinberg disequilibrium were likely from inbreeding in the isolated mountainous area studied. Genetic factors were associated with NTDs. Further study involving a larger sample is necessary.

# WC08: Emerging environmental exposures in the study of reproduction and child development

020, September 27, 2017, 14:00 - 15:30

## A Pilot Exploring *in Utero* Exposure Acetaminophen and Neurodevelopmental Scores in Children

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**Background/Aim:** Experimental studies have detected an association between maternal report of acetaminophen use during pregnancy and childhood neurodevelopment. To date, no studies have used an objective measure of fetal acetaminophen exposure. We measured acetaminophen in meconium to determine whether *in utero* exposure is associated with neurodevelopment tests in mid-childhood in the GESTation and Environment (GESTE) study, a longitudinal birth cohort in Sherbrooke, Québec, Canada.

**Methods:** Meconium was collected and concentrations of acetaminophen were measured using ultra performance liquid chromatography tandem mass spectrometry. Concentrations were log transformed to achieve a normal distribution. At age 6-7, children completed subtests of the Developmental NEuroPSYchological Assessment (NEPSY-II) and the Weschler Intelligence Scale for Children (WISC-IV). Data on covariates were collected via questionnaire and extracted from maternal clinical files. We restricted analyses to children whose mothers did not smoke or drink during pregnancy ( $n=83$ ) and used multivariable linear regression analyses adjusted for child sex and parental characteristics to determine the association between acetaminophen levels and NEPSY-II/WISC-IV scores. Additional analyses tested for effect modification by child sex.

**Results:** Acetaminophen concentrations were associated with a significant increase in “total errors” on the NEPSY-II Visuomotor Precision subtest ( $\beta = 2.20$ ; 95% CI 0.17, 4.22). Similarly, acetaminophen concentration was associated with a significant decrease in score on the WISC-IV Block Design subtest ( $\beta = -0.44$ ; 95% CI -0.85, -0.28). However, this effect was modified by sex and ameliorated among girls ( $\beta_{\text{interaction}} = 0.74$ ; 95% CI 0.11, 1.37). In this pilot, acetaminophen was not significantly associated with scores on other NEPSY-II or WISC-IV subtests. However, these analyses were underpowered to detect small effects.

**Conclusions:** Using an objective measure of exposure, our data support epidemiological and experimental finding that *in utero* exposure to acetaminophen is associated with delays in visuospatial perception and precision in elementary aged children.

# WC08: Emerging environmental exposures in the study of reproduction and child development

020, September 27, 2017, 14:00 - 15:30

## Temperature Variability may Trigger Spontaneous Early Delivery in Shenzhen, China: A Case-crossover Study

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**Background:** Early delivery (<39 gestational weeks), including early-term and preterm birth, is related to higher infant mortality and neonatal morbidity. Previous studies have shown that extreme temperatures increase the risk of early delivery, however the effect of unstable weather conditions remains unclear. This study aimed to investigate the association between temperature variability (TV) and early delivery in Shenzhen, China.

**Methods:** We obtained records of 293,463 spontaneous early deliveries from Shenzhen Obstetric Data Reporting System during 2003-2012. Meteorological and air quality data were collected from meteorological bureau. TV during 6 exposure windows (preceding 2 days, 3 days, up to 7 days), was separately calculated from the standard deviation of minimum and maximum temperatures (Yuming Guo, 2016). A time-stratified case-crossover analysis with conditional Poisson regression models was used to assess the relationship between TVs and early delivery, adjusting for mean temperature, humidity and air quality index.

**Results:** TV ranged from 0 to 6 °C. The elevated TV<sub>0-1</sub>, TV<sub>0-2</sub> and TV<sub>0-3</sub> significantly increased the risk of overall early delivery, especially for preterm birth, and the effect of TV<sub>0-1</sub> was the most obvious. Compared with the median of TV<sub>0-1</sub> (0.5 °C), the relative risks for early delivery and preterm birth were 1.005 (95%CI: 1.000-1.011) and 1.019 (95%CI: 1.006-1.032) at 99th percentile of TV<sub>0-1</sub> (2.74°C), respectively. TV<sub>0-1</sub> effect was modified by delivery season, maternal education and parity. Low educated mothers, multiparae or those delivered in spring and winter were more likely to delivery early due to TV. By stratified analyses, the TV<sub>0-1</sub> increased the early delivery risk due to preterm labor, while the risk of early delivery following premature rupture of membrane declined.

**Conclusions:** Temperature variability may trigger spontaneous early delivery due to preterm labor, especially during spring and winter. Pregnant women with lower education and multi-parity should pay more attention to unstable weather.

## WC08: Emerging environmental exposures in the study of reproduction and child development

020, September 27, 2017, 14:00 - 15:30

The relationship between airborne pollen and cedar-specific immunoglobulin E during early pregnancy: a subdivision of a nationwide birth cohort study

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### Background/Aim:

The Japan Environment and Children's Study (JECS) measured serum immunoglobulin E (IgE) concentrations against Japanese cedar (*Cryptomeria japonica*) pollen during early pregnancy. A Japanese cedar-specific IgE of Class 2 or higher was most prevalent (66%) in pregnant women at the Koushin Unit Center located in rural central Japan. However, the relationship between airborne pollen and cedar-specific IgE was not fully understood. Therefore, the aim of this study was to investigate the relationship between airborne cedar pollen exposure levels and cedar-specific, serum IgE concentrations.

### Methods:

Data were obtained from the JECS, which measured cedar specific, serum IgE concentrations in 6,564 subjects at the Koushin Unit Center between February 14, 2011, and May 29, 2014. Airborne cedar-pollen concentration data were obtained from the Ministry of Environment. The pollen values contained the following indices: date and the average value of the previous 14- or 28-day period, including the day. Multiple linear regression analysis was conducted to assess the correlation of cedar-specific IgE with pollen concentration and other variables.

### Results:

The correlation between cedar-specific IgE and the 28-day pollen concentration was significant after adjustment for the region ( $\beta=0.16$ , 95% confidence interval [CI]: 0.07–0.24,  $p<0.001$ ) and for non-specific IgE. When the 28-day pollen concentration was divided into quartiles, a significant difference in cedar-specific IgE was found between the lowest quartile and the highest quartile ( $\beta=0.20$ , 95% CI: 0.04–0.35,  $p=0.02$ ).

### Conclusions:

A positive association between cedar-specific, serum IgE and cedar-pollen concentrations was observed. To assess an interaction between individual sensitivity and exposure level, further investigation will be needed, such as the stratified evaluation of people with and without hay fever.

## WC08: Emerging environmental exposures in the study of reproduction and child development

020, September 27, 2017, 14:00 - 15:30

Occupational exposures and reproductive effects among women in the AGRICAN cohort

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**Background/Aim:** Agricultural exposures have been associated with several negative effects on fertility, pregnancy and child development. Our aim was to study the course of the last pregnancy of women enrolled in the French AGRICAN cohort.

**Methods:** AGRICAN cohort was initiated in 2005-2007 and enrolled about 180,000 people affiliated to the French health insurance for agriculture. More than 1,100 women reported at least one pregnancy since 2005 and received a questionnaire in order to collect data about last pregnancy, lifestyle and some occupational exposures. Women who worked on farm during pregnancy were interviewed by phone to collect data about agricultural activities and tasks performed.

**Results:** Approximately 70% of women returned the questionnaire. Less than 12% smoked during pregnancy and 70% attained more than high school's degree. At enrollment 44% had ever worked on a farm (cattle breeding and vineyard predominantly) mainly as farmworkers. About 90% worked during their pregnancy, including one third on a farm, 42% performed administrative tasks and less than 4% reported pesticide use during pregnancy. For about 36%, the husband worked on a farm during pregnancy and 25% used pesticides. For the last pregnancy, 17% of women reported time to pregnancy longer than 12 months. There were 86% of single live births and about 4% spontaneous abortions. Among non-preterm single births (more than 90% of live births), the means birthweight, birth height, head circumference were approximately 3,400g (SD=0.44) with 2.3% below 2,500g, 50cm (SD=2.3) and 35cm (SD=1.6) respectively. Less than 1% had Apgar score below 8 at 5 minutes. Congenital abnormalities were reported in less than 3% of live births.

**Conclusion:** Our study provides original results about reproductive effects of agricultural work in France. Further analyses are needed to measured effects of agricultural tasks. This is the first stage of development of a prospective mother-child cohort in AGRICAN.

# WC08: Emerging environmental exposures in the study of reproduction and child development

020, September 27, 2017, 14:00 - 15:30

## Association between Incense Burning and Childhood Gross Motor Function Development: A Nationwide Birth Cohort Study

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### Background/Aim

Air pollution and high dose biomass burning were known to be associated with neurodevelopmental deceleration, but studies concerning the effect of low dose, indoor biomass burning was limited. Incense burning is a common household ritual practice in Taiwan, and past studies of indoor incense burning exposure focused on birth weight and allergic disease. We aimed to find the association between different incense burning exposure and children's neurodevelopment parameters.

### Methods

The Taiwan Birth Cohort Study (TBCS) was the first nationwide birth cohort study in Taiwan that follows representatively sampled mother-infant pairs in the year 2005. Children were assessed by home interview with structured questionnaires upon the age of six and eighteen months old. Multivariate logistic regression adjusting confounding factors were applied to explore the relative risk (RR) between household incense burning exposure and caregiver-reported neurodevelopment milestones.

### Results

In this study, 15,310 term singletons were included, and perinatal incense burning at home was associated with delay in care-giver reported gross motor neurodevelopment milestone, such as able to walk with support (For infrequent incense burning: RR = 1.25, 95% confidence interval (CI): 1.11 to 1.40, for constant incense burning : RR = 1.38, 95% confidence interval (CI): 1.23 to 1.56) and steadily (For infrequent incense burning: RR = 1.15, 95% confidence interval (CI): 1.04 to 1.27, for constant incense burning : RR = 1.25, 95% CI: 1.12 to 1.39). Perinatal incense burning had little effect on other developmental milestone.

### Conclusions

Our study suggested the exposure to indoor incense burning was associated with delay in child development milestone, especially gross motor. Further research is necessary to further elucidate the dose-response effect.

Key words: Incense, biomass burning, gross motor, neurodevelopment, children

## WC09: Occupational Health: respiratory & other effects

022, September 27, 2017, 14:00 - 15:30

Work activities, self-reported symptoms, and diminished lung function in a population of predominantly Hispanic industrial hog operation workers in North Carolina, USA

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**Background/Aim:** Although swine worker respiratory disease is established, evidence is mainly from predominantly Caucasian farm-owner-operator cohorts whose work exposures may differ from laborers hired to perform day-to-day intensive swine production jobs in confinement barns. The Rural Empowerment Association for Community Help (REACH) has initiated community-based participatory research (CBPR) with Hispanic laborers hired to work in industrial hog operations (IHOs) in eastern North Carolina. Together with REACH, we investigated whether such IHO workers' occupational exposures were related to respiratory health outcomes.

**Methods:** During 2013-14, we completed a 4-month CBPR panel study, involving baseline and 8 bi-weekly visits to collect demographic, personal, and work exposure data and spirometry measurements. We assessed the relation of IHO work activities with respiratory outcomes at baseline (linear regression) and longitudinally (fixed-effects ordinal logistic regression), adjusting for potential confounders.

**Results:** One hundred and three IHO workers were enrolled (88% Hispanic; 46% male; age mean[ $\pm$ SD] 38 $\pm$ 11 years) and completed 782 bi-weekly visits. Asthma prevalence was 8.7% and 92.6% were non-smokers. At baseline, total number of years of IHO work was negatively associated with forced expiratory volume (L) in the first second (FEV<sub>1</sub>) ( $\beta$ =-0.031; 95% confidence interval [CI]: -0.060, -0.001). Longitudinally, positive associations were observed between pressure washing barns and coughing (odds ratio [OR]=3.8; 95%CI: 1.2, 12.3), herd changes and nasal congestion (OR=7.4; 95%CI: 1.2, 44.6) and confinement barn ventilation fans turned off and difficulty breathing (OR=11.2; 95% CI: 2.8, 44.4), eye irritation (OR=5.8; 95%CI: 1.1, 30.7), and chills (OR=5.1; 95%CI: 3.0, 8.9).

**Conclusions:** In a predominantly Hispanic cohort of IHO workers, we observed relations between IHO work activities and adverse respiratory outcomes, particularly prolonged IHO employment and activities that aerosolize and keep waste in-barn. Challenges in exposure assessment from lack of on-IHO access and worker reluctance to enroll in cohorts can be mitigated using an empowering CBPR approach.

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## WC09: Occupational Health: respiratory & other effects

022, September 27, 2017, 14:00 - 15:30

Establishment of recommended occupational exposure limit (REL) for carbon nanotube (CNT) in Korea

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### Background/Aim

Among the nanomaterials, one carbon nanotube (CNT) model is classified as a potential carcinogen (group 2B) by International Agency for Research on Cancer (IARC). Worker could be exposed to CNT during manufacturing and handling process at workplaces. The amount of use of CNT is increasing in Korea recently according to the government statistics. Though no legal occupational exposure limit (OEL) of CNT was established, some guidelines to manage the CNT exposure at the workplace were suggested. We established REL for Korean workplace.

### Methods

Review of established occupational exposure limit was performed. Also, exposure assessment of CNT was performed at seven workplaces including large- and lab- scale workplaces to reflect context of exposure.

### Results

U.S.NIOSH suggested that the recommended exposure limit (REL) as  $1 \mu\text{g}/\text{m}^3$  by elemental carbon (EC). Japan AIST suggested  $30 \mu\text{g}/\text{m}^3$  as a 'Period Limit' OEL after toxicity test of various types of CNT and estimation of  $\text{NOAEL}_H$ . Three workplaces among seven workplaces exceeded the U.S.NIOSH REL which was  $1 \mu\text{g}/\text{m}^3$ . The range was from 0.36 to  $14.24 \mu\text{g}/\text{m}^3$  by EC. But in Korea, average background level of EC was over  $1 \mu\text{g}/\text{m}^3$  and NIOSH REL was inappropriate to compare with. In the U.S., the background level was lower than  $1 \mu\text{g}/\text{m}^3$  but it ranged 1.40 to 3.48 in Korea.

### Conclusions

We recommended the interim recommended occupational exposure limit for carbon nanotube in Korea with  $10 \mu\text{g}/\text{m}^3$  as elemental carbon at the workplace.

### Acknowledgement

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# WC09: Occupational Health: respiratory & other effects

022, September 27, 2017, 14:00 - 15:30

## Exposure to Diesel Engine Exhaust among Forklift Drivers

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### Background/Aim

The diesel engine exhausts (DEE) were classified as Group 1, a group of sufficient evidence to generate lung cancer in the IARC in 2012. Elemental carbon (EC) is a representative indicator of the DEE exposure. This study aimed to compare EC exposure levels of forklift drivers and nearby workers between indoor and outdoor worksites.

### Methods

A total of twenty forklift drivers in five paper manufacturing companies were assessed from January to February 2017. Three to five forklift drivers and nearby outdoor as a background were monitored at each workplace using pre-fired quartz filter mounted within personal environmental monitor. EC were analyzed with the OC-EC analyzer based on the NIOSH method 5040.

### Results

The concentration of personal samples ( $GM=10.5 \mu g/m^3$ ) were significantly higher than that of background area samples ( $GM=2.5 \mu g/m^3$ ). Forklift drivers worked inside were significantly highly exposed to EC than outdoor drivers (indoor worker  $GM=14.0 \mu g/m^3$ , outdoor worker  $GM=5.3 \mu g/m^3$ ,  $p\text{-value}=0.039$ ). High exposure of indoor was explained by no ventilation system in all workplace and door close most of time due to cold outdoor temperature. Also, trucks came into the indoor warehouses and stayed without turning off engine during loading and unloading of raw materials or products. There were EC concentration differences between loading amounts ( $\leq 3$  ton ( $GM=8.0 \mu g/m^3$ ) vs.,  $> 3$  ton ( $GM=14.6 \mu g/m^3$ )) and between forklift types (fork type ( $GM=8.4 \mu g/m^3$ ) vs. clamp type ( $GM=13.1 \mu g/m^3$ )) but without statistical significance.

### Conclusions

Forklift drivers were highly exposed to EC, especially indoor workers were more exposed to EC. Several factors including worksites (indoor or outdoor), ventilation, work load, forklift types, other vehicle (truck) engine affected the EC exposure level.

## WC09: Occupational Health: respiratory & other effects

022, September 27, 2017, 14:00 - 15:30

### A cohort mortality study of lead-exposed workers in the US, Finland, and the UK

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**Background/Aim:** Lead is among the more common occupational exposures, and considered a probable carcinogen by IARC (brain, lung, and stomach).

**Methods:** We conducted internal analyses and external analyses of mortality in three cohorts of lead-exposed workers with blood lead data (US, Finland, UK), with 88,000 workers and 14,000 deaths. Our exposure metric was maximum blood lead (BL). To try to validate our use of short-term BL as an exposure metric, we measured tibial bone lead (a surrogate for cumulative exposure) on 115 workers in the US cohort.

**Results:** The combined cohort had a median BL of 26 ug/dl, a mean first year BL test of 1990, and a mean of 4 BL tests. Significant ( $p < 0.05$ ) positive trends in internal analyses, using the log of each worker's maximum BL, were found for lung cancer, chronic obstructive pulmonary disease (COPD), stroke, and heart disease, while borderline significant trends ( $0.05 \leq p \leq 0.10$ ) were found for bladder, brain, and larynx cancer. In external comparisons we found significantly elevated ( $p < 0.05$ ) standardized mortality ratios for those with BLs  $> 40$  ug/dl, for bladder, lung, and larynx cancer, and COPD. In our subsample, bone lead was positively correlated with past BL, after adjusting for education and age ( $p = 0.003$ ); this relationship was driven by high bone lead among those with BL over 40 ug/dl ( $p = 0.004$ ). Smoking pack-years did not correlate with BL (Spearman,  $r = 0.01$ ).

**Conclusions:** We found positive mortality trends, with increasing BL, for several outcomes. Many of these outcomes are associated with smoking. Data from a small sub-sample of US subjects did not provide any evidence for potential confounding by smoking. Bone lead results indicated that our BL exposure metric was associated with cumulative exposure to lead, for those with BL levels over 40 ug/dl.

## WC09: Occupational Health: respiratory & other effects

022, September 27, 2017, 14:00 - 15:30

### Health assessment and biomonitoring of workers in a coal-fired power plant in Malaysia

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Coal fired thermal plants generation of electricity is an interesting choice for Malaysia that has historically depended on oil and natural gas for energy. For power generation, the country cannot depend totally on renewables to provide base load power as the domestic natural gas supplies are depleting and fuel prices are volatile. It also recognizes that hydropower capacity in Peninsular Malaysia is nearly fully developed. However, atmospheric pollutants emitted from the coal combustion at these coal-fired power plants pose great challenge to local, regional and even global ecosystems. The compositions of PM<sub>2.5</sub> at the surrounding areas of a coal fired power plant have ability to influence the human health. Evaluation on the toxicity of these contaminants in PM<sub>2.5</sub> and their risks to human health risk are limited. A study was conducted to assess exposure of workers to PM<sub>10</sub> & PM<sub>2.5</sub> with their inorganic composition and their biological monitoring. A cross sectional survey was carried using a standardized questionnaire among 137 workers in a coal-fired power plant in Peninsular Malaysia. A purposive sampling method was conducted in August 2016 and the biological samples (urine and blood) were collected and analyzed for blood Pb and Al and urinalysis for Cd, As, Mn and Ni using ICP-MS. All urinary results were standardized with urinary creatinine. These workers have worked for  $3.9 \pm 3.7$  years and between 8-10 hours a day. Majority of workers (98.5%) have good safety awareness, namely through job safety training and awareness on preventive measure at work and good compliance on for good work practice. The biological monitoring showed concentration above the biological exposure index (BEI) for Mn, Ni and Al. These workers will be closely monitored and managed individually where immediate control measures to minimize exposure to coal dusts and repeated biological sampling will be conducted.

## **WC09: Occupational Health: respiratory & other effects**

**022, September 27, 2017, 14:00 - 15:30**

How has OSHA's New Silica Dust Standard Impacted Silica Health Work Outside the U.S.?

Background: In 2016 the U.S. Occupational Safety and Health Administration (OSHA) completed a new standard for workplace crystalline silica. We are trying to understand what this will mean outside the U.S.

Current situation: On March 24, 2016 OSHA issued a revised silica dust rule setting levels in construction and general industry at 50 ug/m<sup>3</sup> for 8 hour workday—1/2 of the 100 ug/m<sup>3</sup> previous standard. More information available <https://www.federalregister.gov/documents/2016/03/25/2016-04800/occupational-exposure-to-respirable-crystalline-silica>. OSHA is now labeling silica a known human carcinogen, as it has been judged by IARC since 1996. In addition to silica being known to cause silicosis, it is now judged to be linked with auto-immune and kidney diseases. The new rule expected to save 600 lives and 900 cases of silicosis annually in U.S.

International scene: The World Health Organization (WHO) is leading efforts to document the numbers of silicosis cases worldwide. Although the rates of silicosis have declined in most industrialized nations, they appear to be steady or rising in Asia, Africa, South America and the former Soviet Union. In South Africa, there is a strong effort to control silica dust because it is linked with excess silico-tuberculosis. OSHA is likely to be asked by other global regulatory agencies to share their work, though we do not expect the new administration to be very supportive. There may be some collaboration to study nonsilicosis lung diseases, lung cancer and other cancer endpoints in countries such as China and Chile. In the Philippines there have not been any published research, but there should be a focus on education of miners and construction workers.

Conclusion: The new OSHA silica rule may spur other nations to adopt the 50 ug/m<sup>3</sup> standard, to undertake novel research studies, and to offer education to alert workers to silica's health risks.

## WC10: Ambient air pollution & other childhood respiratory effects

100, September 27, 2017, 14:00 - 15:30

### Exposure to acute air pollution and risk of otitis media

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**Background/Aim:** Infants may be more susceptible to illness as a result of altered immune function due to exposure to particulate matter less than 2.5µm in diameter (PM<sub>2.5</sub>). Our aim is to estimate associations between acute increases in PM<sub>2.5</sub> exposure and risk of otitis media among births born 2001 through 2008 in Massachusetts, USA.

**Methods:** We analyzed 42,336 first time otitis media clinical encounter visits (hospitalizations, emergency department visits, and observational stays) using a case-crossover study design. PM<sub>2.5</sub> was estimated using satellite, remote sensing, meteorological and land use data based on geocoded birth address. We used conditional logistic regression models adjusted for temperature, humidity, atmospheric pressure, and holiday using a semi-symmetric bidirectional referent design per 10-µg/m<sup>3</sup> increase in PM<sub>2.5</sub>. We examined the influence of PM<sub>2.5</sub> on (1) symptom exacerbation using very short exposure lags of 0 and 1 day and (2) susceptibility to infection using longer exposure lags of 4 and 7 days. To determine susceptible subgroups, effect modification was assessed by gestational age, birth weight, season of diagnosis, subsequent clinical encounter, insurance payer codes, median income by census block group, infant sex, breastfeeding initiation in hospital at birth, age of infant at time of clinical encounter and maternal race.

**Results:** Preterm infants were at substantially increased risk of otitis media 4 days (Odds Ratio (OR) = 1.09, 95% Confidence Interval (CI) = 1.02-1.16) and 7 days (OR = 1.08, 95% CI = 1.02-1.15) prior to clinical encounter. The association between PM<sub>2.5</sub> exposure and otitis media clinical encounters was significantly different by gestational age (lag4 p=0.03; lag 7 p=0.02). There was no further evidence of effect modification. Overall, we found non-significant positive associations with otitis media across all lags.

**Conclusions:** Preterm infants are more susceptible to otitis media associated with acute PM<sub>2.5</sub> exposures compared to full term infants.

# WC10: Ambient air pollution & other childhood respiratory effects

100, September 27, 2017, 14:00 - 15:30

## The effect of Asian dust on infants' nose, eyes and respiratory symptoms

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Japan Environment and Children Study

### Background/Aim

Accumulating evidence suggests that desertification and climatic variability can contribute to increased desert dust formation in the air. Desert dust has been shown to exert adjuvant effects in animals. We examined if desert dust enhances nose/eyes/lung symptom in infants.

### Methods

We conducted a panel study for 1,492 infants from October 2014 to July 2016 in three regions in Japan as an adjunct study of the Japan Environment and Children's Study. We timely acquired infants' daily symptom scores by sending a web-based questionnaire on high desert-dust days and on some randomly selected other days (control days) for each infant. Their mothers answered the questionnaire within a day using their mobile phones. The odds ratio (OR) by  $100\mu\text{g}/\text{m}^3$  increase of desert dust was estimated by GEE logistic regression model. Average temperature on the day, temperature difference from the previous day, temperature difference within the day, air pressure on the day, air pressure difference from the previous day,  $\text{SO}_2$ ,  $\text{NO}_2$ , and Ozone were taken into account for possible confounders.

### Results

Infants showed an increased risk of nose/eyes/lung symptom; OR 1.15 (95%CI 1.09 – 1.22) by  $100\mu\text{g}/\text{m}^3$  increase of desert dust. The risk increase was observed even among non-wheezers; OR 1.13 (95%CI 1.03 – 1.23). Age and if they opened windows on the day were significant effect modifiers (interaction  $p < 0.1$ ).

### Conclusions

Ambient desert dust level was associated with increased risk of nose/eyes/lung symptoms in infants.

This work was supported by the Environment Research and Technology Development Fund from the Ministry of the Environment, Japan [5-1555(2015-2017)], and by Environmental Restoration and Conservation Agency (2014-2016), and conducted as an adjunct study of Japan Environment and Children Study (JECS).

The findings and conclusions of this article are solely the responsibility of the authors and do not represent the official views of the Japanese government.

# WC10: Ambient air pollution & other childhood respiratory effects

100, September 27, 2017, 14:00 - 15:30

Association between exposure to traffic-related air pollution and prevalence of allergic diseases in children, Seoul, Korea

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## Background/Aim

Although there has been suggestive evidence of the association between traffic-related air pollution and allergic diseases, findings remained inconsistent possibly due to limited population. We investigated the association between traffic-related air pollution and allergic diseases in a large population of children with rich spatial coverage and expanded age span in Seoul, Korea.

## Methods

The Seoul Atopy Friendly School Project survey provided prevalence of eczema, asthma, and allergic rhinitis in 31,576 children aged 1-12 years and living mostly in all 25 districts of Seoul. Prevalence was defined as symptoms for previous 12 months based on the modified International Study of Asthma and Allergies in Childhood (ISAAC) questionnaires. Traffic exposures were estimated by proximity to and density of major roads within 300 meters from children's residences. Major roads were defined as national and metropolitan highways and roads with more than six lanes. We estimated the association between two traffic exposures and three allergic diseases using generalized mixed model after adjusting for individual characteristics and accounting for variability across schools and regions. Our primary analysis was restricted to 14,765 children living on the third floor or lower. In sensitivity analyses, primary results were compared to those for children above the third floor. We also investigated whether the association varied by household and regional socioeconomic status.

## Results

We found significant and marginal associations of eczema for road density (Odd ratio=1.08, 95% confidence interval=1.01-1.15) and road proximity (1.07, 0.98-1.18), respectively. There was no association with asthma and allergic rhinitis. Effect estimates were higher in children on the third floor or below than above, and generally the highest in the low socioeconomic region.

## Conclusions

Children living surrounded by large and busy roads were likely to be at greater risks for eczema, with increased vulnerability when living in deprived areas.

# WC10: Ambient air pollution & other childhood respiratory effects

100, September 27, 2017, 14:00 - 15:30

The association between particulate air pollution and respiratory admissions amongst young children in Hanoi, Vietnam

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## Background/Aim

In recent decades, Hanoi has faced several serious air pollution issues, especially high levels of airborne particulate matter including PM<sub>10</sub>, PM<sub>2.5</sub>, and PM<sub>1</sub>. However, there has been very few studies about the effects of ambient air pollution on health conducted in Vietnam so far and this is one of the first attempt to evaluate the relationship between airborne particulate matter and children health in Hanoi.

The aim of our study was to investigate the short-term effects of PM<sub>10</sub>, PM<sub>2.5</sub>, and PM<sub>1</sub> on respiratory admissions among children under 5 years old in Hanoi.

## Methods

Data on daily hospital admissions for respiratory diseases from the Vietnam National Hospital of Paediatrics and daily records of PM<sub>10</sub>, PM<sub>2.5</sub>, PM<sub>1</sub> and other confounding factors as NO<sub>2</sub>, SO<sub>2</sub>, CO, O<sub>3</sub> and temperature were obtained from September 2010 to September 2011. A time-stratified case-crossover design with individual lag model was used to analyse the data.

## Results

The levels of PM<sub>10</sub>, PM<sub>2.5</sub> and PM<sub>1</sub> measured in Hanoi were higher than both Vietnam's standard and WHO guideline. Consequently, exposure to PM<sub>10</sub>, PM<sub>2.5</sub> and PM<sub>1</sub> poses great risks of hospital admissions for respiratory diseases. An increase in 10 µg/m<sup>3</sup> of PM<sub>10</sub>, PM<sub>2.5</sub> or PM<sub>1</sub> was significantly associated with a 1.4% [95%CI (0.9-2.0)], 2.2% [95%CI (1.2-3.1)] and 2.5% [95%CI (1.4-3.5)], respectively, increase in respiratory admission on the same day of exposure. There is no significant difference between the effects created by genders found in this study.

## Conclusions

Our study demonstrated that infants and young children in Hanoi are at increased risk of hospital admissions for respiratory due to the high level of airborne particles in the city's ambient air. Therefore, control measures are needed to reduce the air pollution in Hanoi to ensure a better health protection for children as well as the general public.

# WC10: Ambient air pollution & other childhood respiratory effects

100, September 27, 2017, 14:00 - 15:30

School area air pollution, rhinitis and other respiratory symptoms in Hong Kong children

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## Background/Aim

Previous research indicated the detrimental effect of air pollution on respiratory systems. We investigated the association between air pollution and respiratory symptoms in school children based on our school cohort in Hong Kong starting from 2012.

## Methods

This is a retrospective study conducted with our baseline data: 1735 participants from 17 schools across Hong Kong were included in this cross-sectional analysis. Parents-administrated questionnaires were used to collect information on non-infectious rhinitis, asthma, bronchitis, sinusitis and a wide range of confounders. Data of air quality for each school were retrieved from nearest Hong Kong Environmental Protection Department (HKEPD) monitoring stations. The pollutant concentrations for past 12 months were averaged to estimate the exposure, including particulates (PM2.5, PM10, TSP) and gaseous pollutants (SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>). A two-level logistic regression model was used for data analysis

## Results

In total, 27.3% (473 of 1735) students reported rhinitis occurrence in past 12 months. The simple regression result demonstrated higher likelihood of rhinitis occurrence is significantly associated with higher concentration of NO<sub>2</sub> (OR: 1.008, 95%CI: 1.001, 1.014) and PM<sub>2.5</sub> (OR: 1.092, 95%CI: 1.011, 1.180). The statistical significance remained after adjusting for asthma, gender and age. For other symptoms, no effect is observed.

## Conclusions

The result indicated higher concentrations of ambient pollutants in school area may contribute to the occurrence of rhinitis in school children.

# WC10: Ambient air pollution & other childhood respiratory effects

100, September 27, 2017, 14:00 - 15:30

## Addressing Gaps in Age-Specific Evidence Used for United States Air Pollution Policy

Author information; Arial 8pt (please overtype this)

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### Background/Aim

Associations between air pollution and respiratory events in the U.S. have been estimated in multi-city studies using Medicare data. For populations not covered by Medicare (i.e., people under 65), evidence has relied on single-city studies. These studies may have limitations for informing national policy due to between-city differences in air pollution composition and population characteristics. Using emergency department (ED) data centralized by the U.S. Centers for Disease Control and Prevention's National Environmental Public Health Tracking Program, we obtained the first multi-county effect estimates in the U.S. for respiratory ED visits across all ages.

### Methods

With 47.4 million respiratory ED visits, data included 894 U.S. counties for 2001–2012 (with 3 to 12 years per county). County-specific time-series analyses using quasi-Poisson log-linear models were conducted to estimate associations between air pollution and respiratory ED visits among children 0–<19, adults 19–<65, and adults 65 and older. We used ozone and fine particulate matter (PM<sub>2.5</sub>) concentration estimates from a Bayesian space-time downscaling fusion model. Overall health effect estimates were generated using a Bayesian approach to pool the county effect estimates.

### Results

In single pollutant models, we observed significant positive associations for respiratory ED visits and ozone for all age groups and PM<sub>2.5</sub> for all age groups except for adults 65 and older. In two pollutant models, the association with ozone was greater among adults 19–< 65 (Rate Ratio [RR] 1.041 per 20 ppb, 95% Credible Interval [CI]: 1.036 – 1.047) than adults 65 and older (RR 1.034, 95% CI: 1.027 – 1.041) and no longer significant for children. For PM<sub>2.5</sub>, the association was higher among children (RR 1.029 per 10 µg/m<sup>3</sup>, 95% CI: 1.023 – 1.035) than adults 19–<65 (RR 1.008, 95% CI: 1.004 – 1.013).

### Conclusions

Our multi-county analyses covering people of all ages address a key gap in the evidence used to evaluate U.S. air pollution policy.

# WC11: Phthalates, pesticides, and polychlorinated aromatic hydrocarbons: health impacts of early life exposures

102, September 27, 2017, 14:00 - 15:30

## Prenatal Phthalate, Paraben, and Phenol Exposure and Timing of Puberty in Girls and Boys

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**Background/Aim:** Phthalates, parabens, and phenols are chemicals used in plastics, cosmetics, and other consumer products. These chemicals have demonstrated endocrine disrupting properties and are associated with altered pubertal timing in animals, but few human studies exist.

**Methods:** We measured biomarker concentrations of eight phthalates, three parabens, and five other phenols in urine collected during pregnancy from mothers participating in the CHAMACOS cohort study. Children were followed through adolescence, with clinical Tanner staging conducted every 9 months from ages 9 to 13 and information on age at menarche gathered by self-report. Prenatal biomarker concentrations were log<sub>2</sub> transformed for analysis. We calculated relative risks (RR) for earlier puberty using Poisson regression and time ratios (TR) for reaching Tanner stages using parametric survival analysis.

**Results:** Prenatal concentrations of several phthalate biomarkers, including monobenzyl phthalate, monocarboxynonyl phthalate, monocarboxyoctyl phthalate, mono(3-carboxypropyl) phthalate, and the sum of metabolites of di(2-ethylhexyl) phthalate ( $\Sigma$ DEHP) were associated with later pubertal onset in girls and earlier pubertal onset in boys. For example, each doubling of prenatal  $\Sigma$ DEHP metabolite concentrations was associated with decreased risk of earlier breast development (RR=0.80, 95% CI: 0.66, 0.95) and earlier menarche (RR=0.75, 95% CI: 0.66, 0.85) in girls and increased risk of earlier genital development in boys (RR=1.19, 95% CI: 1.05, 1.36). Prenatal concentrations of methyl paraben, propyl paraben, benzophenone-3, and 2,4-dichlorophenol were also associated with later puberty in girls and earlier puberty in boys. For example, later timing of menarche was associated with prenatal concentrations of methyl paraben (TR=1.13, 95% CI: 1.06, 1.22), propyl paraben (TR=1.09, 95% CI: 1.04, 1.14), benzophenone-3 (TR=1.09, 95% CI: 1.04, 1.15), and 2,4-dichlorophenol (TR=1.08, 95% CI: 1.01, 1.16).

**Conclusions:** We present evidence that *in utero* exposure to some phthalates, parabens, and phenols may affect pubertal timing in boys and girls.

# WC11: Phthalates, pesticides, and polychlorinated aromatic hydrocarbons: health impacts of early life exposures

102, September 27, 2017, 14:00 - 15:30

Phthalate exposure is associated with carotid intima-media thickness in adolescents and young adults

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## Abstract:

**Background and Purpose:** Exposure to phthalates has been linked to cardiovascular risk factors. However, it is unclear regarding phthalates exposure and the risk of subclinical atherosclerosis. This study investigated the association between phthalates exposure and carotid intima-media thickness (CIMT) in young population.

**Methods:** From a nationwide mass urine screening for renal health, conducted in 1992-2000 among school children 6 to 18 years of age in Taiwan, we recruited 789 subjects to participate the cardiovascular health examination in 2006-2008. Among them, 787 received measurements of 7 urinary phthalate metabolites and CIMT.

**Results:** Both mean and maximal values of CIMT at all segments of carotid arteries significantly increased with the urinary mono-2-ethylhexyl phthalate (MEHP),  $\Sigma$ MEHP, and mono-n-butyl phthalate (MnBP) in a dose-response relationship after adjustment for multiple linear regression models. Multivariate logistic regression analysis showed that higher quartiles of urinary concentrations of MEHP,  $\Sigma$ MEHP, and MnBP were associated with a higher risk of thicker CIMT. Compared to subjects with the lowest quartile (Q1) of urinary MEHP, the adjusted odds ratios (aORs) (95% confidence interval (CI)) for thicker CIMT among subjects with higher urinary MEHP were 2.13(1.18-3.84) at Q2, 4.02(2.26-7.15) at Q3 and 7.39(4.16-13.12) at the highest Q4. Comparing those with lowest urinary MnBP, the corresponding aORs (95% CI) were 1.84 (1.08-3.15) for subjects at Q3, and 2.80 (1.65-4.75) for subjects at the highest Q4.

**Conclusions:** Urinary phthalate metabolites of MEHP,  $\Sigma$ MEHP, and MnBP are strongly associated with CIMT in adolescents and young adults in Taiwan.

# WC11: Phthalates, pesticides, and polychlorinated aromatic hydrocarbons: health impacts of early life exposures

102, September 27, 2017, 14:00 - 15:30

Ambient pesticide exposure during pregnancy and risk of cerebral palsy: a California statewide study

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**Background:** Cerebral palsy (CP) is a group of permanent and non-progressive movement and posture disorders affecting about 2-3 per 1,000 births. The etiology of most CP cases remains unexplained. Disruptions of maternal hormone function during pregnancy have been shown to increase the risk of CP. We investigated whether *in-utero* exposure to pesticide compounds with endocrine disrupting effect is associated with CP risks.

**Methods:** We assessed records from the Department of Developmental Services (DDS) and identified 6,851 CP cases born between 1998 and 2007 in the state of California. For each CP case, we randomly selected 1:10 matched controls from California birth certificates. Pregnancy trimester-specific ambient pesticide exposure estimates were created using a Geographic Information System (GIS) model that links residential addresses at delivery reported on birth certificates to the California Pesticide Use Reporting (PUR) system. The PUR system contains comprehensive information on the type, date, and location of agricultural pesticide applications in California since 1974. In our analysis, we focused on 32 frequently used pesticide compounds that were considered suspected endocrine disruptors in the Pesticide Action Network database. We estimated odds ratios (OR) and 95% confidence intervals (CI) for CP following pesticide exposures, adjusting for maternal age, education, foreign-born status, DDS regional center, birth year, and child's sex.

**Results:** First trimester exposure to the 32 pesticide compounds was associated with elevated CP risks (OR=1.08, 95% CI 1.00-1.18) compared with the unexposed. The effect estimates appear to be stronger among Whites (OR=1.19, 95% CI 1.02-1.38), female offspring (OR=1.21, 1.05-1.38), in spastic CP sub-phenotypes (OR=1.13, 95% CI 1.01-1.26) and bilateral CP cases (OR=1.12, 95% CI 1.01-1.24).

**Conclusions:** Early life exposure to pesticide compounds with endocrine disrupting effect was related with risks of CP. Future work to estimate the effects of exposure to individual pesticides and/or chemical mixtures is recommended.

# WC11: Phthalates, pesticides, and polychlorinated aromatic hydrocarbons: health impacts of early life exposures

102, September 27, 2017, 14:00 - 15:30

## Prediagnostic exposure to polychlorinated biphenyls (PCBs) and organochlorine pesticides and thyroid cancer in the Janus Serum Bank cohort

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**Background/Aim:** Polychlorinated biphenyls (PCBs) and organochlorine insecticides (OC) have been associated with altered thyroid hormone levels in humans but their relationship with thyroid cancer is unknown.

**Methods:** We conducted a nested case-control study of thyroid cancer in the Norwegian Janus Serum Bank cohort with prediagnostic blood samples from 1972-1985. Incident thyroid cancer (N=108) was ascertained through 2008. Controls were matched 2:1 to cases by date and age at blood draw, gender, and region (Oslo, Oppland, Sogn og Fjordane, Finnmark). We used gas chromatography/mass spectrometry to quantify 36 PCB congeners and metabolites of the OC insecticides DDT, chlordane, hexachlorocyclohexane, and hexachlorobenzene. Odds ratios (OR) and 95% confidence intervals (CI) were computed using conditional logistic regression per 10 or 100 ng/g increase in lipid-adjusted concentration. We conducted stratified analyses by median age at blood draw (<40, ≥40) and median years between blood draw and diagnosis (<20, ≥20).

**Results:** Overall, we observed no association with thyroid cancer for individual PCBs, the sum of PCB congeners by chlorination level (low, moderate, high), or for the OC insecticides. For 10 moderately-chlorinated PCBs, we observed statistically significant positive associations among those <40 years of age at blood draw with ≥20 years of follow-up (e.g. PCB180: OR<sub>per 10ng/g</sub>=1.13, 95% CI 1.01-1.27; p-interaction=0.04) but not among those who were older at blood draw or with shorter follow-up. The sum of highly-chlorinated PCBs was associated with elevated risk in the younger age group with longer follow-up (OR<sub>per 100ng/g</sub>=4.21, 95% CI 0.86-20.1; p-interaction=0.02); whereas, associations were nonsignificantly inverse among those aged ≥40 at blood draw regardless of follow-up duration. OC insecticides were not associated with risk except for positive associations with chlordane metabolites among those <40 years at blood draw with ≥20 years of follow-up (e.g. trans-nonachlor OR<sub>per 10ng/g</sub>=2.04, CI 0.99-4.22, p-interaction=0.08).

**Conclusions:** Our findings suggest that PCBs may increase thyroid cancer risk and that the association varies by age and follow-up time.

## **WC11: Phthalates, pesticides, and polychlorinated aromatic hydrocarbons: health impacts of early life exposures**

**102, September 27, 2017, 14:00 - 15:30**

Navigating the ethical challenges within epidemiologic research of endocrine disrupting chemicals (EDCs)

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There is increasing awareness of the potential for toxic chemicals to have endocrine disrupting health effects. Many chemical classes which have these characteristics have been identified, and more are being discovered each year. Unlike other exposures to toxic chemicals without ED effects, many people who are exposed to these EDCs are unaware of the sources which have exposed them. Furthermore, many of these EDCs can have health effects in subsequent generations within the exposed populations. The ethical need to protect the vulnerable, concern ourselves with environmental justice, in addition to complex risk communication messaging, all serve to confound this area of epidemiologic enquiry. Consequently, the ethical dimensions of this research area are complex with profound implications for generational effects. This ethics discussion session will foster healthy debate and dialogue regarding these ethical issues while identifying strategies to mitigate them.

# WC12: Causal inference of environmental risk factors

105, September 27, 2017, 14:00 - 15:30

Valid and informative p-values from big data, illustrated in environmental epigenomics

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## Background/Aim

A common issue that arises with analyses of epigenomic data is the repeated use of statistical tests. Consider 17 people in a randomized experiment measuring the epigenomic effect of two exposure conditions (e.g., clean air and ozone) on DNA methylation assessed at 484,531 epigenome locations. The aim is to find the locations with an epigenetic effect of ozone versus clean air.

## Methods

We describe the use of randomization-based tests to obtain a Fisher exact p-value that is valid whatever the correlational structure of the data. The power of the resultant test to detect real differences, however, requires the careful *a priori* selection of the single test statistic. We consider the generalized Elastic-Net regularization. We choose the tuning parameters that minimized the Bayesian Information Criterion using a two-dimensional grid search. These two penalties aim to shrink the "irrelevant" regression coefficients towards zero and has been suggested to have the "Oracle" property (i.e., consistency in variable selection and asymptotic normality of the estimated non-zero coefficients). Note that many epigenomic studies stop at this step, i.e., after the regularization method is performed, studies report the estimated "true" non-zero coefficients assuming the "Oracle" property implicitly. The main innovation of our approach consists of going beyond one step by using the non-zero coefficients to construct a test statistic and provide a randomization test-based p-value.

## Results

The Elastic-Net procedure selected 13 CpG sites and the associated Fisher exact p-value was equal to 0.14. Here, we provide a non-parametric, non-asymptotic, approach that provides a p-value that suggests modest support towards the Elastic-Net selection and modest evidence about causal effects of ozone on the epigenome.

## Conclusions

This procedure is compatible with any test statistic and generates valid and informative p-values. To our knowledge, this is the first time that regularization methods are coupled with Fisherian inference.

## WC12: Causal inference of environmental risk factors

105, September 27, 2017, 14:00 - 15:30

### Do air quality alerts influence public health? A regression discontinuity analysis in Toronto, Canada

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**Background/Aim:** Ambient air pollution is a major health risk globally. To reduce adverse health effects on high air pollution days, government agencies worldwide have implemented air quality alert programs. Despite their widespread use, little is known whether these programs produce any observable public health benefits. We evaluated the effectiveness of such programs using a quasi-experimental approach.

**Methods:** We assembled a population-based cohort comprising all individuals who resided in the City of Toronto (Ontario, Canada) from 2003 to 2012 (~2.6 million). We ascertained seven health outcomes known to be affected by short-term elevation of air pollution, including cardiovascular- and respiratory-related deaths, as well as hospitalizations or emergency-department visits from acute myocardial infarction, heart failure, stroke, asthma, and chronic obstructive pulmonary disease (COPD) using provincial health administrative databases. We applied a regression discontinuity design to assess the effectiveness of an intervention. To quantify the impact of the air quality alert program, we estimated, for each outcome, the absolute rate difference and rate ratio attributable to alert announcements and program eligibility (intention-to-treat analysis), respectively.

**Findings:** Between 2003 and 2012, there were on average three to 27 daily cardiovascular or respiratory events in Toronto (depending on the outcome). Alert announcements reduced asthma-related emergency-department visits by 4.73 cases (95%CI: 0.55, 9.38) per 1,000,000 persons per day or in relative terms by 25% (95%CI: 1%, 47%). Program eligibility also led to 2.05 (95%CI: 0.07, 4.00) fewer daily asthma emergency-department visits. Furthermore, there was a tendency toward decreased asthma- and COPD-related hospitalizations. However, we did not detect a reduction in any other outcome as a consequence of alert announcements or program eligibility.

**Conclusions:** In this population-based cohort, air quality alert program was related to some decreases in respiratory morbidity, but not any other outcome examined.

# WC12: Causal inference of environmental risk factors

105, September 27, 2017, 14:00 - 15:30

## Doubly Robust Exposure-Response Curve Estimation Using Penalized Spline: Application to Long-term PM<sub>2.5</sub> and Probability of Death in a Year

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### Background/Aim

The effect of long-term exposure to PM<sub>2.5</sub> on mortality has traditionally been presented using hazard ratios, whereas how exposures change the probability of death in a year is rarely estimated, but more intuitive, and allows more interpretable additive effect modifications.

### Methods

We proposed a causal inference method to estimate a doubly robust exposure-response curve for long-term PM<sub>2.5</sub> and the probability of death in a year. We first fit an exposure model on PM<sub>2.5</sub> against confounders and a pooled logistic regression on death indicator for each person-year against PM<sub>2.5</sub> and confounders. Leveraging these two models, we constructed an adjusted outcome, which was further regressed against PM<sub>2.5</sub> using a penalized B-spline. We studied the asymptotic properties of the resulting B-spline exposure-response curve, tested the procedure using simulations, and applied it to 13 million Medicare beneficiaries aged 65 or older with 95 million person-years of follow-up in the southeastern US.

### Results

The exposure-response estimator is doubly robust to model misspecification, consistent, and asymptotically normal. The average probability of death in a year decreased from 0.050 to 0.045 for a reduction in annual average PM<sub>2.5</sub> from the current USEPA standard (12 $\mu\text{g m}^{-3}$ ) to 8 $\mu\text{g m}^{-3}$ , preventing 35 thousand premature deaths per year among older adults in the southeastern US. The estimated curve is approximately linear below 11  $\mu\text{g m}^{-3}$  and is causal if either the exposure or the outcome model is correctly specified. The reduction in the probability of death increased with age, was higher among dual eligible beneficiaries, and was higher among beneficiaries that have ever been admitted due to congestive heart failure, myocardial infarction, diabetes, and COPD.

### Conclusions

The proposed method provides a novel exposure-response function for PM<sub>2.5</sub> and mortality on the scale of probability of death, which is doubly robust and has a better interpretation than hazard ratios.

## **SYM08: “Informal” waste management: occupational, environmental and public health issues**

**101, September 27, 2017, 16:00 - 17:30**

Uncontrolled hazardous waste dumping: epidemiological investigations and public health implications in an Italian context

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**Background/Aim.** Uncontrolled and poor hazardous waste management is widespread in some areas of industrialized and middle-low income countries. The frame of epidemiological investigations performed in an Italian area characterized by illegal hazardous waste dumping or burning and their contribution to public health policy are described.

**Methods.** Standardized Mortality/Morbidity Ratios and cluster analyses for cause-specific mortality, congenital anomalies prevalence and cancer incidence were conducted in 196 municipalities interested by the phenomenon. A regression analysis was performed, classifying the municipalities in “waste pressure indicator” groups. Subsequently, an updating of mortality, hospitalizations and cancer incidence for the diseases with an *a priori* evidence of association with waste exposure was conducted in “Land of Fires”, a subarea where illegal waste burning was widespread; prevention and healthcare actions were advised. A communication process with both population and Institutions was built, based on transparency and mutual listening.

**Results** A subarea with a higher number of diseases in excess was highlighted, where illegal waste sites are concentrated. In regression analysis, specific diseases correlated with the municipal “waste pressure” indicator. Scientific and public communication events raised the awareness of the possible health impact of hazardous waste exposure. Subsequently, an *ad hoc* Law of the Italian Parliament required an epidemiological updating in “Land of Fires”: localized excesses of diseases with *a priori* evidence of association with waste exposure were shown and a specific program of healthcare actions suggested.

**Conclusions** The accumulated evidence on the health impact of hazardous waste, although their etiological role is not ascertained, requires public health acts. Epidemiological studies contribute to identifying the subareas and the populations on which health prevention, including environmental remediation, and healthcare actions should be performed, indicating the diseases to be considered. The communication process with populations contributes to raising public awareness and implementing evidence-based health policy actions.

## **SYM08: “Informal” waste management: occupational, environmental and public health issues**

**101, September 27, 2017, 16:00 - 17:30**

Inflammatory markers in sanitary landfill workers and inhabitants of surrounding areas, in relation to endotoxin suspended particulate levels (PM<sub>10</sub>) in Morelos, Mexico

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### Background/Aim

This study used an ecosystem approach to examine the health risks due to exposure to pollutants generated in an open pit garbage dumps in the State of Morelos, Mexico. Markers of inflammation and incidence of respiratory symptoms in the landfill workers associated with suspended particles will be presented.

Waste management pollution is a public health concern. The aim of this study was to evaluate the relationship between systemic inflammation markers and exposure to endotoxin and (1→3)-β-D-glucan, present in particulate matter less than 10 micrometers (PM<sub>10</sub>), in workers of a landfill facility (LF) and control populations of non-occupationally exposed individuals living around the facility.

### Methods

After an environmental characterization, we conducted a cross sectional study to evaluate inflammatory markers in 58 males between ages 18 to 40: 24 LF workers and 34 males living around. Interleukin 6 (IL-6) and 8 (IL-8), tumor necrosis factor-α (TNFα), white blood cell (WBC) count, percentages of lymphocytes, neutrophils and monocytes were analyzed with standardized methods in relation to work in LF and to live in downwind or upwind towns. Using Limulus Amebocyte Lysate (LAL) we assess endotoxin and (1→3)-β-D-glucan concentrations associated to PM<sub>10</sub>.

### Results

Airborne PM<sub>10</sub> are related with time of work and wind direction, also with endotoxin content. With regression models, adjusted by potential confounders, we found that IL-6 and neutrophils were significantly lower for LF workers comparing with upwind population, otherwise lymphocytes are higher. Lymphocytes, neutrophils and monocytes had relation with endotoxin content in PM<sub>10</sub>.

### Conclusions

We suppose that endotoxin content in PM<sub>10</sub> decrease immune response in landfill workers. It suggest, that inflammation could be at other cellular level. It is important to use health and safety items during work likewise to study particles quantity induced by urban solid waste management.

# **SYM08: “Informal” waste management: occupational, environmental and public health issues**

**101, September 27, 2017, 16:00 - 17:30**

## **Characterization of the health, occupation and environmental conditions of the Waste Pickers in Costa Rica**

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### **Background/Aim**

In 2010, Costa Rica allows the Law for the Integrated Waste Management, which sorts all the citizens, government and industry to be responsible of managing the waste.

This project set a combined work with local government and social organizations that pick solid waste to commercialize it. The objective is to describe the conditions of health, occupational and environment that workers have in those organizations.

### **Methods**

The activities are set in three work lines: occupational health, environmental health and environmental management.

About occupational and environmental health, tests of levels in noise personal and into the waste collection center, lighting and heat were made. In addition we collected hand washing samples and air pollution samples for particulates matter and heavy metals. 63 workers were interviewed to know occupational health conditions. 3 work meetings were set with those workers and local governments.

### **Results**

Levels of noise do not show a risk in waste collection centers but personal noise increase during breaking glass duty. The measurement of lighting holds up that the level is insufficient in some specific places inside the centers. The heat inside of the centers is constant, but it seems to not cause damage to workers. Hand washing showed that workers had contact with total and faecal coliforms. All air samples didn't detect heavy metals, only two samples detected particulate matter ( $<0,44 \text{ mg/m}^3$ ). The interviews showed a lack of labor contracts and social security result in informal workers. Also, two work meetings were realized: twice with workers and once with local governments.

### **Conclusions**

Occupational health at waste collection center had to improve in illumination, working areas and to reduce high temperatures, also in personal protective equipment, especially for avoided coliforms contact. We expect that the project help the recognition of waste pickers to improve the access to social guarantees, environmental conditions and occupational health.

## **SYM08: “Informal” waste management: occupational, environmental and public health issues**

**101, September 27, 2017, 16:00 - 17:30**

Urban solid waste and collectors of recyclable material: health, work and the environment

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**Background/Aim:** Solid waste, including eletro-eletronic waste (WEEE) is a serious environmental and public health issue since it can affect the environment, the health of the population and the professionals involved with its management. Around 600,000 people work as recyclable materials collectors in Brazil and are responsible for the expansion of the recycling market in the country. This study evaluated the environmental and occupational conditions in cooperatives of recyclable materials and the health risks of collectors.

**Methods:** Ambient air samples for fungi and toxic metals were collected in the work environment of four cooperatives in Sao Paulo; blood samples were obtained from collectors and analyzed for metal content. Questionnaire were applied and ergonomic analysis performed to identifying the main risks posed by this activity.

**Results:** ambient levels of toxic metals were below and fungi levels were above occupational limits with significant differences among cooperatives. The mean concentration of Cd (AM: 0.47 µg/L; GM: 0.34 µg/L) was almost four times higher while Pb (AM: 39.13 µg/L; GM: 34.11 µg/L) was 1.4 times higher than a reference population. Both metals were associated with age, gender, smoking, meat consumption and the cooperative. Musculoskeletal pain/discomfort was reported by 65% of collector, and was associated with the means of production of the cooperative, among other factors.

**Conclusions:** recyclable materials collectors might be exposed to Cd and Pb during their recycling activities although ambient toxic metals were low. This might be due to the discontinuity of the WEEE processing, and the unpredictability of the occurrence of fluorescent lamps and other WEEE mixed with recyclable materials. High fungi levels indicate the need to better process the recycling materials before sending for recycling as it can lead to respiratory problems. Working conditions were extremely precarious and constitute an important risk factor for musculoskeletal disorders.

# **SYM17: Air Pollution and Children's Health**

**024, September 27, 2017, 16:00 - 17:30**

## **The association between long-term exposure to air pollution and post-neonatal mortality in South Korea**

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### **Background/Aim**

Air pollution has been suspected to increase the risk of post-neonatal mortality. However, evidence for an association between long-term air pollution and post-neonatal mortality is still inconsistent and insufficient. Further research is needed to clarify the link between long-term exposure to air pollution and post-neonatal mortality. Hence, the aim of this study is to examine the effect of long-term exposure to air pollution on post-neonatal mortality in South Korea.

### **Methods**

Infant mortality data were obtained from the Statistics Korea. A total of 1,692 normal-birth-weight post-neonates born full-term were followed from birth to death. Annual means of air pollutants (PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO, and O<sub>3</sub>) at birth year were calculated from air pollution monitoring data and linked to the mortality data by administrative divisions in South Korea. Cox proportional hazards model was applied to assess the effects of long-term exposure to air pollution on post-neonatal mortality for selected causes: respiratory, cardiovascular, perinatal circumstances, congenital malformations, deformations and chromosomal abnormalities, and sudden infant death syndrome. For multivariate analyses, sex, maternal age, and APGAR score at 5 minute were adjusted.

### **Results**

Although unadjusted hazard ratios of PM<sub>10</sub> and SO<sub>2</sub> were 1.002 (95% confidence interval, 0.991-1.012) and 1.042 (0.980-1.108), respectively, no significant association was found in single pollutant models. A significant association between exposure to SO<sub>2</sub> and post-neonatal mortality was shown in a two-pollutant model of SO<sub>2</sub> and CO with an adjusted hazard ratio of 1.104 (1.006-1.211).

### **Conclusions**

The findings of this study can provide evidence of the detrimental effect of long-term exposure to air pollution on post-neonatal mortality. Given that exposure to air pollution at gestation period can be a suspected cause of infant mortality, further analyses need to be conducted to specify the critical period.

# SYM17: Air Pollution and Children's Health

024, September 27, 2017, 16:00 - 17:30

## Association Between Air Pollution and Pervasive Developmental Disorders in Children

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### Background/Aim

The literature on the adverse impacts of air pollution on brain, cognition and behavior has exponentially increased in recent years. With increasing prevalence of neuropsychological developmental disorders in children worldwide, the etiology of it still remains unclear. Our aim is to explore the association between prenatal exposure to particulate matter (PM) air pollution and pervasive developmental disorders (PDD) in child.

### Methods

We conducted a case–control study using the National Health Information Database (NHID) of South Korea, a retrospective cohort birth cohort of 288,715 babies who underwent children health screening at first year, born in South Korea between January 1 and December 31, 2008, and followed to December 31, 2013. Study participants were the children with PDD (n=1,195), and children without PDD (n=4,780) randomly selected using propensity score matching for gender and diagnosis age. Diagnosis of PDD was identified based on ICD-10 code (F84). Air pollution exposure levels were predicted by daily averages of PM with diameters < 10 µm (PM10) and nitrogen dioxide (NO<sub>2</sub>) using ordinary kriging model, based on nationwide monitoring data. Logistic regression was used to investigate the association between estimated exposure to PM10 and NO<sub>2</sub> during prenatal period and the risk of PDD.

### Results

PM10 exposure during third trimester was associated with increased odds of PDD, with an adjusted odds ratio (OR) for PDD of 1.10 (95% confidence interval (CI): 1.09, 1.11). With NO<sub>2</sub> exposure during third trimester, an adjusted OR for PDD was 1.09 (95% CI: 1.08, 1.10). Associations with both pollutants in the first and second trimester of pregnancy were not statistically significant.

### Conclusions

Our findings provide the supportive evidence of association of prenatal exposure to ambient particulate matter with PDD in children, particularly the third trimester.

# **SYM17: Air Pollution and Children's Health**

**024, September 27, 2017, 16:00 - 17:30**

## **Maternal exposure to particulate matter during early pregnancy affects fetal cardiac abnormalities**

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### **Background/Aim**

Few studies have used ultrasound measurements to assess particulate matter (PM) on fetal abnormalities. We examined the relationship between ambient particulate matter less than 10  $\mu\text{m}$  (PM<sub>10</sub>) and fetal abnormalities found by ultrasound at the 20-week among 2,710 mid-term pregnant women from an obstetrics and gynecology clinic.

### **Methods**

We used kriging models to estimate exposure to PM<sub>10</sub> from conception to 20 week of pregnancy. We fitted logistic regression models to estimate odds ratios (OR) of having fetal abnormalities including musculoskeletal, nervous, cardiovascular, and urology system after controlling for maternal age, smoking, passive smoking, alcohol drinking, baby sex, multiple births, ultrasound fetal weight, gestational age at the ultrasound measurement, enrollment year, season, and temperature during pregnancy.

### **Results**

Exposure to PM<sub>10</sub> from conception to 20 week of pregnancy was positively associated with cardiac abnormalities, OR: 1.37 (95% confidence intervals [CI], 1.12 – 1.66) per 1  $\mu\text{g}/\text{m}^3$  increase in PM<sub>10</sub>. However, other fetal abnormalities did not show significant associations with PM<sub>10</sub>.

### **Conclusions**

Our results suggest an effect of exposure to PM from early pregnancy on fetal cardiac abnormalities.

# **SYM17: Air Pollution and Children's Health**

**024, September 27, 2017, 16:00 - 17:30**

## **The prenatal greenness and traffic related air pollution on allergic diseases in children**

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### **Background/Aim**

Green spaces and traffic related air pollution (TRAP) have been associated risks of health outcomes. However little is known about the impacts of greenness and TRAP exposure on allergic outcomes. To explain this association, we examined whether greenness and TRAP are associated with allergic diseases.

### **Methods**

Subjects included in the Mothers and Children's Environmental Health (MOCEH) study for the years 2006-2010 were geocoded to residential addresses and matched with the air pollution data modeled by land use regression. Information on childhood allergic diseases was obtained by a questionnaire on the history of allergic diseases diagnosed ever administered to parents or guardians of children. Association between allergic diseases and exposure to nitrogen dioxide (NO<sub>2</sub>) or particulate matter with an aerodynamic diameter < 10 μ m (PM<sub>10</sub>) or green space was examined by logistic regression models.

### **Results**

Childhood asthma was associated with the exposures to PM<sub>10</sub> and NO<sub>2</sub> during the third trimester, with odds ratios (ORs) [(95% confidence interval (CI))= 1.31 (1.00-1.28) per 1 μg increase in PM<sub>10</sub> and 1.09 (1.03-1.15) per 1 ppb increase in NO<sub>2</sub>. An increase in green space (m<sup>2</sup>) was associated with a decreased risk of asthma. The analysis of residential green space revealed indications of strong associations of TRAP with asthma in the areas with less green space.

### **Conclusions**

This study indicates that exposures to TRAP during pregnancy are risk factors for childhood asthma. Exposure to lower green space may intensify the effect of PM<sub>10</sub> and NO<sub>2</sub> exposure on childhood asthma.

\*This study was supported by the Ministry of Environment, Republic of Korea

# **SYM17: Air Pollution and Children's Health**

**024, September 27, 2017, 16:00 - 17:30**

## **'Big data' for Korean Children's Environmental Health Study: current status and emerging possibilities**

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### **Background/Aim**

The Korean government announced the new vision for government operation, which places emphasis on openness, sharing, and collaboration. This has opened the doors to link Korean Children's Environmental Health Study(Ko-CHENS) data with national registers from health-related database in the National Health Information Service(NHIS) of Korea to database in Statistics Korea. The value of combining environmental and epidemiological data by using large-scale cohort study design is growing in recognition and using national data for public health study purpose are already established or under way. To create big data for national children's health, we are in the process of defining a new birth cohort model.

### **Methods**

Through linked national registers, a close to complete follow-up of the cohort study is expected. About 97% of the total birth population in Korea can be investigated through NHIS database including national health screening data, healthcare utilization database, etc. Furthermore, Ko-CHENS offers in-depth information of each participant's, both mothers and their children, health and their environments. In addition, various national environmental data are being linked as the exposures. By using statistical matching methods, procedures to impute or reconstruct missing values are considered.

### **Results**

All-inclusive data, around 2 million births in total, would provide a platform for diverse research, which will maximize the interoperability with various studies. Rather than classifying participants into predetermined disease categories, having sizable data can empower researchers to administer their own criteria with diverse cases. This could lead them to conduct most appropriate methods for each analysis including children's rare diseases, deaths and cause specific death, etc.

### **Conclusions**

The need for wholesome data regarding children's health will continue to grow commensurately. We expect that Ko-CHENS with big data linkage will provide important insights for children and mothers' environmental health, children's growth and development.

## WC13: Environment and Cancer

026, September 27, 2017, 16:00 - 17:30

### Exposure to artificial light-at-night and breast and prostate cancer risk in Spain (MCC-Spain study)

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**Background/Aims.** Night shift work, exposure to light-at-night and the consequent circadian disruption may increase the risk of hormone-dependent cancers. We evaluated the association of exposure to artificial light at night (ALAN) during sleeping time with breast and prostate cancer in a population based multicase-control study (MCC-Spain), among subjects who had never worked at night. We took into account chronotype, a characteristic that may relate to adaptation to light-at-night.

**Methods.** We enrolled 1219 breast cancer cases, 1385 female controls, 623 prostate cancer cases and 879 male controls from 11 Spanish regions, 2008-2013. Indoor-ALAN information was obtained through questionnaires and outdoor-ALAN was analyzed using images from the International Space Station (ISS) available for Barcelona and Madrid, including data of remotely sensed upward light intensity and blue light spectrum information for each geocoded longest residence of each MCC-Spain subject.

**Results.** Among participants with information on both indoor and outdoor ALAN, exposure to higher levels of blue light spectrum (outdoor-ALAN) was associated with an increased risk of breast (adjusted odds ratio OR=1.54, 95%CI 1.0-2.4) and prostate cancer (OR=1.90, 95%CI 1.2-2.9). Overall light intensity (outdoor-ALAN) was not associated with cancer risk. Those sleeping in more illuminated bedrooms (indoor-ALAN) had a higher risk of prostate cancer [OR=2.82, 95%CI 1.5-5.3] while there was no clear association for breast cancer (OR=1.19, 95%CI 0.6-2.6). Evening types tended to have slightly higher prostate cancer risks.

**Conclusion.** Both indoor and outdoor ALAN and particularly blue enriched light spectrum were associated with an increased risk of breast and prostate cancer.

## WC13: Environment and Cancer

026, September 27, 2017, 16:00 - 17:30

Light at night exposure and breast cancer risk: a matched case-control study in England

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**Background/Aim:** There is evidence that light at night (LAN) is a breast cancer risk factor, with in vitro and in vivo studies showing LAN can interrupt melatonin production, a hormone with oncostatic properties. Epidemiological evidence is limited, but a case-control study in Georgia, USA, using lung cancer controls, found LAN exposure to be associated with an increased risk of breast cancer. We conducted a matched case-control study to establish the association between outdoor LAN exposure and female breast cancer risk in England.

**Methods:** Cancer data were obtained from the Office for National Statistics for years 2001 to 2012. LAN values were obtained from satellite data and assigned to each case/control's residential postcode centroid (the geographic centre of a collection of approximately 15 adjacent households). Breast cancer cases aged  $\geq 15$  years were matched to controls by age at diagnosis (in years) and quintile of neighbourhood-level deprivation. The association between LAN and breast cancer was assessed using: i) skin cancer controls, ii) lung cancer controls, and iii) skin, leukaemia, brain/CNS and urinary organs (excluding kidney) cancer controls, using logistic regression, adjusted for year of diagnosis.

**Results:** Our study included 348,561 matched breast cancer cases/skin cancer controls, 163,896 breast cancer cases/lung cancer controls, and 377,495 breast cancer cases/skin, leukaemia, brain, CNS and urinary organ cancer controls. In preliminary analyses, the risk of breast cancer was lower among women exposed to outdoor LAN when using lung cancer controls (Odds ratio in 5<sup>th</sup> vs 1<sup>st</sup> LAN quintile 0.90 (95% CI 0.88-0.92), but higher when using skin cancer controls (OR 5<sup>th</sup> vs 1<sup>st</sup> LAN quintile 1.41 (95% CI 1.39-1.43).

**Conclusions:** Globally, breast cancer is the most commonly diagnosed cancer and it has the highest mortality rate among women, and any modifiable risk factors (such as LAN) warrant further investigation to assess possible associations.

# WC13: Environment and Cancer

026, September 27, 2017, 16:00 - 17:30

Association between environmental quality and lung cancer survival in the United States, 2000-2005

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**Word Count:** 292

## **Background/Aims**

Lung cancer remains one of the most prevalent and lethal cancers in the United States. Individual environmental exposures have been associated with lung cancer incidence. However, the impact of cumulative environmental exposures on survival is not well understood and we aim to address this gap in literature.

## **Methods**

We estimated county level overall environmental quality in the United States using U.S. Environmental Protection Agency's (USEPA) Environmental Quality Index (EQI). The EQI captures exposure to over 200 environmental factors across five environmental domains (air, water, land, sociodemographic, and built) for the years 2000-2005. For persons diagnosed with lung cancer from 2000-2005 (n=272,371), county-level smoking prevalence and individual level data on survival time (through Dec. 31, 2013) and co-variates (age, marital status, sex, histology, stage, race, surgery, radiation) from the Surveillance, Epidemiology, and End Results Program (SEER) were linked to the EQI based on place of residence. We modeled the EQI and associated domain-specific indices as quartiles (Q; Q4 worst environment) and used Cox Proportional Hazard models to estimate hazard ratios (HR) and 95% confidence intervals. We adjusted for individual-level covariates and stratified by stage at diagnosis (local, regional, distant) and rural-urban status.

## **Results**

Prior to stratification, overall EQI and individual domains showed mostly null or slight positive or negative associations comparing highest to lowest index quartile (EQIQ4: HR=0.92(0.89,0.95). Post stratification, we observed stronger positive associations for individual domains across different strata (e.g. Non-Metro Urban, Local Stage AirQ4: HR=1.21(1.11, 1.33); Metro Urban, Local Stage SociodemQ4: HR=1.08(1.03,1.13)). Most positive associations were observed for urban areas and at the localized cancer stage.

## **Conclusions**

Our results suggest a link between aspects of environmental quality and lung cancer survival with potential variation by rural-urban status and stage at diagnosis. This abstract does not necessarily reflect EPA policy.

## WC13: Environment and Cancer

026, September 27, 2017, 16:00 - 17:30

### Exposure to ambient particulate matter elements and incidence of gastric cancer in European cohorts from 7 countries.

Author information; Arial 8pt (please overtype this)

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ESCAPE study group

**Background/Aim:** Previous analysis from the large European multicentre ESCAPE study showed an association of particulate matter <2.5µm (PM<sub>2.5</sub>) exposure at residence with the incidence of gastric cancer. However, it is unclear which components of PM<sub>2.5</sub> are most relevant for disease causation. We evaluated the association between long-term exposure to chemical elements contained in PM<sub>2.5</sub> and gastric cancer incidence in ESCAPE.

**Methods:** Baseline addresses of individuals were geocoded and exposure was assessed by land-use regression models for Cu, Fe and Zn representing non-tailpipe traffic emissions; S indicating long-range transport; Ni and V for mixed oil-burning and industry; Si for crustal material and K for biomass burning (de Hoogh et al.,2013). We used Cox regression models adjusting for potential confounders in cohort-specific analyses and combined the effect estimates using meta-analyses random effects models.

**Results:** We included data on 227,044 individuals contributing 3,382,997 person-years at risk (average follow-up 14.9 years) with 633 incident cases. The hazard ratio (HR) for an increase of 200 ng/m<sup>3</sup> of PM<sub>2.5</sub>\_S was (1.92 (95%-confidence interval (95%-CI) 1.13;3.27) for gastric cancer, with no indication of heterogeneity between cohorts (I<sup>2</sup>=0%), and 1.63 (95%-CI 0.88;3.01) for PM<sub>2.5</sub>\_Zn (I<sup>2</sup>=70%). For the other elements, HRs between 0.78 and 1.21 with mostly wide CIs indicating no association were seen. Adjustment for additional, including dietary, factors yielded very similar HRs. Restriction to study participants with stable addresses over follow-up resulted in small increases of the effect estimates for PM<sub>2.5</sub>\_S and for PM<sub>2.5</sub>\_Zn with a decrease in precision.

**Conclusions:** This large multicentre study shows an association between exposure to sulphur content in PM<sub>2.5</sub> and gastric cancer, suggesting that air pollution from long-range transport may be particularly important for the effect of PM<sub>2.5</sub> on gastric cancer.

**Reference:** Development of land use regression models for particle composition in twenty study areas in Europe. de Hoogh K, Wang M, Adam M, Badaloni C, Beelen R, Birk M, et al. Environ Sci Technol. 2013, 4;47(11):5778-86.

## WC13: Environment and Cancer

026, September 27, 2017, 16:00 - 17:30

### Air pollution and prostate cancer risk in the multicase-control study in Spain (MCC-Spain)

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#### Background/Aim

Age, race and family history of cancer are well established risk factors while there is little knowledge on environmental and lifestyle factors. Air pollution was suggested as a potential risk factor but evidence is scarce. We examined the association between PM<sub>2.5</sub> and NO<sub>2</sub> levels and risk of prostate cancer.

#### Methods

840 prostate cancer cases and 1,179 controls were recruited between 2008-13 from 11 hospitals in 7 Spanish provinces. We geocoded the current residence of each participant and estimated the annual mean concentration of particulate matter with an aerodynamic diameter < 2.5 µm (PM<sub>2.5</sub>) and of nitrogen dioxide (NO<sub>2</sub>) during 2009 using European land-use regression models. We used mixed models for logistic regression controlling for hospital and adjusting for potential confounders.

#### Results

Mean (standard deviation) levels of PM<sub>2.5</sub> and NO<sub>2</sub> were 17.97 (2.74) µg/m<sup>3</sup> and 39.32 (7.59) µg/m<sup>3</sup>, but marked variation in mean values was observed between provinces [PM<sub>2.5</sub>: lowest values in Asturias (14.22 (0.80)) and highest in Huelva (23.33(0.72)); NO<sub>2</sub>: lowest values in Huelva (21.69 (4.42)) and highest in Valencia (44.58 (7.57))]. Overall, PM<sub>2.5</sub> and NO<sub>2</sub> levels were not associated with risk of prostate cancer after adjusting for age, education, socio-economic status (SES) at individual level and at area level [OR (95%CI)=1.05 (0.74 – 1.51) and OR (95%CI)=1.03 (0.86 – 1.22), respectively]. The association between NO<sub>2</sub> levels and risk of prostate cancer was modified by levels of individual SES, with a suggested increase in risk with decreasing levels of SES [results stratified by SES: high: OR (95%CI)=0.83 (0.55 – 1.25), middle: OR (95%CI)=1.09 (0.86 – 1.39) and low: OR (95%CI)=1.12 (0.83 – 1.50)].

#### Conclusions

PM<sub>2.5</sub> and NO<sub>2</sub> levels do not seem to be associated with risk of prostate cancer. However, PM<sub>2.5</sub> and NO<sub>2</sub> levels vary greatly between study regions and therefore further analysis will explore the association between air pollution and prostate cancer within each province.

## WC13: Environment and Cancer

026, September 27, 2017, 16:00 - 17:30

### Nitrate and disinfection by-products in drinking water and risk of colon and rectum cancers in older women

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**Background/Aim:** *N*-nitroso compounds (NOC) formed endogenously after nitrate/nitrite ingestion and disinfection by-products (DBP) are suspected colorectal carcinogens. However, epidemiologic evaluations are limited and most have not examined these exposures simultaneously.

**Methods:** We evaluated historical nitrate-nitrogen (NO<sub>3</sub>-N) and the regulated DBP class total trihalomethanes (TTHM) in public water supplies (PWS) and dietary nitrate/nitrite in relation to incident colorectal cancers among postmenopausal women in the Iowa Women's Health Study cohort. We computed average concentrations of these contaminants by duration of PWS use, and years of exposure above one-half the maximum contaminant level (>½-MCL; >5ppm NO<sub>3</sub>-N and >40ppb TTHM). Dietary nitrate/nitrite intakes were estimated using a food frequency questionnaire. We computed hazard ratios (HR) and 95% confidence intervals (CI) from multivariable Cox regression of NO<sub>3</sub>-N and TTHM quintiles and ≥ or < median years >½-MCL (4 and 36, respectively), mutually adjusting models of water contaminants. We assessed nitrate interactions with TTHM and with factors influencing NOC formation, including smoking and dietary intakes of vitamin C and heme iron.

**Results:** We identified 624 colon and 158 rectum cancers (1986-2010) among 15,910 women who used their PWS ≥10 years. Drinking water NO<sub>3</sub>-N exposures were not associated with risk of either malignancy. We observed a slightly elevated colon cancer risk among women ingesting TTHM >18ppb (HR<sub>Q5vsQ1</sub>=1.2, CI=0.9-1.5; p<sub>trend</sub>=0.06) or exposed to >½-MCL ≥36 years (HR=1.3, CI=0.8-1.9; p<sub>trend</sub>=0.08) versus no years exposure >½-MCL. We observed increased rectum cancer risk in the highest average TTHM quintile (HR<sub>Q5vsQ1</sub>=1.9, CI=1.1-3.2; p<sub>trend</sub>=0.17) but not with years >½-MCL. Colon cancer risk increased with dietary nitrate/nitrite intake from some types of processed meats, but without monotonic trend. We found no evidence of interactions.

**Conclusions:** Our results suggest that long duration of exposure to >18ppb TTHM is associated with increased risk of rectum cancer. Nitrate ingestion was not associated with risk overall or in analyses of factors affecting nitrosation.

## WC14: Biomarkers

020, September 27, 2017, 16:00 - 17:30

### Associations between air pollution exposure & HbA1c – an analysis in non-diabetic participants of the Heinz Nixdorf Recall study

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#### Background/Aim

Prior studies investigating a possible link between air pollution exposure and glycated hemoglobin (HbA1c) levels, a measure of medium-term blood glucose, have shown mixed results. As few studies have had sufficient power to evaluate this association among non-diabetics, this study aimed to estimate the effect of medium-term air pollution exposure on HbA1c among persons with normal glucose metabolism.

#### Methods

Data from participants of the prospective Heinz Nixdorf Recall study who were non-diabetic and presented with normal HbA1c levels (4.0-6.5%) at baseline (n=3,580) and first follow-up examination (n=2,942) were used in this study. Exposure to particulate matter (PM; diameter  $\leq 10, 2.5 \mu\text{m}$ ), particle number (PN; accumulation and coarse modes), and  $\text{NO}_2$  was assessed using the EURAD chemistry transport model, which estimates air pollution exposures on a  $1 \text{ km}^2$  grid, and assigned to participants' addresses. We evaluated the association between medium-term (28- and 91-day mean) exposure to air pollution prior to blood draw and HbA1c level using linear regression analysis, including a random participant intercept to account for repeated measures and adjusting for demographic, lifestyle, and meteorological variables.

#### Results

In fully adjusted models, interquartile range increases in 91-day mean exposure to PM and PN were positively associated with HbA1c levels ( $\text{PM}_{10}$ : 0.04% (0.03, 0.06) per  $5.5 \mu\text{g}/\text{m}^3$ ;  $\text{PM}_{2.5}$ : 0.06% (0.04, 0.08) per  $4.0 \mu\text{g}/\text{m}^3$ ; PN: 0.08% (0.06, 0.09) per 1,345 particles). These effects were significantly modified by season at examination, with strongest effects in spring, and by smoking status, with strongest effects among former smokers. Effects using 28-day mean exposures, while weaker, were in the same direction as the 91-day exposures.  $\text{NO}_2$  exposure was not associated with HbA1c level.

#### Conclusions

Increased medium-term exposure to fine particulate matter mass and particle number is positively associated with HbA1c among persons without diabetes.

## WC14: Biomarkers

020, September 27, 2017, 16:00 - 17:30

Identification of lead exposure through biomarker surveillance, Victoria, Australia

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### Background/Aim

Lead poisoning can impact neural, renal and cardiovascular health, and adversely affect neurodevelopment in children. The ISEE Call for Action for Global Control of Lead Exposure to Eliminate Lead Poisoning highlights the importance of surveillance programs to identify lead exposed individuals and new sources of lead exposure. In Victoria since 1 January 2010, elevated blood lead level (BLL) test results must, by law, be notified to the Department of Health and Human Services (DHHS). We describe the epidemiology of elevated BLLs, and the utility of this biomarker surveillance system for identifying lead exposure sources, in Victoria.

### Methods

Case and exposure history information for elevated BLL (>10 micrograms per decilitre) notifications received between 1 January 2010 and 31 December 2015 were extracted from the DHHS Public Health Event Surveillance System.

### Results

In 2010-2015, 1,530 incident cases with elevated BLLs were notified to DHHS. Incidence rates declined from 13.7 per 100,000 population in 2010 to 1.8/100,000 in 2015. Cases were mostly male (94.4%) and aged 20-59 years. Cases aged  $\geq 15$  years were primarily exposed through known lead-risk occupations (88.2%). Non-occupational lead exposures included home renovation, Ayurvedic medicine use and hobby activities; clusters of cases were linked to exposure at several shooting ranges. In children, 24 cases were aged <15 years, 16 were <5 years. Their median BLL was 15 $\mu$ g/dL (range: 10-64) and reported exposures included ingestion of lead-containing materials or objects, and dust inhalation during home renovation.

### Conclusions

Victoria has no major industrial source of lead air pollution. Lead-risk occupations remain the principal lead exposure source identified in Victoria, reflecting mandatory occupational BLL testing. Occupational cases were referred to WorkSafe Victoria, who have jurisdiction to conduct workplace investigations. Elevated BLL surveillance identified Ayurvedic medicine use, recreational shooting and legacy paint sources as non-occupational lead exposure hazards, enabling distribution of public health messages to at-risk groups.

## WC14: Biomarkers

020, September 27, 2017, 16:00 - 17:30

### Urinary concentrations of insecticide and herbicide metabolites among pregnant women in rural Ghana: a pilot study

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#### Background/Aim

Use of pesticides by households in rural Ghana is common for residential pest control, agricultural use, and for reduction of vectors carrying disease; yet, few data are available about exposure to pesticides among this population. Our objective was to quantify urinary concentrations during pregnancy of metabolites of organophosphate (OP), pyrethroid, and select herbicides and explore exposure determinants.

#### Methods

In 2014, 17 pregnant women from the Brong Ahafo Region of rural Ghana were surveyed about household pesticide use and provided weekly first morning urine voids at three visits (n=51 samples). The study utilized the Ghana Randomized Air Pollution and Health Study (GRAPHS; Trial Registration NCT01335490) to recruit pregnant women into this pilot study on prenatal pesticide exposure. A questionnaire was administered to participants about household use of pesticides, personal and family agricultural activities, as well as bednet use and other antimalarial prevention strategies. The metabolite concentrations were natural log-transformed to normalize the distribution and were used to estimate the geometric mean of the three urine samples per participant.

#### Results

90.1% (46/51) of samples had detectable OP metabolites [geometric mean, GM (95% CI): 3,5,6-trichloro-2-pyridinol 0.54 µg/L (0.36-0.81), para-nitrophenol 0.71 µg/L (0.51-1.00)], 75.5% (37/49) had detectable pyrethroid metabolites [GM: 3-phenoxybenzoic acid 0.23 µg/L (0.17, 0.32)] and 70.5% (36/51) had detectable 2,4-dichlorophenoxyacetic acid, an herbicide [GM: 0.46 µg/L (0.29-0.73)].

#### Conclusions

Concentrations of para-nitrophenol and 2,4-dichlorophenoxyacetic acid in Ghanaian pregnant women appear higher when compared with nonpregnant reproductive-aged women in a reference US population. Larger studies are necessary to more fully explore predictors of exposure in this population.

## WC14: Biomarkers

020, September 27, 2017, 16:00 - 17:30

### Hair as biomarker of toxic and essential trace elements in children

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#### Background/Aim

Metals and other trace elements in hair have been commonly used as exposure biomarkers, as hair collection is non-invasive. However, concern has been raised regarding the appropriateness for assessing the actual absorbed dose. The aim was therefore to evaluate children's hair as biomarker of internal dose for toxic (As, Mn, Cd, Pb) and essential (Mg, Ca, Fe, Co, Cu, Zn, Se, Mo) elements.

#### Methods

In 207 children (9-10 years), belonging to a mother-child cohort in rural Bangladesh, we measured concentrations of the selected elements in hair (2 cm closest to the scalp) by ICP-MS, following Triton X-100 washing and acid digestion. We compared these concentrations with those in blood (erythrocyte fraction), urine and water, collected about six months earlier. For a sub-set of children (n=19), we analyzed four consecutive 2 cm-pieces of hair.

#### Results

There were significant correlations between hair As and the other biomarkers (blood:  $r_s=0.73$ ,  $p<0.001$ ; urine:  $r_s=0.66$ ,  $p<0.001$ ) and water ( $r_s=0.60$ ,  $p<0.001$ ), and between Se in hair and blood, especially when assessing Se in hair and blood representing the same time period, i.e. the 7-8<sup>th</sup> cm of hair ( $r_s=0.54$ ,  $p=0.026$ ), assuming one cm growth per month. Suitability of hair-Se as exposure biomarker was supported by associations with cognitive abilities. Hair Co and Mo showed weak correlations with concentrations in blood. We found no associations between Mn in hair and blood, urine, or water, and the geometric mean concentration increased almost 5 times from the 2 cm closest to the head to the 7-8<sup>th</sup> cm ( $p<0.001$ ). Also Mg, Ca, Co, Cd, and Pb increased from the scalp outwards ( $p<0.001$ ).

#### Conclusions

Hair was found to be appropriate for assessment of absorbed As and Se only. Out of all measured elements, hair Mn seemed the least reflective of internal dose.

## WC14: Biomarkers

020, September 27, 2017, 16:00 - 17:30

### Meconium: a Novel Biomarker of *in Utero* Exposure to Acetaminophen and Caffeine

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**Background/Aim:** Epidemiology relies on cord blood concentrations to estimate *in utero* exposure to environmental chemicals, but collection can be hampered by delivery complications or timing. Meconium is a non-invasive biological matrix that accumulates over the last two trimesters of pregnancy and can be collected outside the stressful environment of the delivery room. We assessed whether meconium concentrations of acetaminophen and caffeine were associated with maternal intake of these compounds during pregnancy in the GESTation and Environment (GESTE) study, a longitudinal birth cohort in Sherbrooke, Québec, Canada.

**Methods:** We recruited pregnant women (n=238) during the first trimester and assessed maternal intake of acetaminophen during pregnancy (yes/no) via questionnaire. Clinical files from the hospital medical database and medical charts were used to determine administration of acetaminophen during labor (yes/no) and maternal coffee intake (yes/no) during pregnancy. We measured concentrations of acetaminophen and caffeine in meconium using ultra performance liquid chromatography tandem mass spectrometry and log-transformed them to achieve a normal distribution. We used multivariable linear regression analyses adjusted for pre-pregnancy BMI to determine the association between maternal intake of acetaminophen during labor/delivery and meconium levels. In our analysis for caffeine we also adjusted for gestational age to account for duration of exposure.

**Results:** Acetaminophen administration during labor was associated with a significant increase in meconium acetaminophen concentration ( $\mu_{no}=2.30$  ng/g,  $\mu_{yes}=4.15$  ng/g;  $p=0.0002$ ), accounting for acetaminophen intake during pregnancy. Acetaminophen intake during pregnancy was marginally associated with meconium concentrations ( $\mu_{no}=2.51$  ng/g,  $\mu_{yes}=3.83$  ng/g;  $p=0.10$ ), adjusting for administration at delivery. Maternal report of caffeine intake during pregnancy was associated with a significant increase in meconium caffeine concentrations ( $\mu_{no}=5.46$  ng/g,  $\mu_{yes}=6.33$  ng/g;  $p<0.0001$ ).

**Conclusions:** Maternal acetaminophen and caffeine intake is associated with concentrations in meconium, suggesting that meconium can be used to assess *in utero* exposure. This method may be extended to environmental chemicals.

## WC14: Biomarkers

020, September 27, 2017, 16:00 - 17:30

### Reconstructing Infant Dietary Transitions and Composition from Novel Tooth Matrix Biomarkers

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#### Background/Aim

Early life diet is a major determinant of lifelong health trajectories. However, studies of the long term health outcomes of breastfeeding and formula supplementation are difficult to study due to cost and time restraints in collecting data prospectively and the inherent limitations of questionnaires. A biomarker that can retrospectively measure the dose, intake duration and composition of breastmilk and formula would be a major advancement in the study of the health trajectories associated with infant diet, particularly for health outcomes that are rare or can only be measured much later in life, years after the cessation of breastfeeding.

#### Methods

Chemical signals in teeth can be used to reconstruct infant diet transitions and composition from birth till early childhood. Our method precisely analyses aged dentine layers, generating longitudinal, weekly estimates of biomarkers of infant diet. Using reversed distributed lag models (DLM) we investigated which chemical signatures in teeth were the best markers of breastmilk or formula intake. We tested this method in a non-human primate model and have further applied the method in a second primate model of cyclical nursing and human studies.

#### Results

Preliminary studies identified barium as a sensitive marker of infant diet transition from mother's milk to solid foods in non-human primates and the introduction of infant formula in humans. Reversed DLMs indicated strontium may be a sensitive marker to infant formula use and lithium as a marker for long term breastfeeding.

#### Conclusions

Infant diet transitions and composition can be reconstructed using chemical signatures in teeth. We plan to use a lagged weighted quantile sum regression analyses to identify the chemical mixture unique to breastmilk or formula to precisely measure the dose of breastmilk during mixed feeding. This method can be applied to more accurately investigate associations of breastfeeding with long term health outcomes.

## WC15: Chronic Arsenic Exposure in Asia

022, September 27, 2017, 16:00 - 17:30

### Arsenic, DNA damage, and cancers of bladder and kidney – Long-term follow-up of residents in arseniasis endemic area of North-eastern Taiwan

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**Background/Aim:** Arsenic is ubiquitous and becoming one of the largest environmental health concerns in the area where ground water is needed as source of drinking water, or arsenic is prevalent in air pollutants. High inorganic arsenic exposure has been found related to various cancers and cardiovascular diseases. The aim is to assess dose-response association between arsenic exposure, DNA damage biomarkers, and the incidence of bladder and kidney cancers.

**Methods:** A total of 8102 men and women from 3901 households have been enrolled in 1991-1994, and followed in 2011-2014. The data collected included well water consumption, habits of cigarette smoking, alcohol consumption, exercise and diet, and personal and family history of major diseases through standardized personal interview. The individual urinary arsenic species were quantified using high-performance liquid chromatography–inductively coupled plasma/mass spectrometry (HPLC-ICP/MS). For assessment of oxidative and methylated DNA lesions and depletion, urinary 8-oxo-7,8-dihydro-2'-deoxyguanosine (8-oxodG) and N7-methylguanine (N7-MeG) were measured respectively, using liquid chromatography/tandem mass spectrometry (LC-MS/MS). The National Cancer Registry Data using the pathology finding defined bladder and kidney cancers.

**Results:** Urinary levels of the two DNA adducts increased significantly with increasing urinary arsenic level (iAs+MMA+DMA) in both men ( $\beta=0.82$ ,  $\beta=0.34$  for 8-oxodG and N7-MeG, respectively,  $p<0.0001$  for both) and women ( $\beta=1.03$ ,  $0.38$ ,  $p<0.0001$ ) adjusted for potential confounders of age and cigarette smoking. Incidence rate of bladder and kidney cancer using person-years tended to be the highest for higher urinary inorganic and methylated arsenic with higher DNA adduct level than the medians.

**Conclusions:** It is suggested that subjects with high arsenic exposure experienced further cancer risk with high level of DNA damage biomarker.

For: **Oral (General Sessions)** with topic of **Arsenic**

## WC15: Chronic Arsenic Exposure in Asia

022, September 27, 2017, 16:00 - 17:30

### Associations of arsenic exposure in drinking water and renin–angiotensin–aldosterone system related gene polymorphisms with chronic kidney disease

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#### Background

Both arsenic and the renin–angiotensin–aldosterone system may play a role in kidney damages, and therefore, we conducted a study in Taiwan to evaluate whether arsenic exposure in drinking water and angiotensinogen (AGT) genetic polymorphisms are associated with the risk of chronic kidney disease (CKD).

#### Methods

We conducted a case-control study and recruited 228 patients of CKD and 125 controls without CKD were from the National Cheng Kung University Hospital. All the participants were interviewed using a standard questionnaire to collect data on demographics, lifestyle factors such as cigarette smoking, alcohol, drinking water history, and other relevant risk factors for CKD. Polymorphisms of AGT (A[–20]C) and (Thr174Met) were examined by polymerase chain reaction-restricted fragment length polymorphism. The arsenic level in drinking water of each participant was assessed on the basis of the measurement in 311 townships obtained by a nationwide survey.

#### Results

The frequency of AGT(A[–20]C) A/A genotype in case and control groups was 71.9% and 77.7%, and that of A/C genotype was 28.1% and 22.3%, respectively. In the case and control groups, the frequencies of AGT(Thr174Met) Thr/Thr genotype (78.5% vs. 81.3%), Thr/Met genotype (20.5% vs. 18.8%), and Met/Met genotype (0.0% vs. 1.0%) were similar. However, the distributions of arsenic levels were different between the two groups; while 52.7% of the cases were from townships with high arsenic level, only 35.2% of the controls were from those townships.

#### Conclusions

While AGT(A[–20]C) A/C genotype was more prevalent in patients with CKD, the distribution of AGT(Thr174Met) genotypes has no association with CKD. Arsenic levels in drinking water was also associated with CKD.

# WC15: Chronic Arsenic Exposure in Asia

022, September 27, 2017, 16:00 - 17:30

## Associations between Arsenic in Drinking Water and the Occurrence of End-Stage Renal Disease with Modifications by Comorbidities: A Nationwide Population-Based Cohort Study in Taiwan

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### Background/Aim

Arsenic may affect the function of proximal convoluted tubules and glomerulus, but epidemiological data in the association between arsenic ingestion and end-stage renal disease (ESRD) are limited. Our objective is to study the associations between exposure to arsenic from drinking water and the occurrence of ESRD in Taiwan, where the prevalence and incidence of ESRD are among the highest in the world.

### Methods

Using data extracted from the Longitudinal Health Insurance Database (LHID2000) of the National Health Insurance in Taiwan, we constructed a cohort with age  $\geq 40$  years and identified patients of ESRD newly diagnosed between January 1, 1998 and December 31, 2010. Arsenic levels were assessed on the basis of a nationwide census survey conducted by the government, of which measurement reports were available for 311 townships, covering almost 85% of the townships in Taiwan. We performed multivariate Cox proportional hazard regressions to identify risk factors of ESRD and evaluate their effects. In addition, we studied the potential effect modification by comorbidities, including hypertension, hyperlipidemia, diabetes mellitus, stroke, cardiovascular diseases, and anemia.

### Results

In the uni-variate analyses, we found residents of areas with arsenic levels  $\geq 50$   $\mu\text{g/L}$  in the drinking water had a hazard ratio (HR) = 1.14 (95% confidence interval [CI]: 1.08-1.21) for ESRD. After adjusting for sex, age, income, urbanization level, and comorbidities, the increased risk was still statistically significant, with an adjusted HR (AHR) = 1.12 (95%CI: 1.05-1.18). The effect was modified by comorbidities, with more prominent effects on patients with less than three comorbidities.

### Conclusions

We found that a high arsenic level in the drinking water was a risk factor for developing ESRD, independent of most documented risk factors, and observed effect modification by comorbidities. Intervention programs should be implemented in endemic areas of arsenic exposure to reduce the occurrence of ESRD.

**Keywords:** arsenic, drinking water, end-stage renal disease (ESRD), National Health Insurance Research Database (NHIRD), Taiwan

## WC15: Chronic Arsenic Exposure in Asia

022, September 27, 2017, 16:00 - 17:30

Early life arsenic exposure and non-malignant respiratory illnesses among adolescents in rural Bangladesh

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**Background/Aim:** Evidence suggests that exposure to arsenic through drinking water increases the risk of non-malignant respiratory illnesses including impairment of lung function in adults. However, early life arsenic exposure and subsequent respiratory system effects in adolescents have not been reported so far.

**Methods:** The study was conducted in rural Bangladesh, Matlab. A cohort of 200 children now aged 11-22 years were enrolled of which 107 had in utero and early childhood (first five years) exposure to drinking water arsenic concentration over 400 µg/L (exposed group) and 93 had less than 10 µg/L (unexposed group). Histories of respiratory symptoms were collected through a validated structured questionnaire (ISAAC). Lung function (FEV1, FVC) was tested by EasyOne spirometry following the standard American Thoracic Society criteria. Water arsenic concentrations were measured by hydride generation atomic absorption spectrophotometry.

**Results:** The mean age was 15 years. Chronic respiratory symptoms were evident in male participants in the exposed group. In an adjusted model, boys with in early life arsenic exposure (>400 µg/L) were more likely to report wheezing attacks 1-3 times/week (Prevalence Odds Ratio (POR): 4.99, 95% Confidence Interval (CI): 1.00-24.9), wheezing after exercise (POR: 4.14, 95% CI: 1.05-16.4) and waking up with chest tightness (POR: 5.01, 95% CI: 1.00-25.0). Decrease in FEV1 (-117.3 ml, CI: -246.5, 11.8) and FVC (-135.2 ml, CI: -269.9, -0.37) were observed in male respondents in the exposed group compared to the unexposed. No respiratory impairment was observed among exposed girls.

**Conclusions:** High exposure to arsenic in utero and early childhood may result in increased risk of chronic respiratory symptoms and decrements in lung function in adolescent males. We plan to follow this unique cohort further to see if early life arsenic exposure respiratory effects persist in males as they grow older, and remain absent in females.

# WC15: Chronic Arsenic Exposure in Asia

022, September 27, 2017, 16:00 - 17:30

Associations between arsenic exposure in drinking water and retinopathy: A nationwide population-based study in Taiwan

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## Background

Arsenic is associated with many microvascular diseases, including atherosclerosis, and diabetes mellitus (DM), and these conditions play important roles in the development of retinopathy. We conducted a study to evaluate the association between arsenic in drinking water and retinopathy.

## Methods

We conducted a retrospective cohort study of whose age was more than 40 years old and had no retinopathy before 1998 in the Longitudinal Health Insurance Database 2000. We adopted measurement data on 311 townships obtained from a nationwide survey of drinking water to assess the arsenic level in drinking water for each cohort member. In addition, we followed up the cohort members to assess the incidence of retinopathy and carried out stratified analysis to evaluate the effect modification by DM. Cox proportional hazard models were used to calculate the hazard ratio (HR) associated with arsenic exposure and adjust for the effects of potential confounders.

## Results

Of the 265,204 qualified cohort members, 17,097 (6.45%) were diagnosed as having retinopathy during the study period, including 3,139 (6.62%) from the high-level exposure group, 3,785 (6.58%) from the middle-level exposure group, and 10,173 (6.35%) from the low-level exposure group. After adjusting for potential confounders, we observed positive associations between arsenic exposure and the incidence of retinopathy in cohort members without DM. In comparison with low-level exposure, the HR associated with high-level exposure was 1.46 (95% confidence interval [CI]: 1.20 -1.77), and the HR associated with middle-level exposure was 1.28 (95% CI: 1.07 -1.54). However, the associations were not observed in patients with DM.

## Conclusions

We found a positive association between arsenic exposure in drinking water and the occurrence of retinopathy, but such an association was not observed in DM patients.

## WC15: Chronic Arsenic Exposure in Asia

022, September 27, 2017, 16:00 - 17:30

### Hair Arsenic Level and Prevalence of Arsenicosis among Secondary school Children in Kandal Province, Cambodia.

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Children worldwide are exposed to arsenic in drinking water at concentrations that exceed the guideline recommended by the World Health Organization and the U.S. Environmental Protection Agency which is a maximum arsenic level of 10 µg/L or ppb. Contaminated groundwater from tub wells in Cambodia was discovered in 2001 leading to the detection of the first cases of arsenicosis in 2006. The research was carried out at three study sites with varying groundwater As levels in Kandal province, Cambodia. Kampong Kong Commune was chosen as a heavily contaminated site (300-500ppb), Svay Romiet Commune was chosen as moderately contaminated site (50-300ppb) and Along Romiet Commune was chosen as a control site (<10ppb). A health questionnaire survey was conducted in a sample of exposed and control school children from three arsenic contaminated sites with varying levels of arsenic in their groundwater. Physical examination was carried out all respondents in order to identify any sign and symptom of arsenicosis. Children's hair samples were also collected to investigate the association of hair As levels and prevalence of arsenicosis. The results from ICP-MS analyses of hair samples presented that hair As levels at the 3 study sites were significantly different ( $p < 0.001$ ), whereby hair samples from highly contaminated site ( $n=157$ ) had a median As level of 0.93ppm, moderately contaminated site ( $n=151$ ) had a median As level of 0.22ppm, and control site ( $n=214$ ) had a median As level of 0.08ppm. The prevalence of the signs and symptoms of arsenicosis were highest at the highly contaminated site, followed by the moderately contaminated site and control site. The most prevalent sign of arsenicosis was hypomelanosis with a prevalence of 4.4% among all respondents, followed by hyperkeratosis (2.8%), mee's lines (2.3%) and hyperpigmentation (1.7%).

# WC16: Ambient air adult respiratory mortality & morbidity

100, September 27, 2017, 16:00 - 17:30

## Long-term Exposure to Ambient Ozone and Mortality in Korea: A 12-Year Nationwide Cohort Study

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### Background/Aim

Although there is strong evidence that short-term exposure to ozone is associated with adverse health outcomes, the effects of long-term exposure to ozone have not been well studied. Investigating the health effects of long-term exposure to ozone is important in terms of climate change, disease burden and public health policy. In this study, we assessed the relationship between long-term exposure to ambient ozone and mortality in Korea, using a nationwide population-based cohort.

### Methods

Mortality data were obtained from National Sample Cohort (2002-2013) in Korea. Several ozone exposure matrices were calculated for each district in 7 major cities, and matched with the cohort data. The final study sample consisted of 212,315 individuals (2,047,103 person-year). Cox-proportional hazard regression model was used to estimate the effects of both fixed and time-dependent exposure of ozone on mortality.

### Results

Both fixed and time-dependent ozone exposures were associated with all-cause and cause-specific mortality. The association with respiratory mortality was relatively large. The hazard ratios for respiratory mortality in association with 1 ppb increase in ozone (24-hr annual mean) were: 1.027 (95% confidence interval (CI): 1.009, 1.045) for fixed baseline exposure; 1.038 (95% CI: 1.015, 1.061) and 1.028 (95% CI: 1.007, 1.051) for time-varying cumulative and yearly mean exposure, respectively. Inclusion of PM10 in the model did not considerably change the results.

### Conclusions

This study provides evidence on mortality effects of long-term exposure to ozone. The stronger association with respiratory mortality is consistent with previous studies, even though the effect sizes are relatively large. However, the paucity of independent studies regarding long-term ozone exposure and mortality, especially outside of the United States, limits the comparison of the present result with other studies.

# WC16: Ambient air adult respiratory mortality & morbidity

100, September 27, 2017, 16:00 - 17:30

Distributed lag association between wildfire smoke and cardiopulmonary-related morbidity during the 2012 Washington wildfires

Author information; Arial 8pt (please overtype this)

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## Background/Aim

Washington State (US) experienced a number of intense wildfires that produced a large amount of smoke during September 2012. We evaluated lagged associations between wildfire smoke exposure and cardiopulmonary morbidity.

## Methods

Smoke exposure was estimated from July 1<sup>th</sup> to October 31<sup>st</sup> 2012 using geographically weighted ridge regression (GWR). GWR is a data-fusion method that blends information from surface monitors, chemical-weather models, and satellite observations to estimate smoke particulate matter  $\leq 2.5$  microns in diameter (PM<sub>2.5</sub>). Population-weighted daily average estimates of smoke were linked with daily counts of county-aggregated pulmonary-related and cardiovascular disease-related (CVD) emergency department or urgent care hospital visits. Quasi-Poisson distributed lag models for each county were used to assess the relationship between the time series of daily lagged smoke for a 10 to 0 day period prior to daily morbidity counts. We then pooled county-specific results using meta-analysis to estimate the overall effect.

## Results

A 10  $\mu\text{g}/\text{m}^3$  increases in smoke exposure was significantly associated with an increase in pulmonary-related hospital visits 1 day following smoke exposure (Risk Ratio [RR]: 1.02, 95% confidence interval [95%CI]: 1.00–1.04); this increased risk persisted until 2.5 days following smoke exposure. A 10  $\mu\text{g}/\text{m}^3$  increases in smoke exposure was significantly associated with a reduced risk of CVD hospital visits 1.5 days following exposure (RR: 0.98, 95%CI: 0.98–0.99), which persisted until 2.5 days following smoke exposure. However, an increased risk for CVD hospital visits was observed 6.5 days following exposure (RR: 1.02, 95%CI: 1.00–1.03), which persisted until 8 days following smoke exposure.

## Conclusions

Wildfire smoke exposure increases risk for pulmonary-related hospitalizations roughly a day after smoke exposure, where this elevated risk can last for a couple days. The relationship between smoke exposure and CVD appears to be more complicated, where risk for CVD may be elevated a week after smoke exposure.

## WC16: Ambient air adult respiratory mortality & morbidity

100, September 27, 2017, 16:00 - 17:30

### Satellite-based estimates of long-term exposure to PM<sub>2.5</sub> and its association with chronic obstruct pulmonary disease in Taiwan adults

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#### Background/Aim

Previous studies have shown the short-term effects of fine particulate matter (PM<sub>2.5</sub>) on lung function. However, the effects of long-term exposure to PM<sub>2.5</sub> on lung function and chronic obstructive pulmonary disease (COPD) are not well-documented. This study aimed to investigate the satellite-based estimates of long-term exposure to PM<sub>2.5</sub> and its association with lung function and COPD in a large prospective Taiwan cohort.

#### Methods

A total of 366,756 participants aged 20 years or older were recruited with 1,031,849 spirometry tests in Taiwan in 2001-2014. We performed generalized linear mixed models to examine the associations between PM<sub>2.5</sub> and lung function adjusting for a wide range of confounders. For the 125,475 participants who were free of COPD in baseline, we used cox proportional hazard regression models to investigate the PM<sub>2.5</sub> effects on COPD development.

#### Results

PM<sub>2.5</sub> was associated with lower lung function. After adjusting for confounders, participants with 4<sup>th</sup> quantile of PM<sub>2.5</sub> had a decrease of 3.61% (95% confidence interval (CI): -3.76 to -3.47), 4.35% (95%CI: -4.36 to -4.34), and 7.75% (95%CI: -7.96 to -7.55) in forced vital capacity (FVC), forced expiratory volume in 1 s (FEV<sub>1</sub>), and maximum mid-expiratory flow (MMEF), respectively. They also had a faster decline of 0.24%, 0.64%, and 1.62% in FVC, FEV<sub>1</sub>, and MMEF, respectively. Compared to the participants with 1<sup>st</sup> quantile of PM<sub>2.5</sub>, participants with the 4<sup>th</sup>, 3<sup>rd</sup> and 2<sup>nd</sup> quantiles of PM<sub>2.5</sub> had a hazard risk of 1.10 (1.00, 1.22), 1.15 (1.03, 1.27) and 1.24 (1.12, 1.37) in COPD development, respectively.

#### Conclusions

Long-term exposure to ambient PM<sub>2.5</sub> is associated with decrease in pulmonary function and increased risk of COPD incident in Taiwan adults.

# WC16: Ambient air adult respiratory mortality & morbidity

100, September 27, 2017, 16:00 - 17:30

## MAIAC-based long-term trends in Ambient PM<sub>2.5</sub> and the Effects on Population Mortality in Beijing, China.

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### Background/Aim

This study was to estimate daily PM<sub>2.5</sub> concentrations at 1 km spatial resolution from 2004 to 2014 using the Multi-angle implementation of atmospheric correction (MAIAC) AOD values and to explore both effects of short-term and long-term exposure to ambient PM<sub>2.5</sub> on daily cause-specific population mortality in Beijing, China.

### Methods

A high-performance three-stage (LME-GAMM-KED) model was developed with AOD, meteorological, demographic, and land use variables as predictors, which includes a custom-designed AOD gap-filling method. Double-exposure models were performed at 5 km grid cells in the urban area of Beijing to estimate the acute and chronic health effect on mortality simultaneously, with temperature, socioeconomic and hospital information adjusted.

### Results

The 11-year overall mean of predicted PM<sub>2.5</sub> was 70.3 µg/m<sup>3</sup> in Beijing city. Downward trends of PM<sub>2.5</sub> were clear from southwest to north geographically for all the 11 years. The MAIAC-based three-stage models have a cross-validation R<sup>2</sup> of 0.82 in 2013 and 0.79 in 2014 and predicted relatively high accuracy PM<sub>2.5</sub> at the seasonal levels (R<sup>2</sup> ranged from 0.78 to 0.80). For every increase of 10 µg/m<sup>3</sup> in PM<sub>2.5</sub>, the acute effects on non-accidental, respiratory and cardiovascular mortality could be 0.04% (95% CI: -0.19%, 0.28%), 0.89% (95% CI: -0.02%, 1.82%) and 0.06% (95% CI: -0.26%, 0.38%), respectively, and the chronic effects could be 17.34% (95% CI: 10.87%, 24.18%), 52.69% (95% CI: 26.11%, 84.89%) and 4.29% (95% CI: -3.46%, 12.67%), respectively. All long-term effects were more robust than that of short-term.

### Conclusions

The long-term PM<sub>2.5</sub> prediction approach could fill the gaps left by ground monitoring network, and provide high resolution data even at the time periods without ground observations, which is helpful to environmental epidemiological studies. For non-accidental, respiratory and cardiovascular disease mortality, chronic effects of PM<sub>2.5</sub> were significant robust than that of short-term effects, which should be more concerned for public health.

## WC16: Ambient air adult respiratory mortality & morbidity

100, September 27, 2017, 16:00 - 17:30

### Obesity as a Risk Factor for Reduced Lung Function from Air Pollution in Adults

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**Background/Aim** Obesity may increase human sensitivity to environmental toxicants through multiple mechanisms including inflammation. Obesity has been shown to increase susceptibility of asthma symptoms and severity with exposures to outdoor and indoor pollution in children but few studies have explored obesity as a risk factor for reduced lung function associated with chronic ambient air pollution exposure among adults. Data from the 2008-2013 Survey of the Health of Wisconsin study were utilized to determine if previously found associations between air pollution and reduced lung function were modified by obesity status among non-asthmatic adults age 21-74 (n=2011).

**Methods:** Multiple linear regression analysis using survey procedures to account for complex design and spatial clustering were used to estimate the association between chronic 3-year average fine particulate matter (PM<sub>2.5</sub>) exposure and lung function measured by FEV<sub>1</sub> (forced expiratory volume in 1 second (L/sec)). Air pollution exposure was estimated using the USEPA's Bayesian space-time downscaler model for PM<sub>2.5</sub>, and body mass index was calculated using measured height and weight.

**Results:** Overall, average FEV<sub>1</sub> was 2.98 L (SD .89) and 3-year average PM<sub>2.5</sub> was 10.5 µg/m<sup>3</sup>. In fully adjusted models, a five-unit increase in PM<sub>2.5</sub> was associated with a -0.18 L/s (CI -0.32, -0.04) reduction in FEV<sub>1</sub> among non-asthmatics. In stratified analyses, larger effects were seen in obese with BMI over 30 (B= -0.23, CI -0.29, -0.17) than non-obese (B= -0.15, CI -0.16, -0.14). No significant interactions between air pollution and BMI were observed in the total sample, however, among obese, air pollution and BMI interaction terms were significant (p<.001).

**Conclusions:** Results suggest obese individuals may be more prone to adverse effects of ambient air pollution on lung function even with relatively low chronic exposures. Additional research is needed to track longitudinal changes overtime and understand the biologic underpinnings of observed sensitivity among obese.

# WC16: Ambient air adult respiratory mortality & morbidity

100, September 27, 2017, 16:00 - 17:30

## Respiratory healthcare encounters among U.S. military personnel following deployment in support of Operation Enduring Freedom

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### Background/Aim

Inhalational hazards are numerous in operational environments. Each service member's deployment has a unique respiratory hazard profile; however, common environmental hazards include local and regional sources, exhaust from operational support equipment, and exposure to emissions from open burning, among others.

### Methods

A retrospective cohort study was conducted to investigate associations between deployment to Kabul, Afghanistan and subsequent respiratory health among U.S. military personnel. The study population consisted of personnel who deployed to Kabul, select Operation Enduring Freedom locations, personnel stationed in the Republic of Korea, and U.S.-stationed personnel. Incidence rate ratios (IRRs) were estimated for respiratory symptoms, signs, and ill-defined conditions, asthma, and chronic obstructive pulmonary disease.

### Results

A significantly elevated rate of prevalent symptoms, signs, and ill-defined conditions was observed among Kabul-deployed personnel compared to personnel deployed or stationed in Bagram (IRR 1.12; 95% confidence interval [CI], 1.05-1.19), Republic of Korea (IRR 1.20; 95% CI, 1.10-1.31), and the United States (IRR 1.52; 95% CI, 1.43-1.62). A statistically elevated rate of incident asthma was observed among personnel deployed to Kabul, relative to U.S.-stationed personnel (IRR 1.61; 95% CI, 1.22-2.12). Statistically significant rates were not observed for incident chronic obstructive pulmonary disease among Kabul-deployed personnel compared to other study groups.

### Conclusions

Elevated rates of respiratory symptoms and asthma among service members with a history of deployment to Kabul were observed, although the majority of findings suggest similar rates among the Kabul group compared to other comparison groups. Further investigation is warranted to better understand these relationships, and to quantify the impacts of specific deployment-associated exposures on post-deployment respiratory health.

# WC16: Ambient air adult respiratory mortality & morbidity

100, September 27, 2017, 16:00 - 17:30

## Prevalence and predictors of asthma in the megacity of Pakistan: findings from the Adult Asthma Study-Karachi

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### Background/Aim

Scarce data is available regarding burden of asthma from spirometry-based epidemiological surveys, especially from low and middle income countries. This study was conducted to determine the prevalence and predictors of asthma among adults in Karachi, Pakistan.

### Methods

A multi-stage, community based cross-sectional survey was conducted from May 2014-August 2015 comprising of 1630 adults ( $\geq 18$  years) from 75 randomly selected (out of 9400) clusters in Karachi. From each cluster, 25 households were randomly selected and all eligible participants were recruited. Data were collected through questionnaire-based interviews in Urdu, consisting of respiratory health related questions (American Thoracic Society (ATS) questionnaire), socio-demographic characteristics and risk factors for asthma. Pre and post-bronchodilator spirometry was performed according to the ATS criteria. The prevalence of asthma was calculated considering presence of respiratory symptoms with reversibility on spirometry ( $\geq 12\%$  increase, post-bronchodilator) and/or history of physician-diagnosed asthma.

### Results

The overall prevalence of asthma was 6.6% ( $n=61$ ; 95% CI: 5.0-8.1) among 930 participants with acceptable spirometry data. Asthma was less likely among the younger age group (AOR: 0.2, 95% CI: 0.1-0.6) and those having birds and animals at home (AOR: 0.5, 95% CI: 0.2-0.9). Asthma was more likely to occur among participants with history of allergies (AOR: 2.8, 95% CI: 1.6-4.9) and those exposed to passive smoking at home (AOR: 1.9, 95% CI: 1.1-3.4).

### Conclusions

This is the first robust epidemiological assessment regarding actual burden of asthma among adults in Pakistan, reporting a high burden in the country.

## WC17: Environmental equity

102, September 27, 2017, 16:00 - 17:30

### Race/ethnicity, neighborhood socioeconomic composition, and urban greenspace in the contiguous United States, 2001-2011

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**Background/Aim:** Cross-sectional studies suggest unequal distribution of urban greenspace. The extent to which neighborhood demographics are related to changes in greenspace over time remains unknown. We aimed to estimate racial/ethnic and socioeconomic disparities in (1) 2001 greenspace and (2) change in greenspace between 2001-2011; and (3) the modifying effect of Index of Concentration at the Extremes for income (ICE).

**Methods:** We estimated greenspace using satellite-derived normalized difference vegetation index (NDVI) in 59,483 urban census tracts in the contiguous U.S. Using 2000 census data, we fit linear and logistic regression models to estimate the association between racial/ethnic composition and ICE and 2001 NDVI and NDVI change (2001-2011). Models were adjusted for population density, climatic factors, and housing tenure and considered effect modification by ICE.

**Results:** In 2001, average NDVI across urban tracts was 0.58 (SD = 0.18). NDVI decreased by an average of 0.02 (SD = 0.06) by 2011. A SD increase in percent White residents was associated with 0.032 (95% CI: 0.029, 0.034) higher 2001 NDVI. For an increase in proportion White residents, odds of higher levels of 2001 NDVI were elevated across levels of ICE, while an increase in proportion Black residents only in affluent tracts (high ICE) was associated with reduced odds of higher NDVI levels. Tracts with higher proportions of Black or Hispanic residents were more likely to experience a reduction in urban greenspace between 2001-2011. When stratified by ICE, tracts with higher proportions of Asian and Black residents in the lowest ICE tracts and higher proportions of White residents in both low and high ICE tracts were associated with increased odds of increased greenspace between 2001-2011.

**Conclusions:** Census tracts with a higher proportion of racial/ethnic minority residents, compared to a higher proportion of White residents, had less greenspace in 2001 and lost more greenspace between 2001-2011.

## WC17: Environmental equity

102, September 27, 2017, 16:00 - 17:30

### The Effects of Neighborhood Social Stressors on Birth Weight

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#### Background/Aim

Racial and economic isolation are two social stressors that are novel in studying neighborhood effects on public health. Since these variables depend on the race and economic status of each individual subject, they represent a finer and perhaps more accurate measure of social and economic status. We investigate the effect of these social stressors on birth weights of Massachusetts newborns between 2001 and 2012.

#### Methods

Racial and economic isolation were both scored from -1 to +1, where -1 represents the least isolated and +1 the most. We assign these social stressor indices to each birth ( $n = 664,828$ ) based on maternal race and address at the block group level. Regression was used to determine the effect of each stressor on birth weight, adjusted for covariates marital status, maternal education, government-supported prenatal care, maternal/paternal age and race, maternal cigarette smoking before/during pregnancy, parity, Kotelchuck Index for prenatal care, gestational/other diabetes and hypertension, mode of delivery, infant sex, and clinical gestational age. We adjusted for particulate air pollution ( $PM_{2.5}$ ) additionally.

#### Results

An interquartile range (IQR) increase in racial isolation (0.57 units) was associated with a -10.04 (95% CI: -13.25, -6.83) gram change in birth weight. After adjusting for  $PM_{2.5}$ , this change was attenuated to -8.36 (-11.87, -4.84) g. In the full model with racial isolation, economic isolation,  $PM_{2.5}$ , and covariates found an association of -8.61 (-12.11, -5.10) g change per IQR increase in racial isolation.

#### Conclusions

Increased maternal racial isolation was found to be associated with lower birth weights in Massachusetts. Even with adjustment for economic isolation,  $PM_{2.5}$  exposure, and many individual health and socioeconomic covariates, racial isolation had a statistically significant detriment on birth weight.

## WC17: Environmental equity

102, September 27, 2017, 16:00 - 17:30

### Health burden of PM<sub>2.5</sub> and socioeconomic status in the NSW Greater Metropolitan Region

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#### Background/Aim

Exposure to ambient particulate matter is not uniformly distributed in urban environments. In addition, there is a social gradient in the population level susceptibility to the health effects of air pollution. Such disparities may result in vulnerable populations bearing a relatively greater burden of disease attributed to this exposure compared with the population at large.

#### Methods

Using high resolution chemical transport modelling, blended with fixed-site monitoring data, of particulate matter of diameter less than 2.5  $\mu\text{m}$  (PM<sub>2.5</sub>), baseline health incidence rates and known health risk estimates, we implemented a health impact assessment methodology to estimate the burden of disease by quintile of socioeconomic status in the New South Wales Greater Metropolitan Region (GMR).

#### Results

We found that for each health endpoint, there was an increasing burden of disease attributable to anthropogenic PM<sub>2.5</sub> exposure with decreasing socioeconomic status in the GMR and subregions with the difference in burden exceeding the difference in baseline incidence. The areas with the lowest socioeconomic status had 50% more years of life lost (YLL) attributable to PM<sub>2.5</sub> than the areas of highest socioeconomic status in the whole GMR.

#### Conclusions

The disparity that we found in burden due to PM<sub>2.5</sub> contributes to a growing body of evidence in the field of environmental justice and supports the need for policy to protect vulnerable communities from inequitable exposure to environmental hazards.

## WC17: Environmental equity

102, September 27, 2017, 16:00 - 17:30

### The burden of disease hospitalization due to coal burning in Beijing

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#### Background/Aim

Coal plays an irreplaceable role in the energy use in China, however, it causes severe air pollution and adverse health impacts, i.e. outpatient /emergency visit, hospital admission, and death. Hospital admission of the exposed population costs large direct medical expenses, but its quantitative estimate is rarely studied in China. In this article we evaluated the direct economic burden caused by hospital admissions due to coal burning in Beijing.

#### Methods

The data of daily air quality and hospital admissions with the related medical expenses for ischemic heart disease (IHD), lung cancer (LC), chronic obstructive pulmonary disease (COPD) and stroke in Jan 1st, 2013-Oct 22nd, 2014 were collected in Beijing. Time series study using a generalized additive model was used to evaluate the exposure-response relationship between PM<sub>2.5</sub> concentration and hospital admission (for the four diseases as a whole and each). With the contribution rate of coal burning for PM<sub>2.5</sub> and the insurance rate in Beijing, the extra hospital admissions caused by coal burning was estimated, and then the mean medical expenses were used to figure out the economic burden.

#### Results

The daily average concentration of PM<sub>2.5</sub> was 89.90 (6.28-397.30) µg/m<sup>3</sup> during the study period. 162,009 patients were admitted for the four diseases, with a daily average of 247 inpatients. An increase of 10µg/m<sup>3</sup> of PM<sub>2.5</sub> could increase the risk of hospital admission for the four diseases by 0.66% (95%CI: 0.59%, 0.73%). Accordingly, at least 2287 extra inpatients occurred because of coal burning, with the total economic loss of 65.69 million RMB. The highest two extra inpatient numbers were from IHD (at least 898, 39.27%) and stroke (at least 868, 37.95%), which caused about 41.85% and 28.94% of the total medical expenses.

#### Conclusions

Coal burning caused adverse health impact and huge economic burden on the exposed population in Beijing, especially on IHD and stroke patients.

## WC17: Environmental equity

102, September 27, 2017, 16:00 - 17:30

Ethical issues in Environmental Equity: Environmental Racism or Inadequate understanding of a complex relationship?

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The dependence of human health and well-being on nature is well recognized. A delicate balance between this human relationship and the external environment requires that biodiversity be safeguarded and that the biosphere be maintained in way suitable for agriculture and sustainability. Alterations in the relationship between humans and their environment can lead to imbalances, which in turn result in inequities. The latter can be harmful to people living in this context, even if a direct effect on their health is not immediately recognized. The local community of environmentally damaged areas are often disadvantaged compared with those who live in better environments. Benefits from a healthier and balanced relationship with the surrounding environment include improved health, social stability and economic advantage. This is evident, for instance, in the role of green spaces for the positive development of human life in all its dimensions.

The ethical principle of distributive justice calls for equity in the distribution of risks and benefits. Where inequity has resulted, remedial justice would require that health research be conducted on vulnerable groups that tend also to be least protected from environmental harms. However, the collection of epidemiological data and establishing causal inference takes time and waiting for conclusive results may lengthen the time to take corrective action.

For what reasons, would an intervention be justified when there is compromise of environmental matrices in the absence of estimates of health risks? How can environmental epidemiology research contribute to preventive intervention in the context of environmental inequity? What is the role of environmental health practitioners and policy makers in reducing social gaps and protecting vulnerable communities from inequitable exposure to environmental hazards? This session will promote discussion around these questions in line with the increased burden of diseases and lesser urban green spaces reported among racial/ethnic minorities and socio-economically disadvantaged groups.

# WC18: Traffic Noise – new research on cardiovascular disease & risk factors

105, September 27, 2017, 16:00 - 17:30

Road traffic noise: mortality and incidence of cardiovascular events in an Italian population-based large cohort

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**Background/Aim:** Road traffic is highly prevalent in Europe and it is a source of both noise and air pollution. Our aim was to study whether long-term exposures to road traffic noise are associated with mortality, incidence of coronary events and stroke, independently from air pollution, in a cohort of residents in two Italian metropolitan areas (Rome and Turin).

**Methods:** Population-based cohorts for a total of 1,867,838 people (aged  $\geq 30$  years) were enrolled on 21st October 2001 and followed for mortality and hospitalization until 31<sup>st</sup> December 2010. For all residential addresses we estimated average traffic noise levels (Lden) using the acoustic model Sound Plan 7.4 based on 2009 traffic data. We used a city and gender stratified Cox regression models with age as the time-scale to estimate associations while adjusting for individual characteristics (marital status, occupation, education, place of birth) and contextual variables [annual NO<sub>2</sub> concentrations (from a land use regression model, ESCAPE protocol), residential addresses with a green area within 300m and area-based socioeconomic status (Hazard Ratios, HR, 95% CI)].

**Results:** During the 9 years of follow-up we identified 213,962 deaths, 57,602 incident coronary events, and 34,385 stroke cases. Noise and NO<sub>2</sub> were only moderately correlated ( $r=0.36$ ). A 10dB increase in road traffic noise was associated with an HR for non-accidental mortality equal to 1.013. After adjusting for the potential confounders we found an HR of 1.008 (1.002,1.015). Corresponding estimates for incidence of coronary events and stroke were 1.008 (0.996,1.021) and 1.021 (1.005,1.038), respectively. Association estimates were only moderately affected by NO<sub>2</sub> adjustment.

**Conclusions:** This study strongly supports an independent effect of long-term exposure to noise on mortality and on incidence of stroke in a large cohort of residents in metropolitan areas. The results are relevant for policy decisions to reduce population exposure and prevent large health effects.

# WC18: Traffic Noise – new research on cardiovascular disease & risk factors

105, September 27, 2017, 16:00 - 17:30

Road traffic noise and incident cardiovascular disease: a joint analysis of the HUNT, EPIC-Oxford and UK Biobank cohorts

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## Background/Aim

This study aimed to investigate the effects of long-term exposure to road traffic noise on incident CVD in three large cohorts: HUNT, EPIC-Oxford and UK Biobank.

## Methods

In a complete-case sample (N=361,699), 4,014 IHD and 2,109 cerebrovascular incident cases were ascertained between baseline (1993-2010) and end of follow-up (2008-2015) through medical record linkage. Annual mean road traffic noise exposure was modelled at baseline address. Individual-level covariate data were harmonised and data were pooled. Analyses used Cox proportional hazards model with adjustments for confounders, including air pollution.

## Results

For an interquartile range (IQR) (3.9 dBA) higher daytime noise, a non-significant association with incident IHD was seen (Hazard ratio (HR): 1.015, 95% Confidence Interval (CI): 0.989-1.042), fully adjusted. Statistically significant associations and interaction terms were seen in obese individuals (HR: 1.099, 95%CI: 1.029-1.174), and current-smokers (HR: 1.054, 95%CI: 1.007-1.103). No associations were found for ischemic or hemorrhagic stroke.

## Conclusions

Our study strengthens the evidence base for an effect of road traffic noise on incident IHD, whilst the association with incident stroke remains unclear.

# WC18: Traffic Noise – new research on cardiovascular disease & risk factors

105, September 27, 2017, 16:00 - 17:30

Long-term exposure to traffic noise in relation to development of hypertension – A cohort study

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## **Background/Aim**

Numerous studies have shown associations between exposure to traffic noise and hypertension but most were cross-sectional and based on self-reported outcome data. Aim of this cohort study was to investigate the relationship between traffic noise from various sources and incidence of hypertension.

## **Methods**

We assessed individual long-term exposure to noise from road traffic, railways and aircraft based on residential histories in a cohort of 4913 men and women from Stockholm County, free of hypertension at recruitment. Noise levels were estimated at the most exposed façade of each dwelling based on a modification of the Nordic prediction method. Hypertension incidence was assessed during an average follow-up period of 8.9 years based on doctor diagnosis or blood pressure measurements. Extensive information on potential confounders was available from repeated questionnaires and registers. We used Cox proportional hazards regression models with age as the time scale and estimated hazard ratios (HR) adjusted for age, sex, smoking, body mass index at recruitment and socioeconomic status.

## **Results**

A total of 1357 (27%) subjects were diagnosed with hypertension during follow-up. A 10 dB  $L_{den}$  increase in estimated noise levels during 5 years preceding the event was associated with a 9% increased risk of hypertension due to aircraft noise (HR 1.09, 95% confidence interval 1.05 to 1.15). However, no clear association was observed for road or railway traffic noise, with HRs of 0.97 (95%CI 0.92 to 1.03) and 0.96 (95%CI 0.90 to 1.02), respectively, per 10 dB  $L_{den}$ . The association for aircraft noise appeared particularly high in men (HR 1.15, 95%CI 1.08 to 1.23 per 10 dB  $L_{den}$ ) compared to women (HR 1.05, 95%CI 0.98 to 1.12 per 10 dB  $L_{den}$ ).

## **Conclusions**

Our results provide further evidence linking environmental noise exposure to development of hypertension, particularly from aircraft.

# WC18: Traffic Noise – new research on cardiovascular disease & risk factors

105, September 27, 2017, 16:00 - 17:30

## Long-term exposure to traffic related noise and incidence of diabetes: a Danish Nurse Cohort study

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### Background/Aim

Well-established risk factors for diabetes include diet, body mass index and physical activity, all of which are individually modifiable factors. However, recent evidence suggests that environmental factors including road traffic noise and air pollution may affect the risk of developing diabetes. Here we examine whether road traffic noise is associated with diabetes incidence, when accounting for air pollution exposure.

### Methods

28,731 female nurses from the Danish Nurse cohort (>44 years old at recruitment in 1993 or 1999) were linked to the Danish Diabetes Register with information on incidence of diabetes from 1995 until 2013. The annual mean weighted levels of 24-hour average road traffic noise ( $L_{den}$ ) were modeled with Nord2000. Annual mean concentrations of  $PM_{2.5}$  at residence were modeled with Danish AirGIS system. Cox proportional hazards regression models with age as underlying time was used to examine the association between annual mean  $L_{den}$  at the study baseline (1995 or 1999) and the incidence of diabetes in a model adjusted for lifestyle factors and additionally, for annual mean  $PM_{2.5}$  concentration at the study baseline (1995 or 1999).

### Results

Of 23,169 nurses free of diabetes at the cohort enrolment, 1,099 developed diabetes during a mean follow-up of 15.2 years. The diabetes risk was increased among those exposed to high (>57 dB) when compared to low ( $\leq 47$  dB)  $L_{den}$  in crude model (hazard ratio (HR); 1.25 (95% confidence interval (CI): 1.06-1.47), and adjusted for diabetes risk factors (1.18; 1.00-1.39). However, the effect of  $L_{den}$  diminished (HR 1.03; 0.86-1.24) when adjusting for  $PM_{2.5}$ . In the fully adjusted model, an interquartile range (3.89  $\mu g/m^3$ ) increase in  $PM_{2.5}$  was associated with 18% (HR: 1.18, 95% CI: 1.09-1.29) increase in diabetes risk.

### Conclusions

We detected association between road traffic noise and diabetes risk, but which disappeared after adjustment for  $PM_{2.5}$ .

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Authors have no conflict of interest to declare.

# WC18: Traffic Noise – new research on cardiovascular disease & risk factors

105, September 27, 2017, 16:00 - 17:30

The effect of nightly maximum aircraft noise levels on cardiovascular diseases – results of a case-control study based on secondary data

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## Background/Aim

The health effects of aircraft noise are commonly examined based on continuous sound pressure levels. However, at the same average noise level, aircraft noise tends to be more annoying than road traffic noise. This may be related to specific characteristics of aircraft noise (irregular, disruptive events, potentially leading to nightly awakenings). We aimed to examine if maximum aircraft noise levels comprise cardiovascular risks that are not adequately reflected by the risks of continuous sound levels alone.

## Methods

This case-control study included individuals that were insured by three large statutory health insurance funds in the Rhine-Main area of Germany. Exposure to aircraft, road and railway traffic noise in 2005 was estimated address-specifically. Cases with a new diagnosis of a cardiovascular disease (between 2006 and 2010) based on insurance claims and prescription data, i.e. myocardial infarction (n=19,632), stroke (n=25,495), and heart failure/hypertensive heart disease (n=104,145), were compared with control subjects (>500,000 for all case groups) not suffering from the respective disease. When we calculated odds ratios (OR) for categorized 24-h continuous aircraft noise levels (reference category: <40dB), we separately analyzed the risk for individuals with 24-h continuous noise levels <40dB but with nightly maximum sound levels >50dB.

## Results

For individuals with nightly maximum sound levels of >50dB (with 24-h continuous noise levels <40dB), we observed increased OR for myocardial infarction (OR=1.05; 95% CI 0.98-1.11), stroke (OR=1.07; 95% CI 1.02-1.13), and heart failure/hypertensive heart disease (OR=1.06; 95% CI 1.03-1.09).

## Conclusions

This large case-control study suggests that maximum aircraft noise levels at night negatively affect the cardiovascular system. Thus, the inclusion of this exposure group in the reference category is likely to lead to an underestimation of the risks of aircraft noise exposure. Aircraft noise protection measures should take into account not only continuous noise levels, but also maximum aircraft noise levels.

**Acknowledgments:** The NORAH case-control study was supported by the Gemeinnützige Umwelthaus GmbH, Kelsterbach.

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# WC18: Traffic Noise – new research on cardiovascular disease & risk factors

105, September 27, 2017, 16:00 - 17:30

Combined traffic noise exposure from different sources: is the whole more than the sum of its parts?

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## Background/Aim

Many people are simultaneously exposed to several sources of traffic noise. Simple adding of sound pressure levels might not adequately reflect the cardiovascular risks. In a large secondary-data based case-control study, we analyzed the combined effect of simultaneous exposure to different sources of traffic noise.

## Methods

Address-specific exposure to aircraft, road and railway traffic noise in 2005 was estimated for individuals that were insured by three large statutory health insurance funds in the Rhine-Main area of Germany. Based on insurance claims and prescription data, 122,213 cases with newly diagnosed cardiovascular disease (CVD; including myocardial infarction, stroke, heart failure, and hypertensive heart disease) diagnosed between 2006 and 2010 were identified and compared with 596,462 control subjects. We applied the Akaike Information Criterion (AIC) to compare the adequacy of different models describing combination effects of aircraft, road and railway traffic noise.

## Results

Multiplication of risks for road, railway and aircraft noise fitted the (linear) exposure-risk relationship considerably better than a model based on simple addition of sound pressure levels ( $\Delta$  AIC = -14). For instance, applying a risk-multiplying approach, we found the highest CVD risk increase of 22% for a simultaneous exposure to 71.2 dB road traffic noise (24-h-sound level), 80.7 dB railway noise and 47.0 dB aircraft noise. The corresponding CVD risk increase for a sound-pressure addition model would be only 12.5% in this example (based on a statistically significant risk increase of 2.9% per 10 dB, starting point 40 dB).

## Conclusions

Cardiovascular risks of combined exposure to different sources of traffic noise seem to be considerably higher than it would be expected from simple adding of sound pressure levels. Noise protection measures should take into account the combination effects of simultaneous exposure to different sources of traffic noise.

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# THP01: Environmental noise, the new air pollution

Seymour Centre, September 28, 2017, 08:30 - 10:00

## Noise, a Public Health Problem

**Anna Hansell\*, School of Public Health, Imperial College London, UK**

Noise is a major environmental issue, particularly in urban areas, affecting a large number of people (2011 WHO Burden of Disease from environmental noise).

The risk of hearing damage from high occupational noise exposure and effect of noise exposure on quality of life and sleep disturbance are well established. However, in recent years, attention has increasingly been focussed on effects of noise on disease risk, particularly cardiovascular disease (CVD). Noise exposure is of particular concern in cities, where road traffic, railways and aeroplanes constitute the major sources of noise and current urban design features may enhance noise exposure. There is also concern that some of the health effects attributed to air pollution may actually be caused by noise, given that transport is a major source of both pollutants.

The evidence base on noise and health has been growing rapidly in recent years. Recent studies have looked not only at CVD but also at CVD risk factors including metabolic disease. A range of other outcomes have also been explored from cancer to birthweight. Studies have also explored exposure metrics that may be more relevant for health than noise averages (used in noise annoyance studies) and to use large cohorts to provide the large sample sizes needed to investigate small excess risks.

Discussions about causality and public health significance are ongoing, as to be expected with any emerging disease risk factor. Much of the work on evaluating the evidence and quantifying disease burden from environmental noise has been done in Europe. The WHO 2011 review suggested at least one million healthy life years are lost every year from traffic-related noise in the western European countries. New WHO Environmental Noise Guidelines for the European Region are currently at stakeholder consultation stage and will provide an authoritative evidence base for public health policy.

## THP01: Environmental noise, the new air pollution

Seymour Centre, September 28, 2017, 08:30 - 10:00

### Studies on Noise and Response in Urban Areas

**Lex Brown\***

The presentation will touch on several projects on environmental noise and human response in urban areas – with a focus on road traffic sources. These include a study of road traffic noise in high-density, high-rise, Hong Kong, estimating the exposure of the population and development of an exposure-response function for annoyance with traffic noise. The Hong Kong exposure is compared to those of European cities and the responses to earlier exposure-response functions from Western cities with lower densities. Another is the systematic review of evidence as to whether interventions for transport noise in cities have resulted in measureable change in the health effects of affected communities, not just in noise levels. This is part of the evidence-base for the revision of the Environmental Noise Guidelines currently being finalized by the WHO. There is very large expenditures on transport noise management, but the evidence base is thin - but suggestive that interventions work. The third project considers the assessment and approval processes for new transport infrastructure projects in cities. These routinely incorporate noise in Environmental Impact Assessments (EIA) using established methods of exposure predictions and effect estimates. But project-based noise assessment needs to be scaled up to Strategic Environmental Assessments (SEA) of transport policies and plans, including integration of noise health assessments directly into transport modelling, including estimates of Environmental Burden of Disease of alternatives transport and urban development policies/plans. Finally there is now emerging interest in the acoustic environment of cities and regions as a resource, not just as a waste product to be managed. The noise management paradigm of mitigation of high levels of exposure – the sounds of discomfort – can be complemented with a soundscape approach – planning and management of the sounds of preference. Throughout, specific issues associated with studies of noise exposure and human response to environmental noise in urban areas are emphasised.

# SYM09: Ecosystem Change, Infectious Disease Transmission and Early Warning

101, September 28, 2017, 10:30 - 12:00

## Ecosystem change: a threat to population health

**Shilu Tong**<sup>1-3</sup>

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**Background:** Human activity is rapidly altering the planet's land cover, rivers and oceans, climate system, biogeochemical cycles, and the functioning of its ecosystems. Nature's goods and services are the ultimate foundations of life and health and changes in these natural systems can affect human health in a variety of ways.

**Methods:** We provide an overview of the impacts of ecosystem change on population health, using Dengue and Ross River virus as case studies.

**Results:** 1. We assessed the epidemiological evidence on the joint effects of climate variability and socioecological factors (including urbanisation and land use) on dengue transmission, and found that the relative importance of climate variability and socioecological factors on dengue transmission varied with population/geographic area. 2. Mosquitoes thrive in certain climate conditions and can spread diseases like Ross River virus (RRV). Increased temperatures and sea level rise appear to increase the risk for RRV transmission. As climate change progresses, the transmission of RRV may increase in Australia and surrounding island nations.

**Conclusions:** Although the relationship between ecosystem change and population health is complex, empirical evidence suggests that the disease burden associated with these alterations is relatively large and growing. We propose a more integrated and comprehensive approach to understanding the health impacts of ecosystem change so that evidence-based public health policy can be developed.

# SYM09: Ecosystem Change, Infectious Disease Transmission and Early Warning

101, September 28, 2017, 10:30 - 12:00

## Changing ecosystems and vector-borne disease control in Australia

1. Brendan Trewin, Mosquito Control Laboratory, QIMR Berghofer, Brisbane, Australia
2. Amanda Murphy, Mosquito Control Laboratory, QIMR Berghofer, Brisbane, Australia
3. Jon Darbro, Mosquito Control Laboratory, QIMR Berghofer, Brisbane, Australia
4. Jon Knight, Mosquito Control Laboratory, QIMR Berghofer, Brisbane, Australia
5. Cassie Jansen, Communicable Diseases, Queensland Health, Brisbane, Australia
6. Francesca Frentiu, Biomedical Sciences, Queensland University of Technology, Brisbane Australia
7. Wenbiao Hu, Public Health and Social Work, Queensland University of Technology, Brisbane Australia
8. **Gregor Devine\***, Mosquito Control Laboratory, QIMR Berghofer, Brisbane, Australia

Oral (Symposium) : *Ecosystem Change, Infectious Disease Transmission and Early Warning - Wenbiao Hu*

### Background

The incidence of vector-borne diseases, their transmission pathways and the population dynamics of mosquitoes are impacted by environmental change. Some of that change is driven by climate. The mechanisms by which climate change *per se* will influence disease transmission are poorly understood, but we can draw on a number of Queensland-based studies that demonstrate the potential impacts of some ecological correlates.

### Methods

We review how water-storage behaviour, the topography of coastal habitats and urban ecology can affect vector-borne disease risks.

### Results

1) An analysis of rainwater storage behaviours in relation to mosquito eradication and historical dengue incidence in Brisbane shows how local government policy and human responses to drought can alter the distribution and abundance of disease vectors. 2) A review of coastal habitat change shows a tremendous loss of salt marsh in South East Queensland since the 1950s - largely as a result of sea level rise. Subsequent encroachment by mangroves may increase the available mosquito habitat. 3) Urban development and the ecosystems that are created by it can alter the disease transmission pathways between humans, vectors and disease reservoirs. In Australia, this may account for changing patterns of locally important diseases such as Ross River virus.

### Conclusions

The impacts of climate change on the incidence of vector-borne disease in Australia are difficult to predict given the complexity of the environmental and human response to that change. It is clear, however, that for some diseases and in some environments, the risks of transmission will increase. Combating that increased risk will require an informed, adaptable response by all public health stakeholders.

# sYM09: Ecosystem Change, Infectious Disease Transmission and Early Warning

101, September 28, 2017, 10:30 - 12:00

## Arboviruses in Australia: A Changing Landscape

Francesca D. Frentiu\*, School of Biomedical Sciences, Queensland University of Technology, Brisbane, Australia

### Background/Aim

Arboviruses pose a significant threat to Australia. Endemic viruses such as Ross River cause outbreaks each year, sometimes numbering in thousands of cases. Although not endemic, outbreaks of dengue also occur every year in Australia. Emerging viruses such as Chikungunya and Zika may also pose a threat. Understanding temporal trends in cases of endemic viruses and identifying threats from emerging viruses is essential for better public health preparedness.

### Methods & Results

We review trends in locally-acquired and imported cases of several major arboviruses over the past 3 decades in Australia.

### Conclusions

We discuss recent patterns of endemic virus transmission and their implications for public health planning in Australia. We also identify emerging arboviral threats and highlight areas where urgent research is needed for better public health planning.

# SYM09: Ecosystem Change, Infectious Disease Transmission and Early Warning

101, September 28, 2017, 10:30 - 12:00

The role of climate and land cover variability in the geographical distribution of zoonotic diseases in China

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**Background/Aim:** Exposure of humans to zoonotic pathogens is driven by spatiotemporal variation in the distribution of animal and human populations, climate and physical environment and application of control strategies. Modern surveillance systems for zoonotic infections need to integrate dissimilar spatial data and consider methodological platforms that account for spatiotemporal correlations in the data. Spatiotemporal early warning systems assist in the identification of spatiotemporal emergence of zoonotic disease outbreaks. Here, we analyzed time-series of zoonotic diseases from China and review the adequacy of current disease mapping methods for early warning outbreak response and targeted surveillance.

**Methods:** Data on human notifications from 2000-2017 from the Chinese notification system for top 5 zoonotic diseases (Rabies, Japanese encephalitis, Anthrax, Scrub typhus and Leptospirosis) were provided by China Centres of Disease Control. We applied visualization and cluster detection methods integrated into a spatial modelling pipeline that includes environmental change indicators to discover the spatiotemporal variation in incidence rates and disease burden (as measured by DALYs).

**Results:** Using the time-series of the top 5 zoonotic diseases in China, we found important spatiotemporal clustering of zoonotic infections within known high-risk areas. The effect of the distribution of animal and human populations, climate and physical environment and the control strategies on the spatiotemporal distribution of zoonotic infections was heterogeneous in China. Our analysis demonstrated that spatiotemporal variation in incidence rate is not a good correlate of the spatial variation in DALYs.

**Conclusions:** Our analyses of top 5 zoonotic diseases in China indicate that there are important spatial non-stationary effects that current early warning analytic approach fails to account. The application of a spatial analysis pipeline that models both disease incidence and mortality integrated with environmental change data can help optimize outbreak response and targeted zoonotic disease surveillance in China with the objective of reducing the burden of infection.

# SYM09: Ecosystem Change, Infectious Disease Transmission and Early Warning

101, September 28, 2017, 10:30 - 12:00

Assessing the social and environmental determinants of infectious diseases based on Bayesian spatiotemporal models

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Oral (Symposium) : *Ecosystem Change, Infectious Disease Transmission and Early Warning - Wenbiao Hu*

## Background/Aims

Time series and Bayesian spatiotemporal models have played a key role in understanding the social and environmental determinates of infectious diseases. The development of early warning systems (EWS) based on sociodemographic, biological and ecological data can constitute inexpensive and very valuable tools for more effectively controlling outbreaks of infectious diseases. However, some predictive models used in the development of EWS perform relatively poorly with high dimensional data in a spatiotemporal context. This study aims to explore the possibility of developing an empirical forecast system based on social and environmental determinants using Bayesian spatiotemporal models.

## Methods

This study used dengue and influenza surveillance data of both China and Australia to explore the relationship between socio-ecological factors and infectious diseases, and what extent these social (including web search queries data) and environmental predictors can be used for developing EWS in different regions using Bayesian spatiotemporal models.

## Results

We reckon that a combination of the spatial non-parametric methods together with parametric models is an informative and comprehensive way to assess the determinants of infectious diseases. The integrated use of these models at a variety of spatial scales has provided new insights into EWS for infectious diseases.

## Conclusions

A future predictive model for estimating the probability of epidemic occurrence in relation to socio-ecological change can help decision-makers to determine where and when infectious diseases is likely to occur and which community is most vulnerable so that response can be made promptly.

# SYM11: Exposome approach to hazard identification and risk assessment of air and water contaminants (Exposomics project)

024, September 28, 2017, 10:30 - 12:00

## The science of water contamination: contribution of Exposomics

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**Background/Aims.** Disinfection byproducts (DBPs) that are produced from the reaction of chlorine with organic matter in water are animal carcinogens and may be associated with bladder cancer and other health outcomes in humans. Water chemical contamination is widespread in both high income and newly developed countries. The mechanisms through which trihalomethanes (THMs the most prevalent DBPs) or other DBPs produce cancer, are poorly understood and skepticism has been expressed on whether human exposure at considerably lower levels than those associated with cancer in animals could be a hazard for health. We applied an exposome approach in short and long-term exposure studies and evaluated the association of exposure to DBPs different omics, biomarkers of effect and clinical outcomes.

**Methods.** We conducted a pre-post study in an indoor chlorinated pool including 116 healthy non-smoking subjects 18 to 40 years old. We collected blood, urine, exhaled breath before and after a 40 minutes swim and collected environmental samples. We evaluated THMs in exhaled breath and several DBPs in water and air, conducted transcriptomics and microRNA analysis, metabolomics, proteomics, and determined micronuclei as effect biomarker. We examined long-term exposure in a case-control study on colorectal cancer and analysed methylation, metabolomics, and proteomics in 400 cases and controls.

**Results.** We observed numerous statistically significant hits in all omics analyses in the pool study after adjusting for multiple comparisons and identified suggestive pathways including pathways related to bladder and colon cancer. Micronuclei were associated with exposure to brominated compounds only at high exposure levels. Long term exposure to THMs was associated with colorectal cancer risk and also with several hits in omic analyses.

**Conclusions.** An exposome approach on short and long-term exposure studies in humans provides additional evidence on the toxicity of water DBPs at real life level of exposure and new knowledge on mechanisms.

# **SYM11: Exposome approach to hazard identification and risk assessment of air and water contaminants (Exposomics project)**

**024, September 28, 2017, 10:30 - 12:00**

The science of air pollution exposure assessment and biological mechanisms in the  
Exposomics project

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## **Background**

Epidemiologic studies have consistently shown associations between long-term exposure to ambient air pollution and incidence and prevalence of chronic diseases such as respiratory and cardiovascular disease. However, due to limitations in exposure assessments disease associations might be underestimated or missed. Furthermore, limitations in understanding how ambient air pollution may exert its biological effects limits causal interpretations.

## **Methods**

Within the framework of an FP7 EU-project –EXPOSOMICS, we have evaluated air pollution in Short-Term Studies, Panel studies, Mother-Child Cohorts and Adult Long Term Studies in relation to air-pollutants and to several disease outcomes. In these studies we improved ambient air pollution assessments by land use regression (LUR) models based on mobile monitoring and personal monitoring of ultrafine particulates (UFP) and black carbon. In addition, we improved individual air pollution assessment by personal sensors (UFP) in combination with individual positioning (GPS) and accelerometry from smartphones.

These improved estimates were used to study its relation with several adult and child health outcomes. In addition, air pollution estimates were linked with changes in the methylome, transcriptome, proteome, metabolome, and adductome. In subsequent mediation analyses we investigated if the effect of air pollution was mediated by these changes in OMIC-markers.

## **Conclusions**

The EXPOSOMICS project has resulted in improved air pollution measurements for different epidemiological study designs by using mobile and personal sensor data and linkage to GPS and accelerometer data.

Studies investigating the impact of ambient air pollutants on the biological system has implicated several novel biological targets. These are currently, being followed up within the different study designs to establish if these markers are related to air pollution, if they reflect long or short-term effects, and what the biological interrelations are between these novel biological targets.

# SYM11: Exposome approach to hazard identification and risk assessment of air and water contaminants (Exposomics project)

024, September 28, 2017, 10:30 - 12:00

## Characterizing the Exposome with Adductomics

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### Background/Aim

Studies have indicated the potential link between exposure to air pollution and increased risks of diseases such as Lung Cancer or Cardiovascular disease. OMICs measurements (metabolomics, proteomics, etc) are useful tools for the investigation of pathways that lead to the increased risk. Among the OMICs technologies, untargeted adductomics is a new approach that allows the analysis of adducts of human serum albumin (HSA) and reactive electrophiles in serum. HSA adducts have a longer life span in the blood, therefore, they can provide suitable markers to measure exposure to toxic electrophiles.

### Methods

Human serum samples were obtained as part of the European EPIC prospective study for Lung Cancer (n=200) and Cardio-vascular disease (n=60). Both studies included matched cases and controls. Human Serum Albumin Cysteine (34) adducts were analysed with an untargeted method using nano-HPLC with high resolution mass spectrometry (Orbitrap Elite, Thermo). Data on tobacco smoking habits (including cessation) were obtained as part of the EPIC cohort questionnaires, exposure to air pollutants (NO<sub>x</sub>, PM 2.5, PM10) was obtained by the ESCAPE assessment. Data extraction and statistical analysis was performed with R version 3.2.2.

### Results

More than 68 adducts were detected and verified in serum samples and adducts profiles differed for each studied cohort. Of the 68 identified, 15 adducts were not previously described. Adducts profiles in conjunction with exposure were investigated for the characterization of the Exposome. Associations between cases and control status and exposure to air pollution indicated promising preliminary results.

### Conclusions

Adducts of Cys34 HSA were successfully detected in serum samples. Previously reported as well as novel adducts were identified. Adducts profiles for Lung Cancer and Cardiovascular disease cohorts differed. This work demonstrates that adductomics is a new interesting approach to the detection of biomarkers of exposure and disease and the characterization of the Exposome.

# SYM11: Exposome approach to hazard identification and risk assessment of air and water contaminants (Exposomics project)

024, September 28, 2017, 10:30 - 12:00

## Cord blood metabolic signatures of birthweight

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### Background/Aim

Birthweight is an important indicator of maternal and fetal health and a predictor of many diseases in later life. While birthweight is known to be strongly determined by the maternal environment, the aetiological origins of variance in birthweight are still poorly understood. We applied untargeted metabolomics of cord blood samples to investigate the biological pathways important in determining birthweight, which may be perturbed by environmental exposures.

### Methods

Metabolic signatures were acquired using high-resolution mass spectrometry coupled to liquid chromatography from cord blood samples collected on delivery in the ENVIRONAGE (Belgium), INMA (Spain), Piccolipiu (Italy) and Rhea (Greece) birth cohorts. Exposure to environmental risk factors such as smoking and air pollution were assessed by questionnaire and land use regression models. We performed a metabolome-wide association study for birthweight on 481 samples, adjusting for gestational age, sex, cohort, maternal height, maternal weight, and paternal height. Mediation by the metabolome of factors associated with birthweight was explored in an attenuation analysis

### Results

We identified 68 metabolites significantly associated with birthweight after controlling the false discovery rate at 5%. These metabolites included vitamin A, progesterone, docosahexaenoic acid, indolelactic acid, and multiple acylcarnitines and phosphatidylcholines. We observed significant enrichment ( $p < 0.05$ ) of the tryptophan metabolism, prostaglandin formation, C21-steroid hormone signalling, carnitine shuttle and glycerophospholipid metabolism pathways. Vitamin A was associated with both maternal smoking and birthweight, suggesting a mediation pathway.

### Conclusions

These results provide insight into mechanisms that affect birthweight and may have implications for the developmental origins of diseases in adulthood.

# THC01: Noise and health, time and (work)place

026, September 28, 2017, 10:30 - 12:00

## Prevalence of noise exposure in Australian Workplaces

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### Background/Aim

The two most common causes of adult hearing loss in developed countries are ageing and noise, particularly occupational noise. Occupational noise is estimated to be responsible for between 10% and 20% of all hearing loss. However, there are limited data on how many workers are exposed to noise in the workplaces. The aim of this study was to estimate the prevalence of noise and exposure across the breadth of workplaces in Australia.

### Methods

A cross-sectional survey of 4993 workers aged 18 -64 years across Australia was undertaken from mid- 2106 to March 2017. Participants were recruited through random digit dialling of land lines as well as mobile phone numbers. They were asked about the tools used, tasks undertaken and duration of these during the previous working day. Using these data, OccIDEAS, a validated and algorithm based software was used to estimate exposure to noise.

### Results

Fifty-four per cent of respondents were male. Sixteen per cent of participants had an estimated LAeq,8h exceeding the 85dB exposure limit for their last working day. The prevalence of noise exposure over the standard was 23% among males and 7% among females. Of the 788 participants that had an estimated LAeq8h over 85dB for their last working day, 56% reported that they did not wear hearing protection. Exposure prevalence also differed across occupations.

### Conclusions

These results allow a better understanding of the sources of exposure to noise in the workplace. Interventions to target particular occupational and demographic groups to reduce exposure to noise in the workplace can be developed based on our findings.

# THC01: Noise and health, time and (work)place

026, September 28, 2017, 10:30 - 12:00

## Occupational noise exposure and the incidence of hypertension: A prospective cohort study

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### **Background/Aim**

Exposure to occupational noise might increase the risk of hypertension. However, there is limited cohort studies to address the occupational noise exposure may change over time.

### **Methods**

We conducted a 30-years cohort study including 1467 workers in aircraft industry. The cumulated noise exposure levels were calculated by using time-weighted average exposure ( ). The effect estimates were presented as hazard ratio and 95% confidence intervals of hypertension, adjusting for potential confounders. We further classified the cumulated noise exposure level as four categories, the reference level (<70dBA-year), low (70-79dBA-year), medium (80-89dBA-year) and high exposure (>=90dBA-year).

### **Results**

In Cox proportional model adjusting for confounders, we found the association of noise exposure and hypertension. Comparing with the reference group (<70 dBA-year), the hazard risk of hypertension was related to medium (adjusted HR=2.00, 95%CI=1.34-2.96) and high exposure (adjusted HR=2.60, 95%CI=1.55-4.36) during 3-30 years.

### **Conclusions**

Our study suggests that long term exposure to noise over 80 dBA-year during 3-30 years may increase the risk of development of hypertension.

# THC01: Noise and health, time and (work)place

026, September 28, 2017, 10:30 - 12:00

## Diurnal variation of transportation noise exposure and cardiovascular mortality in Switzerland

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### Background/Aim

Most studies investigating the long term health effects of noise consider 24-hour, day or night average noise exposure levels. We aimed to analyse the impact of noise exposure at specific time windows on cardiovascular mortality.

### Methods

Within the SiRENE (Short and Long Term Effects of Transportation Noise Exposure) project we generated Switzerland-wide exposure models for road traffic, railway and aircraft noise in 2001 for different time windows. Specific windows included: 07-19h; 19-23h; 23-01h; 01-05h; 05-06h; and 06-07h. Combined-source noise exposure levels at the most exposed residential façade were assigned to each of the 4.41 million adults in the Swiss National Cohort. Hazard ratios (HR) of noise effects on various cardiovascular disease (CVD) deaths as primary cause were computed by Cox regression models adjusted for potential confounders and NO<sub>2</sub> levels.

### Results

During follow up (2000-2008), there were 142,955 deaths from CVD, of which 42.2%, 15.7%, 9.4%, 8.6% were from ischemic heart disease (IHD), stroke, blood-pressure related (BP) and heart failure. For most outcomes we observed a distinct diurnal pattern. For IHD the highest HR was observed for the core night hours from 01-05h (normalized HR per standard deviation of noise exposure: 1.023, 95% CI: 1.014-1.033) and lower HR for the daytime 07-19h (1.018 [1.009-1.028]). For heart failure daytime noise exposure yielded the highest HR (1.047 [1.027-1.068]).

### Conclusions

While nocturnal noise exposure tended to be more relevant than daytime exposure for acute CVD mortality, the opposite was found for chronic conditions such as heart failure. Our results thus indicate that different mechanisms are at play in the aetiology of noise induced cardiovascular deaths. In particular, it suggests sleep is an important mediator for long term health consequences of transportation noise for acute CVD.

# THC01: Noise and health, time and (work)place

026, September 28, 2017, 10:30 - 12:00

Short-term association between personal exposure to noise and heart rate variability: a sensor-based study

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## Background/Aim:

Studies revealed long-term associations between noise exposure and cardiovascular health, but the underlying mechanisms remain uncertain. Few studies on noise and heart rate variability (HRV) objectively assessed both personal noise exposure and personal accelerometry as a major confounder. The aim of this study was to explore the concomitant and lagged short-term associations between personal exposure to noise and heart rate variability in a real life setting in the Île-de-France region.

## Methods:

The RECORD MultiSensor Study collected noise and heart rate data for 75 participants, aged 34 to 74 years, in their living environments for 7 days using a personal dosimeter, an electrocardiography sensor on the chest, an accelerometer on the hip and a GPS completed by a mobility survey. Heart rate variability (HRV) parameters, noise level, accelerometry and heart rate were calculated for 5-minute windows. Short-term relationships between noise level and HRV parameters were assessed using mixed effects models adjusted for accelerometry and heart rate with a random intercept for participants, a temporal autocorrelation structure, and short-term trends accounted for in the random part of the model as well.

## Results:

An increase in A-weighted equivalent sound pressure level in dB(A) was associated with concomitant non-linear increases of the standard deviation of normal to normal intervals (SDNN), of the low frequency (LF) and high frequency powers (HF), and of the LF/HF ratio. The analysis of lagged exposures to noise adjusted for the concomitant exposure illustrates the dynamic of recovery of the autonomic nervous system with decreases of smaller magnitude for exposures measured further away.

## Conclusions:

Personal noise exposure was found to be related to a concomitant increase of the overall HRV, with evidence of unbalance of the autonomic nervous system towards sympathetic activity and effects observed with up to 15-minutes lagged noise.

# THC02: Epigenetics – How the environment influences our genetic code

020, September 28, 2017, 10:30 - 12:00

## Epigenome-wide meta-analysis of DNA methylation in children related to prenatal particulate air pollution exposure

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**Background/Aim:** Exposure to air pollution has increasingly been associated with adverse effects on child health, particularly if experienced *in utero* or during infancy. Although the exact molecular responses to air pollution exposure during prenatal life are still not fully understood, epigenetic changes have been suggested as a link between early-life air pollution exposure and subsequent health end-points, including airway disease. In the present study we aimed to investigate associations between *in utero* exposure to particulate matter with an aerodynamic diameter of  $<10 \mu\text{m}$  ( $\text{PM}_{10}$ ) and  $<2.5 \mu\text{m}$  ( $\text{PM}_{2.5}$ ) and epigenome-wide DNA methylation in newborn children.

**Methods:** We meta-analyzed the associations of cord blood DNA methylation (Illumina 450K BeadChip) in nine European and North American studies with the mean estimated ambient exposure to  $\text{PM}_{10}$  ( $n=1949$ ) and  $\text{PM}_{2.5}$  ( $n=1551$ ) at maternal home addresses during pregnancy, with subsequent look-up analyses in children aged 8 years ( $n\sim 1000$ ). To assess influence of exposure at the transcriptomics level, we related mRNA expression in blood cells to both PM exposures in 16-year-olds from the Swedish birth cohort BAMSE ( $n=245$ ).

**Results:** We found 6 CpG (cytosine-guanine dinucleotide) sites epigenome-wide significantly associated with prenatal  $\text{PM}_{10}$  exposure, and 14 CpG sites associated with prenatal  $\text{PM}_{2.5}$  exposure [false discovery rate (FDR)  $p<0.05$ ] after adjustment for the estimated cord blood cell composition. Interestingly, two of the  $\text{PM}_{10}$ -related sites mapped to genes *FAM13A* (cg00905156) and *NOTCH4* (cg06849931) that have been previously associated with lung function and asthma phenotypes in genome-wide association studies (GWAS). These associations were also significant in the older children ( $p<0.05$ ).  $\text{PM}_{10}$  exposure had a significant impact on *NOTCH4* expression in adolescents (FDR  $p<0.05$ ).

**Conclusions:** The differentially methylated CpG sites related to PM exposure found in our study may provide insights into mechanisms underlying adverse childhood health effect of air pollution, including complex diseases like asthma.

# THC02: Epigenetics – How the environment influences our genetic code

020, September 28, 2017, 10:30 - 12:00

An epigenome-wide association study for prenatal lead exposure and umbilical cord blood DNA methylation in Project Viva

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## Background/Aim

Early-life exposure to lead is associated with deficits in neurodevelopment and hematopoietic system toxicity. DNA methylation may be one of the underlying mechanisms for the adverse effects of prenatal lead on the offspring, but epigenome-wide methylation data for low levels of prenatal lead exposure are lacking. We aimed to investigate the association between prenatal maternal lead exposure and epigenome-wide DNA methylation in umbilical cord blood in Project Viva, a prospective US-based pre-birth cohort with relatively low levels of lead exposure.

## Methods

Among 268 mother-infant pairs, we measured lead concentrations in red blood cells (RBC) from prenatal maternal blood samples, and using HumanMethylation450 Bead Chip, we measured genome-wide methylation levels at 482,397 CpG loci in umbilical cord blood and retained 394,460 loci after quality control. After adjustment for batch effects, cell types and covariates, we used robust linear regression models to examine associations of prenatal lead exposure with DNA methylation in cord blood at epigenome-wide significance level (FDR<0.05).

## Results

Mean (SD) maternal RBC lead level was 1.22 (0.63) µg/dL. CpG cg10773601 showed an epigenome-wide significant negative association with prenatal lead exposure (-1.4% per doubling increase in lead exposure,  $p=2.3E^{-07}$ ) and was annotated to C-Type Lectin Domain Family 11, Member A (*CLEC11A*), which functions as a growth factor for primitive hematopoietic progenitor cells. In sex-specific analyses, we identified more CpGs with FDR<0.05 among female infants (n=38) than among male infants (n=2). One CpG (cg24637308), which showed a strong negative association with prenatal lead exposure among female infants (-4.3% per doubling increase in lead exposure,  $p=1.1E^{-06}$ ), was annotated to Dynein Heavy Chain Domain 1 gene (*DNHD1*) which is highly expressed in human brain. Visualized regional DNA co-methylation pattern showed similar changes in adjacent CpGs around cg24637308.

## Conclusions

Prenatal low-level lead exposure was associated with newborn DNA methylation, especially in female infants.

# THC02: Epigenetics – How the environment influences our genetic code

020, September 28, 2017, 10:30 - 12:00

## Histone Modifications of PPAR $\gamma$ gene in Human Placenta in Relation to Prenatal Phthalate Esters Exposures

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### Background/Aim

Phthalate esters (Phthalates) are plasticizers widely used in polyvinyl chloride products. Prenatal phthalate exposures may inhibit the growth and development of placenta and result in adverse health effects in neonates. Epigenetic studies have reported DNA methylation and miRNA in placenta can mediate the effects of phthalates. However, histone modification changes in this aspect remain unclear. This study is to investigate histone modifications of peroxisome proliferator-activated receptor  $\gamma$  (PPAR $\gamma$ ) gene in human placenta, which is contributed to the placental differentiation and transportation of fatty acid, and to investigate the mediation effects between prenatal phthalate exposures and birth outcomes.

### Methods

Among the 483 mother-infant pairs in Taiwan Birth Panel Study (TBPS), 163 of them had maternal urine samples collected at third trimester and phthalate metabolites measured. Placenta samples were used to measure PPAR $\gamma$  histone methylation levels by chromatin immunoprecipitation (ChIP). Medical records were used to extract information of birth outcomes. Univariable and multivariable linear regression models were used to study the phthalates exposure effects on PPAR $\gamma$  histone methylation levels and birth outcomes.

### Results

Every natural-log unit increase in maternal urinary concentration of MEP was negatively correlated with birth weight (g) ( $\beta=-79.96$ ,  $p=0.013$ ), birth length (cm) ( $\beta=-0.43$ ,  $p=0.005$ ) and head circumference (cm) ( $\beta=-0.28$ ,  $p=0.018$ ); MEHP was negatively correlated with birth weight (g) ( $\beta=-53.88$ ,  $p=0.034$ ) and gestational age (week) ( $\beta=-0.22$ ,  $p=0.008$ ). After adjusting for maternal age, birth type and infant gender, urinary concentration of MEP was still negatively correlated with birth length ( $\beta=-0.37$ ,  $p=0.014$ ).

### Conclusions

Prenatal phthalate exposures may result in adverse health effects in neonates through altering the histone modification levels in placenta. We are now working on ChIP among the 163 subjects' histone modification data. Further analysis regarding the association between phthalate exposures and histone modifications will be tested.

# THC02: Epigenetics – How the environment influences our genetic code

020, September 28, 2017, 10:30 - 12:00

## Assessment of the Association between Environmental Justice Data for Air Pollution and Telomere Length

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### Background/Aim

CalEnviroScreen (CES) data were developed to be used as an environmental justice (EJ) tool to help identify California communities that are impacted by pollution and socioeconomic disadvantage. We sought to determine if EJ measures of air pollution were associated with telomere length (TL), a health related outcome.

### Methods

The CES is collection of 19 pollution and population indicators where each is calculated at the census tract level using the most up-to-date data. We ascertained the CES indicators for diesel, PM2.5, ozone and traffic and mapped them to participants in the Genetic Epidemiology of Research on Aging (GERA) Cohort (n=110,266). TL has been measured for the GERA participants using quantitative PCR (qPCR) using leukocytes collected in 2009-2011. Genomic DNA was quantified, normalized and analyzed using the tel1b and single-copy gene (human beta-globin) primers. Relative telomere length (T/S) was obtained from the initial concentrations of the sample telomere (T) with the corresponding sample reference gene (S) (human beta-globin). After quality control filtering and log transformation, we used the log(T/S) estimates derived from the average value from replicate assays per subject.

### Results

Of the GERA cohort, 103,653 individuals had valid TL and CES data available. We observed significant associations when we compared the highest quartile of exposure to the for ozone ( $p < 0.001$ ) and PM2.5 ( $p = 0.03$ ). The highest quartile relative the lowest for diesel exposure was associated with shorter TL and of borderline significance ( $p = 0.06$ ). We found no association with traffic.

### Conclusions

Environmental justice indicators may be useful in assessments of health outcomes.

# THC03: Short & long term respiratory effects of Ambient air pollution in adults

022, September 28, 2017, 10:30 - 12:00

## Effects of TRAP exposure on development and persistence of asthma and low lung function in middle age adults

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**Background/Aim:** There has been limited investigation of the association between exposure to Traffic Related Air Pollution (TRAP) and development or persistence of asthma and impaired lung function in adults.

**Methods:** Associations between TRAP exposure and asthma (n=649), and lung function (n=573), were investigated using data from three follow-ups (mean ages of 45, 50 and 55 years) of the Tasmanian Longitudinal Health Study. TRAP exposure at residential address at the age of 45 years was assigned using two methods: 1. Mean annual NO<sub>2</sub> from a validated land-use regression model, and; 2. distance to the nearest major road. Multinomial logistic regression was used to model the association between TRAP exposures at age 45 years and change in both asthma status and lung function while adjusting for confounders. Low lung function was defined by FEV<sub>1</sub> less than the 5<sup>th</sup> percentile (z-score <-1.645).

**Results:** Among those who did not have asthma at 45 years, living <200 metres from a major road at age 45 years and NO<sub>2</sub> exposure were associated with increased risk of new asthma at 50 and 55 years (adjusted Odds Ratio [aOR] 3.57; 95%CI 1.55, 8.25 and aOR 1.43; 95%CI 1.06, 1.93 [per IQR increase of NO<sub>2</sub> = 2.4 ppb], respectively). Among those who had asthma at 45 years, living <200m from a major road was associated with persistent asthma from 45 to 55 years (aOR 1.79; 95%CI 1.10, 2.90). For those with a low FEV<sub>1</sub> at 45 years, living < 200m from a major road was associated with persistent low FEV<sub>1</sub> from 45 to 55 years (aOR 2.09; 95%CI 1.03, 4.25), a similar trend was observed with NO<sub>2</sub> exposure.

**Conclusions:** TRAP exposure in middle-aged adults is associated with new asthma, persistent asthma and persistently impaired lung function.

**Grant Support:** This research has been supported by the Centre for Air quality & health Research and evaluation (CAR), National Health and Medical Research Council, Clifford Craig Foundation, and Asthma Foundations of Tasmania, Victoria and Queensland.

## THC03: Short & long term respiratory effects of Ambient air pollution in adults

022, September 28, 2017, 10:30 - 12:00

### Short-term exposure to high ambient air pollution increases airway inflammation and respiratory symptoms in chronic obstructive pulmonary disease patients in Beijing, China

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**Background** Few studies have investigated the short-term respiratory effects of ambient air pollution in chronic obstructive pulmonary disease (COPD) patients in the context of high pollution levels in Asian cities.

**Methods** A panel of 23 stable COPD patients was repeatedly measured for biomarkers of airway inflammation including exhaled nitric oxide (FeNO) and exhaled hydrogen sulfide (FeH<sub>2</sub>S) (215 measurements) and recorded for daily respiratory symptoms (794 person-days) in two study periods in Beijing, China in January–September 2014. Daily ambient air pollution data were obtained from nearby central air-monitoring stations. Mixed effects models were used to estimate the associations between exposures and health measurements with adjustment for potential confounders including temperature and relative humidity.

**Results** Increasing levels of air pollutants were associated with significant increases in both FeNO and FeH<sub>2</sub>S.

Interquartile range (IQR) increases in PM<sub>2.5</sub> (76.5 µg/m<sup>3</sup>, 5-day), PM<sub>10</sub> (75.0 µg/m<sup>3</sup>, 5-day) and SO<sub>2</sub> (45.7 µg/m<sup>3</sup>, 6-day) were associated with maximum increases in FeNO of 13.6% (95% CI: 4.8%, 23.2%), 9.2% (95% CI: 2.1%, 16.8%) and 34.2% (95% CI: 17.3%, 53.4%), respectively; and the same IQR increases in PM<sub>2.5</sub> (6-day), PM<sub>10</sub> (6-day) and SO<sub>2</sub> (7-day) were associated with maximum increases in FeH<sub>2</sub>S of 11.4% (95% CI: 4.6%, 18.6%), 7.8% (95% CI: 2.3%, 13.7%) and 18.1% (95% CI: 5.5%, 32.2%), respectively. Increasing levels of air pollutants were also associated with increased odds ratios of sore throat, cough, sputum, wheeze and dyspnea.

**Conclusions** FeH<sub>2</sub>S may serve as a novel biomarker to detect adverse respiratory effects of air pollution. Our results provide potential important public health implications that ambient air pollution may pose risk to respiratory health in the context of high pollution levels in densely-populated cities in the developing world.

# THC03: Short & long term respiratory effects of Ambient air pollution in adults

022, September 28, 2017, 10:30 - 12:00

The effects of Asian dust for allergic symptoms may be partly attributed to PAH-quinone, secondarily formed on the dust surface - Observational study in 3 regions in Japan -

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## Background/Aim

We showed that Asian dust (AD) exposure is associated with increased risk for exacerbations of asthma and allergic symptoms in children or pregnant women in Japan. AD particles contain anthropogenic pollutants such as PAHs. Further, its catalytic effects promote secondary-formation of chemicals, one of which, PAH-quinone is known to generate ROS in human body, which may contribute to allergic diseases. We estimated how much of the effects of AD are attributed to PAH-quinone.

## Methods

We conducted an observational study for 3,327 pregnant women during spring and fall in 2011-2013 in 3 regions in Japan as an adjunct study of Japan Environment and Children's Study. There, we timely acquired subjects' daily allergic-symptoms by sending web-based questionnaires on some days for each participant. We also sampled TSP every day, and measured some PAH-quinones by HPLC. We estimated odds ratio (OR) of log-transformed AD per 1SD-change for occurrence of allergic symptom with interaction term of AD and PAH-quinone in the GEE logistic regression model.

## Results

Both AD and PAH-quinone showed significant associations with allergic symptom. Interaction term of AD and PAH-quinone was significantly larger than 0 ( $p < .01$ ), and the OR of AD (per log-transformed 1SD change) when log-transformed PAH-quinone is mean, was 1.12 (95%CI: 1.04-1.22), while the OR was 1.34 when log-transformed PAH-quinone is 1SD above the mean.

## Conclusions

The effect of AD was significantly exacerbated by the presence of PAH-quinone. We may be able to reduce the effects of AD by reducing PAH emissions.

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# THC03: Short & long term respiratory effects of Ambient air pollution in adults

022, September 28, 2017, 10:30 - 12:00

## Respiratory health effects of black carbon and physical activity depend on baseline exposure levels

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### Background/Aim

The Physical Activity through Sustainable Transport Approaches (PASTA) study aims to increase physical activity (PA) levels by promoting active mobility. Performing PA in traffic, however, implies heightened exposure to air pollution. We studied the relation between daily PA, air pollution exposure and respiratory health.

### Methods

Healthy adults (N=122: 45% males; age: 35±10 years; BMI: 24±3 kg/m<sup>2</sup>) participated in the data collection campaigns of Antwerp, Barcelona, and London. Participants wore personal-monitoring devices to track movement and black carbon (BC) for seven consecutive days (repeated in three seasons). Respiratory health outcomes were measured on the final day (lag0): FEV<sub>1</sub>, FVC, PEF and exhaled NO (eNO). Mixed-effects regression models were used to assess the effects of BC, PA and their interaction on respiratory health outcomes at lag0. All models included age, gender and height as covariates and participants nested per city as random effect. Stratified analysis was performed by dividing the dataset at the median of BC and PA.

### Results

Median levels of BC and PA were 1.4 µg/m<sup>3</sup> and 71 minutes/day. Overall, a trend towards a lower PEF with increasing BC concentrations (p=0.07) and higher eNO levels with increasing PA (p=0.09) was observed. The strength of the effect depended on the combination of BC and PA: it remained only for participants with both BC and PA below the median (p<0.05) and with BC and PA levels above the median (p<0.1). A significant interaction was observed for PEF in participants with PA and BC below and above the median, respectively (p<0.01). There were no effects on FEV<sub>1</sub> and FVC.

### Conclusions

It is indicated that physiological effects of BC and PA depend on baseline levels, and interaction between the two is suggested. This research aids to inform whether the health benefits of PA in an urban environment outweigh the risks.

# THC03: Short & long term respiratory effects of Ambient air pollution in adults

022, September 28, 2017, 10:30 - 12:00

Nitrogen dioxide exposure and its interaction with smoking on measures of chronic obstructive pulmonary disease (COPD)

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**Background/Aim:** While both outdoor air pollution and personal smoking are known causes of cardiorespiratory disease, it is not well documented whether these two risk factors have a synergistic effect on COPD risk. Our aim was to assess the interaction between the effects of nitrogen dioxide (NO<sub>2</sub>) exposure and smoking status on COPD-related lung function measures in middle-aged Australian adults.

**Methods:** Cross-sectional data was from the fifth decade follow-up of the Tasmanian Longitudinal Health Study cohort (TAHS, n=1,389). COPD-related lung function measures included post-bronchodilator forced expiratory ratio (FEV<sub>1</sub>/FVC) and gas transfer factor (D<sub>L</sub>CO) expressed by z-scores (standard deviations). The corresponding annual outdoor mean NO<sub>2</sub> concentration [parts per billion (ppb)] was measured at the participant's residential address using a validated satellite-based, land-use regression model (n=1,355). Multivariable regression was adjusted for pack-years, smoking status (if no effect modification), current asthma, familial COPD, current occupation and sampling weights

**Results:** Eighty-three participants (6.1%) resided in areas with an outdoor mean NO<sub>2</sub> concentration of ≥10 ppb [National Environmental Protection Measure (NEPM) standard=30ppb]. A negative association was seen between NO<sub>2</sub> exposure and gas transfer factor, but not FEV<sub>1</sub>/FVC, that was independent of smoking [z-score -0.18 per 5 ppb increments (95%CI -0.3 to -0.1), p<0.001]. Compared with the reference group (never smokers exposed to NO<sub>2</sub> levels <10 ppb), the airflow obstruction observed for current smokers exposed at these levels [FEV<sub>1</sub>/FVC z-score -0.38 (-0.6 to -0.2), p<0.001] was not seen for current smokers exposed to higher NO<sub>2</sub> ≥10 ppb [z-score +0.24 (-0.3 to +0.7), p=0.334; p[interaction]=0.041].

**Conclusions:** Even at low pollution levels, NO<sub>2</sub> exposure is adversely associated with gas transfer factor that may represent lung tissue damage. The paradoxical interaction identifies a subgroup who are relatively resistant to obstructive effects of air pollutants on airway function, and this stratification provides more complete information about pollution-related associations for current smokers.

# THC03: Short & long term respiratory effects of Ambient air pollution in adults

022, September 28, 2017, 10:30 - 12:00

## Long-term exposure to low concentration air pollution and hospitalisation for respiratory diseases: a cohort study

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**Introduction:** Time series studies have found short-term relationship between exposure to ambient air pollution and hospital admission for respiratory conditions. The associations between long term exposure to air pollution and hospital admissions, however, are inconsistent, particularly for areas with low concentration air pollution.

**Methods:** The 45 and Up cohort study includes 267,153 participants [aged 45 years and above at baseline (2006 – 2009)] from the state of New South Wales, Australia. This study was limited to the 100,084 participants residing in the Sydney Metropolitan Region. The cohort was linked to hospital admissions data from 1 July 2001 to 30 June 2014. The first respiratory hospital admission between baseline and 30 June 2014 was defined as the main outcome. NO<sub>2</sub> and PM<sub>2.5</sub> concentrations were estimated at the baseline residential addresses of participants using a land use regression model, and a chemical transport model blended with fixed site monitor data respectively. Cox proportional hazard models were used to assess the associations between hospital admission for respiratory diseases and exposure to air pollution while adjusting for gender, smoking status and education.

**Results:** The median estimated NO<sub>2</sub> and PM<sub>2.5</sub> levels were 9.2 ppb and 4.5 µg.m<sup>-3</sup> respectively. PM<sub>2.5</sub> concentrations were associated with risk of hospitalisation for respiratory diseases in participants aged between 45 to 60 years at enrolment (HR and 95% CI per 1 µg.m<sup>-3</sup>: 1.14; 1.03 – 1.27), while no such associations were observed in the same age group with NO<sub>2</sub> (HR and 95% CI per 1 ppb: 1.00; 0.97 – 1.03).

**Conclusions:** Exacerbations of respiratory disease are associated with long-term exposure to relatively low air pollution levels. Long-term exposure to air pollution was associated with increased risk of hospitalisation in a relatively younger age group of a large Australian cohort of adults.

## THC04: Ambient air adult neurological

100, September 28, 2017, 10:30 - 12:00

### Associations of Long-term Noise Exposure and Cognition in Older Adults

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**Background:** Noise has been associated with cardiovascular disease, a known risk factor for Alzheimer's disease dementia (AD) and cognitive decline. Little, however, is known about the impacts of community noise on cognition in older adults of the general population or those with AD.

**Methods:** The Chicago Healthy Aging Project is a prospective cohort study of adults  $\geq 65$  years that collected demographic, health, and lifestyle data while also testing for global cognitive functioning, episodic memory and perceptual speed in triennial interviews (1993-2011). We estimated noise for participant addresses in the 5-years preceding each interview using a land use regression model developed with Chicago-specific measurements. NO<sub>x</sub>, a traffic-related air pollutant, was estimated using an existing spatiotemporal model. We used linear mixed models to estimate associations of noise with baseline cognition and the rate of cognitive decline in all participants and those with clinically diagnosed AD, adjusting for age, sex, smoking, alcohol, income, education, neighborhood socioeconomic status, and NO<sub>x</sub>.

**Results:** Mean global cognition, episodic memory, and perceptual speed scores were  $0.4 \pm 0.6$ ,  $0.4 \pm 0.8$ ,  $0.5 \pm 0.8$  among all participants (N=4,733), respectively. Participants with AD (N=220) were more impaired at  $-0.5 \pm 0.6$ ,  $-0.5 \pm 0.9$ , and  $-0.6 \pm 0.7$ . Overall, an interquartile range difference in noise (2.7 dB) was cross-sectionally associated with 0.02 lower scores for all cognitive measures, with the most precise association for perceptual speed (95%CI: -0.03,-0.01). Longitudinally, noise was only associated with steeper increases in the change rate of episodic memory. More adverse associations were observed among participants with AD, with higher noise levels associated with lower baseline cognition and faster cognitive decline (e.g., for global cognition 2.7 dB was associated with a 0.06, 95%CI:-0.13,0.02 lower baseline score and 0.007 unit/year, 95%CI:-0.03,0.02 steeper decline over time) but these associations were indistinguishable from the null.

**Conclusions:** Noise exposure may lead to worse cognition in older adults, especially among individuals with AD.

# THC04: Ambient air adult neurological

100, September 28, 2017, 10:30 - 12:00

Differential susceptibility of Chinese adults to ambient particle-related stroke onset risk: findings from a national case-crossover study

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## Background/Aim

Exposure to fine particulate (PM<sub>2.5</sub>) air pollution has been suggested significantly linked to stroke, but reported effect estimates remain inconsistent. Differential distribution of susceptibility among the study populations may explain some of this variation.

## Methods

Associations between stroke risk and PM<sub>2.5</sub> were assessed by time-stratified case-crossover design involving 1,356 events derived from the China National Stroke Screening Survey (CNSSS) database. Daily PM<sub>2.5</sub> averages with a spatial resolution of 0.1° across China were estimated using a data assimilation approach combining satellite measurements, air model simulations and monitoring values, and individual exposure to PM<sub>2.5</sub> was assessed according to residential address records. Distribution of susceptibility was derived according to individual-specific effects of PM<sub>2.5</sub> modified by different combinations of individual-level characteristics in socioeconomic status, lifestyle and medical history and their joint frequencies among all the CNSSS participants (n=1,292,010).

## Results

Overall, first-ever stroke onset was significantly associated with PM<sub>2.5</sub> in a lagged time of two days (odds ratio=1.08 [95% confidence interval = 1.06–1.09] per 10 µg/m<sup>3</sup>). This effect was significantly modified by sex, overweight/obesity and diabetes. Combined effects of PM<sub>2.5</sub> varied from 0.96 (95% confidence interval: 0.90–1.02) to 1.26 (95% confidence interval: 1.16–1.36) per 10 µg/m<sup>3</sup> by different subpopulations, and ignoring this variation resulted in overestimating the risk of PM<sub>2.5</sub>-related stroke among 73% adults. PM<sub>2.5</sub>-stroke association was significant for 41% of the CNSSS participants.

## Conclusions

Variations in PM<sub>2.5</sub>-related stroke susceptibility are attributable to distributions of individual specific characteristics. Ignoring differential susceptibility may result in substantial biased estimations on particulate related health effects.

# THC04: Ambient air adult neurological

100, September 28, 2017, 10:30 - 12:00

## Association between ambient air pollution exposure and dizziness

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### Background/Aim

Exposure to environmental chemicals has been suggested to alter the physiologic state of the inner and middle ear. However, it is unknown if air pollutant exposure is associated with dizziness. Therefore, we evaluated the association between daily concentration of ambient air pollutants and the number of dizziness hospital visits using time series analysis.

### Methods

We used National Health Insurance Service-National Sample Cohort (NHS-NSC), which is nationally representative cohort of Korea. Among total NHS-NSC participants, we selected 210,000 Seoul residents and linked daily hospital use data to daily levels of air pollutants data [nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), carbon monoxide (CO), ozone (O<sub>3</sub>), and particulate matter < 2.5µg/m<sup>3</sup> (PM<sub>2.5</sub>)]. Time series analysis using the Poisson generalized additive model was applied in our analysis.

### Results

There were total 1,462 dizziness hospital visits during 4 year study periods (2007-2010). An interquartile range (IQR) increase of NO<sub>2</sub> on lag day 0 and 1 was significantly associated with an increased risk of dizziness hospital visits [relative risk (RR), 95% confidence interval (CI): lag 0: 1.06, 1.00-1.11; lag 1: 1.06, 1.00-1.11]. In a subgroup analysis by sex, we found significant association between an IQR increase of NO<sub>2</sub> and dizziness hospital visits in both men and women [RR, 95% CI: men, lag 4: 1.12, 1.02-1.22; women, lag 0: 1.09, 1.03-1.16; lag 1: 1.10, 1.04-1.17]. In a subgroup analysis by age, an IQR increase in SO<sub>2</sub> was significantly associated with dizziness hospital visits from elderly individuals in lag day 3 [RR, 95% CI: 1.09, 1.03-1.16]. In addition, NO<sub>2</sub> was significantly associated with dizziness hospital visits from non-elderly individuals in lag day 0 [RR, 95% CI: 1.09, 1.03-1.16]. Additional case-crossover analyses showed similar results.

### Conclusions

Dizziness hospital visits were associated with ambient air pollution exposure. Among diverse air pollutants, NO<sub>2</sub> was most significantly associated with dizziness hospital visits.

# THC04: Ambient air adult neurological

100, September 28, 2017, 10:30 - 12:00

## Ambient air pollution and occurrence of multiple sclerosis relapses

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### Background

Triggers of multiple sclerosis (MS) relapses are essentially unknown. Relapses' incidence varies across seasons, suggesting a possible role of season-dependent factors such as meteorological variables and ambient air pollution. Relatively few studies have investigated this hypothesis, but the role of ambient air pollution is of growing interest; a recent study from our group observed an increased risk of relapses with ambient PM<sub>10</sub> exposures until 3 days before the relapse onset (cold season).

### Methods

We conducted a time-stratified case-crossover design to further explore separately the short-term associations between other pollutants (e.g., NO<sub>2</sub>, Benzene (C<sub>6</sub>H<sub>6</sub>), O<sub>3</sub>, and CO) and the odds of MS relapses occurrence. Our study population consists of 536 relapsing MS patients living in Strasbourg area (France) who experienced 2,052 relapses (2000-2009). Control days are chosen to be ±35 days relative to the case (relapse) day. We performed a conditional logistic regression coupled with a distributed-lag model (considering lags 0 to 3) using the "*dlnm*" R package, stratified by season (hot and cold), and adjusted on all lagged meteorological variables (daily maximum temperature, maximum relative humidity and maximum atmospheric pressure), lagged pollen count, lagged influenza-like epidemics, and holidays.

### Results

An interquartile range increase in NO<sub>2</sub> (lags 1 to 3 cumulated) was associated with MS relapses incidence (OR<sub>NO<sub>2</sub></sub>=1.28 [95%CI: 1.05-1.55]) during cold months (i.e., October to March). C<sub>6</sub>H<sub>6</sub> and CO were not significantly related to MS relapse incidence (OR<sub>C<sub>6</sub>H<sub>6</sub></sub>=1.13 [95%CI: 0.95-1.35] and OR<sub>CO</sub>=1.09 [95%CI: 0.89-1.34], respectively). We also observed non-significant association between O<sub>3</sub> during hot months and MS relapse incidence (OR<sub>O<sub>3</sub></sub>=1.12 [95%CI: 0.88-1.44]).

### Conclusion

We found a significant association between NO<sub>2</sub> and the occurrence of MS relapses using a case-crossover design, relevant to studies with rare event outcomes. Strengths of our study include a precise exposure spatio-temporal model and a clinically-diagnosed outcome from a fairly exhaustive MS registry.

# THC04: Ambient air adult neurological

100, September 28, 2017, 10:30 - 12:00

## Association between Air Pollution and Depressive Symptoms: Effect modification by Greenness Level

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### Background/Aim

The association between air pollution and depressive symptoms have been suggested in several studies. A few studies have reported that this association may be affected by greenness level. Greenness is expected to reduce air pollution and affect mental health through stress reduction, increased physical activity, noise mitigation. The objective of this study is to examine the association between long-term exposure to air pollution and depressive symptoms of 7 major cities of Korea and whether this association differs by greenness level.

### Methods

This study included a total of 43,104 individuals from Community Health Survey 2009. Individuals with Center for Epidemiological Studies Depression (CES-D) score  $\geq 16$  were classified as having depressive symptoms. District-level annual concentrations of PM<sub>10</sub>, SO<sub>2</sub> and NO<sub>2</sub> were obtained. To measure greenness, we used Normalized Difference Vegetation Index (NDVI) and categorized NDVI into two level: high vs low. A logistic regression was used to estimate the association between long-term exposure to air pollution and depressive symptoms. We analysed effect modification by greenness level.

### Results

Odds ratio (OR) of having depressive symptoms was 1.038 (95% CI: 0.971, 1.109) with interquartile range (IQR) of PM<sub>10</sub> increase. Effect modification by greenness level was observed. In the lower greenness group, the association between exposure to PM<sub>10</sub> and depressive symptoms was found [OR=1.206 (95% CI: 1.079, 1.349)]. In the higher greenness group, on the other hand, the association was not found [OR=0.957 (95% CI: 0.873, 1.047)]. These associations did not change when the concentration of SO<sub>2</sub> and NO<sub>2</sub> were adjusted.

### Conclusions

We found that the long-term exposure to PM<sub>10</sub> was associated with depressive symptoms in population with lower greenness level.

# THC04: Ambient air adult neurological

100, September 28, 2017, 10:30 - 12:00

## Trajectories of Cognitive Aging in Older Women: Role of Fine Particulate Matter

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### Background

Cross-sectional studies have found associations of cognitive deficits with long-term exposure to particulate matter. Few longitudinal studies have shown inconsistent associations, and their analyses with limited neuropsychological assessments could not separate learning effects from trajectories of cognitive decline in late life.

### Methods

We examined how fine particulate matter (PM<sub>2.5</sub>: PM with aerodynamic diameters <2.5µm) was associated with cognitive declines in a geographically-diverse US population of older women (N=7064; aged 65-80) from the Women's Health Initiative Memory Study, with up to 9 annual global cognitive assessments (in 6.3±2.1 visits) using the Modified Mini-Mental State (3MS) Exam. Given residential histories and ambient monitoring data coupled with air quality model simulation, the Bayesian Maximum Entropy method was used to estimate long-term (3-year average) PM<sub>2.5</sub> exposures preceding each visit. We fit longitudinal linear mixed-effects models to standardized 3MS z-scores and assessed how cognitive trajectories were influenced by PM<sub>2.5</sub> exposures, adjusting for socio-demographic (age; residential geography; race/ethnicity; education; income; employment status), lifestyle (smoking; alcohol use), and clinical factors (body mass index; hypertension; cardiovascular diseases).

### Results

Two concurrent processes of cognitive aging were identifiable. The first trajectory showed 3MS scores increased with visit numbers (p<0.001), likely reflecting a systematic difference that included the learning effect. The second trajectory was defined by the age-related decrease in 3MS, incrementally with faster declines during the extended follow-up (interaction p<0.0001). For the first trajectory, we found no appreciable differences by PM<sub>2.5</sub> exposure (interaction p=0.88). The effect of aging on 3MS was accelerated by increased PM<sub>2.5</sub> (interaction p<0.0001); this apparent neurotoxic effect was masked when the second trajectory was ignored in the mixed-effect model.

### Conclusions

This longitudinal study provides further evidence that late-life exposure to PM<sub>2.5</sub> accelerates age-related cognitive decline. Our analyses also demonstrate the importance of accounting for the underlying trajectories of cognitive aging in community-dwelling populations.

## THC05: Other topics

102, September 28, 2017, 10:30 - 12:00

The epidemiology of lead poisoning notifications in New South Wales, Australia, 1996-2016

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### *Background/Aim:*

Elevated blood lead levels have been notifiable in New South Wales (NSW), Australia since 1996. In that time the notifiable blood lead level has been reduced twice, from 15µg/dL to 10µg/dL in 2012 and to 5µg/dL in 2016. We evaluated the impact of this change on notification rates in NSW, and assessed the characteristics and quality of surveillance data.

### *Methods:*

We analysed notification data for 1996-2016 by geographical area, age, sex, exposure status and occupation, and described trends in blood lead levels. We calculated notification rates and compared these over time and between geographic regions. We also described the characteristics of the surveillance dataset and made recommendations for improvement. We used Stata version 14.1 for all analyses.

### *Results:*

There were 9724 notifications between 1996–2016, with an average annual notification rate of 6.8 per 100,000. In 2016 the notification rate of 12.9 per 100,000 was double the average rate for the preceding five years. When only notifications of blood lead levels above 15µg/dL were considered, the notification rate for 2016 was 1.94 per 100,000, the lowest rate during the 21-year study period. Notification rates in rural regions where lead mining has occurred, and where there is systematic screening, were more than 10 times higher than in other regions. Key limitations of the data included the lack of a single comprehensive data source, high rates of missing data, and the presence of free-text responses. These limitations made it difficult to analyse notifications rates, particularly by risk and exposure history.

### *Conclusions:*

Changes to the case definition increased notification rates of elevated blood lead, however when considering only notifications above 15µg/dL rates are at their lowest since lead poisoning became notifiable. It is important to improve data completeness in the lead surveillance system to enhance understanding of the epidemiology of elevated blood lead levels in NSW and factors which lead to increased risk.

## THC05: Other topics

102, September 28, 2017, 10:30 - 12:00

### Beverage consumption trends in Australian children: 2004-2014

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**Background/Aim:** Beverages are an important source of water and some essential nutrients, but the consumption of sweet beverages has been linked to adverse health outcomes. Beverage sales data is available in Australia but longitudinal data is lacking, making it difficult to understand changes in beverage consumption over time. This study aimed to investigate consumption trends of sweet and unflavoured beverages in a cohort of Australian children.

**Methods:** The Longitudinal Study of Australian Children (LSAC) has run biennially since 2004. 24 hour recall data collected over 6 waves from the birth cohort (aged 0-12 months at baseline) was analysed and demographics were assessed for associations.

**Results:** 5,107 children participated at baseline. Proportions of fruit juice consumers overall decreased with increasing age, but increased significantly from 38.1% (0-1y) to 60.5% (2y). Soft drink and cordial consumer proportions increased from 1.3% (0-1y), to 27.8% (2y) and 43.0% (10y). The majority of the participants did not consume diet soft drinks, until 10-11y when proportions increased from 6.5% to 23.5%. Consumption of full cream milk decreased from 82.7% (2y) to 74.7% (10y). Proportions of skim milk consumption increased by 50.7% between ages 2 and 10y. Higher consumption of soft drink and cordial was significantly associated with older children, males, children with a medical condition, living in a rural area, living in a low socio-economic index area and Indigenous Australians.

**Conclusions:** Fruit juice was introduced into the diet in early infancy. While proportions of fruit juice consumers decreased after the age of 2y, proportions of soft drink consumers increased. Full cream milk appeared to be largely replaced by the consumption of skim milk by the time the cohort was aged 10y. The findings from this study should inform policy and interventions aimed at reducing consumption of sweet beverages and the associated burden of disease.

## THC05: Other topics

102, September 28, 2017, 10:30 - 12:00

### Indoor Air Quality Police-project: a new practice to assess indoor air quality

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#### Background/Aim

Pupils and teachers spend a lot of their times at school, thus the poor indoor air quality at schools may cause adverse health effects, absence at school and adversely affect student performance. In addition, school environments are particularly complex and have a lot of different and interconnected factors having effect to occupants' health. We aimed 1) to develop the real-time questionnaire (discomfort and symptoms) method and 2) to assess associations between measured (real-time measurements) and perceived (online-questionnaires about discomfort and symptoms) indoor air quality in school buildings.

#### Methods

Indoor Air Quality Police-project was conducted in six secondary schools with (4 schools) and without (2 schools) reported indoor air quality problems. Study involves six classrooms (6<sup>th</sup>- 9<sup>th</sup> grade) from each schools where the measured and perceived indoor air quality were detected. Pupils and teachers completed the questionnaires in two weeks period at the end of the lessons in the studied classrooms. Following indoor air quality parameters were measured for two weeks periods: humidity, temperature, carbon dioxide, TVOC, ozone, arsine, ammonia, hydrogen sulfide, formaldehyde, particulate matter, dustiness, noise and lightness.

#### Results

The fieldwork was build up due the autumn 2016 and end at the March of 2017. Preliminary results will be present at the conference.

#### Conclusions

Indoor Air Quality Police-project will establish a new practice to assess the associations between measured and perceived indoor air quality. We have an opportunity to assess an information about possible indoor air related symptoms and discomfort simultaneously with real-time measured exposure factors. Information has been collected from the same indoor air space and from the same people for several times. There is potential to notice and determine new markers that are in key roles and have adverse effect on indoor air quality and on human.

## THC05: Other topics

102, September 28, 2017, 10:30 - 12:00

### Grand challenges in the climate and health research

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Climate change is increasingly affecting human health but the approach to quantifying the health risks of climate change remains to be improved. We face many new challenges, ranging from assessing the net balance of temperature-related mortality to examining the impacts of climate change on infectious disease. This presentation will illustrate how the health risks of climate change can be better quantified and what measures we should take to minimise the uncertainty in future research. It will advance what we know about the impacts of climate change on population health, and the way forward to significantly improve our understanding of health consequences of climate change.