

# ISEE Young Rennes 2024 Abstracts

Abstracts have been reviewed by the scientific committee of the ISEE Young Conference in Rennes. Those published in ENVIRONMENTAL EPIDEMIOLOGY have been accepted for presentation and presented at the conference. They are presented by session. These abstracts have not undergone review by the Editorial Board of ENVIRONMENTAL EPIDEMIOLOGY.

## AIR POLLUTION 1: NEW EVIDENCE ON HEALTH EFFECTS OF AIR POLLUTION

### Waste-to-energy plants PM10 emissions and cardio-respiratory health in a residential cohort in Latium region, Italy

Lisa Bauleo<sup>1</sup>, Paola Michelozzi, Isabella Bottini, Marina Davoli, Carla Ancona

<sup>1</sup>Department of Epidemiology of Lazio Region Health Service/ASL Rome 1, Rome, Italy

#### Abstract

**Introduction:** We compared the risk of hospitalization for cardio-respiratory diseases during the operational period of two WTE plants in Lazio region (central Italy) with that of the preceding and post operational period, using a difference-in-differences (DiD) approach.

**Methods:** Residents within 7 km from two WTE plants were enrolled from 1996 to 2008 in a retrospective cohort study and followed up until 31/12/2022. A SPRAY dispersion model was used to estimate WTE PM10 concentration at residential address of each cohort member. Background PM10 was estimated using random forest models. Hospital admissions were obtained for the period before (1996-2002) and after (2003-2022) the activation of the plants. The association between WTE PM10 concentrations and hospitalizations in the two periods was assessed using a multivariate Cox model for repeated events, adjusting for age, area-level SES, distance from industries, highways and background PM10. An interaction term between period of follow-up and categoric exposure level was used as DiD estimator. Additional analysis accounted for the health effects of Colferro plant closure in 2018.

**Results:** We enrolled 47,192 residents (50,6 % females, 44.6% 15-44 years old, 27.1% medium-high SES). Increased risks of hospitalization associated to medium and high PM10 concentrations were observed for respiratory diseases (HR 1.15; 95% CI 1.00-1.33), and for COPD (HR 1.65; 95% CI 1.04-2.61), respectively after the activation of the plants. The closure of Colferro plant showed increased risks of circulatory (HR 1.29; 95% CI 1.09-1.52), cardiac (HR 1.27; 95% CI 1.03-1.57) and cerebrovascular (HR 1.52; 95% CI 1.02-2.26) hospitalizations. Results were stronger among women.

**Discussion:** Results are coherent with previous research and with the biological mechanisms that link PM to the studied diseases. Living at the same address before and after the activation of the WTE plants was associated in this cohort with increased morbidity level

### Comparison of air pollution mortality effect estimates using different long-term exposure assessment methods

Femke Bouma<sup>1</sup>, Nicole Janssen, Joost Wesseling, Sjoerd van Ratingen, Jules Kerckhoffs, Ulrike Gebring, Wouter Hendrixx, Kees de Hoogh, Kees Meliefste, Roel Vermeulen, Gerard Hoek

<sup>1</sup>Institute for Risk Assessment Sciences, Utrecht University, Utrecht, the Netherlands

#### Abstract

**Introduction:** Epidemiological studies have used different approaches to assess long-term exposure to ambient air pollution. Little is known

about how different exposure models affect health effect estimates in these studies. The aim of this study was to compare air pollution mortality effect estimates in an administrative cohort in the Netherlands based on different exposure assessment methods.

**Methods:** Annual average air pollution exposure estimates using eight different methods, differing in modelling (dispersion, empirical with different algorithms) and monitoring strategy (fixed site, mobile), were applied to a Dutch national cohort of 10.8 million adults aged  $\geq 30$  years. Hazard ratios (HR) for natural and cause-specific mortality were estimated using Cox proportional hazards models with adjustment for individual and area-level confounders. Heterogeneity in effect estimates was assessed using meta-analysis.

**Results:** Exposure estimates from different exposure models were highly correlated and generally resulted in similar conclusions on the presence of associations with natural, respiratory and lung cancer mortality. However, the effect estimates differed substantially, e.g. the HR (95% CI) for black carbon (BC) with natural mortality ranged from 1.01 (0.99; 1.02) to 1.09 (1.07; 1.10) per increment of 1  $\mu\text{g}/\text{m}^3$ . I2 values of the meta-analysis across models were above 0.85 for all pollutants with natural mortality.

**Discussion:** Different exposure models generally resulted in similar conclusions on the presence of associations with natural and cause-specific mortality, but effect estimates differed substantially. Differences in exposure assessment may therefore contribute substantially to the observed heterogeneity of effect estimates in systematic reviews of epidemiological studies.

### Increase in sick leave episodes from short-term air pollution exposure: A case-crossover study in Stockholm, Sweden

Hedi Katre Kriit<sup>1,2,3,4</sup>, Bertil Forsberg, Johan Nilsson Sommar

<sup>1</sup>Section of Sustainable Health, Department of Public Health and Clinical Medicine, Umeå University, Umeå, Sweden; <sup>2</sup>Health Economics and Health Financing Group, Institute of Global Health, Heidelberg University, Heidelberg, Germany; <sup>3</sup>Climate-Sensitive Infectious Disease lab, Interdisciplinary Centre of Scientific Computing, Heidelberg University, Heidelberg, Germany; <sup>4</sup>Climate-smart Health Systems, Institute of Global Health, Heidelberg University, Heidelberg, Germany

#### Abstract

**Introduction:** Air pollution effects on the adult working population through sick leave episodes have not been studied. Sick leave episodes are frequent events that have direct negative health impacts to the individual, but also economic consequences to the individual, the employer, and the state. This study aims to 1) estimate the associations between particulate matter  $\leq 2.5 \mu\text{m}^3$  (PM2.5) and sick leave episodes and 2) calculate the attributable number of sick leave days and the consequential productivity loss in the City of Stockholm, Sweden.

**Methods:** Individual level daily sick leave data was obtained from Statistics Sweden for the years 2011-2019. Daily average concentrations of PM2.5 were obtained from the main urban background monitoring station in Stockholm. A case-crossover study design was applied to

estimate the association between short-term PM<sub>2.5</sub> and onset of sick leave episodes. Conditional logistic regression was used to estimate the relative increase in odds of onset per 10 µg/m<sup>3</sup> of PM<sub>2.5</sub>, adjusting for temperature, season, and pollen. A human capital method was applied to estimate the PM<sub>2.5</sub> attributable productivity loss.

**Results:** In total, 1.5 million (M) individual sick leave occurrences were studied. The measured daily mean PM<sub>2.5</sub> concentration was 4.2 µg/m<sup>3</sup> (95th percentile 11.35 µg/m<sup>3</sup>). The odds of a sick leave episode was estimated to increase by 8.5% (95% CI: 7.8-9.3) per 10 µg/m<sup>3</sup> average exposure 2-4 days before. Sub-group analyses showed that private sector and individuals 15-24 years old had a lower increase in odds of sick leave episodes in relation to PM<sub>2.5</sub> exposure. In Stockholm, 4% of the sick leave episodes were attributable to PM<sub>2.5</sub> exposure, corresponding to €17M per year in productivity loss.

**Discussion:** Despite the relatively low exposure in the study population, the significant risk increase suggest that current health impact assessments underestimate the short-term air pollution effects on the adult working population.

### Long-term ambient air pollution exposure and renal function and biomarkers of renal injury in the population based Swedish CardioPulmonary bioImaging Study (SCAPIS)

Karl Kilbo Edlund<sup>1</sup>, Yiyi Xu, Eva M. Andersson, Anders Christensson, Mats Dehlin, Helena Forsblad-d'Elia, Florencia Harari, Stefan Ljunggren, Peter Molnár, Anna Oudin, Magnus Svartengren, Petter Ljungman, Leo Stockfelt

<sup>1</sup>Occupational and Environmental Medicine, School of Public Health and Community Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg, Sweden; Sahlgrenska University Hospital, Gothenburg, Sweden

#### Abstract

**Introduction:** Emerging evidence indicates that air pollution contributes to renal disease. In light of the severe medical complications and costly treatment, the potential public health implications are large. However, epidemiological studies on air pollution and measures of renal function are still inconclusive and studies on air pollution and cardio-renal biomarkers are scarce. Our aim was to investigate this in a large middle-aged cohort recruited from the general population.

**Methods:** We coupled baseline medical data from the Swedish CardioPulmonary bioImaging Study (SCAPIS; n = 30 154) with a state-of-art dispersion model of air pollution (dynamic resolutions up to 50 x 50 m). Exposure assessment covered both total and locally emitted PM<sub>2.5</sub>, PM<sub>10</sub> and NO<sub>x</sub>. Linear regression models were fit to estimate cross-sectional associations with estimated glomerular filtration rate (eGFR), based on both serum creatinine and cystatin C, and biomarkers of renal injury (KIM-1, MCP-1, IL-6, IL-18, MMP-2, MMP-7, MMP-9, FGF-23, and uric acid). Statistical adjustment was made for an extensive set of potential individual, sociodemographic, and environmental confounding factors.

**Results:** Exposure levels were low in international and European comparison (e.g., median 10-year average PM<sub>2.5</sub> 6.2 µg/m<sup>3</sup>). Renal function was generally high and, surprisingly, positively associated with PM<sub>2.5</sub> exposure. This association persisted after statistical adjustment. PM<sub>2.5</sub> exposure was associated with elevated levels of serum MMP-2 concentration.

**Discussion:** In this large, healthy general-population cohort at low exposure levels, PM<sub>2.5</sub> exposure was associated with better renal function, contrary to most previous studies. The results do thus not support an association between ambient air pollution and decreased kidney function at these exposure levels. Interestingly, PM<sub>2.5</sub> exposure was associated with higher serum MMP-2 though, an early indicator of both renal and cardiovascular pathology.

### Short-term exposure to ultrafine particles and respiratory infection hospital admissions in children

Marie L. Bergmann<sup>1</sup>, Zorana J. Andersen, Andreas Massling, Steffen Loft, Heresh Amini, Thomas Cole-Hunter, Claus Nordstrom, Stéphane Tuffier, Jiawei Zhang, Youn-Hee Lim

<sup>1</sup>Section of Environmental Health, Department of Public Health, University of Copenhagen, Denmark

#### Abstract

**Introduction:** Short-term exposure to ultrafine particles (UFP; <100 nm in diameter) may trigger hospitalizations from respiratory infections, potentially even more so among children, but available evidence is limited. In this study, we examined the association between short-term exposure to UFP and respiratory infection hospital admissions among children in Copenhagen, Denmark.

**Methods:** Daily levels of UFP (number of particles in size range 11-700 nm), particulate matter, nitrogen dioxide, ozone, and meteorological factors were monitored at an urban background station in Copenhagen during 2002-2018. Daily counts of hospital contacts for respiratory infections (acute lower/upper respiratory infections [ALRI/AURI], pneumonia, and bronchitis) among children (<18 years) were obtained from the Danish National Patient Register. Hospital admissions associated with interquartile range (IQR) increases in UFP up to six days prior (lag 0 to lag 0-6) were examined in a time-stratified case-crossover design. Rate ratios (RR) with 95% confidence intervals (CI) were estimated after adjusting for temperature, relative humidity, and public holidays. Additionally, we analyzed the associations for different sex, age (0-4/5-14/15-18 years) and disposable family income (in quartiles) groups.

**Results:** We observed 109,585 hospital admissions for respiratory infections in children. Hospital admissions for ALRI, AURI, pneumonia, and bronchitis were positively associated with IQR increases in UFP, with RRs of 1.02 (lag 0; 95% CI: 0.99, 1.05), 1.04 (lag 0-2; 1.01, 1.08), 1.06 (lag 0-3; 1.00, 1.12), and 1.04 (lag 0-5; 0.97, 1.12), respectively. Moreover, we found that associations were stronger among boys and children below 14 years, with no clear trends in different income groups.

**Conclusion:** We find that short-term exposure to UFP can trigger respiratory infections in children, emphasizing the need for policies and regulations aimed at improving urban air quality to protect children's health.

### Temporal Variations in the Short-Term Effects of Ambient Air Pollution on Cause-specific Mortality in 380 Urban Areas

Maximilian Schwarz<sup>1,2</sup>, Annette Peters, Massimo Stafoggia, Francesca De'Donato, Francesco Sera, Michelle L. Bell, Yuming Guo, Yasushi Honda, Veronika Huber, Jouni J. K. Jaakkola, Aleš Urban, Ana Maria Vicedo-Cabrera, Pierre Masselot, Eric Lavigne, Haidong Kan, Samuel Osorio, Souzana Achilleos, Jan Kyselý, Hans Orru, Ene Indermitte, Marek Maasikmets, Niilo Rytty, Mathilde Pascal, Klea Katsouyanni, Antonis Analitis, Evangelia Samoli, Alireza Entezari, Fatemeh Mayvaneh, Masahiro Hashizume, Yoonhee Kim, Chris Fook Sheng Ng, Barrak Alahmad, Magali Hurtado Diaz, Eunice Elizabeth Félix Arellano, Shilpa Rao, Alfonso Diz-Lois Palomares, Susana das Neves Pereira da Silva, Joana Madureira, Noah Scovronick, Fiorella Acquaotta, Rebecca M. Garland, Ho Kim, Whanhee Lee, Aurelio Tobias, Carmen Iñiguez, Bertil Forsberg, Martina S. Ragetti, Yue Leon Guo, Shih-Chun Pan, Shanshan Li, Ben Armstrong, Antonella Zanobetti, Joel Schwartz, Antonio Gasparrini, Alexandra Schneider, Susanne Breitner

<sup>1</sup>Institute of Epidemiology, Helmholtz Zentrum München - German Research Center for Environmental Health (GmbH), Neuherberg, Germany; <sup>2</sup>Institute for Medical Information Processing, Biometry, and Epidemiology, Faculty of Medicine, LMU Munich, Munich, Germany

#### Abstract

**Introduction:** Ambient air pollution, including particulate matter (PM) with diameters ≤10µm (PM<sub>10</sub>) or ≤2.5µm (PM<sub>2.5</sub>) and nitrogen

dioxide (NO<sub>2</sub>), has been linked to mortality. It is unclear whether populations' vulnerability to these pollutants has changed over time, and particularly there is a lack of studies based on multi-center analyses. We therefore evaluated whether changes in exposure were associated with changes in mortality effect estimates over time using a standardized analytical framework.

**Methods:** We examined over 21.6 million cardiovascular and 7.8 million respiratory deaths in 380 cities across 24 countries between 1995 and 2016. We applied a two-stage approach to analyze short-term effects of NO<sub>2</sub>, PM<sub>10</sub>, and PM<sub>2.5</sub> on cause-specific mortality using confounder-adjusted city-specific time series regression analyses and multilevel random-effects meta-analysis. We assessed changes over time using a longitudinal meta-regression with time as a linear fixed term. We considered two-pollutant models and explored potential sources of heterogeneity.

**Results:** All three air pollutants showed decreasing concentrations over time. The pooled longitudinal results suggested no significant temporal change in the mortality effects for PM<sub>10</sub> and NO<sub>2</sub>. A 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> showed a significant temporal difference from 0.14% (95% CI: -0.32% to 0.61%) in 1998 to 0.77% (95% CI: 0.35% to 1.19%) in 2012. No changes were seen when NO<sub>2</sub> was added to PM models, but NO<sub>2</sub> effect estimates showed an increasing trend with PM adjustment. Regional analyses indicated stronger associations in the regions of the Americas.

**Discussion:** Although air pollution levels have decreased, the effect sizes per unit increase have not changed accordingly. This might be due to the toxicity, composition, and sources of air pollution, but also other factors, such as a potential non-linear exposure-response function, socioeconomic determinants or changes in population distribution and susceptibility.

### **Air pollution is associated with reduced odor identification: Results from the KORA FIT study**

Nikolaos Nikolaou<sup>1</sup>, Kathrin Wolf, Susanne Breitner, Regina Pickford, Tamara Schikowski, Annette Peters, Alexandra Schneider  
<sup>1</sup>Institute of Epidemiology, Helmholtz Zentrum München, German Research Center for Environmental Health, Neuberberg, Germany

#### **Abstract**

**Introduction:** The impact of air pollution on human health is substantial. However, there is still uncertainty in the literature regarding the effects of air pollution on the olfactory system and early cognitive impairment. In this study, we investigated the association between long-term air pollution and odor identification, an early indicator of various neurodegenerative conditions.

**Methods:** This population-based study involved 3,059 participants, born 1945-1964, from the KORA FIT study (2018-2019), conducted in Augsburg, Germany. Odor identification was assessed by the Sniffin' Sticks 12-item Test. Air pollution concentrations were predicted at residential addresses by Land Use Regression models. We applied logistic regression after dichotomizing in normosmia (score ≥ 10) versus hyposmia or anosmia (score < 10), adjusted for basic characteristics (age, sex), socioeconomic (SES) factors (education, income, SES status), lifestyle features (physical activity, smoking, BMI, alcohol consumption) as well as chronic diseases (e.g., asthma).

**Results:** We found higher odds of hyposmia or anosmia in comparison with normosmia per interquartile range increase in the concentrations of NO<sub>x</sub>, NO<sub>2</sub>, PM<sub>2.5</sub>, PM<sub>coarse</sub>, PM<sub>10</sub> and PNC [OR, and 95% CI: 1.13 (1.01, 1.27), 1.20 (1.06, 1.37), 1.10 (0.98, 1.25), 1.20 (1.06, 1.36), 1.21 (1.07, 1.37) and 1.12 (1.01, 1.24); respectively]. For O<sub>3</sub>, no clear effects were observed. Females were found to be more susceptible. There were no distinct indications of other effect modifications. The results remained consistent across several sensitivity analyses.

**Discussion:** This study provides evidence for an association between long-term exposure to air pollution and reduced odor identification even in a region with relatively low air pollution levels. It may provide a potential link between prolonged exposure to air pollution and reduced

cognitive ability which depend on both the executive and semantic memory.

### **NEUROLOGICAL & MENTAL HEALTH: NEW EVIDENCE ON EFFECTS OF ENVIRONMENTAL EXPOSURES ON NEUROLOGICAL AND MENTAL HEALTH**

### **Two- and three-dimensional indicators of green and grey space exposure and mental health in a large Italian cohort**

Federica Nobile<sup>1</sup>, Giuseppina Spano, Vincenzo Giannico, Mario Elia, Paola Michelozzi, Andrea Bosco, Payam Dadvand, Giovanni Sanesi, Massimo Stafoggia

<sup>1</sup>Department of Epidemiology, Lazio Region Health Service/ASL Roma, Rome, Italy; Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden

#### **Abstract**

**Introduction:** Evidence on the association between urban greenness and mental health is limited and primarily relies on 2D indicators. The association between 2D and 3D indicators of green and grey spaces and the incidence of psychiatric disorders was investigated in a large population-based cohort from Rome (Italy).

**Methods:** Data from 593,894 adults (≥30 years) from the Rome Longitudinal Study were analysed. Mental health outcomes were defined through drug prescriptions (antidepressants, antipsychotics, lithium and other mood stabilisers, and anxiolytics, hypnotics and sedatives), or hospitalisations (schizophrenia spectrum disorder, depression, anxiety, stress-related and somatoform, and substance use disorders). Exposures to Normalized Difference Vegetation Index (NDVI), green volume, grey volume, number of trees, and Normalized Difference Green-Grey Volume Index (NDGG) were assigned to the baseline participants' addresses. Cox proportional hazards regression models were applied and the effect modification by sex, age and deprivation index was tested.

**Results:** We found protective associations between NDVI and the number of trees and antipsychotic (HR: 0.976; 95% CI: 0.958–0.993 per IQR increases and HR: 0.975; 95% CI: 0.956–0.993) and lithium and other mood stabiliser drugs (HR: 0.979; 95% CI: 0.968–0.990 and HR: 0.970; 95% CI: 0.959–0.982), and between NDGG and anxiolytic, hypnotic and sedative drugs (HR: 0.851; 95% CI: 0.762–0.950) and lithium and other mood stabilisers (HR: 0.977; 95% CI: 0.965–0.990). We observed adverse associations between grey volume and mood stabilisers and anxiolytic, hypnotic and sedative drugs. The associations for hospitalisations were less consistent.

**Discussion:** Findings suggested that higher green areas around residence are associated with reduced use of drugs for psychiatric disorders, while higher grey space exposure with increased use. The study highlights the importance of accurately characterising green and grey spaces.

### **Prenatal Exposome and Autism in Children: An Equal-Life European Multi-Cohort Study**

Fan Wu<sup>1</sup>, Libor Šulc, Sanne Meijering, Hendriek Boshuizen, Angel Dzhambov, Peter Lercher, Carmen Peuters, Boris Cheval, Nuria Botella, Payam Dadvand, Jordi Júlvez, Jolanda M.A. Boer, Roel C.H. Vermeulen, Christoph Giehl, Jan Spilski, Yingxin Chen, Anna Hansell, Rik Bogers, Tanja Vrijkotte, Gabriele Bolte, Achilleas Psyllidis, Karl Lundin Remmélius, Sven Bölte, Elise van Kempen, Irene van Kamp, Jenny Selander, Equal-Life team

<sup>1</sup>Unit of Occupational Medicine, Institute of Environmental Medicine (IMM), Karolinska Institutet, Stockholm, Sweden

#### **Abstract**

**Introduction:** Autism typically manifests before age 2 and affects individuals lifelong. It is a largely genetic neurodevelopmental condition, but environmental factors may also contribute. Using exposome

databases and four European cohorts of the Equal-Life project, we aimed to assess the association between prenatal exposome and autism diagnoses in children.

**Methods:** Given the availability of exposome variables and ages of children at data collection, we focused on cohorts FAIR (Sweden) and PIAMA (The Netherlands) and used ABCD (The Netherlands) and ALSPAC (United Kingdom) for replication. Autism diagnosis was collected from registries (FAIR) or reported by parents (PIAMA, ABCD, ALSPAC). Physical exposome (indicators of air pollution, noise, land use, and built environment) and social exposome (parental/familial sociodemographic factors) were obtained from registries, surveys, or estimated by GIS/remote-sensing and modeling. Sex and age of the children served as covariates. A Random Forest algorithm with standard Classification and Regression Trees ranked the importance among the approximately 60 harmonized, preselected prenatal exposome variables. A Random Forest algorithm with Conditional Inference was used for sensitivity tests.

**Results:** Rates of autism were 2.4% in FAIR (1,074/44,736), 5.6% in PIAMA (130/2,305), 2.0% in ABCD (56/2,853), and 1.2% in ALSPAC (91/7,395). In preliminary results, physical exposome variables, particularly NO<sub>2</sub>, noise, green space indicators, and street network variables, were consistently ranked higher than others and dominated the top 25 factors. The relatively higher-ranked social exposures included income and parental occupations.

**Discussion:** We explored social and environmental exposomes simultaneously. Preliminary results highlighted the associations between environmental exposures (i.e., air pollution, noise, greenery) and autism phenotypes. However, the impacts of the identified factors have to be validated in further analyses.

### Do urban green spaces protect against depressive and anxiety symptoms? Findings from an African low-income country

Hilbert Mendoza<sup>1</sup>, Katrien De Troeyer, Busisiwe Shezi, Hayat Bentouhami, Solomon Tsebeni Wafula, Grace Bitynzika Lubega, Rawlance Ndejjo, John Bosco Isumju, Richard Mugambe, David Musoke, Lidia Casas

<sup>1</sup>*Social Epidemiology and Health Policy, Department of Family Medicine and Population Health, University of Antwerp, Campus Drie Eiken, Doornstraat 331, BE-2610 Wilrijk, Belgium*

#### Abstract

**Introduction:** Urban green spaces (UGS) have been suggested to improve mental health. However, the majority of the available evidence has originated from high-income countries. In this study, we investigated the association between UGS and depressive and anxiety symptoms among residents of an African low-income country (Uganda). Additionally, we assessed potential effect modification by sex, age, and educational attainment and the role of potential mediators (physical activity, social interaction, and distance to major roads) in the aforementioned association.

**Methods:** We conducted a cross-sectional household survey among residents aged 18 years or older in Kampala, Uganda (n=641). UGS were assessed using the Normalised Difference Vegetation Index (NDVI) and Modified Soil Adjusted Vegetation Index-2 (MSAVI-2) within 100m, 300m, 500m, and 1,000m buffers around the residential addresses. Depressive and anxiety symptoms were assessed using the Patient Health Questionnaire-9 and Generalised Anxiety Disorder assessment questionnaire respectively. To assess the association between UGS and depressive and anxiety symptoms, we utilized mixed-effects regression models. We present our association estimates as prevalence ratios (PR) and their 95% confidence intervals (CI).

**Results:** We observed a 6% (95%CI 0.89-0.99) and 7% prevalence reduction (95%CI 0.90-0.97) in depressive symptoms for an inter-quartile range (IQR) increase in surrounding greenness for NDVI

100m and MSAVI-2 100m buffers respectively. Likewise, a 10% (95%CI 0.85-0.95) and 11% (95%CI 0.80-0.98) prevalence reduction in anxiety symptoms for an IQR increase in surrounding greenness for NDVI 100m and MSAVI-2 1,000m buffers respectively. We found limited evidence for potential effect modification and mediation by the aforementioned modifiers and mediators.

**Discussion:** Our study findings suggest UGS may have a protective effect against depressive and anxiety symptoms among individuals in resource-constrained settings.

### Multi-cohort analysis of exposome and its association with ADHD phenotypes in children

Libor Šulc<sup>1</sup>, Fan Wu, Sanne Meijering, Hendriek Boshuizen, Angel Dzhambov, Peter Lercher, Carmen Peuters, Boris Cheval, Nuria Botella, Payam Dadvand, Jordi Júlvez, Jolanda M.A. Boer, Roel C.H. Vermeulen, Christoph Giehl, Jan Spilski, Yingxin Chen, Anna Hansell, Rik Bogers, Tanja Vrijkotte, Gabriele Bolte, Achilleas Psyllidis, Karl Lundin Remnélius, Sven Bölte, Elise van Kempen, Irene van Kamp, Jenny Selander, Equal-Life team  
<sup>1</sup>*Unit of Occupational Medicine at the Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden*

#### Abstract

**Introduction:** The worldwide prevalence of attention deficit hyperactivity disorder (ADHD) is approximately 5.3% making it one of the most diagnosed neurodevelopmental conditions. While its aetiology is primarily attributed to genetic factors, the complex interplay with environmental exposures remains poorly understood. To help fill this gap, our study aimed to assess the relationship between ADHD and environmental exposures using a large number of longitudinal and cross-sectional data.

**Methods:** Early life exposure (the first three years of life) to a wide spectrum of factors and their association with ADHD in children was analysed. Data from 8 European cohorts and cross-sectional studies, enriched with newly developed physical and social indicators, were used. After harmonizing the data as much as possible, a supervised machine learning model (Random Forest) was used to discover what indicators were relatively important for the prediction of ADHD. In a further step, a meta-analysis was conducted to assess the relationship between ADHD and selected indicators across involved studies.

**Results:** In the preliminary results, physical exposures frequently occurring as relatively important were distance to roads, length of streets, the closeness to intersections, NO<sub>2</sub> exposure, percentage of natural land, and population density. Among social exposures, relatively important were low-education areas, low-income areas, and father's education. Overall, physical exposures ranked higher and therefore relatively more important in comparison to social exposures for the ADHD phenotype.

**Discussion:** The identified exposures mainly the physical ones, are in line with contemporary findings linking similar exposures with an increased likelihood of ADHD. However, the underlying mechanism needs to be further studied. Suggestive evidence also associated ADHD with area deprivation indicators such as education and income status.

### Long-term exposure to outdoor light at night and depressive symptoms among older people in England

Rina So<sup>1</sup>, Giorgio Di Gessa, Su-Hwan Kim, Yujin Park, Paola Zaninotto

<sup>1</sup>*Department of Epidemiology and Public Health, University College London, London, United Kingdom*

#### Abstract

**Introduction:** Animal studies suggested that light at night (LAN) might cause depression-like symptoms, but epidemiological evidence on the association of LAN with depression is scarce.

**Methods:** We used data from 8,559 participants (25,142 observations) of the English Longitudinal Study of Ageing wave 6 (2012-2013) to wave 9 (2018-2019). The annual levels of exposure to outdoor LAN (in nanowatts/cm<sup>2</sup>/sr) at participants' residential addresses at each interview year were assessed with the satellite image data at the 500m resolution. Depressive symptom was defined as reporting 4 or more items of the Center for Epidemiologic Studies Depression Scale. We used the generalized linear mixed model to examine the associations of long-term exposure to LAN (in quartiles) with depressive symptom, adjusting for age, sex, current smoker, frequency of alcohol consumption, physical activity, having chronic disease, race, having higher education, wealth, marital status, area-level multiple deprivation index, urbanity, and fine particulate matter.

**Results:** We observed 1,783 (23.8%), 1597 (24.3%), 1523 (25.8%), and 1,341 (25.8%) subjects with depressive symptom for wave 6, 7, 8, and 9, respectively. Outdoor LAN exposure of participants ranged from 0.00 to 182.40 nanowatts/cm<sup>2</sup>/sr. In a model adjusted for age and gender, subjects in the higher quartiles (Q2-Q4) showed statistically significantly higher odds of having depressive symptom with odds ratio (OR) (95% confidence interval) of 1.35 (1.17, 1.57) for Q2, 1.50 (1.28, 1.75) for Q3, and 1.77 (1.51, 2.08) for Q4, compared to those in the lowest quartile (Q1). The associations were attenuated in a fully adjusted model with the corresponding ORs of 1.11 (0.94, 1.30), 1.04 (0.86, 1.25), and 0.93 (0.76, 1.14).

**Discussion:** Long-term exposure to outdoor light at night was associated with an increased risk of having depressive symptoms in the minimally adjusted model, and wealth seemed to explain most of these associations.

### Outdoor artificial light at night exposure and risk of conversion from mild cognitive impairment to dementia

Tommaso Filippini<sup>1</sup>, Sofia Costanzini, Annalisa Chiari, Teresa Urbano, Francesca Despini, Manuela Tondelli, Roberta Bedin, Giovanna Zamboni, Sergio Teggi, Marco Vinceti

<sup>1</sup>CREAGEN - Environmental, Genetic and Nutritional Epidemiology Research Center, Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Modena, Italy

#### Abstract

**Introduction:** A few studies have suggested that exposure to light during night hours, i.e. light at night (LAN), may increase the risk of dementia. In this study, we aimed to evaluate the association between exposure to outdoor artificial LAN and risk of conversion to dementia in an Italian cohort of subjects with mild cognitive impairment (MCI).

**Methods:** We recruited subjects with a diagnosis of MCI at the Cognitive Neurology Clinic of Modena Hospital in the period 2008-2014, and we followed them up to 2021 for conversion to dementia. We collected their residential history and we assessed LAN exposure at subjects' residences using satellite imagery data available from the Visible Infrared Imaging Radiometer Suite for the period 2014-2022. Using a Cox-proportional hazards model adjusted for relevant confounders, we computed the hazard ratio (HR) of dementia with 95% confidence interval (CI) according to increasing LAN exposure through linear, categorical, and non-linear restricted-cubic spline models.

**Results:** Out of 53 recruited subjects, 34 converted to dementia of any type including 26 Alzheimer's dementia. In linear regression analysis, LAN exposure was positively associated with dementia conversion (HR 1.03, 95% CI 1.00-1.06 for 1-unit increase). Using as reference the lowest tertile, subjects at both intermediate and highest tertiles of LAN exposure showed increased risk of dementia conversion (HRs 2.26, 95% CI 0.88-5.85, and 2.89, 95% CI 1.10-7.58). In spline regression analysis, the risk linearly increased up to a LAN exposure of 30 nW/cm<sup>2</sup>/sr reaching a plateau. Results were almost confirmed when limited to conversion to Alzheimer's dementia, except for an almost linear relation.

**Discussion:** Our findings suggest that exposure to outdoor artificial LAN may increase conversion from MCI to any type of dementia, especially above 30 nW/cm<sup>2</sup>/sr, while such relation appears to be almost linear for Alzheimer's dementia.

### METHODS: NOVEL APPROACHES FOR EXPOSURE ESTIMATION AND EPIDEMIOLOGICAL ANALYSIS

#### Local approach to attributable disease burden: a case study for air pollution and mortality in Belgium

Arno Pauwels<sup>1</sup>, Eva De Clercq, Claire Demoury, Brecht Devleeschauwer

<sup>1</sup>Epidemiology and public health, Sciensano, Brussels, Belgium

#### Abstract

**Introduction:** The calculation of the burden of disease and the attribution to risk factors is usually conducted at the national or regional level. This research proposes a novel approach where attributable disease burden is derived locally, and compares the estimates with those obtained under a wide-scale approach.

**Methods:** Mortality in Belgium due to long-term exposure to particulate matter with a diameter <2.5 µm (PM<sub>2.5</sub>) and nitrogen dioxide (NO<sub>2</sub>) is derived for the year 2019. In the local method, the attributable burden is calculated at the level of census tracts. Area-level exposure is translated into the fraction of attributable deaths using a concentration-response function derived for the general population, which suggests potential bias in the local results. Therefore, the local method is validated by comparing the results, summed to national and province totals, to estimates derived with a wide-scale 'global' approach.

**Results:** The local method estimates 12,050 (95% CI: 6340, 17,350) deaths from PM<sub>2.5</sub> and 7770 (95% CI: 4590, 11,070) deaths from NO<sub>2</sub> in Belgium. For both pollutants, these national estimates never deviate more than 2% from those obtained with the global method, and never more than 4% in the individual provinces. These discrepancies are limited compared to the confidence interval, where the deviation from the central estimate is in the range of 40 to 50% for the national as well as the provincial results.

**Discussion:** Aggregated local burden estimates prove to be accurate when compared to results obtained with a wide-scale approach. This means the local method shows potential for comparing areas and population groups at sub-national level. Other benefits that merit further research are the possibility to stratify estimates and to account for interactions between different risk factors in case of combined exposure.

#### High-resolution air quality mapping in Great Britain (2003-2021) with ensemble machine-learning and remote-sensing data

Arturo de la Cruz Libardi<sup>1</sup>, Pierre Masselot, Rochelle Schneider, Emily Nightingale, Ai Milojevic, Antonio Gasparrini

<sup>1</sup>Environment & Health Modelling (EHM) Lab, Department of Public Health Environments and Society, London School of Hygiene & Tropical Medicine, London, UK

#### Abstract

This study set out to reconstruct the daily concentrations of nitrogen dioxide (NO<sub>2</sub>) as well as inhalable and fine particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>) at 1km resolution over Great Britain for the period between 2003 and 2021.

We implemented a multi-stage framework using ground monitors, satellite products, atmospheric reanalyses, chemical transport models, and advanced machine learning (ML) methods.

Hourly pollutant observations were processed to obtain representative daily averages. Records of PM<sub>2.5</sub> were augmented via simultaneous PM<sub>10</sub> observations with a light gradient boosting machine algorithm (LGBM). Similarly, gaps in aerosol optical depth and NO<sub>2</sub> column satellite data were filled-in with random forest (RF) models. All features

were harmonized to a 1 km resolution and matched with co-occurring pollutant observations to train yearly ensemble models.

Each ensemble combined three ML (RF, LGBM, and extreme gradient boosting) and two linear algorithms (lasso and ridge), with their predictions feeding into a non-negative least squares meta-model. Accurate performance estimates were obtained by applying a ten-fold monitor-based cross-validation procedure to each ensemble model.

The mean overall model performance was good for NO<sub>2</sub> (R<sup>2</sup>=0.690 [min. year 0.611 - max. year 0.792]) and PM<sub>10</sub> (R<sup>2</sup>=0.704 [0.609-0.786]), and very good for PM<sub>2.5</sub> (R<sup>2</sup>=0.802 [0.746-0.888]). Monitored levels (ug/m<sup>3</sup>) decreased over time (2003-2021) from 42 to 22, 29 to 15 and 17 to 8 for NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> respectively. Regional and sub-regional scale variation was present in PM and NO<sub>2</sub> country-wide estimates, a trend that held at the daily level and was salient in urban and highly trafficked areas where NO<sub>2</sub> distribution was most heterogeneous.

This work resulted in 5 billion data points representing estimated air pollution concentration over nearly two decades, and may be linked with large health databases, cohort data, and targeted data collections to power health and environmental research.

### Comparison of Statistical, Machine Learning and Ensemble Methods to Model Grass and Birch Pollen Concentration

Kees de Hoogh<sup>1,2</sup>, Marloes Eeftens

<sup>1</sup>Swiss Tropical and Public Health Institute, Allschwil, Switzerland;

<sup>2</sup>University of Basel, Basel, Switzerland

#### Abstract

Statistical and machine learning are commonly used to model spatial and temporal variability in environmental stressors, to support the estimation of exposure in epidemiological studies. We aimed to compare the performances, strengths and limitations of six different algorithms in the retrospective spatiotemporal modeling of daily birch and grass pollen concentrations across Switzerland.

Daily birch and grass pollen concentrations were collected from fourteen stations across Switzerland between 2000-2019. We considered several temporal, spatial and spatiotemporal predictors including meteorological factors, land-use, elevation, species distribution and Normalized Difference Vegetation Index to develop spatiotemporal models using six various linear and nonlinear algorithms: LASSO, Ridge, Elastic net, Random forest, XGBoost and ANNs. We combined these six models through multiple linear regression to develop an ensemble hybrid model. We optimized models through feature selection and grid search techniques to obtain the best predictive performance. We used train-test split and cross-validation as validation strategies to avoid overfitting and over-optimistic models.

The 5th-99th percentiles of birch and grass pollen concentrations were 0-1153 and 0-290 grains/m<sup>3</sup>, respectively. The hybrid ensemble model achieved the best RMSE on the test dataset for grass and birch pollen with 19.67 and 94.35 grains/m<sup>3</sup>, respectively. Nonlinear models achieved the lowest test RMSE for both pollen types, ranging from 19.97 to 25.36 grains/m<sup>3</sup> and from 105.86 to 140.47 grains/m<sup>3</sup> for grass and birch pollen respectively, compared to linear models.

The Random forest algorithm yielded the best performance among the six evaluated modeling methods and nonlinear algorithms performed better than linear models. They may explore non-linear relationships between environmental factors and measured concentrations. The ensemble hybrid model outperformed the six linear and nonlinear algorithms.

### Spatial Bayesian Distributed lag non-linear models: a case study of small-area temperature-mortality association

Marcos Quijal-Zamorano<sup>1</sup>, Miguel A. Martinez-Beneito, Joan Ballester, Marc Mari-Dell'Olmo

<sup>1</sup>ISGlobal, Barcelona, Spain

#### Abstract

**Introduction:** Distributed lag non-linear models (DLNMs) are the reference framework for modelling lagged non-linear associations. They are usually used in large-scale multi-location studies. Attempts to study these associations in small areas either did not include the lagged non-linear effects, did not allow for geographically-varying risks, or downscaled risks from larger spatial units through socioeconomic and physical meta-predictors when the estimation of the risks was not feasible due to low statistical power.

**Methods:** Here we proposed Spatial Bayesian DLNMs (SB-DLNMs) as a new framework for the estimation of reliable small area lagged non-linear associations, and demonstrated the methodology for the case study of the temperature mortality relationship in the 73 neighbourhoods of the city of Barcelona. We generalized location-independent DLNMs to the Bayesian framework (B-DLNMs), and extended them to SB-DLNMs by incorporating spatial models in a single-stage approach that accounts for the spatial dependence between risks.

**Results:** The results of the case study highlighted the benefits of incorporating the spatial component for small-area analysis. Estimates obtained from independent B-DLNMs were unstable and unreliable, particularly in neighbourhoods with very low numbers of deaths. SB-DLNMs addressed these instabilities by incorporating spatial dependencies, resulting in more plausible and coherent estimates, and revealing hidden spatial patterns. In addition, the Bayesian framework enriches the range of estimates and tests that can be used in both large- and small-area studies.

**Discussion:** SB-DLNMs account for spatial structures in the risk associations across small areas. By modelling spatial differences, SB-DLNMs facilitate the direct estimation of non-linear exposure-response lagged associations at the small area level, even in areas with as few as 19 deaths. We provide an illustrative code to reproduce the results to facilitate its implementation.

### Navigating Variable Selection and Mixture Identification: A Comprehensive Simulation Study with Mixture Models

Nicolas Jovanovic<sup>1</sup>, Xavier Basagaña, Charline Warembourg, Augusto Anguita-Ruiz, Claire Philippat

<sup>1</sup>University Grenoble Alpes, Inserm U-1209, CNRS-UMR-5309, Environmental Epidemiology Applied to Reproduction and Respiratory Health Team, Institute for Advanced Biosciences, 38000, Grenoble, France

#### Abstract

**Introduction:** In recent years, mixture models have gained significant traction in epidemiological research, chiefly for their capacity to simultaneously evaluate the joint effect of all chemicals in a mixture and identify the primary drivers of this cumulative effect. Despite their growing use, definitive guidelines for model selection remain absent. To bridge this gap, our research undertakes a comprehensive evaluation of the Bayesian Kernel Machine Regression (BKMR), Bayesian Weighted Quantile Sum (BWQS), and G-computation (GCOMP) models across various scenarios.

**Methods:** This study simulated 46 variables using a correlation matrix from environmental chemicals measured in the blood and urine of pregnant women, as part of the European HELIX project. A continuous health outcome was also simulated.

We varied the simulated scenarios by altering parameters such as population size (n = 400, 800, and 3000), the proportion of exposure variables affecting the outcome (0%, 10%, 25%, 50%, and 75%), the strength and direction of these associations, and the shape of the exposure-outcome relationship. The scenarios also differed based on the structure of the mixture effect, comparing additive models and models including interactions between chemicals. Furthermore, Exposome Wide Association Study (EWAS) models, controlling or not for false

discovery rate, were used to assess how mixture models aid in identifying key drivers of mixture effects.

For each scenario, we generated 100 unique datasets and applied the aforementioned models (BKMR, BWQS, GCOMP, and EWAS) to each. The models were evaluated in terms of sensitivity, specificity, and false selection rate.

**Results:** Simulations are currently in progress. We anticipate presenting the results at the upcoming ISEE Young conference in June.

**Discussion:** This study aims to provide practical guidelines for researchers, offering insights into the most suitable model for their specific research question.

### Mixed Frequency Regression Model For Environmental Epidemiology

Nidhi Shukla<sup>1,2</sup>, Anna L. Hansell, Suzanne E. Bartington, Tim C.D. Lucas

<sup>1</sup>Department of Population Health Sciences, University of Leicester, Leicester, United Kingdom; <sup>2</sup>Centre for Environmental Health and Sustainability, University of Leicester, Leicester, United Kingdom

#### Abstract

**Introduction:** The rationale of this work is to eliminate the need to use aggregated low-frequency exposure data in environmental epidemiology. The use of low-frequency exposure data in the absence of high-frequency response data results in the loss of information. Therefore, we aim to develop a mixed-frequency model, referred to as mixed-frequency Distributed Lag Nonlinear Model (mf-DLNM), inspired by the Mixed-Data Sampling (MIDAS) model from econometrics. This new model employs the framework of the DLNM to predict high-temporal-resolution risk with low-frequency response and high-frequency exposure data.

**Methods:** We test and demonstrate our new method using land temperature data and respiratory mortality data for nine regions of England. We fit both mf-DLNM and standard DLNM, using daily temperature data for both, and weekly mortality for mf-DLNM and daily mortality data for standard DLNM. Additionally, we fit both MIDAS and mf-DLNM with daily temperature data and weekly mortality data and compare their predictive performance at weekly resolution.

**Results:** The results showed that mf-DLNM and standard DLNM exhibit similar performance in RMSE and R-values (0.50-0.66 for mf-DLNM and 0.51-0.67 for standard DLNM). Therefore, despite having low-resolution response data, mf-DLNM demonstrates only minor performance differences compared to standard DLNM. Additionally, the mf-DLNM and MIDAS also perform comparably in low-resolution weekly risk prediction, with slight variations in RMSE and R-values (0.68-0.77 for mf-DLNM and 0.66-0.74 for MIDAS).

**Discussion:** The introduction of this mixed-frequency modelling approach in environmental epidemiology will overcome the limitations of predicting health risks with aggregated exposure data and will also provide estimates of high-resolution health risks in the absence of high-frequency health outcomes.

### Influence of vegetation spatial resolution on the prediction of pollen concentrations over Northern Italy

Sofia Tagliaferro<sup>1</sup>, Mario Adani, Nicola Pepe, Gimo Briganti, Massimo D'Isidoro, Maira Bonini, Antonio Piersanti, Sandro Finardi, Pierpaolo Marchetti, Francesco Domenichini, Mihaela Mircea, Maria G. Villani, Alessandro Marcon, Camillo Silibello

<sup>1</sup>Unit of Epidemiology and Medical Statistics, Department of Diagnostics and Public Health, University of Verona, Verona 37134, Italy

#### Abstract

**Objective:** Accurate pollen forecasting models will be useful to inform allergic populations about pollen concentrations. Our study introduces and validates, for the first time, a pollen modelling system

covering the Veneto Region (Italy) at 3 km spatial resolution. We analysed the influence of the spatial resolution of vegetation coverage (VC) maps on predicted pollen concentrations for alder, birch, olive, grass, and ragweed.

**Material and Methods:** the model simulated the pollen dispersion, diffusion and deposition using VC maps, phenological emission algorithms, and meteorological forecasting. Two VC datasets were used: CAMS VC: the European CAMS dataset at ca. 10 km horizontal resolution; detailed VC: high-resolution datasets (from 250 m to 1 km spatial resolution). Predicted daily averaged concentrations obtained with CAMS and detailed VC were compared to the observations collected at 15 monitoring stations, using model performance indicators (RMSE) and pollen seasonal-derived parameters. A stratified analysis assessed performance variations in lowland versus mountain environments.

**Results:** a reduction of mean error was obtained for alder and birch pollen using the detailed VC (detailed VC vs. CAMS VC: 15.69 vs. 133.58; 17.83 vs. 52.54 p/m<sup>3</sup>, respectively), while higher RMSE resulted for grass (24.49 vs. 20.68 p/m<sup>3</sup>). Similar RMSEs were obtained for olive and ragweed pollen (3.82 vs. 3.98; 3.90 vs. 3.90 p/m<sup>3</sup>, respectively). Results from the differences in Seasonal Pollen Integrals (SPI<sub>n</sub>) were consistent with the RMSE patterns. The onset of the pollen season was more accurately predicted than its end. The general improvement of pollen predictions obtained with the detailed VC was particularly evident in the mountains.

**Conclusion:** the use of detailed VC in pollen dispersion models improves prediction accuracy, particularly in the mountains. Enhancing pollen forecasts in response to climate-induced variations would improve the well-being of the allergic population.

## CHEMICALS: EXPOSURE AND HEALTH EFFECTS

### Investigating trace concentrations of per- and poly-fluoroalkyl substances (PFAS) in London drinking water

Alexandra Richardson<sup>1</sup>, Diana Varaden, Leon Barron, Frédéric Piel  
<sup>1</sup>Imperial College London, NIHR HPRU MRC Center for Environment & Health, School of Public Health, Faculty of Medicine, Imperial College London, 86 Wood Lane, London W12 0BZ, United Kingdom

#### Abstract

**Introduction:** PFAS are a diverse class of compounds which are extremely persistent in the environment and have been detected in surface waters, food and human biological samples. There are concerns of human exposure to PFAS via drinking water, but evidence from the UK is lacking. Therefore, the aim of this project is to better understand human exposure via municipal drinking water at the point of consumption. The objectives are a) to develop a direct injection liquid chromatography-mass spectrometry (LC-MS/MS) method for the analysis of 40 PFAS; b) recruit a cohort of participants to collect tap water samples; and c) perform quantitative analysis on all samples and disseminate results to participants in-line with the UK Drinking Water Inspectorate (DWI) guidelines.

**Methods:** Households from North-West and South London were recruited from the West London Healthy Home and Environment Study (WellHome), representing a diverse urban community with ongoing air quality monitoring. Participants were provided with a sampling kit to collect tap water from their kitchen tap in early 2024.

**Results:** A direct injection LC-MS/MS method for the analysis of tap water was developed, with good linearity over the range of 0.5-1000 ng/L and average limits of detection and quantification of 2±4 ng/L and 8±13 ng/L, respectively. Thirty households were recruited and tap water samples were collected over two months. To-date, nine PFAS have been quantified in tap drinking water over the range of 1-5 ng/L. Analyses are ongoing, but individual and total PFAS measurements are well below DWI guidelines.

**Discussion:** This work provides important information on PFAS in household drinking water, with London representing a large and dense population served by a single utility provider. Combined with other data taken during the WellHome project, this provides an excellent opportunity to formulate hypotheses for future studies to understand human health outcomes from PFAS exposure in the UK.

### Child exposure to organophosphate and pyrethroid insecticides measured in urine, wristbands and household dust.

Adriana Fernandes Veludo<sup>1,2</sup>, Céline Degrendele, Mohamed Aqiel Dalvie, Petra Stuchlík Fišerová, Roman Prokeš, Petra Přibylková, Petr Šenk, Jiří Kohoutek, Mufaro Mugari, Jana Klánová, Anke Huss, Daniel Martins Figueiredo, Hans Mol, Jonatan Dias, Martin Röösl, Samuel Fuhrmann

<sup>1</sup>Swiss Tropical and Public Health Institute (Swiss TPH), 4123 Allschwil, Switzerland; <sup>2</sup>University of Basel, 4002, Basel, Switzerland

#### Abstract

**Introduction:** Children in agricultural areas are exposed to organophosphate (OP) and pyrethroid (PYR) insecticides. This explorative study investigated child exposure to OPs and PYRs, comparing temporal and spatial exposure variability within and among urine, wristbands, and dust samples.

**Methods:** During spraying season 2018, 38 South African children in two agricultural areas (Grabouw/Hex River Valley) and settings (farm/village) participated in a seven-day study. Child urine and household dust samples were collected on days 1 and 7. Children and their guardians were wearing silicone wristbands for seven days. Intraclass correlation coefficients (ICCs) evaluated temporal agreements between repeated urine and dust samples, Spearman rank correlations (Rs) evaluated the correlations among matrices, and linear mixed-effect models investigated spatial exposure predictors. A risk assessment was performed using reverse dosimetry.

**Results:** Eighteen OPs/PYRs were targeted in urine, wristbands, and dust. Levels of chlorpyrifos in dust (ICC = 0.92) and diethylphosphate biomarker in urine (ICC = 0.42) showed strong and moderate temporal agreement between day 1 and day 7, respectively. Weak agreements were observed for all others. There was mostly a weak correlation among the three matrices (Rs = -0.12 to 0.35), except for chlorpyrifos in dust and its biomarker 3,5,6-trichloro-2-pyridinol in urine (Rs = 0.44). No differences in exposure levels between living locations were observed. However, 21% of the urine biomarker levels exceeded the health-risk threshold for OP exposure.

**Conclusion:** Observed high short-term variability in exposure levels during spraying season highlights the need for repeated sampling. The weak correlation between the exposure matrices points to different environmental and behavioral exposure pathways. Exceeding risk thresholds for OP should be further investigated.

### Hair versus blood and urine for biomonitoring campaigns: the case of organophosphate flame retardants (OPFRs)

Ashna Lallmahomed<sup>1</sup>, Fabien Mercier, Nathalie Costet, Marie Pécheux, Arthur David, Vincent Bessonneau, Nathalie Bonvallot, Barbara Le Bot

<sup>1</sup>Univ Rennes, Inserm, EHESP, Irset (Institut de recherche en santé, environnement et travail) - UMR\_S 1085, F-35000 Rennes, France

#### Abstract

**Introduction:** The choice of relevant biomarkers of exposure is a major issue when assessing health impacts of exposure to chemicals in epidemiological studies. Blood and urine are mainly used as biological matrices, but hair recently appeared as an advantageous complementary matrix. It is non-invasive, easy to collect and store, and could reflect a wider retrospective window of exposure. However,

its performance and limits for exposure assessment to chemical compounds such as OPFRs, still need to be assessed before wider use in epidemiological studies.

**Methods:** Hair, blood and urine samples from 62 subjects were analysed for ten OPFRs, parent compounds and metabolites. We compared OPFR concentrations resulting from the analysis of the three matrices using descriptive statistics, correlations, and clustering analyses. The effects of different normalisation methods of urinary concentrations (by creatinine, osmolality and specific gravity) and hair concentrations (washed or not) were also investigated.

**Results:** More OPFR parent compounds and metabolites were detected in hair (N=7), while urine only contained metabolites (N=5), and blood only two parent compounds. Hair concentration levels were not correlated with neither sample length nor sex. Concentrations in washed-vs unwashed hair were highly correlated (R>0.9) for all OPFRs. Washing hair decreased significantly the concentration levels (median washed/unwashed ratio = 61% for triphenyl phosphate). Correlation between hair and urinary (creatinine) concentrations was 0.34 for diphenyl phosphate.

**Discussion:** Our study shows that both parent compounds and metabolites were detected in short hair samples (3cm) that can reflect the global exposure to OPFRs. Washing hair samples before analysis may distinguish internal from external contamination. Hair, as an innovative matrix, may improve exposure assessment in epidemiological studies, complementing advantageously blood and urine based exposure assessments.

### Human Oral Exposure to Micro- and Nanoplastics and Plastic Additives in Barcelona, Spain: a series of single-case studies

Emma Calikanzaros<sup>1,2</sup>, Carolina Donat-Vargas, Guillaume Chevance, Maria Rosa Boleda, Joan Dalmau, Xavier Borrell, Rachida Mazigh, Marta Llorca, Marinella Farré, Cristina M Villanueva

<sup>1</sup>Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain;

<sup>2</sup>Department of Medicine and Life Sciences, Universitat Pompeu Fabra, Barcelona, Spain

#### Abstract

**Aim:** Recent evidence suggests human exposure to micro- and nanoplastics (MNP) through food and water ingestion, though it remains insufficiently studied. We aimed to evaluate the influence of drinking water sources on MNP exposure.

**Methods:** We conducted single-case ABAB trials. For about 50 days, three female participants sequentially switched between tap and plastic bottled water as their drinking water sources. Tap water (n=24), urine (n=48), and stool samples (n=48) were collected, along with two samples of the provided bottled water. Tap water samples were analyzed by pyrolysis coupled with gas chromatography/mass spectrometry. MNP and plastic additives in urine and stool samples were measured using double suspect screening based on reverse-phase liquid chromatography coupled with high-resolution mass spectrometry. Participants answered daily questionnaires on water and food consumption. Individual-level data analysis included visual inspection of plots depicting the dependent variable over time and effect size estimation (Tau-U).

**Results:** MNPs were found in 62% of the tap water samples at median (interquartile range) concentrations (µg/L) of 0.18 (0.15-0.29), with PP (polypropylene), PE (polyethylene), PET (polyethylene terephthalate), and PVC (polyvinyl chloride) in various proportions. Stool and urine samples showed MNP detection rates of 83% and 56%, respectively. A total of 26 different plastic additives were detected in urine. Visual analysis and Tau-U coefficients showed minimal variability in plastic polymers and additives in biological samples across water consumption phases, with random peaks. The results suggest little impact of water type on MNP levels.



**Conclusion:** Despite MNP being found in stool and urine, the variability in the levels cannot solely be attributed to drinking water type. Further analysis of food plastic packaging use will provide insights and improve our understanding of the main sources of human exposure to MNP.

### **Pregnancy blood pressure trajectories in relation to PFAS: a longitudinal study from the Ronneby mother-child cohort.**

*Erich Batzella<sup>1</sup>, Annelise Blomberg, Christian Lindh, Kristina Mattsson, Christel Nielsen*

<sup>1</sup>*Unit of Biostatistics, Epidemiology and Public Health, Dpt. of Cardio-Thoraco-Vascular Sciences and Public Health, University of Padova, Padova, Italy*

#### **Abstract**

**Introduction:** Studies investigating the association between perfluoroalkyl substances (PFAS) and pregnancy hypertensive disorders are inconsistent and often focus on a single blood pressure (BP) measurement without considering continuous changes. This study characterizes the development of systolic and diastolic blood pressure trajectories during pregnancy and determines their association with PFAS in Ronneby Sweden, where a third of the population was highly exposed to primarily PFOS and PFHxS from contaminated drinking water.

**Methods:** We used longitudinal data from the Ronneby mother-child cohort. Nine PFAS were measured from a blood sample collected during pregnancy and BP measurements taken at each routine maternal care visit. Trajectories of BP were identified by Group Based Trajectory Modelling, which identifies subgroups of subjects who share similar underlying patterns. Odds ratios for membership in each trajectory group were calculated via multinomial logistic regression models; Quantile G-computation was then applied to quantify the joint effect of PFAS and their weights.

**Results:** The final cohort comprised 91 women with 705 BP measurements. PFOS was detected at the highest level (median 16.7ng/mL). Trajectory analysis identified a cubic shape three-trajectory solution (maximizing BIC and enabling an adequate repartition), where one trajectory had a high BP throughout pregnancy, increasing in the third trimester. The probability of membership in this adverse trajectory increased with increasing PFAS concentrations, both in single pollutant models (particularly PFOS and PFHxS) and when considering an inter-quartile increase in the PFAS mixture.

**Conclusions:** This longitudinal study provides a unique opportunity to explore the temporal dynamics of BP changes during pregnancy and their correlation with PFAS exposure levels. Our results suggest that exposure to PFAS is associated with an increased probability of an adverse BP trajectory in pregnant women.

### **Dietary exposure to mixtures of chemicals in infancy and allergic multimorbidity profiles up to 8 years**

*Manel Ghozal<sup>1</sup>, Manik Kadawathagedara, Rosalie Delvert, Karine Adel-Patient, Muriel Tafflet, Isabella Annesi-Maesano, Amélie Crépet, Véronique Sirot, Marie Aline Charles, Barbara Heude, Blandine de Lauzon-Guillain*

<sup>1</sup>*Université Paris Cité and Université Sorbonne Paris Nord, Inserm, INRAE, Centre for Research in Epidemiology and Statistics (CRESS), Paris, France*

#### **Abstract**

**Introduction:** Diet is the major source of exposure to environmental chemicals in children. The aim of this study is to investigate the link between dietary exposure to mixtures of chemicals, during the complementary feeding period and allergic and respiratory diseases in children up to 8 years.

**Methods:** 724 children from the EDEN mother-child cohort were included. Dietary exposure to chemicals was previously assessed by

combining children's food intake at 8 months with chemicals concentrations in food stuff assessed in the French infant total diet study. Then, exposure to mixtures of chemicals was assessed using sparse nonnegative matrix under approximation.

Four allergic and respiratory multimorbidity clusters (“asymptomatic” considered as the reference group, “asthma only”, “allergies without asthma”, and “multi-morbidity”) were identified in children between 1 and 8 years of age, using latent class analyses. Multinomial logistic regression was applied to test associations between dietary exposure to mixtures and allergic clusters. Analyses were adjusted for confounding factors such as allergic family history and child's feeding practices.

**Results:** Children with higher scores on a mixture composed mainly of furans, metals, dioxins and polycyclic aromatic hydrocarbons were at higher risk of belonging to the “only asthma” cluster (OR[95%CI]= 2.07 [1.35; 3.18]). Children with higher scores on a mixture of polychlorinated biphenyls and brominated flame retardants were at higher risk of belonging to the “multiallergic” cluster (OR[95%CI]= 2.07 [1.04; 4.14]). Children with higher score on a mixture of pesticides and metals were at higher risk of belonging to the “Allergies without asthma” cluster (OR[95%CI]= 1.54 [1.03; 2.29]).

**Conclusion:** The study highlighted associations between dietary exposure to some mixtures of chemicals in infancy and allergic or respiratory multimorbidity in childhood that need to be confirmed in other studies.

### **Investigation of associations between dietary exposure to POPs and ER+ breast cancer risk in the French E3N cohort.**

*Pauline Frenoy<sup>1</sup>, Vittorio Perduca, Francesca Romana Mancini*

<sup>1</sup>*Université Paris-Saclay, UVSQ, Inserm, Gustave Roussy, CESP, 94805 Villejuif, France*

#### **Abstract**

**Introduction:** Our objective was to explore the relationships between dietary exposure to POPs and estrogen receptor-positive breast cancer (ER+ BC) risk in the French E3N cohort study, using different statistical approaches to manage multicollinearity between exposures.

**Methods:** The intake of 81 POPs were estimated using food consumption data collected through a semi-quantitative food frequency questionnaire, and food contamination data measured in the second French total diet study. First, a hierarchical clustering on dietary exposure to POPs was performed to identify clusters of correlated POPs. For each cluster, all POPs composing it were averaged, and all these averaged variables were included in a Cox model to estimate their associations with ER+ BC occurrence. Second, Principal component Cox regression (PCR-Cox) and partial least squares Cox regression (PLS-Cox), two dimension-reduction methods (respectively unsupervised and supervised) coupled to a Cox model, were used to identify principal components (i.e., linear combinations) of POPs and to estimate their association with ER+ BC occurrence. Cox models were adjusted for potential confounders identified using a directed acyclic graph.

**Results:** Among 67,722 women with a median follow-up of 20.3 years, 3,739 developed incident ER+ BC. The hierarchical clustering method did not identify any association between the averaged variables and ER+ BC risk. Five components were retained using the PCR-Cox and PLS-Cox methods explaining 82% and 77% of the variance in the initial exposure matrix respectively, but none was significantly associated with the occurrence of ER+ BC.

**Discussion:** Three statistical methods adapted for analyzing highly correlated exposures were applied, each addressing different research questions. These methods did not reveal any association between dietary exposure to POPs and ER+ BC.

## ENVIRONMENTAL EXPOSURES &amp; PREGNANCY

**Prenatal exposure to per- and polyfluoroalkyl substances, fetoplacental hemodynamics, and fetal growth**

Bethany Knox<sup>1</sup>, Nuria Güil-Oumrait, Xavier Basagaña, Dora Cserbik, Payam Dadvand, Maria Foraster, Toni Galmes, Mireia Gascon, Maria Dolores Gómez-Roig, Laura Gómez-Herrera, Line Småstuen Haug, Elisa Llurba, Sandra Márquez, Ioar Rivas, Jordi Sunyer, Cathrine Thomsen, Maria Julia Zanini, Mariona Bustamante, Martine Vrijheid  
<sup>1</sup>Barcelona Institute for Global Health, ISGlobal, Barcelona, Spain

**Abstract**

**Introduction:** The impact of legacy per- and polyfluoroalkyl substances (PFAS) on fetal growth has been well studied, but assessments of next-generation PFAS and PFAS mixtures are sparse and the potential role of fetoplacental hemodynamics has not been studied. We aimed to evaluate associations between prenatal PFAS exposure and fetal growth and fetoplacental hemodynamics.

**Methods:** We included 747 pregnant women from a cohort in Barcelona, Spain (2018–2021). 23 PFAS were measured at 32 weeks in maternal plasma, of which 13 showed detectable levels. Fetal growth was measured as estimated fetal weight at 32 and 37 weeks of gestation, and weight at birth. Doppler ultrasound measurements for uterine (UtA), umbilical (UmA), and middle cerebral artery (MCA) pulsatility indices (PIs), as well as the cerebroplacental ratio (CPR – ratio MCA to UmA), were obtained at 32 and 37 weeks to assess fetoplacental hemodynamics. Linear mixed models assessed the association between singular PFAS and longitudinal fetal growth and PIs. Bayesian Weighted Quantile Sum models evaluated associations between the PFAS mixture and outcomes at 32 and 37 weeks, and at birth.

**Results:** Single PFAS and the PFAS mixture tended to be associated with reduced fetal growth and CPR, while associations with PIs varied in directionality. Few associations reached statistical significance. Legacy PFAS PFOS, PFDoDA, and PFHpA were associated with statistically significant decreases in fetal weight z-score of 0.13 (95% CI (-0.22, -0.04), 0.05 (-0.10, 0.00), and 0.06 (-0.10, -0.01), respectively, per doubling of concentration. The PFAS mixture was associated with a 0.11 decrease in birth weight z-score (95% -0.24, 0.01) per quartile increase.

**Conclusion:** This study suggests that legacy PFAS are associated with reduced fetal growth, but associations for next-generation PFAS and for the PFAS mixture were less conclusive. Associations between PFAS and fetoplacental hemodynamics warrant further investigation.

**Elevated placental DNA damage correlates with black carbon accumulation in placental tissue**

Charlotte Van Der Stukken<sup>1</sup>, Dries Martens, Leen Rasking, Tim Nawrot  
<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Hasselt, Belgium

**Abstract**

**Introduction:** Exposure to black carbon (BC) during pregnancy may increase the risk of adverse pregnancy outcomes, with recent studies revealing the translocation of BC particles to the placenta and fetal tissue. Despite being listed as a possible carcinogen by the International Agency for Research on Cancer (IARC), the mechanisms by which in utero BC affects placental and fetal health remains poorly understood. This study investigates the effect of modelled and personal in utero BC exposure on placental DNA damage in mother-newborn pairs within the ENVIRONAGE birth cohort in Belgium.

**Methods:** Based on modelled ambient BC levels at the maternal residential address during pregnancy, 10 high-exposed and 10 low-exposed non-smoking pregnant mothers were selected and matched on population characteristics. Placental samples were analyzed for BC particles using the label-free white-light technique. Placental DNA damage was assessed through immunofluorescent staining of  $\gamma$ -H2AX, a marker

for double-stranded DNA breaks. Spearman correlation was evaluated between modelled and placental BC, as well as their correlation with  $\gamma$ -H2AX levels.

**Results:** The high-exposed group showed more placental BC particles (4.56E+04 vs. 2.84E+04/mm<sup>2</sup>; p=0.08) and placental BC load correlated with modelled BC during the third trimester of pregnancy (r=0.54, p=0.021). The high-exposed group had significant higher  $\gamma$ -H2AX levels in placental tissue compared to the low-exposed group (0.83 vs. 0.32 foci/nucleus; p<0.001), indicating elevated DNA damage. Positive associations were observed between placental  $\gamma$ -H2AX levels and both modelled BC (third trimester: r=0.58, p<0.014 and entire pregnancy: r=0.52, p<0.028) and placental BC (r=0.47, p=0.049), suggesting a direct relationship between BC exposure and DNA damage.

**Discussion:** This study provides initial evidence on increased DNA damage in the presence of BC particles in placenta, which emphasizes the potential adverse impact on placental functioning.

**Toxic metals and essential trace elements in placenta and their relation to placental function**

Klara Gustin<sup>1</sup>, Marijke Grundeken, Marie Vahter, Mathilde Delaval, Malin Barman, Anna Sandin, Ann-Sofie Sandberg, Agnes E. Wold, Karin Broberg, Maria Kippler  
<sup>1</sup>Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden

**Abstract**

**Introduction:** Placental function is essential for fetal development, but it may be susceptible to malnutrition and environmental stressors. Here, we assessed the impact of toxic and essential trace elements in placenta on placental function.

**Methods:** Toxic metals [cadmium (Cd), lead (Pb), mercury (Hg), cobalt (Co)] and essential elements [copper (Cu), manganese (Mn), zinc (Zn), selenium (Se)] were measured in placenta of 406 pregnant women in northern Sweden using inductively coupled plasma-mass spectrometry. Placental function was estimated by placental weight, the fetoplacental weight ratio, and, in a subsample (n=285), placental relative telomere length (TL) and mitochondrial DNA copy number (mtDNAcn) were determined by quantitative PCR. Single exposure-outcome associations were assessed using covariate-adjusted linear or spline regression, and joint associations and interactions with Bayesian kernel machine regression (BKMR).

**Results:** Median Cd, Hg, Pb, Co, Cu, Mn, Zn, and Se concentrations were 3.2, 1.8, 4.3, 2.3, 1058, 66, 10626, and 166  $\mu$ g/kg, respectively. In the adjusted regression, placental weight (mean $\pm$ SD: 614 $\pm$ 133) decreased by 24 g (95% CI: -43, -4.0) per doubling of Pb (at low Se levels) and by 158 g (95% CI: -246, -71) per doubling of Se. Placental weight increased by 41 g (95% CI: 5.9, 77) and the fetoplacental weight ratio decreased (B: -0.01; 95% CI: -0.019, -0.004) per doubling of Mn. Co was inversely associated with mtDNAcn (B: -11; 95% CI: -20, -0.018, per doubling), whereas all essential elements were positively associated with mtDNAcn, individually and jointly.

**Discussion:** Pb appeared to negatively impact placental weight, but only at low Se. Probably, the Se-association with lower placental weight was due to increased Se transport to the fetus in late gestation. Mn seemed to increase placental weight, but not birth weight. Co decreased placental mtDNAcn, while joint essential element concentrations increased placental mtDNAcn.

**Maternal occupational multi-exposures during pregnancy and association with intrauterine growth: the ELFE study**

Marie Tartaglia<sup>1</sup>, Nathalie Costet, Sabyne Audignon-Durand, Elisabeth Cardis, Camille Carles, Alexis Descatha, Daniel Falkstedt, Marie Houot, Katarina Kjellberg, Corinne Pilorget, Nel Roeleveld,

Michelle Turner, Maxime Turuban, Sanni Uksulainen, Marie Noëlle Dufourg, Ronan Garlantézec\*, Fleur Delva\*

\* Contributed equally <sup>1</sup>University of Bordeaux, INSERM, Bordeaux Population Health Center, Epicene Team, U1219, F-33000 Bordeaux, France

#### Abstract

A number of agents are suspected to impair fetal growth. The objectives of our work were to determine maternal profiles of occupational multi-exposures and to study their association with intrauterine growth.

Our analyses were conducted within the ELFE cohort. Occupational exposures to 50 agents (chemical, physical, biological, biomechanical, organizational and psychosocial), were identified using job exposure matrices. Mothers were classified as occupationally exposed, uncertainly exposed, or not exposed depending on their probability of exposure. Outcomes of interest were birthweight, small for gestational age (SGA) and head circumference. Maternal profiles of occupational multi-exposure were determined using hierarchical clustering of principal components. Associations between clusters and intrauterine growth outcomes were studied using linear or logistic regression models adjusted for potential confounders. Analyses were carried out depending on whether mothers stopped working during pregnancy.

The 12,851 women included in our study were exposed on average to 8 factors. Five profiles of occupational multi-exposures were identified, characterized by (1) low exposure, high stress at work, (2) postural constraints, higher decision, (3) postural constraints, intense work, (4) postural constraints, chemical and biological risks, (5) accumulation of all constraints. In multivariate analyses, SGA risk was significantly higher in profile 5, compared to profile 1. Among women who stopped working during the 2nd or 3rd trimester of pregnancy, analyses found associations between the profile 3 and intrauterine growth. None of the other exposure profiles was associated with fetal growth outcomes.

The results show that specific profiles may be at higher risk of fetal growth retardation, but replication of results is warranted. This study provided a better understanding of multiple exposures of pregnant women at the workplace which may help to better adapt prevention strategies

### Exposome of maternal and cord blood cholesterol in the ENVIRONAGE birth cohort

Rossella Alfano<sup>1</sup>, Tim S Nawrot, Charlotte Cosemans, Brigitte Reimann, Congrong Wang, Michelle Plusquin

<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Agoralaan Building D, 3590, Diepenbeek, Belgium

#### Abstract

**Objective:** The association between exposome factors and cholesterol levels in newborns and pregnant mothers is not well understood. This study investigates, for the first time, the association of the exposome with maternal blood at delivery and cord blood cholesterol levels.

**Material and Methods:** Cholesterol levels (Total, HDL, LDL) and exposome (including 325 variables) were measured in 1,965 mother-child pairs at birth from the ENVIRONAGE cohort. Associations were assessed individually through exposome-wide association study (ExWAS) and collectively using Bayesian kernel machine regression (BKMR). Network analysis integrated commonly retrieved associations.

**Results:** 4 internal (maternal plasma oestradiol and cord blood homocysteine, ferritin, and sex hormone-binding) and 3 specific external exposures (high maternal education and consumption of eggs from own chicken and folic acid assumption during pregnancy) were commonly associated in ExWAS and BKMR with cord blood cholesterol levels. Maternal cholesterol levels were similarly linked to 3 internal (maternal plasma homocysteine, ferritin and vitamin D levels) and 4 external, 2 specific (primiparity, and maternal smoking during pregnancy) and 2 general (maternal exposure to black carbon (BC) in the first month of pregnancy and sunshine exposure throughout pregnancy), exposures. Network analysis revealed maternal blood vitamin D as the node with

the highest degree (N=10). Cord blood and maternal blood cholesterol formed separate clusters, indirectly connected by a smaller cluster containing cord and maternal blood homocysteine.

**Conclusion:** Our results identified exposures other than diet and lifestyle (i.e. folic acid assumption, parity, sunshine and exposure to BC) which may contribute to cholesterol levels in pregnancy and at birth. In the context of the developmental origins of adult health and disease, these findings offer insights for interventions potentially impacting lifetime health.

### Associations between prenatal exposures to built environment, greenness and air pollution with cord blood metabolites

Wen Lun Yuan<sup>1,2</sup>, Iman Zarei, Anton Ribbenstedt, Kati Hanhineva, Marjukka Kolehmainen, Johanna Lepeule, Barbara Heude, Janine F Felix, Carl Brunius

<sup>1</sup>Université Paris Cité and Université Sorbonne Paris Nord, Inserm, INRAE, Center for Research in Epidemiology and Statistics (CRESS), F-75004 Paris, France; <sup>2</sup>Singapore Institute for Clinical Sciences, Agency for Science, Technology, and Research (A\*STAR), Singapore, Singapore

#### Abstract

**Introduction:** Urban environmental exposures during pregnancy could influence fetal growth and later-life health, although underlying biological mechanisms still need elucidation. Metabolomics, which examines metabolites as end products of multiple biological processes, could reveal further insights. This study aimed to identify metabolite biomarkers of prenatal urban environmental exposures and metabolic pathways relevant for later-life health.

**Methods:** Cord plasma metabolite features (n≈4000) were obtained from two birth cohorts, EDEN (n=1,485) and Generation R (n=991), using untargeted LC-MS metabolomics. Pregnancy urban exposures included built environment, greenness, air pollutants (NO<sub>2</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>, black carbon, O<sub>3</sub>), and meteorological conditions (temperature, humidity, and UV dose). Random Forest analysis was used to assess associations between metabolites and environmental exposures and to select metabolites of interest. Such metabolites were further analyzed in relation to the exposures by multiple linear regression models to adjust for confounders (maternal age and educational attainment), and precision variables (sex, maternal smoking in both studies, center in EDEN, and ethnicity in Generation R). Air pollution models were further adjusted for meteorological conditions.

**Results:** The cord plasma metabolome was associated with prenatal air pollution, temperature, UV dose and humidity in both cohorts, but not with built environment exposures and greenness. Cross-cohort replication and identification of replicated metabolites is ongoing.

**Discussion:** Air pollution, temperature, UV dose, and humidity may have a stronger metabolic imprint on cord plasma metabolites than the built environment. This could be explained by their presumably more proximal influence on maternal metabolism. Upcoming findings should unveil potential exposure biomarker candidates and metabolic pathways associated with these environmental exposures.

### The role of fetoplacental hemodynamics in the association between prenatal traffic-related air pollution and birth weigh

Yu Zhao<sup>1</sup>, Maria Julia Zanini, Bethany Knox, Toni Galmes, Laura Gómez-Herrera, Marta Cirach, Alan Domínguez, Xavier Basagaña, Maria Foraster, Mireia Gascon, Marta Cosin, Mariona Bustamante, Ioar Rivas, Maria Dolores Gómez-Roig, Elisa Llurba, Jordi Sunyer, Payam Dadvand

<sup>1</sup>Barcelona Institute for Global Health, ISGlobal, Barcelona, Spain; Universitat Pompeu Fabra (UPF), Barcelona, Spain; CIBER Epidemiología y Salud Pública (CIBERESP), Madrid, Spain

**Abstract**

**Introduction:** Prenatal exposure to traffic-related air pollution (TRAP) has been associated with impaired fetal growth. Whether this association could be mediated through impaired placental function has been less explored.

**Methods:** This study was based on Barcelona Life Study Cohort (BiSC) a prospective cohort of 1,080 pregnant women in Barcelona, Spain (recruitment phase: 2018-2021). We integrated objective data on personal time-activity with land use regression models to estimate maternal exposure to black carbon (BC), NO<sub>2</sub>, PM<sub>2.5</sub>, and PM<sub>2.5</sub> Cu, Fe, and Zn in the main microenvironments (home, workplace, and commuting routes) for each participant. Fetoplacental hemodynamics was measured at week 32 of gestation based on Doppler ultrasound indexes including (i) uterine artery pulsatility index (PI), (ii) umbilical artery PI, (iii) middle cerebral artery PI, and (iv) cerebroplacental ratio. Mixed effects models with hospital random intercept were used to investigate the association between each air pollutant and fetal growth, while evaluating the mediatory role of placental function.

**Results:** Maternal exposure to higher BC, NO<sub>2</sub>, PM<sub>2.5</sub>, and PM<sub>2.5</sub> Cu and Fe contents at home and all microenvironments combined were associated with lower birth weight and higher risk of small for gestational age (SGA). We also found a statistically significant association of BC, NO<sub>2</sub>, and PM<sub>2.5</sub> with the umbilical artery PI. Umbilical artery PI could explain 13.4% (95% CIs: -1.0%, 63.2%), 8.0% (95% CIs: 0.2%, 22.6%) and 9.5% (95% CIs: 1.0%, 28.3%), of the associations between BC, NO<sub>2</sub>, and PM<sub>2.5</sub> and birth weight, respectively. Umbilical artery PI could also explain 7.4% (95% CIs: -1.7%, 50.6%), 6.4% (95% CIs: -0.9%, 38.2%) and 5.3% (95% CIs: 0.0%, 20.9%) of the associations between BC, NO<sub>2</sub>, and PM<sub>2.5</sub> and SGA, respectively.

**Conclusion:** Our results indicated that the adverse association of prenatal exposure to TRAP could be mediated, in part, through increasing umbilical artery resistance.

**SOCIAL & PHYSICAL ENVIRONMENT****The physical and social exposome during early life and child selective attention: a multi-cohort study**

*Carmen Peuters<sup>1</sup>, Payam Dadvand, Núria Botella, Boris Cheval, Maria Foraster, Rik Bogers, Yingxin Chen, Jurriaan Hoekstra, Tanja Vrijkotte, Hendriek Boshuizen, Sanne Meijering, Gabriele Bolte, Achilleas Psyllidis, Jenny Selander, Irene van Kamp, Elise van Kempen, Jordi Julvez*

<sup>1</sup>ISGlobal Barcelona Institute for Global Health, Barcelona, Spain

**Abstract**

**Introduction:** Exposure to physical (e.g., air pollution) and social (e.g., family affluence) factors during early life may impact executive functioning such as selective attention. However, such environmental exposures have mainly been investigated in isolation, not taking into account their interrelatedness. This study takes a comprehensive approach by studying the early life exposome with the aim of identifying the most important social and physical predictors of child selective attention.

**Methods:** Selective attention was measured by means of computerized tests in children (age 5-16 years), with five cohorts across Europe (N=11,738) having data available on the mean (M) of the hit reaction time (HRT) and three (N=5,843) on the standard error (SE) of the HRT. Environmental exposures during pregnancy and the first 3 years of life were obtained via public databases, remote-sensing data (e.g., NDVI), modelling approaches, and questionnaires. For each cohort, random forest analyses were first performed for physical and social factors separately, after which the most important factors were included together in a final model. The single-cohort results were

combined into an adjusted rank-based meta-analysis to obtain the order of exposure importance.

**Results:** Considering jointly the results for the HRT-M and HRT-SE, the physical exposures ranking as most important were air pollution, street network indicators, elevation, and extent of blue and green spaces around the home. Youth ratio and income, both at neighbourhood level, and education of the parents at household level, were ranked as most important social exposures.

**Discussion:** Results highlight urbanization consequences (e.g., air pollution and availability of green spaces), elevation, youth ratio and indicators of the socio-economic environment (parental education, neighbourhood income) to be the physical and social exposures that were most strongly associated with child selective attention.

**Spatiotemporal dynamics of the temperature-occupational injuries association in Spain: The role of socioeconomic factors**

*Constanza Vielma<sup>1,2</sup>, Hicham Achebak, Marcos Quijal-Zamorano, Simon Lloyd, Guillaume Cheavance, Joan Ballester*  
<sup>1</sup>Barcelona Institute for Global Health – ISGLOBAL; <sup>2</sup>Universitat Pompeu Fabra (UPF)

**Abstract****Introduction:**

Extensive evidence links both cold and hot temperatures to an increased incidence of occupational injuries. Meanwhile, contextual modifiers of the temperature-injury association have been scarcely researched. The present study focuses on unexplored aspects of this association in Spain during 32 years (1988-2019), specifically addressing temporal variations and effect modifiers, in order to portray Spanish workers' (mal)adaptation to temperatures.

**Methods:**

We assessed the association between daily mean temperatures and occupational using a quasi-Poisson time-series regression model in 48 Spanish provinces for the years 1988-2019 as well as for 4 five-year sub-periods, estimating the relative risk and attributable number and fraction of injuries to temperatures. We performed meta-regressions to explore the modification of this association by demographic and socioeconomic variables, stratifying all the analyses by sex, age, and economic sectors.

**Results:**

We found a 4% and 12% increased risk of injuries at the 1st and 99th percentiles of temperature, respectively. Overall, heat had a greater impact than cold, accounting for a 2.7% (95% CI 2.19%-3.16%) of the total injuries, and the groups more vulnerable to heat were found to be male workers, under 35, in agriculture, construction, and hostelry sectors. Vulnerability to heat peaked in the earliest period (1989-1993), while vulnerability to cold rose during sub-periods of economic expansion (1999-2003) and recession (2009-2013). The proportion of tertiary educated adults emerged as a protective influence during the hot season (April to November).

**Discussion:**

We stress the need for targeted, seasonal and context-relevant, preventive measures to reduce heat and cold vulnerability. Social measures, such as legislation enforcement and education on heat hazards, would bring general benefits to worker safety, thus reducing not only heat-and-cold-related injuries, but overall vulnerability to injuries.

**Socioeconomic Determinants Effect on Lead Poisoning Among Children: A Retrospective Study of Five Regions in Georgia**

*Dali Kekelidze<sup>1</sup>, Iagor Kalandadze, Antoine Pogorzelski, Nana Gabriadze, Robinzon Tsiklauri*  
<sup>1</sup>Ilia State University, Tbilisi, Georgia

**Abstract**

**Introduction:** Lead exposure among children in Georgia is a critical public health issue. Unfortunately, there has been no identification of risk factors that impact the spread of lead poisoning. This study investigates the correlation between socioeconomic factors and blood lead levels among children in five Georgian regions, where blood lead levels in children are greater than or equal to 5 µg/dL.

**Methods:** The present retrospective study focuses on a comprehensive review of the Multiple Indicator Cluster Survey conducted in Georgia, supplemented by a systematic review to provide a clearer picture. For our research, we collected information on the blood lead levels of 1519 children aged 2-7 living in the following regions: Adjara, Guria, Samegrelo-Zemo Svaneti, Imereti and Tbilisi. As the present study centers on the association between socioeconomic determinants and blood lead levels, variables such as children's age and gender, social status, ethnicity, householders' education level, and region are controlled in the analysis.

**Results:** According to the regression model, lead in children's blood is high in the age group up to 6-7 years old in the Autonomous Republic of Adjara. According to the well-being index, the lead level in children's blood is higher in lower socioeconomic group. No statistically significant difference was observed according to children's gender, ethnicity, age of the head of the household, and level of education.

**Discussion:** Our findings provide valuable insights and information to conduct targeted studies in children under 6-7 years and in economically vulnerable groups to reduce lead poisoning among children in Georgia. This retrospective study lays the foundation for future research to develop effective public health policies and the need for public awareness campaigns on lead poisoning.

### **Filling the gap: Evaluating disparities in exposure to outdoor ultrafine particles and black carbon in urban Canada.**

*Emmanuelle Batisse<sup>1</sup>, Marshall Lloyd, Alicia Cavanaugh, Arman Ganji, Junshi Xu, Alessya Venuta, Leora Simon, Mingqian Zhang, Milad Saeedi, Shoma Yamanouchi, Joshua Apte, Kris Hong, Marianne Hatzopoulou, Jill Baumgartner, Scott Weichenthal*

<sup>1</sup>McGill University

**Abstract**

**Introduction:** Disparities in exposure to health-damaging air pollutants, like PM<sub>2.5</sub>, are well-documented in North America and Europe. Ultrafine particles (UFP) and black carbon (BC), likely associated with adverse health effects, are understudied and unregulated. As disparities have only been assessed in the U.S, we aimed to fill this gap by investigating exposure inequalities to UFP and BC in urban Canada, comparing trends over 15 years and between its two largest cities.

**Methods:** We obtained information on material and social deprivation, residential instability, and immigration recency for the 2006 and 2021 Census dissemination areas (DAs) in Montreal and Toronto. We assessed how these data clustered at the DA level using K-mean clustering analysis. Population-weighted average exposure to UFP and BC concentrations and UFP sizes were calculated for DAs and clusters. Exposures were estimated using recently developed models based on a year-long mobile monitoring campaign in Canada (2020-21).

**Results:** UFP and BC concentrations were highest and UFP sizes smallest in DAs adjacent to major roads, railways, and airports. Clusters represented low, average, and high SES areas with changes in socio-demographic composition between cities and years. Overall, we observed low magnitude of exposure disparities. In Montreal, median UFP and BC concentrations were higher in low and average vs. high SES DAs (UFP: 13,343 vs. 10,666 pt/cm<sup>3</sup>; BC: 810 vs. 644 ng/m<sup>3</sup>) with no difference in UFP sizes; trends were consistent over time. In Toronto, patterns differed for BC concentrations with low SES areas having the

highest levels in 2006 (1,489 ng/m<sup>3</sup>) and average SES areas experiencing the lowest overall (1,100 and 939 ng/m<sup>3</sup> in 2006 and 2021).

**Discussion:** We did not observe strong evidence of socio-economic inequalities in exposure to UFP and BC in Canada's largest cities, but we highlighted the importance of prioritizing exposure mitigation for populations near major transport hubs.

### **Socioeconomic disparities in air pollution's effect on cause-specific mortality: A study in central Italy's contaminated**

*Chiara Badaloni<sup>1</sup>, Alessandro Trentalange, Daniela Porta, Marina Davoli, Paola Michelozzi*

<sup>1</sup>Department of Epidemiology of Lazio Region, Asl Rome 1

**Abstract**

**Introduction:** Individual and environmental factors such as socioeconomic status (SES) may contribute to population vulnerability. This study aims to assess how those factors influence the risk of cause-specific mortality in an administrative cohort of residents of the River Sacco Valley (RSV), a contaminated site of central Italy.

**Methods:** Individual exposure to pollutants (PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub>, SO<sub>2</sub>, C<sub>6</sub>H<sub>6</sub>, O<sub>3</sub>) at residential addresses was evaluated using dispersion models with a 1-km<sup>2</sup> resolution. SES was determined by a 5-level area index at the census block level (high to low). Health data, coded with ICD-9, included non-accidental (0-799), cardiovascular (390-459), respiratory (460-519), and cancer (140-250) causes of mortality. Residents in the RSV and adjacent area (~100 municipalities) were enrolled from 1/1/2008 to 31/12/2018. We used Cox proportional hazard models, adjusted for gender, SES, and air pollution to estimate the associations between exposure and outcomes. Finally, we evaluate the interaction between air pollution and SES on the study outcomes.

**Results:** We enrolled 665,160 subjects (median age: 41 years) at the baseline. High SES constituted 8% while low SES 13% of the population. We observed 59,767 non-accidental deaths during the study period. SES-related effects show a clear pattern for each outcome, with HR for low SES up to 1.165 (1.097, 1.238) for non-accidental and 1.184 (1.087, 1.290) for cancer mortality. Air pollutants exhibited positive associations with malignancy and respiratory mortality only, with estimates up to 1.05 (1.02, 1.07) and 1.06 (1.03, 1.09) for PM<sub>2.5</sub> and C<sub>6</sub>H<sub>6</sub>. Air pollution-SES interaction effects were significantly higher in the low SES category for each pollutant.

**Discussion:** Socioeconomic deprivation indicates individual frailty, and air pollution is a major environmental risk factor. However, the effects of long-term exposure vary across the population.

### **How is socioeconomic status associated with environmental burden? Results from six Swedish cities.**

*Mehjar Azzouz<sup>1,2</sup>, Johan Sommar, Martin Tondel, Lars Barregard, Charlotta Eriksson, Mare Löhmus, Michael Ögren, Marta A Kisiel, Stefan Ljunggren, Erica Nordlander, Anna Oudin, Susanna Gustafsson, Göran Pershagen, Leo Stockfelt, Eva Andersson*

<sup>1</sup>Occupational and Environmental Medicine, School of Public Health and Community Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden;

<sup>2</sup>Department of Occupational and Environmental Medicine, Sahlgrenska University Hospital, Gothenburg, Sweden

**Abstract**

**Aim:** To investigate associations between indicators of socioeconomic status (SES) and environmental burdens in six urban cities in Sweden.

**Methods:** The Swedish CARDioPulmonary bioImage Study (SCAPIS) cohort recruited adult participants during 2013-2018 in six Swedish cities. Of the total 30 154 SCAPIS participants, 23 330 nested within 1940 areas were included. Individual-level exposure to environmental burdens, such as: particulate matter <2.5µm (PM<sub>2.5</sub>), <10µm

(PM10), road traffic noise, and lack of greenness (inverse Normalized Difference Vegetation Index – iNDVI), as well as area-level SES in 2018, was assessed based on the participants' home addresses. Individual-level SES data was obtained from a questionnaire. Linear regression models were fitted to area-level (percentage of people with low income and education, living in rental units) and individual-level SES indicators (financial buffer, education, occupation, and type of living). City-specific regressions were used to compare strength and patterns of the associations. Both separate and joint models including all SES factors were used.

**Results:** The mean (standard deviation) levels of environmental burdens were 5.6 (1.1)  $\mu\text{g}/\text{m}^3$  for PM2.5, 13.1 (2.1)  $\mu\text{g}/\text{m}^3$  for PM10, 58 (7) dB for road traffic noise, and 0.55 (0.13) iNDVI for lack of greenness. In areas with lower income and more rental units there was more environmental burden. Conversely, in areas with lower education and more unemployment there was less environmental burden. Most associations were non-linear, and differed substantially between cities (For example, the difference in PM2.5 between high and low-income areas ranged from 0.22-0.41  $\mu\text{g}/\text{m}^3$  by city). Of the individual-level SES factors, only type of living was associated with environmental burden, with more burden among those living in rental units.

**Conclusion:** The relationship between socioeconomic factors and environmental risk factors differed greatly between different indicators and cities.

### Early life environmental exposure and childhood morbidity in Southern Mozambique: An exposome approach

Stefan Sieber<sup>1</sup>, Jovito Nunes, Ariadna Curto, Fabián Coloma, Carles Milá, Marta Cirach, Charfudin Saco, Francisco Saute, Quique Bassat, Cathryn Tonne

<sup>1</sup>ISGlobal, Barcelona, Spain

#### Abstract

**Introduction:** The external exposome is the sum of environmental exposures that can affect health over the life course. We aimed to quantify the association between the early life external exposome and hospital visits among children under 5 in a semi-rural area of Southern Mozambique.

**Methods:** We used data on 20,865 children aged 0-5y born in the Manhica district. We used 22 exposures covering four external exposome domains: socioeconomic adversity, family instability, household environment, surrounding residential environment (e.g. land use, green space, impermeable surfaces). We conducted domain-specific Multiple Correspondence Analysis and Principal Component Analysis to reduce dimensionality and derive interpretable components representing each domain. We selected principal components (PCs) that explained at least 70% of the variance. PCs were used as linear variables in adjusted negative binomial regression models to estimate the association between each external exposome domain and the number of hospital visits.

**Results:** The first four PCs of the surrounding residential environment domain explained 70.0% of the variance (PC1: 30.5%, PC2: 15.5%, PC3: 13.5%, PC4: 10.5%). Loadings from 12 separate exposures on these PCs indicated that PC1 represented grass and shrub land with few trees, PC2 represented bare land with few trees, PC3 trees and shrubland, PC4 crop and bare land. A unit increase in the four PCs modelled separately were associated with all-cause hospital visits as follows: rate ratio of 1.01 (95% CI: 1.00-1.02) for PC1, 0.88 (0.87-0.89) for PC2, 0.87 (0.86-0.89) for PC3, and 1.02 (1.01-1.04) for PC4. Parallel analyses for the other exposome domains are ongoing.

**Discussion:** Results highlight the importance of comprehensive characterization of the diverse external exposome domains of children in a low-income context and their association with morbidity.

### NEURODEVELOPMENT: NEW EVIDENCE ON EFFECTS OF ENVIRONMENTAL EXPOSURES ON NEURODEVELOPMENT

#### Maternal exposure to fluoride and child development outcomes in England in the Millennium Cohort from 2000-2008

Adrian Lee<sup>1</sup>, Sophie Hamilton, Neville Verlander, Emma Benham, Debapriya Mondal, Ayoub Saei, Ariana Zeka, Giovanni Leonardi, Tony Fletcher

<sup>1</sup>Environmental Epidemiology, Radiation, Chemicals and Environmental Hazards Directorate, UK Health Security Agency, Chilton, Oxfordshire, UK

#### Abstract

**Introduction:** Fluoridation schemes across England have proven beneficial in lowering the prevalence of dental caries, however, studies from outside England suggest that exposure to fluoride in drinking water during pregnancy and infancy can have an adverse effect on child neurodevelopment. We aimed to assess the effects of maternal exposure to fluoride from drinking water on cognitive and developmental outcomes in children at ages 5 and 7 years.

**Methods:** Six developmental and cognitive domain measures—five British ability scales (BAS), a battery core sub-tests of cognitive ability and educational achievement covering children, the National Foundation for Education Research Progress in Maths (PiM) exam, were used from the UK Millennium Cohort Study (MCS) survey. We used the MCS data and linked it to Drinking Water Inspectorate data, which is an annual average concentration of fluoride by water supply zone between the years 2000-2008. We assigned mean annual fluoride exposure in drinking water at birth in children living in England taking part in the UK MCS, based on residential postcode as a measure for maternal exposure. We examined the association between the maternal fluoride exposure and six selected child developmental outcomes at age 5 (n=8142) and 7 (n=7043) using multi-level modelling adjusting for covariates.

**Results:** Annual average fluoride exposure at birth was 0.20 mg/L (SD  $\pm$ 0.23). Overall, there was no suggestive evidence of an association. We found weak positive associations between the naming vocabulary, picture similarity BAS sub-tests for 5-year-olds, and the PiM test for 7-year-olds, with increasing annual average fluoride exposure at birth.

**Discussion:** Further analyses are in progress. We are now assessing the effect of post-natal exposure on outcomes, interactions with covariates and categories of fluoridation exposure to evaluate evidence of a dose-response relationship.

#### NO2 Exposure, Attentional Function and Working Memory: Periods of Susceptibility from Pregnancy to Childhood

Anne-Claire Binter<sup>1</sup>, Kellie Crooijmans, Carmen Iñiguez, Kristina Whitworth, Marisa Estarlich, Aitana Lertxundi, Ana Fernández-Somoano, Adonina Tardón, Jesús Ibarluzea, Jordi Sunyer, Mònica Guxens

<sup>1</sup>Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain

#### Abstract

**Introduction:** Air pollution exposure during pregnancy and childhood has been associated with cognitive function impairment in children. However, few studies have assessed these two exposure periods jointly to identify susceptible periods of exposure. Thus, we aimed to identify potential periods of susceptibility of nitrogen dioxide (NO<sub>2</sub>) exposure from conception to childhood on attentional function and working memory in school-aged children.

**Methods:** Within the Spanish INMA Project, we estimated residential daily NO<sub>2</sub> exposure during pregnancy and the first 6 years of childhood using land use regression models (n=1,703). We assessed

attentional function at 4-6 years and 6-8 years, using the Conners Kiddie Continuous Performance Test and the Attention Network Test, respectively, and working memory at 6-8 years, using the N-back task. We used distributed-lag non-linear models to assess the periods of susceptibility of each outcome, adjusting for potential confounders and correcting for multiple testing. We also stratified all models by sex.

**Results:** Higher exposure to NO<sub>2</sub> between 1.3 and 1.6 years of age was associated with higher hit reaction time standard error (HRT-SE) (0.14 [95% CI 0.05; 0.22] per 10 µg/m<sup>3</sup> increase in NO<sub>2</sub>) and between 1.5 and 2.2 years of age with more omission errors during the attentional function test at 4-6 years. Higher exposure to NO<sub>2</sub> between 0.3 and 2.2 years was associated with higher HRT-SE at 6-8 years only in boys. We found no associations between exposure to NO<sub>2</sub> and working memory.

**Conclusion:** NO<sub>2</sub> exposure during the first two years of life is associated with poorer attentional function in children from 4 to 8 years of age, especially in boys. These findings highlight the importance of exploring long-term effects of traffic-related air pollution exposure in older age groups.

### Traffic-Related Air Pollution and White Matter Microstructure Development Across Childhood and Adolescence

Michelle S. W. Kusters<sup>1,2,3,4</sup>, Mónica López-Vicente, Ryan Muetzel, Anne-Claire Binter, Sami Petricola, Henning Tiemeier, Mónica Guxens<sup>1</sup> ISGlobal, Barcelona, Spain; <sup>2</sup>Universitat Pompeu Fabra, Barcelona, Spain; <sup>3</sup>Spanish Consortium for Research on Epidemiology and Public Health (CIBERESP), Instituto de Salud Carlos III, Madrid, Spain; <sup>4</sup>Department of Child and Adolescent Psychiatry/Psychology, Erasmus MC, University Medical Centre, Rotterdam, The Netherlands

#### Abstract

**Introduction:** Emerging evidence suggests that exposure to air pollution during pregnancy and childhood affects brain development, but evidence on white matter microstructure is scarce and does not include repeated measures of white matter microstructure. Therefore, we investigated how air pollution exposure during pregnancy and childhood impacts longitudinal development of white matter microstructure across adolescence.

**Methods:** Our study was embedded in Generation R, a large population-based birth cohort. We included 4,108 children and a total of 5,422 neuroimaging scans. Residential air pollution exposure to 14 air pollutants during pregnancy and childhood was estimated with land-use regression models. Diffusion tensor images were obtained around age 10 and 14. We calculated whole-brain fractional anisotropy (FA) and mean diffusivity (MD) and performed single- and multi-pollutant analyses adjusted for life-style and socioeconomic status variables.

**Results:** Higher exposure to PM<sub>2.5</sub> during pregnancy and childhood, and PM<sub>10</sub>, PM<sub>2.5-10</sub>, and NO<sub>x</sub> during childhood was associated with lower whole-brain FA across the entire adolescence (e.g. -0.34×10<sup>-2</sup> FA [95%CI -0.61; -0.07] per 10 µg/m<sup>3</sup> higher PM<sub>10</sub> childhood exposure). Higher exposure to Si and OPDTT during pregnancy, and PM<sub>2.5</sub> during pregnancy and childhood was associated with a higher MD at baseline. However, the differences attenuated across adolescence, as indicated by a faster decrease (e.g. -0.14×10<sup>-5</sup> mm<sup>2</sup>/s MD [95%CI -0.25; -0.03] per year of age per 5 µg/m<sup>3</sup> higher PM<sub>2.5</sub> exposure during childhood).

**Discussion:** Residential exposure to air pollution was associated with lower whole-brain FA across the entire adolescence, while the association with whole-brain MD attenuated across adolescence. Our findings might indicate both a persisting and age-limiting effect of air pollution exposure on white matter microstructure, even at concentrations below the present European Union guidelines.

### Does placental DNA methylation mediate the association of prenatal exposure to air pollutants with child cognition?

Ariane Guilbert<sup>1</sup>, Lucile Broseus, Ian Hough, Itai Kloog, Jörg Tost, Barbara Heude, Sarah Lyon-Caen, Sam Bayat, Rémy Slama, Olivier François, Claire Philippat, Johanna Lepeule<sup>1</sup> Team of Environmental Epidemiology Applied to Development and Respiratory Health, Institute for Advanced Biosciences (IAB), Université Grenoble Alpes, Inserm, CNRS, 38700 La Tronche, France

#### Abstract

**Introduction:** Increased prenatal exposure to air pollution has been associated with decreased cognitive skills and DNA methylation (DNAm) modifications at birth. We investigated whether placental DNAm changes could mediate the association between prenatal exposure to ambient PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub> and child cognition.

**Methods:** Placental DNAm was measured using the Infinium HumanMethylation BeadChips in 327 and 463 mother-child pairs from the SEPAGES and EDEN French cohorts, respectively. Prenatal exposure to PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub> was estimated at the mother's residence using high spatiotemporal models. Child cognition was evaluated at 3 (SEPAGES) or 5 (EDEN) years through the Wechsler Preschool and Primary Scale of Intelligence batteries. CpG mediators and Aggregated Mediator Regions (AMRs; genomic regions of at least 2 base pairs) were identified using the new High-Dimensional Mediation Analysis with Max squared tests (HDMAX2). A discovery analysis, including an epigenome-wide association study and a candidate approach (genes previously related to neurodevelopmental disorders), was performed in SEPAGES (false discovery rate correction: 0.10). A replication study was conducted in EDEN.

**Results:** In SEPAGES, the candidate approach identified 7 CpGs (located in/near the genes CAMTA1, DNAJC6, HDLBP;SEPT2, MAP3K7, STXB1, TCF7L2 or AP3B2) mediating the association between prenatal NO<sub>2</sub> exposure and child visuospatial abilities. Besides, 58 significant AMRs were identified among the different pollutants and cognitive outcomes investigated. Some of these results were replicated in EDEN.

**Discussion:** Our results highlighted CpGs in genes previously related to neurodevelopmental disorders as well as new regions, whose placental DNAm may partly mediate the associations of prenatal exposure to ambient air pollution with child cognition. This work provides more insight into the underlying biological mechanisms linking early-life exposure to air pollution and child cognition.

### The benefit of woodland and other natural environments for adolescents' educational attainment

Chen Shen<sup>1,2</sup>, Nicole Curtis, Lan Cheng, Sara Larsen, Rhiannon Thompson, Rachel B Smith, Mireille B Toledano<sup>1</sup> MRC Centre for Environment and Health, Department of Epidemiology and Biostatistics, School of Public Health, Imperial College London, UK; <sup>2</sup>National Institute for Health Research Health Protection Research Unit in Chemical and Radiation Threats and Hazards, Imperial College London, UK

#### Abstract

**Introduction:** Exposure to urban nature, especially woodland, is associated with better cognitive development in adolescents. However, it remains unclear whether natural environment exposure contributes to educational attainment. We examined the associations between exposure to natural environment types and adolescents' educational attainment, including the mediation effects of cognitive function.

**Methods:** We analysed longitudinal data (n=4515) from a large, representative Greater London adolescent cohort study: the Study of Cognition, Adolescents and Mobile Phones (SCAMP). Natural environment types were characterised in greenspace and blue space based on participants' residential and school addresses at baseline, 11-12

years. Greenspace was further distinguished into woodland and grassland. Educational attainment at 16 years was based on the General Certificate of Secondary Education (GCSE) 9 to 1 grades via linkage to the National Pupil Database. Executive function and fluid intelligence measured at baseline were included in models. Data were analysed using multi-level Bayesian regression model and Bayesian mediation analysis.

**Results:** Per interquartile range (IQR) increase in daily exposure to greenspace was associated with higher GCSE maths grades ( $b=0.23$ , 95% credible interval (95% CI) 0.1-0.35). Per IQR increase in daily exposure to woodland was associated with higher GCSE maths ( $b=0.23$ , 95% CI 0.1-0.35), science ( $b=0.26$ , 95% CI 0.08-0.43), and English language grades ( $b=0.2$ , 95% CI 0.07-0.35). Daily exposure to grassland or blue space was not associated with educational attainment. Executive function and fluid intelligence partly mediated the associations between woodland exposure and GCSE grades (15.6% to 25.4%).

**Discussion:** Our findings may inform urban planning by showing the associations between natural environment types and educational attainment. These findings also offer important insights for creating healthy equitable cities for children to live in.

### Early-life exposure to lead, cadmium, and fluoride and cognitive abilities at 4 years

Mariza Kampouri<sup>1</sup>, Eric Zander, Klara Gustin, Anna Sandin, Malin Barman, Ann-Sofie Sandberg, Agnes E. Wold, Sven Bölte, Maria Kippler, Marie Vahter

<sup>1</sup>Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden

#### Abstract

**Introduction:** Early-life lead exposure is known to impair cognitive development, and emerging evidence suggests similar effects of cadmium and fluoride exposure. Our objective was to assess the impact of gestational and early-life low-level environmental exposure to lead, cadmium, and fluoride on cognitive abilities at 4 years of age.

**Methods:** We studied 437 mother-child pairs from the NICE cohort in northern Sweden. Concentrations of erythrocyte lead and cadmium and urinary cadmium were measured using inductively coupled plasma mass spectrometry and urinary fluoride with an ion-selective electrode in pregnant women (gestational week 29) and in their 4-year-old children. Cognitive abilities were assessed using Wechsler Preschool and Primary Scale of Intelligence-Fourth Edition.

**Results:** Gestational erythrocyte lead concentrations (median [range]: 11.2 µg/kg [3.8-147.8]) were associated with reduced child cognitive abilities (full-scale: B [95%CI]: -1.2 [-2.9, 0.5], per doubling). Similarly, gestational urinary cadmium (median [range]: 0.10 µg/L [0.02-0.97]) was associated with decreased cognitive abilities (full-scale: B [95%CI]: -1.1 [-2.5, 0.3], per doubling). Both urinary and erythrocyte child cadmium concentrations (median [range]: 0.04 µg/L [0.00-0.36] and 0.14 µg/kg [0.01-1.05], respectively) were inversely associated with cognitive abilities (urinary cadmium, full-scale: B [95%CI]: -1.1 [-2.5, 0.4] and verbal comprehension: -1.4 [-3.4, 0.6], and erythrocyte cadmium, full-scale: B [95%CI]: -0.7 [-1.8, 0.4] and verbal comprehension: -1.1 [-2.5, 0.4]; per doubling). Gestational and child urinary fluoride concentrations showed no association with child cognition at 4 years, probably due to methodological limitations.

**Discussion:** Both gestational and early-life low-level cadmium exposure was independently associated with reduced child cognitive abilities. Moreover, as expected, gestational low-level lead exposure was associated with decreased cognitive abilities.

### Long-term exposure to traffic air pollution and noise and dynamic brain connectivity across adolescence

Mónica López-Vicente<sup>1</sup>, Michelle Kusters, Anne-Claire Binter, Sami Petricola, Henning Tiemeier, Ryan Muetzel, Mònica Guxens

<sup>1</sup>ISGlobal, Barcelona, Spain

#### Abstract

**Introduction:** Traffic-related exposures are associated with brain alterations. This study aimed to investigate the long-term association of traffic air pollution and noise during pregnancy and childhood with dynamic brain functional connectivity development across adolescence.

**Methods:** We used data from a prospective population-based birth cohort, the Generation R Study (Rotterdam, Netherlands). We estimated levels of 14 air pollutants and traffic noise at home addresses during pregnancy and childhood. We used resting-state functional magnetic resonance imaging (fMRI) data acquired at mean ages 10 and 14 years. We included participants with fMRI data in at least one visit and either air pollution data ( $n=3,588$ ) or noise data ( $n=2,642$ ). From the fMRI data we generated five connectivity patterns, called 'states', using k-means clustering. We calculated the mean time spent in each state for each participant and visit. We performed single- and multi-pollutant mixed effects models adjusted for socioeconomic and lifestyle variables including the individual as random effect to test the associations between the exposures and the mean time spent in each state.

**Results:** Exposure to several air pollutants and noise was related to differences in the time spent in the connectivity states, both in the single- and multi-pollutant models. For instance, particulate matter during pregnancy and traffic noise during childhood were associated with more time spent in a default-mode network modularized state. In this state, components from the default-mode network, which is active during self-referential processes, were positively connected among them and they were negatively connected with components from other networks.

**Discussion:** Long-term traffic-related exposure levels might be related to differences in brain functional network organization in adolescents. Further research should explore the potential impact of these differences on cognition and psychopathology.

### URBAN: ENVIRONMENTAL EXPOSURES & HEALTH IN THE URBAN CONTEXT

#### Air pollution, greenspace, and metabolic syndrome in Czechia and Switzerland: Evidence from HAPIEE and SAPALDIA cohorts

Andrea Dalecká<sup>1</sup>, Ayoung Jeong, Medea Imboden, Balint Tamasi, Emmanuel Schaffner, Dirk Keidel, Daniel Szabo, Albert Ksinan, Kees de Hoogh, Jelle Vlaanderen, Roel Vermeulen, Annette Peters, Erik Melén, Martin Bobak, Hynek Pikhart, Nicole Probst-Hensch <sup>1</sup>RECETOX, Faculty of Science, Masaryk University, Brno, Czech Republic

#### Abstract

**Introduction:** The prevalence of metabolic syndrome (MetS) has been increasing rapidly, with considerable variation between European countries. Evidence on the long-term effects of air pollution and greenness remain inconsistent. The study aimed to examine the relationship between air pollutants, greenness and MetS in Czech and Swiss populations.

**Methods:** Cross-sectional data from the Czech HAPIEE ( $n=4,650$ ) and the Swiss SAPALDIA ( $n=4,422$ ) cohorts included participants aged 44-73 years examined in 2002-2005. MetS was defined as presence of at least three of the five phenotypes. Weighted mean concentrations for 365 days were calculated for PM10, PM2.5, NO2 and O3. Exposure to greenness was assessed by using annual median of NDVI within 500 m, and distance to a nearest greenspace (DGS) estimated in 100x100 m. Odds ratios for the MetS and its phenotypes were estimated using multivariate logistic regressions with cluster-robust standard errors models, controlling for multiple confounders.

**Results:** The prevalence of MetS was significantly higher in Czech (53.9%) compared to Swiss (37.1%) population as well as the concentration ranges of PM10 and PM2.5 (for PM2.5: 19.5-35.6 µg/m3 in Czech vs 5.0-26.5 µg/m3 in Swiss cohort). In HAPIEE, increase in



5 µg/m<sup>3</sup> exposures to PM<sub>10</sub> and PM<sub>2.5</sub> were associated with higher odds of MetS (OR=1.21; 95%CI [1.12-1.31] and OR=1.24; 95%CI [1.17-1.32], respectively). In SAPALDIA, no evidence was found for the associations between air pollutants and increased odds of MetS (e.g. OR=1.02; 95%CI [0.95-1.10] for PM<sub>2.5</sub>). Protective effects of NDVI and DGS on MetS were not observed in any of the studies. Additionally, exposures to PM<sub>10</sub> and PM<sub>2.5</sub> were associated with higher odds of various MetS phenotypes in both cohorts.

**Discussion:** The findings suggest that middle-aged and older adults living in higher exposures to PM<sub>10</sub> and PM<sub>2.5</sub> may be at higher risk of MetS, however, the effects were not consistent across the two European cohorts.

### Exposure to blue space and natural-cause mortality among 2.4 million people in urban areas of Greece

Maria-Iosifina Kasdagli<sup>1</sup>, Konstantina Dimakopoulou, Kees de Hoogh, Kyriakos Souliotis, Elpida Fotiadou, Anastasios Tsolakidis, Roel C H Vermeulen, Jelle J Vlaanderen, Klea Katsouyanni, Evangelia Samoli on behalf of the EXPANSE Project Team

<sup>1</sup>Department of Hygiene, Epidemiology and Medical Statistics, School of Medicine, National and Kapodistrian University of Athens, Athens, Greece

#### Abstract

**Introduction:** The beneficial health effects of exposure to natural environments have garnered attention, while the effects of exposure to blue spaces have only recently received attention, with few reported results. We investigated the association of exposure to blue space with natural-cause mortality in urban areas of Greece.

**Methods:** We used data from a country-wide Greek administrative cohort restricted to the 2.4 million participants residing in urban areas of Greece. Exposure to blue space was evaluated using the EU-Hydro baseline map developed by Copernicus Land Monitoring Service, which provides data on the river network, water bodies, drainage network with catchment areas, drainage lines, and sea water. The distance from the residential address to the nearest blue space was calculated and categorized with a cut-off of 1 km. We applied Cox proportional hazard models, accounting for individual and area-level variables and assessed the sensitivity of our results in two-exposure models including PM<sub>2.5</sub>, NO<sub>2</sub>, BC and O<sub>3</sub>. We investigated effect modification patterns between the distance from blue space and the other exposures.

**Results:** Living closer to blue space (≤1 km versus > 1 km) was associated with decreased risk of natural-cause mortality (HR: 0.98, 95% CI: 0.96, 0.99), robust to co-exposure adjustments. In areas with lower levels of NO<sub>2</sub>, distance <1 km from blue space was associated with lower risk of natural-cause mortality (HR = 0.95, 95% CI: 0.93, 0.96), compared with higher NO<sub>2</sub> areas (HR = 1.03, 95% CI: 1.00, 1.05). Similar patterns were observed for PM<sub>2.5</sub>, BC and O<sub>3</sub>, while no statistically significant interaction was observed between greenness and blue space.

**Conclusions:** Our results indicate a beneficial role of exposure to blue space on natural mortality. Nonetheless, further research is required to elucidate our findings.

### Does urban environment affect overweight/obesity in adolescents? New insights from the PARIS birth cohort

Malika Viola<sup>1</sup>, Céline Roda, Isabelle Momas

<sup>1</sup>Université Paris Cité, Sorbonne Paris-Nord, INRAE, INSERM, UMR 1153-CRESS, HERA Team, Paris, France

#### Abstract

**Introduction:** Recent studies suggested that urban environment (air pollution, walkability and green spaces...) might have an impact on childhood obesity which is a major public health concern. Thus, our aim was to study the association of built environment characteristics with overweight/obesity in adolescents from the PARIS (Pollution and Asthma Risk: an Infant Study) birth cohort.

**Methods:** During the health check-up at adolescence, height and weight were measured. Weight status was determined using WHO age- and-sex BMI z-scores. Questionnaires collected data on parental weight status, socioeconomic status, adolescent physical activity, sedentary behaviour, sleep, diet and smoking. Rebound age was also calculated. Exposure to traffic-related air pollution (TRAP) was assessed by nitrogen oxides air dispersion model taking into account both residential and school exposure the year before the health check-up. French deprivation index (FDep), walkability, and green space (proximity [within a 15-minute radius from home] and use) were considered. Associations were estimated in multivariable logistic regression models.

**Results:** Among the participants of the health check-up (N=617), 9.9% were living with overweight/obesity. After adjustment, built environment characteristics were negatively associated with overweight/obesity (aOR [CI95%] for walkability index: 0.45 [0.22-0.90] per IQR increment, and for presence and use of green spaces: 0.14 [0.02-1.00] vs. no green spaces). FDep and TRAP did not show any association with overweight/obesity.

**Conclusion:** These findings show beneficial effects of high walkability neighbourhood and attending green spaces on overweight and obesity in adolescents. These results highlight the necessity of effective urban planning to contribute to a healthy environment.

### Climate Change and Preterm Births. A Multicity Study, Chile 2010 – 2018.

Nicolás Valdés<sup>1</sup>, Magdalena Gil, Héctor Jorquera, Sandra Cortés, Eduardo Undurraga, Aurelio Tobías, Carmen Íñiguez

<sup>1</sup>Pontificia Universidad Católica de Chile

#### Abstract

**Introduction:** Various international studies have linked extreme temperatures to adverse events in perinatal health, highlighting an increased risk of spontaneous abortion, malformations, or preterm birth.

**Objective:** To determine the effect of extreme temperatures on the rise in the incidence of preterm birth in Chile during the years 2010 to 2018.

**Methodology:** A two-stage ecological study of time series was conducted. Secondary birth and temperature data provided by the Department of Statistics and Health Information and the Meteorological Directorate of Chile, spanning the years 1992 to 2018, were utilized. In the first stage, the risk was assessed using nonlinear distributed lag models for the provinces of Santiago, Elqui, Antofagasta, Valparaíso, and Concepción, identifying the risk of extreme episodes. In the second phase, aggregated results were obtained using meta-analytical techniques.

**Results:** During the study period, a total of 6,943,492 births were recorded, of which 66,922 were preterm births (7.1%). The risk of preterm birth exhibited a U-shaped association with temperature, increasing incidence at very cold and warm temperatures. On days when the temperature exceeded the 99th percentile of the distribution, there was a risk increase of 10.2% (95% CI 0.89 – 18.5%).

**Conclusions:** The results demonstrate a higher risk of preterm birth on days with extreme temperatures, emphasizing the need to adopt preventive measures on days with unfavorable forecasts.

### Heat- and Cold Related Mortality Impacts Under Future Scenarios of Climate Change and Urbanization in Switzerland

Evan de Schrijver<sup>1</sup>, Sidharth Sivaraj, Christoph C. Raible, Ana M. Vicedo-Cabrera

<sup>1</sup>Institute of Social and Preventive Medicine (ISPM) and Oeschger Centre for Climate Change Research (OCCR), University of Bern, Bern, Switzerland

#### Abstract

While it is well recognized that urbanization leads to increased temperatures in urban areas, primarily due to the 'Urban Heat Island'

phenomenon, recent epidemiological studies have solely relied on temperature projections to explore future heat- and cold-related mortality impacts. To our knowledge, no study has taken the influence of urbanization into account while projecting future heat-mortality impacts. Our study seeks to address this gap by 1) projecting heat- and cold-related mortality in Switzerland, incorporating future climate and population development models including urbanization models, and 2) dissecting the urbanization-specific contribution to the overall impacts.

We derived age-specific (<75 and ≥75 years) temperature-mortality associations for each Swiss district (1990–2010), through a two-stage time-series analysis. Then utilizing 2km downscaled CMIP5 temperature data we estimated the heat-mortality impacts for different warming targets of 1.5°C, 2.0°C, and 3.0°C using the projected exposure-response association assuming future urbanization levels. We then disentangled the contribution of urbanization on the overall projected heat-mortality impacts for Switzerland at national level and for each district.

We found that the projected heat-related mortality at national level in Switzerland, while taking urbanisation into account, is expected to be 7% higher than that without urbanisation, for 3°C warming under RCP8.5/SSP5. However, the rural regions which are more influenced by urbanization exhibit substantial increases in heat-related mortality for certain districts, potentially increasing heat-related mortality up to 4-fold compared to a non-urbanisation scenario, which could be attributed to the effects of urbanization.

Our findings suggest that current trends in urbanization may amplify the future heat-related mortality in Switzerland, mainly affecting rural areas, emphasizing the need for adaptation measures in view of progressive urbanisation.

### Spatial assessment of the vulnerability to urban heat in cities

*Sujung Lee<sup>1,2</sup>, Moritz Burger, Garyfallos Konstantinoudis, Moritz Gubler, Stefan Brömmimann, Ana Maria Vicedo-Cabrera*  
<sup>1</sup>*Institute of Social and Preventive Medicine (ISPM), University of Bern, Bern, Switzerland;* <sup>2</sup>*Oeschger Center for Climate Change Research (OCCR), University of Bern, Bern, Switzerland*

#### Abstract

Urban development and population growth intensify the Urban Heat Island (UHI) effect, posing health risks. However, understanding spatial vulnerabilities within urban areas is limited. This study in Bern, Switzerland, aims to 1) evaluate demographics and socioeconomic factors contributing to increased UHI exposure and 2) analyse spatial vulnerabilities using a Heat Vulnerability Index (HVI).

We gathered individual-level population and household statistics (2012–2021) from the Swiss Federal Statistical Office. Utilizing high-resolution (50m×50m) urban temperature data, UHI intensity was calculated for each district. Univariate logistic regression models assessed UHI exposure and population characteristics, providing odds ratios (OR) and 95% confidence intervals (CI). The HVI was then developed, focusing on older adults (≥65 years), females, and low socio-economic status, with overall percentile ranks calculated.

Single individuals had a 60% higher odds ratio (OR:1.60; CI:1.59–1.62) than married individuals. Those aged 26–44 had higher odds (1.71; 1.70–1.74) than those aged 0–17. Higher socio-economic status increased UHI exposure odds (medium:2.32; 2.30–2.35, high:1.66; 1.64–1.67) compared to the lowest group. In the work environment, employees in large-size companies (≥250 employees) faced higher risk (1.85; 0.77–6.05) than micro-size (<10). Public company employees (1.17; 0.88–1.62) also had a higher risk than those in private companies. Results showed diverse vulnerability patterns among districts. In the city centre, despite a moderate HVI, UHI intensity exceeded surrounding areas, heightening vulnerability. Conversely, the western part had lower UHI levels but presented a high HVI due to the lowest socio-economic status.

Preliminary results emphasize socioeconomic and demographic considerations in UHI-related public health assessment. The next step involves evaluating UHI-related mortality risk through a case-crossover study design with Bayesian regression models.

### Characterisation of chemical indoor pollutants in British dwellings

*Thiphonie Riveron<sup>1</sup>, Anna Hansell, Rebecca Cordell*  
<sup>1</sup>*Centre for Environmental Health and Suitability, University of Leicester, University Road, Leicester, LE1 7RH, United Kingdom*

#### Abstract

People spend around 90% of their time indoors, which can lead to long-term exposure to poor air quality and be associated with negative health effects. In this pilot study, indoor air was sampled to quantify volatile organic compounds (VOCs) and fine particulate matter (PM<sub>2.5</sub>) in 32 dwellings between November and March 2021/2022 and 2022/2023. During a one-week period, active sampling sensors were installed in participants' home. Participants were asked to complete a house questionnaire to help identify pollutant sources.

Benzene, formaldehyde and trichloroethylene, all classified as carcinogenic, and ethylbenzene, classified as possibly carcinogenic, were detected in all the dwellings. Limonene and  $\alpha$ -pinene, both known for their acute effects on human health, were detected at least in 90% of the dwellings. Formaldehyde was the only VOC measured above the United Kingdom Health Security Agency indoor air guideline (10  $\mu\text{g}\text{m}^{-3}$ ) in all of the dwellings. The dwellings located in urban areas had significantly higher concentrations of total VOC (TVOC) (P=0.0370), benzene, toluene and xylenes (P=0.0270) compared to the dwellings in rural areas. In addition, the flats had significantly higher concentration of TVOC (P=0.0331) compared to the semi-detached houses. No other associations were found between the VOC concentrations and the house characteristics. The mean weekly PM<sub>2.5</sub> concentrations were below the 2021 WHO Air Quality guidelines (5  $\mu\text{g}\text{m}^{-3}$ ) in 6 dwellings. For the rest of the dwellings, the concentrations ranged from 5.2  $\mu\text{g}\text{m}^{-3}$  to 42.1  $\mu\text{g}\text{m}^{-3}$ . The only home where incense burning was recorded experienced some of the highest PM<sub>2.5</sub> concentrations. No other association was observed between the home characteristics and PM<sub>2.5</sub> concentrations.

To conclude, several indoor pollutants of concern for their impact on human health were detected in the majority of the dwellings, some of them at concentrations above the national and international guidelines.

### CARDIOVASCULAR: NEW EVIDENCE ON EFFECTS OF ENVIRONMENTAL EXPOSURES ON CARDIOVASCULAR HEALTH

#### Association between short-term pollen exposure and blood pressure in adults: a repeated-measures study

*Alexandra Bürgler<sup>1,2</sup>, Axel Luyten, Sarah Glick, Marek Kwiatkowski, Regula Gebrigg, Minaya Beigi, Karin Hartmann, Marloes Eeftens*  
<sup>1</sup>*Swiss Tropical and Public Health Institute, Allschwil, Switzerland;* <sup>2</sup>*University of Basel, Basel, Switzerland*

#### Abstract

**Introduction:** Recent studies have related high pollen concentrations to increased cardiovascular mortality and morbidity, yet very little research concerns pre-clinical cardiovascular health, including effects on blood pressure (BP). The EPOCHAL panel study investigated the exposure-response relationship between ambient pollen exposure and systolic and diastolic BP in adults.

**Methods:** BP was measured in 302 adults with and in 94 without pollen allergy during the pollen season, on approximately 16 days per person (6305 observations). Experienced individually-relevant pollen exposure (IPE) in the 96 hours prior to each BP measurement was calculated considering sensitization towards seven highly allergenic pollen and ambient pollen concentrations. Generalized additive mixed models

were used to study the association between mean IPE in the last 96 hours and BP, adjusting for individual and environmental time-varying covariates. Effect modification by pollen allergy status, sex and BMI was evaluated.

**Results:** Positive non-linear associations between IPE and both systolic and diastolic BP were found in the allergic but not in the non-allergic group. BP increased sharply for exposures from zero to 60/80 pollen/m<sup>3</sup> (diastolic/systolic BP), followed by a tempered further increase at higher concentrations. Increases of 1.79 mmHg [95% CI: 0.65– 2.93] in systolic and 1.34 mmHg [0.45 – 2.23] in diastolic BP were associated with 96-hour average pollen exposure of 400 grains/m<sup>3</sup>, compared to no exposure. Obesity (4.91 mmHg) and female sex (2.18 mmHg) were associated with larger BP increases.

**Discussion:** The finding that short-term pollen concentration is associated with increased systolic and diastolic BP in persons with pollen allergy strengthens the evidence that pollen may cause systemic health effects and trigger cardiovascular events.

### The casual architecture of effects of noise on cardiometabolic health: A Structural Equation Modelling Analysis

Danielle Vienneau<sup>1,2</sup>, Fabian Schwendinger, Arno Schmidt-Trucksäss, Martin Röösli

<sup>1</sup>Swiss TPH (Swiss Tropical and Public Health Institute), Allschwil, Switzerland; <sup>2</sup>University of Basel, Basel, Switzerland

#### Abstract

**Introduction:** Transportation noise is known to increase the risk for multiple cardiometabolic diseases. However, the complex relationship between different noise sources, sleep, metabolic and cardiovascular risk factors is still not well understood.

**Methods:** We used data from the cross-sectional COMplete-Health Study, which includes a comprehensive cardiometabolic assessment and accelerometer-based sleep monitoring from 527 healthy adults living in the Basel Area aged between 20 and 89 years. Outcome data were standardized for sex and age before analysis. Road traffic, aircraft and railway noise were modelled at the participants' home addresses. For each noise source, we tested the following conceptual model using Structural Equation Modelling (SEM): Noise was assumed to affect the two latent constructs metabolic risk (MR, defined by Waist-to-Hip Ratio and HDL-Cholesterol) and cardiovascular risk (CVR, defined by systolic blood pressure and pulse wave velocity) directly, as well as indirectly via sleep efficiency. Additionally, MR was assumed to influence CVR.

**Results:** The SEM showed very good fit of the conceptual models. In all models, we saw strong, significant effects of MR on CVR ( $\beta > 0.4$ ). Further, road traffic noise directly increased CVR, while negligible effects on sleep efficiency or MR were observed. Railway noise mainly affected sleep efficiency, with a suggestive direct effect on MR but negligible effect on CVR. Exposure to aircraft noise was too rare for a meaningful analysis.

**Discussion:** While road traffic noise acts directly on cardiovascular risk, railway noise seems to primarily affect metabolic risk through sleep disturbance, which ultimately also affects cardiovascular risk. This distinct pattern may be explained by differences in diurnal variation and the eventfulness of the two noise sources. These insights are important to inform effective measures to protect populations from harmful noise exposure.

### Independent and joint effects of long-term exposure to ambient air pollution and transportation noise on MI

Nguyen Thi Khanh Huyen<sup>1</sup>, Massimo Stafoggia, Mette Sørensen, Zorana Jovanovic Andersen, Leo Stockfelt, Göran Pershagen, Annika Rosengren, Anna Oudin, Andrei Pyko, Agneta Åkesson, Petter Ljungman, Jeroen de Bont

<sup>1</sup>Institute of Environmental Medicine (IMM), Karolinska Institutet, Sweden

#### Abstract

**Objective:** Air pollution and traffic noise often coexist posing myocardial infarction (MI) risks. Most studies assess them separately, neglecting their joint impact. This study investigated the individual and joint effects of ambient air pollution and traffic noise on MI events in Sweden.

**Material and Methods:** We used data on 21,527 adults in Stockholm and followed them from 1992 to 2017 until incident MI, death, migration, loss of follow-up or study end. We ascertained cases of MI from the Swedish Patient and Cause of death registries based on the International Classification of Diseases codes. We modelled particulate matter <2.5 µm (PM<sub>2.5</sub>) and nitrogen oxides (NO<sub>x</sub>) exposures using dispersion models and road and rail traffic noise using a Nordic prediction method. Mean exposure levels at residential addresses 5 years before the occurrence were considered long-term exposure. We estimated single exposures effects using Cox proportional hazards models adjusting for lifestyle and socioeconomic factors and joint associations by modelling product terms of the two exposures.

**Results:** 1342 MI cases were observed. Individually, a 15 dB (Lden LAeq 24h) increment of railway noise was associated with increasing MI incidence (hazard ratio (HR): 1.07 [95% confidence interval (CI): 1.00, 1.16] while each 1.3 µg/m<sup>3</sup> increment of PM<sub>2.5</sub> was not associated (HR: 0.88 [0.81, 0.96]). Jointly, a 15 dB Lden increment of railway noise increased MI incidence between 1.02 [0.84, 1.32] and 2.25 [0.28, 18.00], when PM<sub>2.5</sub> was equal to 5 and 40 µg/m<sup>3</sup>, respectively. We did not find effects of PM<sub>2.5</sub> at specific noise levels. We found a similar trend for the joint effects of PM<sub>2.5</sub> vs Road traffic noise.

**Conclusion:** We found effects of traffic noise, both independent and joint effects, that were increased by high air pollution levels. We discovered no air pollution effects independently or jointly. Results from 8 more Swedish and Danish cohorts will be presented at the conference.

### Association between chronic exposure to ambient PM<sub>2.5</sub> and cardiovascular events: a UK Biobank study

Jennifer Quint<sup>1</sup>, Pierre Masselot, Malcolm Mistry, Arturo De la Cruz, Lina Madaniyazi, Chris Fook Sheng Ng, Antonio Gasparini

<sup>1</sup>Nagasaki University, School of Tropical Medicine and Global Health

#### Abstract

**Introduction:** The link between long-term exposure to air pollution and risk of cardiovascular events is evident. However, few studies investigated the shape of the associations at low levels of exposure. Moreover, gaps still exist in the literature regarding the identification of the most important time frames of effect. Here we assessed long-term associations between PM<sub>2.5</sub> at low concentrations and multiple cardiovascular endpoints.

**Methods:** Using data on adults (aged > 40) from the UK Biobank cohort we investigated the associations between between 1-year, 3-year and 5-year time-varying averages and incident hospital inpatient admissions for major adverse cardiovascular events (MACE), acute myocardial infarction (MI), cerebrovascular diseases, chronic ischaemic heart disease, heart failure, arrhythmias, atrial fibrillation and cardiac arrest. We also investigated outcomes subtypes. We fitted Cox proportional hazard regression models applying strong control for confounding both at individual- and area-level. Finally, we assessed the shape of exposure-response function to assess effects at low levels of exposure.

**Results:** We analysed data for 377,944 study participants after exclusion of prevalent subjects. The average follow-up (2006-2021) was 12.3 years. Among all the outcomes, we detected 19,353 cases of MACE, 6,562 of acute MI and 9,463 of cerebrovascular diseases. For the 5-year exposure frame we detected positive hazard ratios (for 5 µg/m<sup>3</sup> increase) for MACE, cerebrovascular disease, heart failure and arrhythmias-related outcomes. We did not find any association with acute MI and CIHD. The magnitude of associations were sensitive to the width of the exposure

windows. The non-linear exposure-response associations suggested risk may be stronger and at levels lower than 12 µg/m<sup>3</sup>.

**Conclusions:** We found positive associations between long-term PM<sub>2.5</sub> and multiple cardiovascular outcomes for different exposure windows.

### Long-term exposure to air pollution, road traffic noise and greenness, and incidence of myocardial infarction in women

Lara Stucki<sup>1</sup>, Emilie Helte, Östen Axelsson, Jenny Selander, Mare Löhmus, Agneta Åkesson, Charlotta Eriksson

<sup>1</sup>Institute of Environmental Medicine, Karolinska Institutet, Nobels väg 13, 171 77 Stockholm, Sweden

#### Abstract

**Introduction:** Emerging evidence shows that long-term exposure to air pollution, road traffic noise, and greenness can each be associated with cardiovascular disease, but only few studies combined these exposures. In this study, we assessed associations of combined environmental exposures and incidence of myocardial infarction (MI).

**Methods:** In a population-based cohort of 20,407 women in Sweden we estimated a five-year moving average of residential exposure to air pollution (PM<sub>2.5</sub>, PM<sub>10</sub>, and NO<sub>2</sub>, Gaussian dispersion model), road traffic noise (dB Lden, Nordic Prediction Method), and greenness using the normalized difference vegetation index (NDVI in 500 m radial buffers), respectively, for each year from 1998 to 2017 including address history. We used Cox proportional hazards regressions to estimate hazard ratios (HR) and 95% confidence intervals (95% CI) of MI per interquartile range (IQR) increase, adjusting for annual time-varying covariates. We also investigated interactions between the exposures and explored potential vulnerable groups.

**Results:** In the multi-exposure models, greenness was inversely associated with MI risk (HR: 0.89, 95% CI: 0.80-0.99) per IQR NDVI increase. Further, we observed a tendency to an increased MI risk in association with PM<sub>2.5</sub> (HR 1.07; 95% CI 0.93-1.23) in study participants with low education (HR 1.30; 95% CI 1.06-1.58) but not in those with higher education (HR 0.87; 95% CI 0.72-1.06). No associations were detected between MI and PM<sub>10</sub> (HR 0.94; 95% CI 0.82-1.07), NO<sub>2</sub> (HR 0.97; 95% CI 0.91-1.04) or road traffic noise (Lden) (HR 0.96; 95% CI 0.88-1.04). We observed no clear interaction patterns between the exposures.

**Conclusion:** Over a 20-year follow-up period we found a protective association between residential greenness and the risk of MI in women in multi-exposure models. Furthermore, there was a tendency to an increased risk of MI in relation to PM<sub>2.5</sub> in study participants with low education.

### Associations between residential greenspace and hypertension: a cross-sectional analysis in the French Constances cohort

Lucia Rodriguez-Loureiro<sup>1</sup>, Emeline Lequy, Katie Lobodzinski, Danielle Vienmeau, Kees de Hoogh, Marie Zins, Marcel Goldberg, Mohammad Javad Zare-Sakbvidi, Tarik Benmarhnia, Jean-Philippe Empana, Bénédicte Jacquemin

<sup>1</sup>Research Institute for Environmental and Occupational Health (Irset-INSERM-EHESP UMR\_S 1085), Rennes, France

#### Abstract

**Background:** This study aimed to assess the associations between long-term exposure to residential greenspace and hypertension (HT) according to urbanicity using an objective HT definition, as most previous studies relied on self-reported outcome information.

**Methods:** We used data from the French nationwide Constances cohort, that has recruited 205,000 participants aged 18-69 in France between 2012-2019. We excluded participants living in rural areas. HT at inclusion was defined as: measured systolic/diastolic blood pressure

≥140/90 mmHg, and/or physician-diagnosed HT, and/or electronic records of antihypertensive drug dispensation. Residential greenspace was assessed with two indicators: surrounding greenness, ie the Normalized Difference Vegetation Index (NDVI) within 300-1,000m buffers; and normalized distance to green spaces (from 0 the farthest to 1 the closest), ie, the approximate Euclidean distance to agricultural and forest green spaces, separately, using Corine Land Cover. Urbanicity was classified as suburban, cities, and Paris. We fitted Poisson regression models with robust variance to assess the associations between residential greenspace and HT by urbanicity to obtain prevalence ratios (PR) and their 95% confidence intervals per 0.1-unit increase in residential greenspace indicators.

**Results:** From 117,225 participants living in urban areas (mean age 46; 52% women), 28 % (n=32,680) had HT at inclusion. After adjustment for socioeconomic factors and alcohol and tobacco use, we found slightly greater HT prevalence with an increased residential greenspace exposure in cities (eg, higher surrounding greenness within 300m: PR 1.04, 95%CI:1.03-1.06; greater proximity to forests: PR 1.02, 95%CI:1.01-1.04). Associations close to the null were found in Paris and suburban areas.

**Conclusions:** We observed no beneficial associations between residential greenspace and HT prevalence. Further analyses are needed to explore potential selection bias in the study population.

### OMIC: EFFECTS OF ENVIRONMENTAL EXPOSURES ON METHYLOME, PROTEOME AND MICROBIOME

#### Epigenetic footprint of maternal tobacco smoking: replication of differentially methylated CpGs and regions in placenta

Chloé Masdoumier<sup>1</sup>, Lucile Broséus, Jorg Tost, Barbara Heude, Aurélie Nakamura, Johanna Lepeule

<sup>1</sup>Université Grenoble Alpes, Inserm, CNRS, IAB, Site Santé, Allée des Alpes, 38700, La Tronche, France

#### Abstract

**Introduction:** Several studies have described the effects of maternal smoking during pregnancy on placental DNA methylation (DNAm), but replication studies remain scarce despite their huge scientific interest. **Methods:** Following an exploratory study using the Illumina450 array in the EDEN cohort, we performed a replication study of maternal smoking associated CpGs and regions in 341 new placenta samples (85 smokers, 219 non-smokers, 37 former smokers) of the EDEN cohort using the EPIC array. The profile of CpGs and regions was assessed based on the persistence or reversibility of associations in smokers upon smoking cessation.

**Results:** We replicated 38% of probes and 9% of regions, providing robust evidence of effects of prenatal smoke exposure on methylation patterns of these loci (e.g. including the imprinted genes FASTK and BLCAP). Most of the replicated findings were reversible targets, whereas persistence of association in former smokers remained scarce and sometimes inconsistent with previous findings, probably resulting from the low number of former smokers in our study sample. An additional exploratory epigenome-wide association analysis identified 733 novel probes and 75 regions, including respectively 18% and 30% reversible sites, and no persistent loci. Besides, using paternal smoking as a negative control led to a drastic drop in significant associations, suggesting intra-uterine effects of cigarette smoking on placental DNAm.

**Discussion:** Our results bolster existing evidence of specific smoking-sensitive loci in the placental epigenome landscape, and suggest that most smoking associated changes in placental DNAm are reversible upon maternal smoking cessation. This replication study also demonstrates the importance of reproducible work in omic investigations, to provide a more in-depth and robust understanding of the effects of environmental exposures on health biomarkers.

### **Prenatal ambient air pollution alters protein expression profiles in newborns: an ENVIRONAGE birth cohort study**

Liesje Engelen<sup>1</sup>, Dries Martens, Tim Nawrot

<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Agoralaan Building D, 3590 Diepenbeek, Belgium

#### **Abstract**

**Objective:** Proteins play an integral role in human biology. They are involved in many biological processes (e.g., antibodies, enzymes) and are indicators of phenotype in health and disease. In this study we investigate the association between ambient prenatal air pollution exposure and cord blood proteomic signatures. In addition, we aim to map altered proteins to specific pathways to gain insight into the biological mechanisms.

**Methods:** In cord blood samples from 376 newborns enrolled in the ENVIRONAGE (ENVIRONMENTAL influence ON Early AGEing) birth cohort, we measured the Olink® Explore 384 Inflammation II panel with the proximity extension assay (PEA). We used a high spatial temporal air pollution model to obtain residential air pollutants (PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, black carbon) over different time periods of pregnancy (entire pregnancy, trimesters 1-3). Finally, we applied general linear regression models to regress ambient air pollution and cord blood protein expression levels and we performed functional overrepresentation analysis.

**Results:** We demonstrate that a 5 µg/m<sup>3</sup> increment in NO<sub>2</sub> exposure during the entire pregnancy and the second trimester is associated with a significant higher GIMAP7 cord blood level up to 17.25% (95% CI: 8.75% to 25.91%, *p* = 0.026) and 12.94% (95% CI: 6.43% to 19.53%, *p* = 0.037), respectively. Additionally, the AFM cord blood level in boys was 13.88% lower (95% CI: -19.99% to -69.41%, *p* = 0.007) for each 5 µg/m<sup>3</sup> increment in PM<sub>2.5</sub> exposure during the second trimester. We were able to identify twelve significant pathways (*p* < 0.05), the majority related to genetic and environmental information processing (e.g., FOXO-mediated transcription and transcriptional regulation by TP53).

**Conclusion:** We showed that air pollution exposure affects the proteome from birth onwards and that P53 related pathways play a central role.

### **The impact of environmental exposures on DNA methylation in the expanse project**

Megi Vogli<sup>1</sup>, Ayoung Jeong, Zhebin Yu, Judith M. Vonk, Petr Gregor, Dorina Ibi, Jaanika Kronberg, Alessandro Gialluisi, Marta Cirach, Payam Dadvand, Ulrike Gehring, Kees de Hoogh, Kathrin Wolf, Melanie Waldenberger, Pavel Čupr, Erik Melén, Gerard H. Koppelman, Regina Pickford, Marie Standl, Jelle Vlaanderen, Roel Vermeulen, Nicole Probst-Hensch, Annette Peters

<sup>1</sup>Institute of Epidemiology, Helmholtz Zentrum München, German Research Center for Environmental Health, 85764 Neuherberg, Germany

#### **Abstract**

**Objective:** Living in an urban environment exposes the population to a mix of environmental and social factors, known as the Urban Exposome. These factors can have both protective and harmful effects on health. However, the mechanisms underlying these effects are not yet fully understood. Environmental factors can influence DNA methylation. We therefore hypothesize that linking an urban exposome approach with epigenome-wide changes can contribute to understanding the effects of the urban exposome on human health.

**Methods:** We conducted an inverse variance-weighted meta-analysis of epigenome-wide association studies (linear regression - exposures as independent and blood methylation level as dependent variable) of 9 European cohorts within the EXPANSE project. DNA methylation was assessed using Illumina Infinium Methylation 450K or MethylationEPIC arrays, covering 450/850K methylation sites, respectively. The urban exposures estimated at participants' home addresses included the annual exposures to PM<sub>2.5</sub>, NO<sub>2</sub>, and O<sub>3</sub> (summer season), light at

night (buffer 500m), and Modified Soil Adjusted Vegetation Index (buffer 500m).

**Results:** The total study population included 1318 children (4-8 years old), 970 adolescents (16 years old), and 4563 adults (28-87 years old). Children showed no significant associations between the investigated exposures and methylation levels. Adolescents exhibited positive associations between PM<sub>2.5</sub> and one CpG-site and between O<sub>3</sub> and two CpG-sites after Bonferroni correction. Adults showed a positive association between NO<sub>2</sub> and one CpG-site. These identified CpG sites were within different genetic regions.

**Conclusions:** Out of the five exposures considered, two measures of air pollution showed associations with blood DNA methylation, which appear to be age specific. Next, we will incorporate additional cohorts and exposures from the EXPANSE project, to further investigate common patterns in methylation data which will be presented at the meeting.

### **Understanding Irritable Bowel Syndrome through omics technologies: from endotypes to disease response**

Robert van Vorstenbosch<sup>1</sup>, Ekaterina Esenkova, Marlijne de Graaf, Danielle Pachen, Daisy Jonkers, Daniel Keszthelyi, Frederik-Jan van Schooten, Zlatan Mujagic, Agnieszka Smolinska  
<sup>1</sup>Department of Pharmacology and Toxicology, Maastricht University, Maastricht, the Netherlands

#### **Abstract**

**Introduction:** Irritable Bowel Syndrome (IBS) is a heterogeneous gastrointestinal disorder characterized by abdominal pain and altered bowel habits (i.e. constipation and diarrhea). IBS patients are subgrouped using Rome-III criteria: IBS-diarrhea, IBS-constipation, IBS-mixed or IBS-unknown. This lacks biochemical basis and therapeutically carries little value. The interplay of diet, mental health, and the gut microbiome is generally thought to play a triggering role towards symptoms, although the exact interplay differs between patients. We hypothesize it is quantifiable using metabolomics. This study explored omics technologies to aid better informed subgrouping of IBS patients and to non-invasively detect signaling markers for symptom severity.

**Methods:** Fecal metabolic profiles as well as microbiota profiles were obtained from the Maastricht IBS cohort (n=164 IBS; n=143 healthy control). In parallel, dietary and clinical information on all participants was obtained. Through Random Forests markers for IBS for both omics platforms were established. Bio-based endotypes for IBS were calculated based on the relevant microbiome profiles using isolation forests and affinity propagation. Next, per subgroup kernel canonical correlation analysis was performed to calculate multivariate correlations between symptom severity, behavioral factors, and metabolites.

**Results:** Severity of abdominal pain, reflux, diarrhea, indigestion, depression and anxiety correlated significantly to behavioral factors. Bio-based subgrouping showed stronger associations in comparison to Rome-III. Metabolic profiles significantly correlated to symptom severity and microbiota profiles, although differences between subgroups were more subtle.

**Conclusion:** This study proposes a bio-based subgrouping of IBS patients. Moreover, symptom severity significantly correlates to fecal metabolic profiles. These results open up the way to personalized driven therapy for IBS-patients, but should be validated.

### **Skin microbiome alpha diversity of young children in association with surrounding green space**

Thessa Van Pee<sup>1</sup>, Hanne Croons, Doris Vandeputte, Esmee Bijmens, Janneke Hogervorst, Tim S. Nawrot

<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Agoralaan Building D, 3590 Diepenbeek, Belgium

#### **Abstract**

The skin microbiome plays a crucial role in maintaining skin health by influencing immune responses and protecting against pathogens.

Previous research showed that green space was associated with e.g., a lower risk of infantile atopic dermatitis. To date, the relationship between early-life exposure to green space and the skin microbiome in young children remains unstudied.

403 children aged 4 to 12 from the birth cohort ENVIRONAGE participated in this study. After wetting Floq swabs with a drop of sterile saline, the swab was rubbed on the forehead for a minute to collect skin bacteria. We performed bacterial 16S rRNA gene sequencing via 16S Pacbio HiFi to calculate alpha diversity indices (observed richness, Chao1 richness, ACE richness, species evenness, Shannon diversity, and Simpson diversity). Green space (total green, high green, and low green) was estimated in several radius distances (100 m to 2000 m) around their current residence and school based on high-resolution land cover data. We used generalized linear models to examine the associations between green space and alpha diversity indices. Results are expressed as the change in alpha diversity per interquartile range increment in green space.

In childhood, positive associations were found between surrounding total green and high green and all three skin microbial richness indices: observed richness, Chao1 richness, and ACE richness in multiple radius distances. In general, stronger associations were found in smaller radius distances: e.g., each interquartile range (IQR) increment in total green in a 300 m radius was associated with an increase of 17.01 ( $p = 0.01$ ) in observed richness, while each IQR in total green in a 2000 m radius was associated with an increase of 13.64 ( $p = 0.08$ ) in observed richness.

We found that total green and high green in different radius distances were positively associated with skin microbial richness in young children.

### Short term exposure to low ambient temperature and inflammation-related proteins among young Swedish adults

Zhebin Yu<sup>1</sup>, Anna Bergström, Simon Kebede Merid, Maura Kere, Sophia Björkander, Susanna Klevebro, Annika Bendes, Niclas Roxhed, Jochen Schwenk, Shizhen He, Inger Kull, Anne-Sophie Merritt, Kristina Eneroth, Massimo Stafoggia, Petter Ljungman, Olena Gruzjeva, Erik Melén

<sup>1</sup>Institute of Environmental Medicine, Karolinska Institute, Stockholm, Sweden

#### Abstract

**Objective:** The mechanisms of adverse effects from exposure to low ambient temperature remain understudied. We aimed to explore associations of short-term exposure to low ambient temperature with inflammation-related proteins among young Swedish adults.

**Material and Methods:** From August 2020 to February 2022, participants in the BAMSE (Children, Allergy, Environment, Stockholm, Epidemiology [in Swedish]) cohort were followed up with three waves of questionnaires and blood sampling via filter papers. Levels of inflammation-related proteins were measured in eluted blood using the Olink Explore 384 inflammation panel. Daily ambient temperature and air pollution levels were assigned to each individual in the days preceding the date of blood collection obtained from a monitor station in central Stockholm. Mixed-effect models with individual-specific random intercepts were used to estimate the association of low temperature with proteins adjusting for age, season, weekday, infection and vaccine to the COVID-19. Interaction of low temperature by air pollution levels was explored.

**Results:** A total of 798 participants (mean age 25.3 at wave 1) with three repeated measures of proteins were included. A decrease in daily mean temperature from 50th (8.69 °C) to the 1st (-7.8 °C) percentile of the cumulative lags of 0-4 days was significantly associated with 32 out of 365 proteins (false discovery rate <0.05), such as NFATC1 (Nuclear factor of activated T-cells, cytoplasmic 1), PRDX5 (Peroxiredoxin-5,

mitochondrial) and IL-18 (Interleukin-18). Results remained similar using lag 0-1 days. Stronger effects of low temperature were estimated for people exposed to higher levels of air pollution (PM2.5 and NO2).

**Conclusion:** Short-term exposure to low temperature was associated with protein inflammatory profiles among young adults. Our study also suggested potential effect modification of low temperature by air pollution on inflammatory profiles.

### CANCER: NEW EVIDENCE ON EFFECTS OF ENVIRONMENTAL EXPOSURES ON CANCER RISK

#### Perinatal exposure to traffic-related air pollution and risk of childhood leukemia in France

Aurélien Danjou<sup>1</sup>, Antoine Lafontaine, Bénédicte Jacquemin, Danielle Vienneau, Kees De Hoogh, Jacqueline Clavel, Stéphanie Goujon

<sup>1</sup>Inserm UMR 1153 Epidemiology of Childhood and Adolescent Cancer, Centre for Research in Epidemiology and Statistics (CRESS), Paris Cité University, Villejuif, France

#### Abstract

**Introduction:** Traffic-related air pollution is suspected of increasing the risk of childhood acute leukemia (AL). We tested this hypothesis in individuals across metropolitan France, targeting the perinatal exposure window.

**Methods:** The GEOCAP case-control study includes 581 cases of acute lymphoblastic leukemia (ALL) and 136 cases of acute myeloid leukemia (AML), born and diagnosed between 2010 and 2015 (French national registry of childhood cancer), and 11,908 controls representative of births residing in metropolitan France over this period. Exposures included major roads length in 500 m buffers, and annual mean concentrations of nitrogen dioxide (NO2), fine particulate matter (PM2.5) and black carbon (BC, constituent of PM2.5) assessed by land use regression models, estimated at the geocoded residential addresses at birth. Odds ratios (OR) and 95% confidence intervals (CI) were estimated for ALL and AML using polytomous logistic regression models. Additional analyses were carried out: by stratifying on the degree of urbanization; with restrictions to the best geocoded addresses; and adjusting for potential confounding factors.

**Results:** Positive associations were observed between risk of AL and PM2.5 concentrations (OR ALL=1.14, 95%CI=1.08-1.20 and OR AML=1.12, 95%CI=1.00-1.25 for an increment of 2 µg/m3 (interquartile)). An increase in AML risk was observed for the highest levels of NO2, although not statistically significant (OR=1.38, 95%CI=0.92-2.10 for the third versus first tertile of exposure). The risk of ALL was associated with BC in rural and less populated urban areas (OR=1.90, 95%CI=1.22-2.97 and OR=1.58, 95%CI=1.16-2.17 for per 0.5 µg/m3, respectively), but not in the overall population. There was no association with the length of major roads. Results were consistent in all the additional analyses.

**Discussion:** The results support a role of perinatal exposure to air pollution in the risk of childhood AL.

#### Occupational exposures and risk of head and neck cancers in the ICARE study

Lisa Leung<sup>1,2</sup>, Pascal Guénel, Danièle Luce, Loredana Radoi  
<sup>1</sup>Center for Research in Epidemiology and Population Health (CESP), Team Exposome and Heredity, U1018 Inserm, University Paris-Saclay, Institut Gustave Roussy, Villejuif, France; <sup>2</sup>Université de Montréal Hospital Research Centre (CRCHUM) and Université de Montréal School of Public Health, Montreal, Quebec, Canada

#### Abstract

**Introduction:** While tobacco and alcohol consumption are the main risk factors for head and neck (HN) cancers, the epidemiologic evidence on occupational risk factors remains limited as past studies had few

cases, lacked adequate adjustment for confounders, and assessed few agents. This work explored the association between several occupational exposures and HN cancer risk.

**Methods:** We used data from a population-based case-control study conducted in 10 geographical areas in France. Information on sociodemographic characteristics, tobacco and alcohol consumption, and lifetime work history was available for 2,113 incident HN cases and 3,514 controls. Participants' jobs were coded by trained coders and linked to the Canadian job-exposure matrix to generate exposure level estimates to many agents. The relationship between ever and cumulative exposure to each of the 41 most prevalent agents and HN cancer risk was assessed. Odds ratios and 95% confidence intervals (OR (95% CI)) for associations with HN cancer risk were estimated using logistic regression, adjusting for smoking, alcohol consumption and other covariates.

**Results:** Elevated ORs were observed for ever exposure to crystalline silica (1.31 (1.11-1.56)), formaldehyde (1.21 (1.01-1.44)), organic solvents (1.24 (1.06-1.44)), and mononuclear aromatic hydrocarbons (1.37 (1.16-1.60)). Positive associations with ORs above 1.30 were seen for participants in the highest tertile of cumulative exposure vs. unexposed for metallic dust, crystalline silica, aluminum, calcium sulphate, carbon monoxide, metal oxide fumes, other pyrolysis fumes, other paints/varnishes, and iron. In subsite analyses, ever exposure to crystalline silica, nitrogen oxides, mononuclear aromatic hydrocarbons, and welding fumes were more strongly associated with oral cavity cancer.

**Discussion:** Our results support the role of several occupational agents, which are probable or known carcinogens for other cancer sites, in the development of HN cancers.

### Residential proximity to vines and childhood cancer risk in mainland France: GEOCAP case-control study, 2006-2013

Danielle Avounou<sup>1</sup>, Matthieu Mancini, Perrine de Crouy-Chanel, Laurence Guldner, Jacqueline Clavel, Stéphanie Goujon

<sup>1</sup>Inserm UMR1153, Epidemiology of Childhood and Adolescent Cancers (EPICEA) team, Université Paris Cité and Université Sorbonne Paris Nord, Inserm, INRAE, Center for Research in Epidemiology and Statistics (CRESS), Paris, France

#### Abstract

**Introduction:** Several epidemiological studies suggest a link between household pesticide use, parental occupational exposure to pesticides and the risk of childhood cancer. The literature on environmental exposure to agricultural pesticides is however more limited. The objective of the study was to evaluate the risk of acute leukemia (AL) and embryonal tumours (ET) in children living close to vines, a crop subject to intensive pesticide use.

**Methods:** The study is part of the French national registry-based GEOCAP program. Over 2006-2013 period, we included 3,711 AL cases and 2,761 ET cases (neuroblastoma, retinoblastoma, Wilms tumour and rhabdomyosarcoma) under the age of 15 years, and 40,196 controls representative of the same age population. The presence and density of vines within 1,000 m of the geocoded addresses of residence were evaluated by combining three data sources in a geographic information system (GIS): Corine land cover, graphic parcel register, and information from BD TOPO® about vines and orchards. We estimated odds ratios (ORs) and 95% confidence intervals using unconditional logistic regression models adjusted for age and we carried out several sensitivity analyses taking into account geocoding uncertainty, density of other crops and potential demographic and environmental confounders.

**Results:** About 10% of the controls lived within 1 km of vines, with regional variations ranging from <1% to 38%. We observed a 5% increase in the risk of lymphoblastic AL (ALL) and neuroblastoma for a 10% increase in vines density (OR=1.05 [1.00-1.09] and OR=1.05 [0.98-1.13], respectively), with a regional heterogeneity.

No association was observed with retinoblastoma, Wilms tumor or rhabdomyosarcoma.

**Conclusion:** Based on objective indicators built using GIS tools, we evidenced an increase in ALL and neuroblastoma risk in children living near vines, suggesting a role of residential exposure to agricultural pesticides, which requires further investigation.

### Pesticides and risk of pancreatic adenocarcinoma in France: a nationwide spatio-temporal ecological study over 10 years

Mathias Brugel<sup>1,2,3</sup>, Victoria Gauthier, Olivier Bouché, Florent Occelli, Marta Blangiardo, Michael Genin

<sup>1</sup>University of Lille, CHU Lille, ULR 2694 - METRICS: Évaluation des technologies de santé et des pratiques médicales, F-59000 Lille, France; <sup>2</sup>MRC Centre for Environment & Health, Department of Epidemiology and Biostatistics, School of Public Health, Imperial College London, London, United Kingdom; <sup>3</sup>Digestive Oncology, Hepatology and Gastroenterology Department, Centre Hospitalier de la Côte Basque, Bayonne, France

#### Abstract

**Introduction:** Pancreatic adenocarcinoma (PA) is the leading cause of cancer-related mortality with an increasing incidence. Pesticides are substances used to protect crops, mainly used in agriculture. The association between PA and pesticides remains inconclusive. The aims were i) to assess the spatio-temporal distribution of the PA incidence in the French general population between 2011 and 2021, and ii) to determine whether pesticide exposure is associated with the risk of PA.

**Methods:** This study is an ecological regression on 5529 spatial units covering France, between 2011 and 2021. We used a hierarchical Bayesian spatiotemporal Poisson model. The yearly number of cases of PA per spatial unit, age, and sex was extracted from the national medico-administrative database, covering 99 % of the general population. The pesticide exposure index (PEXI) was defined as the ratio quantity of pesticides per agricultural surface for each spatial unit, over the study period. We calculated the PEXI for 9 substances and cumulated pesticides. The model was adjusted on tobacco-related diseases prevalence, healthcare accessibility index and deprivation index.

**Results:** A total of 134102 cases of PA were identified in 5529 spatial units between 2011 and

2021. Areas of higher risk of PA were located around Paris, in central France and on the Mediterranean coast. Pesticide exposure was associated with PA incidence over the study period for cumulated pesticides (RR:1.0140; CI95% [1.0067;1.0214]), sulphur for spraying (RR:1.0132; CI95% [1.0047;1.0218]), mancozeb (RR:1.0107; CI95% [1.0026;1.0164]), and glyphosate (RR:1.0095; CI95% [1.0026;1.0164]).

**Discussion:** This is the first nationwide study to describe PA risk at such a fine spatial scale. The spatial distribution was heterogeneous, generating new hypotheses about environmental PA risk factors. Our model showed an association between pesticide exposure and PA. However, these results need to be supported by further mechanistic evidence.

### Outdoor exposure to artificial light at night and breast cancer risk: A case-control study nested in the E3N Cohort

Nirmala Prajapati<sup>1</sup>, Claire Perrin, Elodie Faure, Pascal Guénel

<sup>1</sup>Université Paris-Saclay, UVSQ, Gustave Roussy, Exposome and Heredity Team, CESP (Center for Research in Epidemiology and Population Health), Inserm, Villejuif, France

#### Abstract

**Introduction:** Light pollution is growing as the newest form of environmental pollution. Experimental and epidemiological studies suggested that exposure to artificial light at night (LAN), especially to blue light, disrupts the circadian rhythm, inhibits melatonin production, and

increases the risk of breast cancer. We assessed the association between exposure to outdoor LAN and breast cancer.

**Methods:** We used the data of 5222 breast cancer cases and 5222 controls from a case-control study nested in a prospective cohort. Exposure to outdoor LAN was assessed using calibrated images from Defense Meteorological Satellite Program (DMSP). LAN exposure at the time of diagnosis was used as main exposure metric. Logistic regression was used to obtain odds ratios (OR) and 95% confidence intervals (CI) for the association, adjusting for sociodemographic, reproductive, and lifestyle-related factors, air pollution and residential greenness.

**Results:** The overall OR for breast cancer per 1 IQR increase in the exposure (261.26 nW/cm<sup>2</sup>/sr) was 1.12 (95% CI: 1.03-1.21). Stratified analyses showed higher ORs in post-menopausal women (OR: 1.11; 95% CI: 1.02-1.20) than in pre-menopausal women. There was an indication of effect modification by urbanization and of a higher association for estrogen receptor positive breast tumor (OR: 1.10; 95% CI: 1.00-1.21).

**Discussion:** Our study found a positive association between exposure to outdoor LAN and breast cancer, supporting the hypothesis of circadian disruption due to LAN and subsequent increase in the breast cancer risk. Strengths of this study include the prospective study design, large sample size, use of calibrated satellite images for outdoor LAN assessment and consideration of a large set of potential confounders including air pollution and residential greenness. Further studies using advanced exposure assessment methods, including measurement of blue light and exposure assessment at the individual level, are required.

### Long-term exposure to air pollution and lung cancer survival in the Danish Nurse Cohort

Sophie MA Effing<sup>1</sup>, Stéphane Tuffier, Jiawei Zhang, Thomas Cole-Hunter, Marie Bergmann, George Maria Napolitano, Rina So, Jørgen Brandt, Matthias Ketzler, Steffen Loft, Youn-Hee Lim, Zorana Jovanovic Andersen

<sup>1</sup>Section of Environmental Health, Department of Public Health, University of Copenhagen, Øster Farimagsgade 5, Building 15, 1 floor, Copenhagen 1014, Denmark

#### Abstract

**Background:** Although the link between air pollution and lung cancer is well established, research regarding the effects of pollution on lung cancer survival is limited, especially in low-exposure settings. We investigated the association of long-term exposure to air pollution with lung cancer survival 5 years post-diagnosis in Denmark.

**Methods:** We analyzed data from 28,731 female nurses in the Danish Nurse Cohort, followed from 1993/1999 until 2020 for lung cancer survival. We estimated residential 5-year moving average concentrations of nitrogen dioxide (NO<sub>2</sub>), ozone (O<sub>3</sub>), particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>), and black carbon (BC) using the THOR/AirGIS modelling system. Time-varying Cox regression models evaluated the associations between these exposures and lung cancer survival. Models were adjusted for socio-economic, lifestyle and area-level factors.

**Results:** Our study found no significant association between the pollutants investigated and lung cancer survival. Hazard ratios (HRs) and 95% confidence intervals for lung cancer incidence associated with exposures to PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, BC, and O<sub>3</sub> were 0.99 (0.71-1.39) per 3.16 µg/m<sup>3</sup>, 0.93 (0.71-1.22) per 3.27 µg/m<sup>3</sup>, 0.99 (0.84-1.17) per 7.67 µg/m<sup>3</sup>, 0.95 (0.82-1.09) per 0.33 µg/m<sup>3</sup>, and 1.04 (0.89-1.22) per 6.02 µg/m<sup>3</sup>, respectively. These findings were robust across various statistical models and sensitivity analyses.

**Conclusions:** We found no association between long-term air pollution exposure and 5-year lung cancer survival in Danish female nurses diagnosed with the disease, contrasting with established links in other contexts. Our study provides valuable evidence from a low-exposure setting.

### The dark side of light at night: unveiling the latest epidemiologic evidence on the association with breast cancer risk

Teresa Urbano<sup>1</sup>, Tommaso Filippini, Marco Vinceti

<sup>1</sup>CREAGEN - Environmental, Genetic and Nutritional Epidemiology Research Center, Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Modena, Italy

#### Abstract

**Introduction:** Nighttime lighting, or light at night (LAN), has become a widespread environmental concern due to increased exposure to artificial light during nocturnal hours. LAN is known to disrupt circadian rhythms, suppress melatonin production, and influence clock gene expression. Recent evidence hints at a potential link between LAN and various diseases, including cancer. Breast cancer, the globally leading cancer diagnosis and second-highest cancer-related cause of death has established connections to several environmental and lifestyle factors. In this study, we updated our previous meta-analysis exploring the impact of LAN exposure on breast cancer risk.

**Methods:** We undertook systematic searches in online databases (PubMed, Scopus, and Web of Science) up to 31 January 2024. We conducted a meta-analysis comparing the highest versus the lowest exposure levels. Subsequently, we performed a dose-response meta-analysis to assess the nature of this relation.

**Results:** 20 eligible studies (10 cohort and 10 case-control) investigating the association between breast cancer risk and LAN exposure were included. The overall findings revealed a positive association between LAN and breast cancer (risk ratio [RR] 1.08, 95% confidence interval [CI] 1.03-1.13). Stratified analyses indicated a higher risk for overweight women (RR 1.14, 95% CI 1.02-1.27), while differences in risk estimates divided into outdoor/indoor exposure and estrogen receptor status were minimal. The dose-response analysis exhibited a linear risk increase up to 80 nW/cm<sup>2</sup>/sr, beyond which the curve plateaued. In further analyses, the risk was more pronounced in premenopausal women (maximum RR 1.20 at 80 nW/cm<sup>2</sup>/sr) compared to postmenopausal.

**Discussion:** These results support the hypothesis that LAN is associated with an increased risk of breast cancer. It becomes evident that proactive public health measures are imperative to minimize LAN exposure and mitigate its adverse effects on human health.

## POLICY

### Health benefits of Open Streets programmes in Latin America: a quantitative health impact assessment

Daniel Velázquez-Cortés<sup>1</sup>, Mark J Nieuwenhuijsen, Michael Jerrett, David Rojas-Rueda

<sup>1</sup>Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain;

<sup>2</sup>Universitat Pompeu Fabra, Barcelona, Spain

#### Abstract

**Introduction:** To improve physical activity in Latin American cities, several interventions have been promoted, such as Open Streets programs. Our study aims to quantify the health and economic effects of Open Streets-related physical activity in 15 Latin American cities.

**Methods:** We used a quantitative health impact assessment approach to estimate annual premature deaths and disease incidence (ischemic heart disease, ischemic stroke, type 2 diabetes, colon cancer, breast cancer, and dementia) avoided, the disability-adjusted life-years (DALYs) gained, and the cost saving (from reduced premature mortality) related to increased physical activity from Open Streets programs in 15 Latin American cities. Input data were obtained from scientific publications, reports, and open street city surveys (2017 to 2019). Physical activity data were converted to metabolic equivalent of the task. Exposure-response relationship functions were applied to estimate relative risk and population-attributable fraction, enabling the assessment of premature deaths and disease incidence.



**Results:** The percentage of male users of the Open Streets programmes ranged from 55% (27500 of 50000 in Guatemala) to 75% (2250 of 3000 in El Alto, Bolivia), and female users ranged from 25% (750; El Alto) to 45% (22500; Guatemala). We estimated that the current Open Streets programmes in the 15 Latin American cities studied could prevent 363 (95% CI 271–494) annual premature deaths due to increased physical activity, with an annual economic impact of US\$194.1 million (144.9 million–263.9 million) saved and an annual reduction of 1036.7 DALYs (346.7–1778.3). If one Open Streets event is added per week in each of those cities, the potential benefit could increase to 496 (370 to 677) premature deaths prevented each year.

**Discussion:** Open Streets programs in Latin America can provide health and economic benefits related to increased physical activity and can be used as a health promotion and disease prevention tool.

### Assessing Health Effects of Long-Term Exposure to Low Levels of Air Pollution: The HEI Experience and What's Next?

Hanna Boogaard<sup>1</sup>, Dan L Crouse, Eva Tanner, Ellen Mantus, Annemoon M van Erp, Sverre Vedal, Jonathan Samet  
<sup>1</sup>Health Effects Institute

#### Abstract

**Introduction:** The Health Effects Institute (HEI) recently completed a comprehensive research initiative to investigate the health effects of long-term exposure to low levels of air pollution in the United States (U.S.), Canada, and Europe. We provide an overview and synthesis of the results of this initiative, and other key research, the strengths and limitations of the research, and remaining research needs.

**Methods:** The three studies funded through the HEI initiative estimated the effects of long-term ambient exposure to fine particulate matter (PM<sub>2.5</sub>), nitrogen dioxide, ozone, and other pollutants on a broad range of health outcomes, including cause-specific mortality and cardiovascular and respiratory morbidity.

**Results:** All three studies documented positive associations between mortality and exposure to PM<sub>2.5</sub> below the U.S. National Ambient Air Quality Standards and current and proposed European Union limit values. Furthermore, the studies observed non-threshold linear (U.S.), or supra-linear (Canada and Europe) exposure-response functions for PM<sub>2.5</sub> and mortality. Heterogeneity was found in both the magnitude and shape of this association within and across studies.

Strengths of the studies included the large populations (7–69 million), state-of-the-art exposure assessment methods, and thorough statistical analyses that included novel methods. Future work is needed to better understand potential sources of heterogeneity in the findings across studies and regions. Other areas of future work include the changing and evolving nature of PM components and sources, including wildfires, and the role of indoor environments.

**Conclusion:** This research initiative provides important new evidence of adverse effects of long-term exposures to low levels of air pollution at and below current standards, suggesting that further reductions could yield larger benefits than previously anticipated.

### Revision of the Air Quality Index of the German Environment Agency: work in progress

Katherine Ogurtsova<sup>1</sup>, Karoline Weik, Florian Pfäfflin, Antonia Fritz, Volker Diegmann, Myriam Tobollik, Barbara Hoffmann  
<sup>1</sup>Institute of Occupational, Social and Environmental Medicine, Heinrich-Heine-University Düsseldorf, Germany

#### Abstract

**Introduction:** To enhance communication on air quality, states often use an air quality index (AQI). Recently, the German Environment Agency initiated a revision of its AQI that was first introduced in 2019. This project aims to propose a new version of AQI, based on the updated

WHO Air Quality Guideline (AQG) 2021, reflecting current epidemiological evidence on the air pollution health impact.

**Methods:** We conducted a broad literature search on MEDLINE and Web of Science and various gray sources for national, international, and commercial AQIs to gather information on different AQI approaches. Methodological details of AQIs were systematically extracted, compared and analyzed. We identified most suitable approaches and applied them to develop a revised proposal for an AQI for Germany.

**Results:** The literature search identified 73 AQIs, of which we selected 24 for further analysis. Key air pollutants, such as nitrogen dioxide, ozone, particulate matter (PM<sub>2.5</sub> and PM<sub>10</sub>), and sulfur dioxide, were considered appropriate for the AQI update. We proposed three versions of an updated AQI, and the difference between the current AQI and one of the newly developed AQI is described in this presentation. The discussed AQI has 5 classes, is based on hourly pollutant measurements, and built on the relative risks of short-term health effects (hospitalizations and emergency department visits for different diseases). The effects of different pollutants were standardized to the effects of PM<sub>2.5</sub>. To analyze the resulting air quality classification, we applied the current and the proposed AQI using 2 years of air quality data of over 400 measurement stations in Germany.

**Discussion:** Compared to the previous index, the distribution of air quality classes changed slightly, rating air quality worse, aligning more closely with WHO AQG 2021. Further AQI development may require a deeper understanding of how the public perceives and uses it.

### Different pathways toward net-zero emissions imply diverging health impacts: a health impact assessment study for France

Léo Moutet<sup>1</sup>, Aurélien Bigo, Philippe Quirion, Laura Temime, Kévin Jean  
<sup>1</sup>MESuRS Laboratory, Conservatoire national des Arts et Métiers (Cnam), Paris, France

#### Abstract

**Introduction:** In the transport sector, efforts to achieve carbon neutrality may generate public health cobenefits by promoting physical activity. This study aims to quantify the health impacts related to active transportation based on four different scenarios leading France toward carbon neutrality in 2050.

**Methods:** The French Agency for Ecological Transition developed four consistent and contrasting scenarios (S1 to S4) achieving carbon neutrality by 2050 as well as a business-as-usual (BAU) scenario that extends our current lifestyles until 2050, without reaching net-zero. For each of these Transitions2050 scenarios, we distributed the mobility demand for walking, cycling and e-cycling across age groups. Relying on the health impact assessment framework, we quantified the impacts of the corresponding physical activity on all-cause mortality. The impact of each of the carbon neutrality scenarios was determined by comparison with estimates from the BAU scenario.

**Results:** In S1 and S2 scenarios, volumes of active transportation are projected to increase to fulfil the World Health Organisations recommendations by 2050, while they increase slightly in S3 and decrease in S4. S2 scenario reaches the highest levels of health cobenefits, with 494,000 deaths prevented between 2021 and 2050. This would translate into a life expectancy gain of 3.0 months for the general population in 2050, mainly driven by e-bikes. S1 would provide smaller but important health benefits, while these benefits would be modest for S3. On the contrary, S4 implies 52,000 additional deaths as compared to the BAU scenario, and a loss of 0.2 month in life expectancy.

**Discussion:** Different ways to decarbonize mobility in a net-zero perspective may achieve very contrasting public health cobenefits. This study illustrates how the public health dimension may provide a relevant insight in choices of collective transformation toward net-zero societies.

## Towards a Planetary Health Impact Assessment Framework: the effects of RF-EMF as case study for a conceptual protocol

Magdalini Stefanopoulou<sup>1</sup>, Tabea Sommenschein, Simon Scheider, Roel Vermeulen, Martin Rössli, Anke Huss

<sup>1</sup>Institute for Risk Assessment Sciences (IRAS), Utrecht University, Utrecht, the Netherlands

### Abstract

**Introduction:** The complexity of current public health challenges calls for a holistic approach that considers the direct effects on human health, the potential impacts on natural systems and their subsequent indirect effects on human health. Therefore, an advanced tool, the Planetary Health Impact Assessment (PHIA), that will judge a policy, decision, or project considering their effects on the planet, is needed. Developing the PHIA requires a comprehensive methodology, starting with the PHIA framework, an evidence-based visual representation of all potential pathways that could describe our planetary system. As a case-study, this protocol outlines the methodology to conceptualize and construct the PHIA framework by investigating radiofrequency electromagnetic fields (RF-EMF) exposure and its effects on humans, insects, and ecosystems.

**Methods:** Knowledge graphs (KGs) will be used to effectively illustrate all the potential direct effects of RF-EMF exposure on human health, its potential direct effects on insects and ecosystems and its indirect effects on human health. Two different pipelines will be used to extract evidence for the KGs construction: one utilizing theoretical knowledge and input from a panel of experts across various fields, and the other employing an automated tool that utilizes Natural Language Processing (NLP) and Deep Learning for systematic evidence extraction from scientific publications.

**Results:** The output will comprise two main KGs: an experts-based KG and an automated tool-based KG. We will compare the two methods and KGs, and assess their quality and precision in depicting the aforementioned relationships.

**Discussion:** This study is an initial attempt to build a PHIA framework. Since there is no established gold-standard methodology for comparison, our goal is to develop a robust methodology that can serve as a template for creating similar frameworks.

## Changes in Transportation Noise Exposure due to Transportation Noise Abatement Measures in Switzerland

Nicole Engelmann<sup>1,2</sup>, Benjamin Flückiger, Danielle Vienneau, Micha Köpfli, Jean-Mark Wunderli, Martin Rössli

<sup>1</sup>Swiss Tropical and Public Health Institute, Allschwil, Switzerland; <sup>2</sup>University of Basel, Basel, Switzerland

### Abstract

**Introduction:** Associations between transportation noise and multiple health outcomes have been established during the past years. However, the beneficial effects of interventions, including noise barriers and low-noise pavement, which are implemented to reduce the exposure to transportation noise and thus the health risk in the population, are less commonly addressed. Therefore, we aimed to gain a better understanding of the effectiveness of these interventions in Switzerland, on the individual and population level.

**Method:** We collected nationwide data on noise mitigation programs and identified time and place of the installation of noise barriers and low-noise pavements. On this basis, we refined state-of-the-art road traffic and railway noise modelling to derive noise levels at the façade for scenarios with and without noise interventions for the years 2001, 2011 and 2015. We then linked the exposure data to individuals in the Swiss National Cohort at the respective time point.

**Results:** In preliminary data analyses, we found that in 2001, 153,209 individuals (2.18% of the population) profited from noise barriers with at least 1 dB reduction in their road traffic noise exposure. This number

increased in 2011 to 273,467 (3.53%) and in 2015 to 316,738 individuals (3.83%). For low-noise pavement, we also observed an increase in the number of profiting individuals: 0.87% in 2001, 1.64% in 2011 and 2.13% in 2015. In terms of railway noise, 149,806 individuals (2.13%) profited from noise barriers with at least 1 dB reduction in their railway noise exposure in 2001. This number increased in 2011 to 383,758 (4.96%) and in 2015 to 524,174 individuals (6.34%).

**Conclusion:** The preliminary results show a positive change in transportation noise exposure due to noise interventions in Switzerland. Next, we will conduct the final analyses and then use this work to quantify the effects of transportation noise abatement measures on cardiovascular mortality in the Swiss National Cohort.

## CLIMATE & HEALTH

### Impacts of weather and air pollution on Legionnaires' disease in Switzerland: A national case-crossover study

Fabienne B. Fischer<sup>1,2,3</sup>, Apolline Saucy, Danielle Vienneau,

Jan Hattendorf, Julia Fanderl, Kees de Hoogh, Daniel Mäusezahl

<sup>1</sup>Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain;

<sup>2</sup>Universitat Pompeu Fabra, Barcelona, Spain; <sup>3</sup>CIBER Epidemiología y Salud Pública, Madrid, Spain

### Abstract

**Objective:** Switzerland has experienced a significant increase in reported cases of Legionnaires' disease (LD) over the past decade, reaching a rate of 6.7 cases per 100,000 inhabitants in 2022. This trend is not unique to Switzerland, as LD cases have also risen globally. While the role of warm, stagnant water has been established as a cause of Legionella outbreaks, the contribution of environmental factors for community-acquired cases remain unclear. The aim of this study was to understand the environmental and weather conditions influencing the regional and seasonal distribution of LD in Switzerland.

**Material and Methods:** We analyzed Swiss LD notification data from 2017 to 2021 using complementary approaches including (1) a geographical cluster analysis to identify disease hotspots; (2) an ecological study design; and (3) a case-crossover design. For the case-crossover design, we conducted uni- and multi-variable conditional logistic regression with distributed lag non-linear models to identify short-term associations between seven weather variables and LD occurrence.

**Results:** The analysis identified the Canton of Ticino in southern Switzerland as a hotspot, with a standardized notification rate of 14.3 cases per 100,000 inhabitants (CI: 12.6, 16.0). The ecological model showed a strong association between LD frequency and large-scale factors such as weather and air pollution. The case-crossover study confirmed a significant association with elevated daily mean temperature (OR 2.83; CI: 1.70, 4.70) and mean daily vapor pressure (OR: 1.52, CI: 1.15, 2.01) 6–14 days preceding LD occurrence.

**Conclusion:** Weather with a specific temporal pattern of warmth and humidity before the onset of LD appears determinant for disease onset in Switzerland, providing insights into a possible effect mechanism. The relationship between air pollution and LD and the interplay with short-term weather phenomena – in the context of global warming – should be further investigated

### The impact of extreme temperatures on cause-specific mortality in Italy

Chiara Di Blasi<sup>1</sup>, Massimo Stafoggia, Claudio Gariazzo,

Paola Michelozzi, Manuela De Sario, Alessandro Marinaccio,

Sara Maio, Giovanni Viegi, Francesca de'Donato

<sup>1</sup>Department of Epidemiology Lazio Regional Health Service, ASL ROMA 1, 00147 Rome

### Abstract

**Introduction:** Epidemiological studies have estimated the association between extreme temperatures and multiple adverse health outcomes.

This study aims to build on the literature and investigate the impact of daily exposure to extreme temperatures on cause-specific mortality in the Italian population.

**Methods:** Within the BigEpi project, cause specific-mortality data for natural, cardiovascular, respiratory, kidney disease, metabolic, central nervous system, mental disorders and diabetes, were retrieved for the period 2006-2015 from the Italian National Institute of Statistics (ISTAT). Daily counts of deaths for each the 8,094 municipalities were linked to daily mean air temperatures, estimated by a satellite-based spatiotemporal model. Firstly, we applied time-series analyses using multiple Poisson regression models and distributed lag non-linear models (DLNM); then, we meta-analysed BLUP (Best Linear Unbiased Prediction) coefficients at province level to obtain national Attributable Fractions (AF) and relative 95% empirical confidence intervals (95% eCI) of cause-specific deaths associated to heat, defined as increases in temperature from 75th to 99th percentile and cold, decreases from 25th to 1st percentile of mean air temperature distribution. We also explored AF by urbanization level, age groups and gender.

**Results:** The overall impact of air temperature on cause-mortality is higher when considering heat than cold. Considering heat, the AF was higher for disease of the central nervous system (3.6% 95% eCI: 1.9-4.9) and mental disorders (3.1% 95% eCI: 1.7-4.4), while considering cold, ischemic disease (1.3% 95% eCI: 1.1-1.6) and diabetes (1.3% 95% eCI: 0.7-1.8) had the greatest impact. By level of urbanization, similar impacts were found in rural, suburban and urban municipalities for both heat and cold.

**Discussion:** Results can help provide further insights on vulnerable groups and areas useful for addressing adaptation policies and public health interventions.

### Ambient temperature and seasonal variation in in-hospital mortality from respiratory diseases

Hicham Achebak<sup>1,2</sup>, Judith Garcia-Aymerich, Grégoire Rey, Zhaoyue Chen, Raúl Fernando Méndez-Turrubiates, Joan Ballester<sup>1</sup>*Inserm, France Cohortes, Paris, France; <sup>2</sup>ISGlobal, Barcelona, Spain*

#### Abstract

**Introduction:** Little is known about the seasonality of inpatient mortality and the role of ambient temperature remains uncertain. We aimed to analyse the association between ambient temperature and in-hospital mortality from respiratory diseases in Spain.

**Methods:** We used data on daily hospitalisations, weather and air pollutants for the Spanish provinces of Madrid and Barcelona during 2006-2019. We applied a daily time-series quasi-Poisson regression in combination with distributed lag non-linear models (DLNM) to assess, on the one hand, the seasonal variation in fatal hospitalisations and the contribution of ambient temperature, and on the other hand, the day-to-day association between temperature and fatal hospital admissions.

**Results:** The study analysed 1 710 012 emergency hospital admissions for respiratory diseases (mean [SD] age, 60.4 [31.0] years; 44.2% women), from which 103 845 resulted in in-hospital death (81.4 [12.3] years; 45.1%). We found a strong seasonal fluctuation in in-hospital mortality from respiratory diseases. While hospital admissions were higher during the cold season, the maximum incidence of inpatient mortality was during the summer and was strongly related to high temperatures. When analysing the day-to-day association between temperature and in-hospital mortality, we only found an effect for high temperatures. The relative risk (RR) of fatal hospitalisation at the 99th percentile of the distribution of daily temperatures vs the minimum mortality temperature (MMT) was 1.395 (95% eCI: 1.211 to 1.606) in Madrid and 1.612 (1.379 to 1.885) in Barcelona. Women were more vulnerable to heat than men, whereas the results by diagnostic of admission showed heat effects for acute bronchitis and bronchiolitis, pneumonia and respiratory failure.

**Discussion:** Unless effective adaptation measures are taken in hospital facilities, climate warming could exacerbate the burden of inpatient mortality from respiratory diseases during the warm season.

### Mortality burden in 35 European countries attributed to anthropogenic warming during the record-breaking summer of 2022

Dominik Schumacher<sup>1</sup>, Ana M Vicedo Cabrera, Sonia Seneviratne, Hicham Achebak, Joan Ballester<sup>1</sup>*ISGlobal, Barcelona, Spain*

#### Abstract

More than 61,000 heat-related deaths were associated with the record-breaking temperatures in Europe during the summer of 2022. In this study, we quantify the number of heat-related deaths that would have been avoided in the absence of anthropogenic warming. For this study, we utilize epidemiological models calibrated for the period 2015–2019 to estimate the heat-related mortality burden in the summer of 2022 for the factual and counterfactual scenario. We derive a counterfactual scenario by removing the regional summer mean warming that arises in response to rising global mean temperatures from the factual temperatures. We use ERA5-Land temperature data and mortality counts from the Eurostat database to estimate the heat-related deaths across 823 distinct administrative regions spanning 35 European countries. At 1.15 °C of global warming since pre-industrial times, we obtain a population-weighted median increase over all regions in Europe of more than 2 °C in summer mean temperatures, with the Mediterranean regions being most affected by the increase. By comparing the factual and counterfactual heat-related mortality, we estimate that approx. 70% [95th CI 53.33%– 82.17%] of the total heat-related deaths would not have occurred without anthropogenic warming. Southern Europe has been the most affected by dangerous heat and consequently features the highest number of heat-related deaths attributable to climate change [64.19% of the climate change-attributable deaths]. In relative terms, however, the impact of anthropogenic warming is strongest in Central Europe where approx. 78% of the heat-related deaths are attributable to anthropogenic warming.

### Temperature-related cause-, sex-, and age-specific ambulance dispatches in Czechia: a nationwide time-series analysis

Tomáš Janoš<sup>1</sup>, Hicham Achebak, Pavel Čupr, Raúl Fernando Méndez-Turrubiates, Joan Ballester<sup>1</sup>*RECETOX, Faculty of Science, Masaryk University, Brno, Czech Republic*

#### Abstract

Although several studies have investigated temperature-related mortality and morbidity, only little is known about the effects of temperature on ambulance dispatches (AMB). We aimed to carry out the first nationwide analysis of temperature-related AMB in Europe.

We collected daily time series of all-cause, cardiovascular and respiratory AMB by sex and age, and population-weighted daily mean 2-metre temperatures for all 77 districts of Czechia (2010-19). We estimated the relationship for each district using a quasi-Poisson regression model with distributed lag non-linear models. We applied multivariate random-effects meta-analysis to derive average associations across the country and calculated AMB attributable to nonoptimal temperatures.

The overall exposure-response curve had a “U” shape, with the optimum temperature at temperature percentile 50th and slightly elevated risk of AMB for heat compared to cold (RR at 99th and 1st temperature percentile vs optimum temperature: 1.142 [95% eCI 1.115 to 1.169] and 1.133 [95% eCI 1.098 to 1.169], respectively). We observed a higher risk due to nonoptimal temperatures for women than men. Except of youth (<20 years), for whom the risks for both heat and cold were among the highest, we generally found increasing risk with

increasing age due to cold and decreasing risk with increasing age in the case of heat. While heat did not contribute to the risk of AMB from cardiovascular causes and only limited contribution from respiratory causes was seen, the risks related to cold were significant. The overall AMB burden attributable to nonoptimal temperatures was 3.22% (3.13 to 3.30), with a predominant contribution of heat (1.80% [1.67 to 1.92]) compared to cold (1.42% [1.29 to 1.56]).

This is the first nationwide study of temperature-related AMB in Europe. Exposure to low and high temperatures increases the risk of AMB, with young individuals being the most vulnerable. The majority of temperature-related AMB was attributable to heat.

### Synergistic associations of heat and ambient air pollution on daily mortality in India

Jeroen de Bont<sup>1</sup>, Ajit Rajiva, Massimo Stafoggia, Suganthi Jaganathan, Siddhartha Mandal, Bhargav Krishna, Itai Kloog, Kevin Lane Amruta Nori-Sarma, Gregory A. Wellenius, Dorairaj Prabhakaran, Joel Schwartz, Poornima Prabhakaran, Petter Ljungman

<sup>1</sup>Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden

#### Abstract

**Background:** Limited studies have evaluated the interaction between heat and ambient air pollution on mortality, especially in regions such as India, where extreme levels of these exposures occur. We investigated the synergistic effect between heat and ambient air pollution on daily mortality in India.

**Methods:** We applied a time-series analysis for ten cities in India between 2008–2019. We assessed city-wide daily temperature and particulate matter  $\leq 2.5$   $\mu\text{m}$  (PM<sub>2.5</sub>) levels at 1x1km using nationwide spatiotemporal models. We estimated city-specific associations through generalised additive Poisson regression models, and meta-analysed them. To evaluate the interaction between heat and PM<sub>2.5</sub> (modelled at lag 0–1), a product term was incorporated between non-linear temperature and linear PM<sub>2.5</sub>. From this model, we estimate the effect of heat for increasing levels of air pollution, and vice versa.

**Results:** Among ~3.6 million deaths, we observed that an increase of temperature (from 75th to 99th percentile) was associated with a 19.4% (95%CI, 12.0%; 27.3%) increase in daily mortality. When daily PM<sub>2.5</sub> levels increased from 20 to 150  $\mu\text{g}/\text{m}^3$ , the percent change in temperature-associated mortality risk increased from 8.2% (3.7%, 12.9%) to 72.4% (32.3%, 124.8%), respectively. In addition, a 10  $\mu\text{g}/\text{m}^3$  increment in PM<sub>2.5</sub> was associated with a 2.19% (1.13%, 3.26%) and 4.07% (1.97%, 6.22%) increase in mortality when daily air temperature was set to the 1st and 99th percentiles, respectively.

**Conclusions:** Our findings reveal a substantial interaction between heat and ambient air pollution in India. Effective climate change adaptation and mitigation measures should prioritize understanding the synergistic health effects from these exposures.

## EXPOSURE ASSESSMENT

### Determinants of exposure to micro- and nano- plastics in women of reproductive age

Amanda M. Durkin<sup>1</sup>, Runyu Zou, Virissa C. Lenters, Barbara Scholz-Boettcher, Roel C.H. Vermeulen

<sup>1</sup>Department of Global Public Health & Bioethics, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, Utrecht, the Netherlands

#### Abstract

**Introduction:** Despite ubiquitous applications of plastic, there is limited knowledge on internal exposure levels of micro- and nano-plastics (MNPs, i.e., plastic particles of less than 5 mm) and the determinants of exposure. Common sources that may contribute to

MNP exposure remain poorly understood. We focus on characterizing MNP exposures in women of reproductive age because pregnancy and early life are critical periods with heightened vulnerability to environmental insults.

**Methods:** To characterize determinants of exposure to MNPs, a questionnaire was developed to assess factors which may contribute to MNP exposure such as household characteristics and food packaging. Additionally, participants were provided with a glass petri dish to set at home for a 30-day passive dust sample collection. Pyrolysis–gas chromatography–mass spectrometry (Py-GC/MS) was applied to characterize the accumulated MNPs in composition and mass. We enrolled 108 women of reproductive age living in Utrecht, the Netherlands. Descriptive statistics were used to describe the most frequent MNP exposure sources.

**Results:** Evaluation of the questionnaire indicated a wide contrast in plastic usage and potential exposure to MNPs. This includes differences in the use of plasticware for food preparation and household textiles, with limited differences observed in the frequency of consuming food packaged in plastic. The Py-GC/MS data will reveal the extent to which the spectrum of plastic use is reflected qualitatively and quantitatively in the associated dust samples collected.

**Discussion:** This is one of the first comprehensive surveys of potential determinants of MNPs to date. The results will identify important sources of MNPs and inform effective policy measures aimed at reducing MNP exposure and its associated risks. Future research will ascertain if levels of MNPs in household dust and potential determinants of MNP exposure are associated with internal levels of MNPs in the body.

### Ammonia air concentration variations at different heights from ground surface and implications for deposition research.

Claire Boeree<sup>1</sup>, Huifang Deng, Serigne Lo, Gerard Hoek, René Verburg, Roel Vermeulen, Dick J.J. Heederik, Wietske Dohmen  
<sup>1</sup>Institute for Risk Assessment Sciences (IRAS), Population Health Sciences, Utrecht University, Utrecht, the Netherlands

#### Abstract

**Introduction:** Nitrogen deposition affects flora diversity in nature reserves in the Netherlands. A part of nitrogen deposition is due to the emission of ammonia (NH<sub>3</sub>) by livestock farms. Estimation of nitrogen deposition relies primarily on models because of the costs and complexity of measurements. These models rely on emission data and limited numbers of air concentration measurements conducted at human-breathing height (180cm). This study investigates differences in ammonia concentrations at human-breathing height (180cm), and vegetation level (100cm) for a more precise environmental insight.

**Methods:** An exposure monitoring network was established in the 40x40 km<sup>2</sup> Foodvalley region, where approximately 2000 livestock farms are located. NH<sub>3</sub> concentrations at 180 and 100cm heights on 72 locations were measured across diverse areas (urban, rural, and nature areas) during 18 months. Two-way repeated measures ANOVA and paired t-test were used to estimate the mean difference in NH<sub>3</sub> concentration between two heights, and multivariable models were used to explore spatial and temporal variations.

**Results:** Mean ammonia concentration was 12.89  $\mu\text{g}/\text{m}^3$  (SD = 9.57) at 180cm and 12.39  $\mu\text{g}/\text{m}^3$  (SD = 9.78) at 100cm. A statistically significant difference of 0.49  $\mu\text{g}/\text{m}^3$  was observed between sample heights (180 vs 100cm, paired t-test,  $p < 0.001$ ). This difference did not correlate clearly to ambient ammonia concentrations. The number of livestock farms in the surrounding area was associated with the differences in concentrations between sample heights.

**Discussion:** At present, the influence of land-use, agricultural, and ecosystem variables on vertical differences in ammonia concentrations are explored more extensively. The observed differences could potentially serve as a crude proxy for dry ammonia deposition measurements.

### A comprehensive GPS-based analysis of activity spaces in early and late pregnancy using the ActMAP framework

Karl Samuelsson<sup>1,2</sup>, Ioar Rivas, Bruno Raimbault, Alan Domínguez, Toni Galmes, Antònia Valentin, Maria Foraster, Mireia Gascon, Maria Dolores Gomez Roig, Elisa Llurba Olivé, Mark Nieuwenhuijsen, Cecilia Persavento, Jordi Sumyer, Payam Dadvand

<sup>1</sup>ISGlobal, Barcelona Biomedical Research Park, Doctor Aiguader 88, 08003 Barcelona, Spain; <sup>2</sup>Department of Building Engineering, Energy Systems and Sustainability Science, Faculty of Engineering and Sustainable Development, University of Gävle, 801 76 Gävle, Sweden

#### Abstract

**Objective:** Exposure to urban environmental factors (e.g. greenspace) in pregnancy has important health ramifications. Assigning environmental exposure requires a detailed understanding of participants' activity spaces. The objective was to increase understanding of daily spatiotemporal behaviour in pregnancy by developing and applying a method that comprehensively describes activity spaces in terms of time-activity patterns, mobility and activity places.

**Material and Methods:** We present ActMAP, a GPS-based framework for quantifying activity spaces in 11 variables. ActMAP 1) distinguishes between travel and stays, 2) accurately delineates activity places, 3) captures the spatial scale and diversity of activity, and 4) distinguishes between weekday and weekend. We applied ActMAP on data from 250 pregnant women in the BiSC cohort in Barcelona, Spain (2018-2020), that were tracked one week in each of the first and third trimesters. Associations between trimester and activity space variables were explored using mixed effects models.

**Results:** Per day, the women typically spent 5-10 hours of their waking time at home and 1-1.5 hours travelling, with active travel constituting the majority of travel time. Although activity space size varied by several orders of magnitude, the women visited a limited number of places (often 5-15) that commonly constituted <1% of the total activity space. Activity was more home-centred in the third trimester, reflected in time-activity patterns and the spatial scale of activity. However, the number of activity places and daily trips were unchanged, indicating that some aspects of spatial behaviour remain constant in pregnancy.

**Conclusions:** The comprehensiveness of ActMAP provides insights about activity spaces in pregnancy and more widely for the study of spatiotemporal behaviour and environmental exposure. The findings suggest that careful attention is warranted regarding activity space variable selection and downstream exposure assessment.

### Occupational exposure to radiofrequency electromagnetic fields and brain tumor risk: application of the INTEROCC RF-JEM

Maxime Turuban<sup>1,2</sup>, Hans Kromhout, Javier Vila, Miquel Vallbona-Vistós, Frank De Vocht, Isabelle Baldi, Lesley Richardson, Geza Benke, Daniel Krewski, Marie-Elise Parent, Siegal Sadetzki, Brigitte Schlehofer, Joachim Schüz, Jack Siemiatycki, Martie van Tongeren, Alistair Woodward, Elisabeth Cardis, Michelle C. Turner

<sup>1</sup>Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain; <sup>2</sup>Universitat Pompeu Fabra (UPF), Barcelona, Spain

#### Abstract

**Background:** Radiofrequency electromagnetic fields (RF-EMF, 100kHz to 300 GHz) are classified by the International Agency for Research on Cancer as possibly carcinogenic to humans (Group 2B). This study evaluates the potential association between occupational RF-EMF exposure and brain tumor risk, utilizing a new RF-EMF Job-Exposure-Matrix (RF-JEM) developed in the context of the multi-country INTEROCC case-control study.

**Methods:** Cumulative and time-weighted average occupational RF-EMF exposure estimates for glioma and meningioma cases and

matched controls were based on lifetime job histories linked to the INTEROCC RF-JEM using three different methods: by considering RF-EMF intensity among all exposed jobs, by considering RF-EMF intensity only among jobs with an exposure prevalence  $\geq$  the median exposure prevalence of all jobs, and by considering RF-EMF intensity of jobs of participants who also reported RF-EMF source use in detailed occupational modules. Conditional logistic regression models were used, considering various lag periods and exposure time windows defined a priori.

**Results:** The prevalence of occupational RF-EMF exposure varied substantially depending on the RF-JEM application method, lag time, and exposure time window. Although generally no statistically significant positive or inverse associations were observed for glioma or meningioma, a statistically increased glioma risk was observed in the highest exposure categories of Method 1 for the most recent 1-4 year exposure window. **Conclusion:** This first application of the INTEROCC RF-JEM did not identify associations between occupational RF-EMF exposure and the risk of glioma or meningioma.

### Extremely-low frequency magnetic fields (ELF-MF) exposure in Switzerland and scenarios of daily averaged levels

Nicolas Loizeau<sup>1,2</sup>, Dominik Haas, Marco Zahner, Johannes Schindler, Markus Gugler, Christa Stefan, Jürg Fröhlich, Toni Ziegler, Martin Rössli

<sup>1</sup>Swiss Tropical and Public Health Institute, 4123 Allschwil, Switzerland; <sup>2</sup>University of Basel, 4001 Basel, Switzerland

#### Abstract

The use of electricity is inevitably accompanied by extremely low frequency magnetic fields (ELF-MF) exposure. Understanding the population's exposure to ELF-MF is of essential for risk assessment and communication. Thus, we aim to provide an overview of ambient ELF-MF exposure for the Swiss population between 2021 and 2023, along with fictional scenarios of daily averaged ELF-MF levels.

We conducted ELF-MF measurements in 300 outdoor areas, 217 public spaces, and numerous modes of transport, as well as in 32 private homes in Switzerland using portable exposimeters (ExpoM-ELF). Outdoor areas were selected to be representative in terms of Swiss population exposed to ELF sources (e.g. high voltage lines, railway lines). Magnetic flux density levels ( $\mu$ T) were measured for railway power (16.7 Hz), domestic power (50 Hz), and tram residual ripple (300 Hz). We collected data for at least 15 minutes in outdoor areas, 5 minutes in public spaces and transport, 24 hours in bedrooms, and 30 minutes in living areas. We simulated 36 fictional daily scenarios (time spent at home, work, commuting) and used the measurements to assign a mean level to each activity, to estimate the daily averaged exposure to ELF-MF.

The highest average ELF-MF levels were recorded in trains (1.17  $\mu$ T), train stations (1.03  $\mu$ T), and bedrooms located near high-voltage lines (0.68  $\mu$ T). All data fall below the Swiss ambient limits (100-300  $\mu$ T). The ELF-MF levels at 50 Hz in one house were between 1.25  $\mu$ T and 2.05  $\mu$ T at 50 Hz, exceeding the Swiss precautionary limits for sensitive use locations (1.0  $\mu$ T). Scenarios of daily averaged ELF-MF levels ranged from 0.07  $\mu$ T up to 0.92  $\mu$ T.

Using real-world ELF-MF measurements between 2021 and 2023, we presented an approach to estimate the daily averaged ELF-MF levels to use for future epidemiological studies. Although the ELF-MF levels were well below the ambient limit levels, systematic controls are essential to mitigate ELF-MF exposure in sensitive use locations.

### Population-wide road traffic noise modeling across Europe using CNOSSOS-EU: comparison to national noise models

Youchen Shen<sup>1</sup>, Gerard Hoek, Roel Vermeulen, Oliver Schmitz, Derek Karssenbergh, Danielle Vienmeau, Kathryn Adams,

Calvin Jephcote, Göran Pershagen, Andrei Pyko, Mikael Ögren, Petter Ljungman, John Gulliver, Kees de Hoogh  
<sup>1</sup>Institute for Risk Assessment Sciences, Utrecht University, Utrecht, The Netherlands

#### Abstract

**Introduction:** Strategic noise mapping in Europe only includes agglomerations (contiguous population >100,000) and major roads outside agglomerations. The limited coverage prevents the study of road traffic noise health effects for entire populations. Therefore, this study aims to estimate road traffic noise with greater coverage, using a simplified CNOSSOS-EU framework and benchmark it against gold standard models in several countries.

**Methods:** For modelling, we developed a road-type-specific random forest model to predict traffic intensity. Then, we obtained traffic speed limits and building geometries from OpenStreetMap (OSM). With these inputs, we estimated road traffic noise at 90,000 locations of the noisiest building façade. We also investigated variations in the noise estimates and compared Europe-wide estimates with national noise model estimates for the Netherlands, Switzerland, the United Kingdom, and Stockholm county at the point locations.

**Results:** Our traffic intensity modelling yielded estimates with an overall MSE-R2 value of 0.81 in 5-fold cross-validation. For noise modelling, 37% of the 90,000 points had values greater than 55 dBA during the day-evening-night period (Lden) based on the European model. In the comparison, we found the overall correlation in the selected areas ranging from 0.38 (Stockholm) to 0.68 (UK). The models showed the same pattern of increasing noise levels from residential to primary roads and highways. With different types of nearby roads, the Europe-wide estimates were, on average, higher than the national estimates, except in Stockholm. The differences ranged from -2.5 to 3.9 dB on average.

**Discussion:** We found overall moderate agreement between Europe-wide and the gold standard national noise estimates. The Europe-wide noise estimates can be useful especially in Europe-wide health studies, supplementing the national models or for areas without national models with sufficient coverage as an alternative exposure metric.

## AIR POLLUTION 2: SPECIFIC ATTRIBUTES OF EFFECTS OF AIR POLLUTION ON HEALTH

### Exposure to airborne cadmium and lead and cognitive performance among Lyon residents within the French CONSTANCES cohort

Antoine Lafontaine<sup>1</sup>, Caroline Meyer, Kees de Hoogh, Marcel Goldberg, Sébastien Leblond, Noémie Letellier, Danielle Vienmeau, Marie Zins, Claudine Berr, Marion Mortamais, Bénédicte Jacquemin\*, Emeline Lequy\*  
 \*equally contributed <sup>1</sup>Univ Rennes, Inserm, EHESP, Irset (Institut de recherche en santé, environnement et travail) – UMR\_S 1085, F-35000 Rennes, France

#### Abstract

**Introduction:** Airborne metals are components of air pollution, including fine particles. Some of them are known to be neurotoxic such as cadmium (Cd) and lead (Pb). In CONSTANCES, a French general population-based cohort, we aimed to estimate the cross-sectional associations between airborne Cd and Pb exposures and cognitive performance in the second conurbation in France, Lyon.

**Methods:** Among participants enrolled between 2012-2020, aged 45 and older, cognitive functions were assessed at inclusion by tests on episodic memory, language skills and executive functions (including trial making test (TMT), parts A and B). We used the cognitive norms previously defined in the cohort by age, sex and education to dichotomize each test. Participants' exposure to airborne metals was assessed at residential addresses using a 500x500m resolution land-use regression model based on metal concentrations accumulated by mosses collected

in 2018. We used logistic regression models for each metal and each cognitive test, adjusted for age, sex, education, socio-economic status, alcohol consumption, smoking status, occupational exposure to metal dust, and area-level deprivation. Metal exposures were log-transformed. Odds ratios (OR) and confidence intervals (CI) are reported for an increase interquartile range (IQR) of exposure.

**Results:** Among the 5,068 included participants, median exposures were 0.47 (IQR: 0.14) and 25.29 (IQR: 4.98) µg.g-1 dry weight for Cd and Pb, respectively. We observed adverse associations between exposure to Cd and TMT-A (1.160 [1.008;1.335]) and TMT-B (1.206 [1.041;1.397]), and no association with the other outcomes. Similar results were found for Pb and TMT-A (1.127 [1.024;1.241]), TMT-B (1.196 [1.080;1.325]), and semantic skills (1.100 [1.009;1.199]).

**Discussion:** These analyses suggest associations between urban airborne metals and poorer cognitive performance, especially for executive functions. Further analyses are warranted to support these findings.

### The impact of mass concentration and chemical composition of PM2.5 on human health in the City of Novi Sad, Serbia

Natasa Dragic<sup>1</sup>, Sanja Bijelovic, Jelena Bjelanovic, Marija Jevtic, Dusica Stojanovic, Katarina Paunovic, Emil Zivadinovic, Ivana Radic, Sanja Harbaji, Zorana J Andersen  
<sup>1</sup>University of Novi Sad, Faculty of Medicine, Novi Sad, Serbia & Institute of Public Health of Vojvodina

#### Abstract

In order to provide additional evidence to the evidence that in Southeast Europe existed highest mortality rate due to air pollution, we aimed to determine the concentration and chemical composition of ambient PM2.5 and to assess its impact on total mortality and cardiovascular morbidity among adult population of the City of Novi Sad, Serbia.

**Method:** Time series study of daily data on mass concentration and chemical composition of PM2.5 (equivalent of the carbonate fraction (CFE), secondary inorganic aerosol (SIA), soluble organic fraction (SOD), calcium, chlorides, sodium, potassium and magnesium), meteorological parameters and health outcomes, at intervals of at least 30 days during four seasons of 2017 was conducted. Generalized linear Poisson regression model was applied in order to evaluate the impact of PM2.5 on all-cause mortality and hospital admissions for cardiovascular diseases (CVD) and cerebrovascular diseases (CD), for the population older than 18, residing within the territory of the Novi Sad.

**Results:** The average annual mass concentration of PM2.5 was 30.27 µg/m3, while mean daily concentrations were in range 8-79 µg/m3. PM2.5 was mainly composed by CFE (60%), SIA (14%) and SOD (12%), while the water-soluble ions were consisting in the lowest percentage. The risk for all-cause mortality and CVD increased by 0.4% (RR=1,004; 95% CI: 1,000-1,007) and 0,6% (RR=1,006; 95% CI: 1,001-1,010), respectively for each daily 1µg/m3 increases of PM2.5 particle mass concentration. Among chemical constituents of PM2.5 it was found that CFE and potassium had a significant contribute to all-cause mortality. Significant effect on CVD was found for CFE and SOD, while risk for CD was contribute mainly by CFE, SOD and calcium ions.

**Conclusion:** The risk of mass concentration and chemical composition of PM2.5 particles for all-cause mortality and cardiovascular morbidity in the City of Novi Sad was quantified for the first time.

### Effect modification of PM2.5-related mortality risks by the pollutant mix complexity in over 200 cities

Pierre Masselot<sup>1</sup>, Richard T. Burnett, Antonio Gasparrini, Jeffrey R. Brook, the MCC Collaborative Research Network  
<sup>1</sup>Environment & Health Modelling (EHM) Lab, Department of Public Health, Environment & Society, London School of Hygiene & Tropical Medicine, London, UK

**Abstract**

**Introduction:** There is important spatial heterogeneity in the risk of mortality associated with fine particulate matter (PM<sub>2.5</sub>). Previous research have suggested that part of this heterogeneity is linked to the local pollutant mix, but has focused on specific components such as the level of oxidant gases (Ox), or the chemical composition of PM<sub>2.5</sub>. In this study, we seek to assess whether a more holistic index of complexity of the pollutant mix can explain spatial heterogeneity of PM<sub>2.5</sub>-related mortality risks.

**Methods:** We extracted daily series of PM<sub>2.5</sub> levels and mortality for 276 cities in 12 countries, along with city-specific socio-economic and environmental indicators, and a recently developed Chronic Air Pollution Index (CAPI) representing the location-specific relative complexity of the pollutant mix. We applied a standard two-stage analysis. In the first stage, location-specific between mortality and a two-days moving average of PM<sub>2.5</sub> are estimated. These associations are then pooled in a second-stage multilevel meta-regression model with the CAPI included as a predictor, along with city indicators to control for local characteristics.

**Results:** We found that the CAPI is highly predictive of the heterogeneity in PM<sub>2.5</sub>-related mortality risks, with an estimated relative excess risk (RER) of 1.0044 (95% CI: 1.0023 to 1.0065). In comparison, the same analysis applied with Ox only results in a RER of 1.0013 (0.9993 to 1.0034). The high association of CAPI is confirmed by the Likelihood Ratio Test (p-value < 0.0001).

**Discussion:** Our results indicate that populations vulnerability to PM<sub>2.5</sub> is influenced by the mixture of pollutants the population is exposed to. It therefore suggests that reducing the level of all pollutants is important to protect populations.

### **The comparison of the associations between different ambient air pollution estimates and lung function in UK Biobank**

*Pimpika Kaewsri<sup>1</sup>, Samuel Y Cai, Calvin Jephcote, Kees de Hoogh, Frank Dudbridge, Anna L Hansell*

<sup>1</sup>*Department of Population Health Sciences, University of Leicester, Leicester, U.K*

**Abstract**

**Introduction:** Air pollution is gaining the attention of researchers and policymakers owing to the accumulating evidence of its adverse effects on health. The UK Biobank cohort is one of the largest prospective studies worldwide, consisting of biomedical data, lifestyles information and annual average air pollutant concentrations at their residential addresses in the UK. Annual air pollution exposure estimates at place of residence from different projects (ESCAPE, EXPANSE, EU-wide and UK-specific) using different models are available in the cohort, raising the question of which air pollution estimates should be used in epidemiological studies.

**Objective:** To compare the associations between air pollution and lung function using different air pollutant estimates within UK Biobank.

**Method:** Annual estimates of nitrogen dioxide (NO<sub>2</sub>), particulate matter ≤ 10 μm diameter (PM<sub>10</sub>), and particulate matter with a diameter ≤ 2.5 μm (PM<sub>2.5</sub>), estimated from different projects with forced expiratory volume in 1 second (FEV<sub>1</sub>) and forced vital capacity (FVC) were cross-sectionally analysed.

**Results:** Different magnitudes of effect sizes were observed across the same pollutants from different models. In particular, the pollutant estimates from the EXPANSE project produced notably larger effect sizes than estimates from other projects for all pollutants investigated. Using the estimates from EXPANSE project, the exposure to PM<sub>2.5</sub> per 5 μg/m<sup>3</sup> reduced FEV<sub>1</sub> by -138.43 mL (95% CI -144.08 - -132.76 mL) whereas the estimates from ESCAPE project reduced FEV<sub>1</sub> by -73.08 mL (95% CI -82.51 - -63.64 mL).

**Discussion:** Choice of air pollutant model is a potential source of heterogeneity in epidemiological studies, with implications for quantitative risk assessment and policy-making decisions. Hence, choice of air pollution estimates for epidemiological studies needs careful consideration in the context of the research question, and advantages and limitations of the air pollution models available.

### **Short-term effects of particle number size distribution modes on health**

*N. Dos Santos Vanessa<sup>1,2</sup>, Rivas Ioar, Garcia-Marlès Meritxell, Pandolfi Marco, Alaustey Andrés, Kalkavouras Panayiotis, Mihalopoulos Nikos, Grivas Georgios, Reche Cristina, Perez Noemi, Salma Imre, Vörösmarty Máté, Casans Andrea, Casquero-Vera Juan Andrés, Petäjä Tuukka, Lampilahti Janne, Timonen Hilikka, J. Gómez-Moreno Francisco, Alonso-Blanco Elisabeth, Hueglin Christoph, Ballester Joan, M. Harrison Roy, Hoek Gerard, Basagaña Xavier, Querol Xavier*  
<sup>1</sup>*Universitat Pompeu Fabra (UPF), Barcelona, Spain;* <sup>2</sup>*Institute for Global Health, ISGlobal, Barcelona, Spain*

**Abstract**

Particulate matter (PM) is a health concern worldwide as it is associated with diseases and premature mortality. Although the smallest fractions of PM (e.g., ultrafine particles, <100nm) have the potential to affect health, evidence on independent effects is still limited. This study aims to quantify the short-term effects of particle size modes on cause-specific mortality.

We used quasi-Poisson regression models to associate the number concentrations of particle size modes with mortality by natural, cardiovascular and respiratory causes in seven cities (Athens, Barcelona, Budapest, Granada, Helsinki, Madrid and Zurich). Modes were size-classified as nucleation (10-25nm), Aitken (25-100nm), UFP (10 – 100nm), Accumulation (>100nm), N<sub>25</sub> (>25nm) and N<sub>total</sub> (>10nm). Our single and two pollutant models were adjusted for long-term and seasonal variations, temperature, relative humidity, holidays and day of the week. We performed a random effect meta-analysis to summarize the health effects across the cities. As 5 cities will be added soon, the results are preliminary.

All particle size modes were significantly associated with increasing effects on natural and cardiovascular mortality, except for the accumulation mode. The health effects of UFP and N<sub>total</sub> were similar in single pollutant models. One IQR increase in UFP (IQR: 3804 particles/cm<sup>3</sup>) and N<sub>total</sub> (IQR: 4528 particles/cm<sup>3</sup>) were associated with 0.83 [95% CI 0.18, 1.49] and 0.77% [95% CI 0.13, 1.41] increase in natural mortality, respectively, with a mean delay of 0 - 2 days after exposure (mean lags 0, 1 and 2). In two pollutant models, the health effects of the UFP and N<sub>total</sub> on natural mortality remained significant after adjusting for PM<sub>2.5</sub> and PM<sub>10</sub>. No significant effects were observed between particle size modes and respiratory mortality.

Our preliminary results indicate that the Nucleation, Aitken, N<sub>25</sub>, UFP and the N<sub>total</sub> particle size modes may increase mortality independently from larger PM fractions.

### **Population exposures to extreme-risk temperature events and compound episodes with air pollution in Europe**

*Zhao-Yue Chen<sup>1</sup>, Raúl Fernando Méndez Turrubiates, Hicham Achebak, Hervé Petetin, Carlos Pérez García-Pando, Joan Ballester*

<sup>1</sup>*ISGLOBAL, Barcelona, Spain*

**Abstract**

Despite ongoing efforts to mitigate air pollution, the complex relationship between pollution and climate change presents additional multifaceted challenges. Rising temperatures intensify air pollution issues

by increasing ozone formation and wildfire-generated particulate matter release. However, limited understanding of extreme temperature and air pollution co-occurrence persists, and existing studies often neglect regional vulnerabilities due to socioeconomic factors, population demographics, and climate adaptation measures.

This study analysed the spatiotemporal distribution of extreme risk-temperature (ERT) days and their interplay with air pollution exceeding WHO guidelines across 1426 NUTS3 regions in Europe During 2003-2020. Epidemiological models derived heat and cold risk thresholds based on mortality data from 35 European countries. Daily ambient PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, and O<sub>3</sub> concentrations were estimated at a 0.1-degree resolution.

The findings revealed a significant increase in Europe's heat-ERT days from 5.65 days (2003-2011) to 8.00 days per year (2012-2020), and a decrease in cold-ERT days (12.07 to 7.48 days per year). Southern and southeastern Europe experienced higher frequencies of both ERT days. The occurrence of heat-related air pollution episodes increased from 4.23 days (2003-2011) to 5.59 days per year (2012-2020), primarily driven by O<sub>3</sub>. Conversely, cold-related air pollution episodes declined from 8.62 days to 5.10 days per year, primarily composed of PM<sub>2.5</sub>.

The study identified region-specific risk thresholds to unveil spatial disparities and changes in extreme temperature events, especially when coupled with air pollution. This understanding is crucial for tailoring adaptation strategies, aiding subsequent health assessments, and implementing effective mitigation measures to safeguard public health.

#### EFFECTS OF ENVIRONMENTAL EXPOSURES ON DEVELOPMENT, HEALTHY AGING AND WELLBEING

### New insights into the impact of environmental exposures on childhood bone health

Ana Inês Silva<sup>1</sup>, Hanne Sleurs, Leen Rasking, Congrong Wang, Michelle Plusquin, Esmée M. Bijmens, Tim Nawrot  
<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Hasselt, Belgium

#### Abstract

**Background and Aim:** A recent study conducted within the ongoing prospective birth cohort ENVIRONAGE (Environmental Influence on Ageing in Early Life) provided evidence about the importance of early-life exposure to residential green space on childhood bone health. However, there is a lack of studies investigating the association between air pollution exposure and childhood bone mineral density (BMD). Thus, this study aims to explore whether long-term exposure to air pollution and residential green space are independently associated with BMD among young children.

**Methods:** In the framework of the ENVIRONAGE project, 327 children were followed up throughout 4 to 6 years. Radial BMD (m/s) was assessed using a quantitative ultrasound technique. Long-term exposure to residential air pollution (µg/m<sup>3</sup>) was estimated through a high-resolution spatial-temporal interpolation method one year before follow-up. Total green space (%) was calculated within 500 m around the residence. Multiple linear models were applied after adjusting for relevant covariates and potential confounders.

**Results:** Radial BMD was on average (SD) 3678.37 (116.12) m/s. An interquartile (IQR) increase in long-term exposure to PM<sub>2.5</sub> (2.52 µg/m<sup>3</sup>) was associated with a decrease of 26.66 m/s (95% CI: -48.76% to -4.56%, p=0.02) in BMD. Moreover, an IQR increment in total green (21.2%) space within 500 m was associated with an increase of 27.38 m/s (95% CI: 9.63% to 45.13, p=0.003) in BMD. Additionally, mutual adjustments for particulate air pollution and green space, or vice versa, exhibited independent associations with BMD.

**Conclusions:** These findings emphasize the impact of long-term exposure to particulate matter and green space independently on BMD during critical periods of growth and development, which might have long-term implications on bone health.

### Plasma levels of polyunsaturated fatty acids in childhood and adolescence and obesity markers in young adulthood

Annachiara Malin Igra<sup>1</sup>, Sandra Ekström, Niklas Andersson, Petter Ljungman, Erik Melén, Inger Kull, Ulf Risérus, Anna Bergström  
<sup>1</sup>Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden

#### Abstract

**Introduction:** Polyunsaturated fatty acids (PUFA), especially from vegetable fat sources, have been suggested to reduce body fat accumulation in animal models and short-term clinical trials. However, few longitudinal studies on childhood exposure are available, with short follow-up time and conflicting results. We aimed to study the relation between plasma levels of PUFA during childhood and adolescence and obesity markers in young adulthood.

**Methods:** We included n=689 participants of the BAMSE cohort in Stockholm, Sweden, with available data on plasma levels of n-3 and n-6 fatty acids [ $\alpha$ -linolenic acid (ALA), eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA), docosahexaenoic acid (DHA), linoleic acid (LA), and arachidonic acid (AA)] at 8y and 16y and body mass index (BMI), waist circumference and fat mass % at 24y. Associations between plasma PUFA and obesity markers were assessed with multivariable-adjusted linear and logistic regression.

**Results:** In analyses of all participants, high proportions of LA at 8y and 16y were inversely associated with BMI, waist circumference, and fat mass % at 24y; however, with a statistically significant interaction between LA and ALA and sex. In sex-stratified models, the associations were confined to females, and proportions of LA at both timepoints and ALA at 16y were inversely associated with all three obesity markers. For example, proportions of LA at 8y and 16y above the median were associated with lower odds of being overweight or obese (BMI $\geq$ 25) at 24y in comparison to LA proportions below the median, with OR 0.57 (95% CI 0.34, 0.94) and OR 0.53 (95% CI 0.32, 0.88), respectively.

**Discussion:** Plasma proportions of LA and ALA, biomarkers of vegetable oil intake, during childhood and adolescence were inversely associated with obesity markers in young adulthood, with a potential sex difference. These findings accord with short-term feeding trials suggesting a potential preventive role of LA on body fat accumulation.

### Emerging environmental determinants of skin aging: the combined role of temperature and humidity

Nidhi Singh<sup>1</sup>, Prince Vijay, Harish C. Phuleria, Gopa Majmudar, Rong Hong, Jean Krutmann, Tamara Schikowski  
<sup>1</sup>IUF-Leibniz Research Institute for Environmental Medicine, Düsseldorf-40225, Germany

#### Abstract

Exposure to extreme temperatures in association with other climate variables is associated with increased mortality and morbidity from cardiovascular, pulmonary and mental disorders. However, the impact of extreme temperature on skin health is largely unknown. The present study investigates the association between long-term exposure to high temperature on facial skin aging signs in German and Indian women.

Facial skin aging phenotypes from 806 German and 1,510 Indian women were assessed by SCINEXA™ scoring in a cross-sectional study. Data on ambient temperature (AT), relative humidity (RH), solar Ultraviolet radiation (UV), and air pollution (Nitrogen dioxide; NO<sub>2</sub>) were obtained from secondary data sources. We employed heat index (HI), a combination of AT and RH as our main exposure. The analysis



was done using an adjusted ordinal multivariate logistic regression model.

We observed positive and significant associations of HI with pigment spots and coarse wrinkles on the face. For eg, for every 1°C rise in HI, German women showed a positive association with pigment spots on cheeks (OR:1.42, 95%CI: 0.81,2.50) and wrinkles on the upper lip (OR:1.88, 95%CI: 1.10,3.20). Indian women on the other hand showed a positive and significant association between HI and hyperpigmented maculae on the forehead (OR:1.07, 95%CI:1.05, 1.09), wrinkles in the forehead (OR: 1.06,95%CI: 1.04, 1.08) wrinkles in frown lines (OR: 1.08,95%CI: 1.06, 1.10), wrinkles in crow's feet (OR: 1.12,95%CI: 1.10,1.14), and wrinkles in upper lip (OR: 1.03,95%CI: 1.02,1.05). These associations between HI and facial skin aging signs were robust in Indian women against the confounding effect of solar UV radiation, NO<sub>2</sub>, and age.

Long-term exposure to high temperatures contributes to facial skin aging in Caucasian and Indian women. Climate factors are thus important factors of the skin aging exposome.

### Biological pathways involved in effects of the early-life exposome on child general health

Ines Amine<sup>1</sup>, Augusto Anguita-Ruiz, Alicia Guillien, Xavier Basagaña, Eva Borràs, Marta Cirach, Andrius Dedele, Judith Garcia-Aymerich, Berit Granum, Regina Grazuleviciene, Juan R. González, Line Småstuen Haug, Jordi Julvez, Hector Keun, Monica Lopez-Vicente, Rosemary McEachan, Mark Nieuwenhuijsen, Eduard Sabidó, Rémy Slama, Cathrine Thomsen, Marina Vafeiadi, John Wright, Tiffany Yang, Wen Lun Yuan, Mariona Bustamante, Arthur Tenenhaus, Martine Vrijheid, Valérie Siroux, Léa Maitre  
<sup>1</sup>Team of Environmental Epidemiology Applied to the Development and Respiratory Health, Institute for Advanced Biosciences, Inserm U 1209, CNRS UMR 5309, Université Grenoble Alpes, 38700 La Tronche, France

#### Abstract

**Introduction:** Early-life environmental exposures are suspected to be involved in the development of chronic diseases later in life. To date, the underlying biological mechanisms are not well understood, and studied for single health domains. Using multi-omic layers focusing on the immune system, we aim at identifying biological pathways involved in effects of the exposome on a general health score.

**Methods:** The analysis is based on 847 children (6-12 years) from six European birth cohorts from the Human Early-Life Exposome project. A score covering the child's cardiometabolic, respiratory and mental health was previously built to represent the child general health status. A total of nineteen environmental factors has previously been associated with this score, including indoor pollutants, maternal diet, smoking and chemical pollutants. Candidate intermediate blood biomarkers were proteins, cell type proportion and DNA methylation sites. A meet-in-the-middle approach and a multiblock analysis (RGCCA) were used to identify biomarkers and pathways involved in the association between the exposome and the general health score.

**Findings:** First results indicated that half of the proteins studied were shown to be significantly associated with at least one exposure and the general health score (uncorrected p-values<0.05), mostly involved in inflammation (e.g. IL1beta, IL6, TNFalpha, CRP) and metabolism (e.g. leptin, apolipoproteins). Using the same approach, two cell types factors were highlighted, indicating the protective role of the adaptive immunity. Only a few CpGs (74 sites) showed statistically significant results. The RGCCA method will be applied to integrate the three biological layers to further highlight biological pathways.

**Conclusion:** This study could identify key biological pathways by which environmental exposures can affect the overall children's health. In particular, changes in inflammation status and metabolism have already been established.

### Long-term associations between air pollution and self-perceived health status: results from the KORA-Fit study

Minqi Liao<sup>1,2,3</sup>, Siqi Zhang, Kathrin Wolf, Gabriele Bolte, Michael Laxy, Lars Schwettman, Annette Peters, Alexandra Schneider, Ute Kraus

<sup>1</sup>Helmholtz Zentrum München – German Research Center for Environmental Health (GmbH), Institute of Epidemiology, Neuherberg, Germany; <sup>2</sup>Pettenkofer School of Public Health, Munich, Germany; <sup>3</sup>Institute for Medical Information Processing, Biometry, and Epidemiology (IBE), Faculty of Medicine, Ludwig-Maximilians-Universität München, Munich, Germany

#### Abstract

**Introduction:** We used data from the Cooperative Health Research in the Region of Augsburg (KORA)-Fit study in Germany to investigate the association between long-term air pollution exposure and health-related quality of life (HRQoL) or self-rated health (SRH).

**Methods:** Annual averages of particulate matter (PM) with a diameter < 10 µm (PM<sub>10</sub>), coarse particles (PM<sub>coarse</sub>), fine particles (PM<sub>2.5</sub>), the absorbance of fine particles (PM<sub>2.5</sub>abs), particle number concentration (PNC), ozone (O<sub>3</sub>), nitrogen dioxide (NO<sub>2</sub>), and nitrogen oxides (NO<sub>x</sub>) were determined via land-use regression models for geocoded residential addresses (2014-2015). The outcomes were obtained using questionnaires or face-to-face interviews (2018-2019). Associations were explored using generalized additive models, multinomial, and logistic regression, respectively.

**Results:** Of the 2,610 participants with an age of 64 years included, 1,428 (54.7%) were females. The result of the European Quality of Life 5 Dimensions 5 Levels questionnaire (EQ-5D-5L) indicated that an increase in O<sub>3</sub> was associated with a reduced EQ-5D index value (%change and 95% confidence interval for each interquartile range (IQR) increase: -0.91 [-1.76; -0.06]). Each IQR increase in PM<sub>10</sub>, PM<sub>coarse</sub>, PM<sub>2.5</sub>abs, PNC, NO<sub>2</sub>, and NO<sub>x</sub> was significantly associated with a declined visual analogue scale score (EQ-VAS), with %changes in each point of score ranging from -1.57 to -0.96. Furthermore, these pollutants were positively associated with a higher likelihood of reporting poor SRH, with odds ratios (ORs) ranging from 1.24 to 3.22. Additionally, PM<sub>2.5</sub>abs was linked to a higher likelihood of reporting a worse age-comparative SRH (2.59 [1.12; 5.99]). Body mass index, physical activity, comorbidity, and self-perceived stress modified these associations.

**Discussion:** Elevated long-term air pollution exposure was associated with deteriorated self-perceived health, represented by a lower HRQoL but higher odds of poor SRH.

### Does exposure to pesticides accelerate biological aging? A systematic review and meta-analysis

Shanshan Zuo<sup>1</sup>, Vidhya Sasitharan, Gian Luca Di Tanna, Judith M. Vonk, Maaïke De Vries, Moustafa Sherif, Balázs Ádám, Juan Carlos Rivillas, Valentina Gallo

<sup>1</sup>University of Groningen

#### Abstract

**Background:** Aging is a time-dependent functional decline characterized by physiological deterioration at the cellular, tissue, and organ levels, resulting in increased risk of morbidity and mortality. Exposure to pesticides is a risk factor for various diseases, yet its association with biological aging remains unclear. We aimed to systematically assess and pool evidence on the relationship between pesticide exposure and biological aging.

**Methods:** PubMed, Embase and Web of Science were searched up to 1 August 2023. Studies investigating the association between pesticide exposure and biological aging measures were included. Three-level random-effect meta-analysis was used to pool the standardized mean differences (SMD) and regression coefficient (β). Quality of studies was assessed using the Newcastle-Ottawa Scale.

**Results:** Twenty studies evaluating the associations of two biological ageing measures in 10398 individuals aged 7-71 were included. Sixteen studies reported telomere length and four studies reported epigenetic clocks. The meta-analysis found pesticide exposure was potentially associated with shortened telomere length (pooled SMD = -0.65; 95%CI: -1.63, 0.33) and accelerated epigenetic age (pooled  $\beta$  = 0.27; 95%CI: -0.25, 0.79).

**Conclusion:** Our findings suggested a tendency toward demonstrating positive association between pesticide exposure and biological aging. However, the current evidence is limited. More studies with larger sample size, more biomarkers of biological aging and more categories and individual active ingredients of pesticides are needed.

### Particulate matter, nitrogen dioxide, ozone, and self-rated health within the German National Cohort (NAKO)

S. Claire Slesinski<sup>1,2</sup>, Kathrin Wolf, Sida Zhuang, Tobia Lakes,

Gabriele Bolte, Annette Peters, Alexandra Schneider

<sup>1</sup>Institute of Epidemiology, Helmholtz Centre Munich, German

Research Centre for Environmental Health, Neuherberg, Germany;

<sup>2</sup>Institute for Medical Information Processing, Biometry, and

Epidemiology (IBE), Faculty of Medicine, LMU Munich, Pettenkofer

School of Public Health, Munich, Germany

#### Abstract

**Objective:** Europeans are exposed to levels of PM<sub>2.5</sub>, PM<sub>10</sub>, O<sub>3</sub>, and NO<sub>2</sub> higher than the WHO guideline, endangering their health. Effects of these pollutants on objective health is well-documented, but their association with self-rated health (SRH) is less understood. This study investigated the association between exposure to these pollutants and SRH.

**Methods:** The German National Cohort (NAKO) enrolled >200,000 adults aged 20-74 at 18 sites. Using NAKO's baseline (n=194,016), we tested whether an increase in intra-quartile range (IQR) of annual mean residential exposure at 1km x 1km spatial resolution was associated with odds of reporting fair/poor SRH, as compared to reporting good, very good, or excellent SRH within the full sample, stratified by sex, and stratified by age group ( $\leq 39$  years, 40-59 years,  $\geq 60$  years). We adjusted analyses by study site, age, sex, marital status, education, and migration background.

**Results:** An increase in PM<sub>2.5</sub> was associated with 7% higher odds of fair/poor SRH in the full sample (95% CI 1.05-1.10), with similar odds for males, females, ages 40-59, and  $\geq 60$ . Similarly, an increase in PM<sub>10</sub> was associated with 8% higher odds of fair/poor SRH within the full sample (95% CI 1.06-1.11) with similar odds for both sexes and all age groups. Increases in NO<sub>2</sub> levels had a weaker association with fair/poor SRH within the full sample (OR 1.04 95% CI 1.02-1.06) and in stratified analyses only females and those ages 40-59 had a statistically significant OR. An increase in O<sub>3</sub> had no statistically significant effect on odds of fair/poor SRH except among those ages 40-59 (OR 0.95 95% CI 0.91-0.98), a result that could be explained by inverse correlation between O<sub>3</sub> and the three other pollutants. Odds of those  $\leq 39$  years reporting fair/poor health was only statistically significant for PM<sub>10</sub> (OR 1.09, 95% CI 1.01-1.17).

**Conclusion:** Higher levels of residential PM<sub>2.5</sub>, PM<sub>10</sub>, and NO<sub>2</sub> are associated with higher odds of reporting fair/poor SRH.

### RESPIRATORY: NEW EVIDENCE ON EFFECTS OF ENVIRONMENTAL EXPOSURES ON RESPIRATORY HEALTH

#### Upper Respiratory Tract Microbiota in Association with Goat Farm Exposure

Beatrice Cornu Hewitt<sup>1</sup>, Myrna M.T. de Rooij, Alex Bossers,

Mari-Lee Odendaal, Aniek Lotterman, Inge Roof, Mei Ling Chu,

Thomas Hagenaars, Joris Yzermans, Rianne van Gageldonk-Lafeber,

Joke van der Giessen, Debby Bogaert, Lidwien A.M. Smit

<sup>1</sup>Utrecht University

#### Abstract

**Introduction:** The presence of livestock farms have been associated with respiratory morbidity in nearby residents. While it is known that there is a heightened risk of pneumonia near goat farms, the underlying causes remain unknown. We therefore aim to study the upper respiratory microbiota in goat farmers, pneumonia patients and healthy controls which may facilitate identification of underlying mechanisms.

**Methods:** For this study, we characterised oropharyngeal (OP) microbiota profiles of 95 Dutch goat farmers, 60 pneumonia patients, and 50 general population controls - a subset of the total study population of >1,000 individuals that will be characterised (sequencing is in progress) - using 16S-rRNA sequencing of OP swabs.

**Results:** Though no significant differences in total microbial biomass were detected among the three populations (Dunn's test; p values > 0.05), goat farmers did exhibit a higher species richness in their OP microbiota compared to both pneumonia patients and controls (Dunn's test; p values = 0.002 and 0.036, respectively). We also observed significant differences in overall microbiota compositions between the three populations (PERMANOVA; p value = 0.005, R<sup>2</sup> = 0.019). Pairwise PERMANOVA tests revealed specific differences: goat farmers vs controls (p value = 0.035, R<sup>2</sup> = 0.013), goat farmers vs pneumonia patients (p value = 0.031, R<sup>2</sup> = 0.014) and controls vs pneumonia patients (p value = 0.072, R<sup>2</sup> = 0.015).

**Conclusions:** Goat farmers possess a microbiota profile that is distinct from both pneumonia patients and controls, suggesting that direct exposure to goat farms may bring about alterations in the OP microbiota. After sequencing of all samples, we will examine whether a closer distance to goat farms has a discernible effect on microbiota profiles within the non-farming population, including both pneumonia patients and general population controls.

#### Occupational exposure patterns to disinfectants and cleaning products and asthma among French healthcare workers.

Bakari Ibrahim<sup>1</sup>, Nicole Le Moual, Guillaume Sit, Marcel Goldberg,

Bénédicte Leynaert, Céline Ribet, Nicolas Roche, Raphaëlle Varraso,

Marie Zins, Rachel Nadif, Laurent Orsi, Oriane Dumas

<sup>1</sup>Université Paris-Saclay, UVSQ, Univ. Paris-Sud, Inserm, Equipe

d'Epidémiologie Respiratoire Intégrative, CESP, Villejuif, France

#### Abstract

**Objective:** Disinfectants and cleaning products (DCPs) are important risk factors for asthma among healthcare workers. However, the multidimensional aspect of exposures has rarely been considered. We used clustering methods to identify patterns of occupational exposure to DCPs and studied their associations with asthma outcomes.

**Methods:** CONSTANCES is a French population-based cohort of  $\approx 220000$  adults (18-69 yrs at inclusion). Current asthma and asthma symptom score were defined by questionnaire at inclusion (2012-2020). In 2022, 4530 healthcare and medical laboratory workers completed an additional questionnaire on their current/last held occupation, workplace, and cleaning activities that were used in unsupervised learning algorithms to identify occupational exposure patterns. Logistic and negative binomial regression models adjusted for age, sex, smoking and body mass index were used to assess associations with asthma outcomes.

**Results:** Participants were on average 48 years, 83% women, 44% nurses, and 8% with current asthma. Four clusters were identified: Cluster1 (C1, n=1940, 43%, reference) mainly characterized by unexposed nurses (42%) and physicians (29%), C2 (n=313, 7%) by medical laboratory staff (81%) moderately exposed to common DCPs (chlorine/bleach, alcohol), C3 (n=1828, 40%) by nursing assistants (31%) and nurses (52%) highly exposed to a few DCPs (mainly quaternary ammonium compounds), and C4 (n=449, 10%) by nurses (51%) highly exposed to multiple DCPs (e.g. glutaraldehyde, hydrogen peroxide, acids). C2 was associated with higher asthma symptom

score (mean score ratio [95%CI]:1.29[1.02;1.62]). Among women, C2 (1.35[1.04;1.75]) and C3 (1.18[1.03;1.37]) were associated with higher asthma symptom score. No association was found with current asthma.

**Conclusion:** Several DCP exposure patterns were identified, reflecting the heterogeneity of healthcare jobs. Two of them were associated with asthma symptoms, especially in women.

### Does living close to allergenic trees affect lung function in German adults?

Clemens Baumbach<sup>1</sup>, Dennis Nowak, Joachim Heinrich

<sup>1</sup>Institute and Clinic for Occupational, Social and Environmental Medicine, University Hospital, LMU Munich, Munich, Germany

#### Abstract

**Introduction:** Studies on greenspace and lung function in adults produced mixed findings. In this exploratory analysis, we hypothesized that some of the findings showing an adverse impact of greenspace exposure on lung function could be due to long-term exposure to tree pollen and investigated whether living in areas with higher greenness, more trees, and more allergenic trees around home is related to worse lung function.

**Methods:** The analytic sample consisted of 900 adults aged 20 to 44 years at baseline from the German cities of Hamburg and Erfurt of the multi-center population-based ECRHS cohort study. Spirometric lung function was measured in 1990, 2000, and 2010 according to a standardized protocol. We assessed exposure to greenness with the Normalized Difference Vegetation Index (NDVI). We counted street trees based on tree registries and classified them into allergenic and non-allergenic. NDVI and tree counts were computed for 300m buffers around home. We also used annual average concentrations of nitrogen dioxide (NO<sub>2</sub>) and ozone derived from ELAPSE models. The longitudinal data were analyzed with linear mixed models.

**Results:** Higher NDVI was related to smaller forced expiratory volume in 1 second (FEV<sub>1</sub>, beta = -61.6 ml per 0.2-increase in NDVI, 95% CI = [-110.7, -12.4]). This effect did not change when the model was additionally adjusted for tree counts but was attenuated after adjusting for ozone (beta = -23.0, 95% CI = [-81.7, 35.7]). The effect was stronger in the around 300 participants with asthma symptoms (beta = -131.4, 95% CI = [-246.1, -16.6]).

**Discussion:** The adverse effect of exposure to greenness on FEV<sub>1</sub> could not be explained by presence of allergenic street trees in residential neighborhood. However, it might be partially attributed to long-term ozone exposure.

### Traffic-related NO<sub>2</sub> and incident asthma children: A register-based study of Greater Copenhagen (2017-2021)

Kirstine Wodschow<sup>1</sup>, Frida Richter Hansen, Michelle Trabjerg Pedersen, Annette Kjær Ersbøll

<sup>1</sup>National Institute of Public Health, University of Southern Denmark

#### Abstract

**Objective:** To examine if exposure to NO<sub>2</sub> at residential address increases the risk of incident asthma among children living in Greater Copenhagen, Denmark.

**Material and Methods:** A register-based prospective open cohort study in the period of 2017-2021 was designed, including children aged 0 to 16 years, with a residential address within Greater Copenhagen. Association analyses were performed for two age groups. The first group included children aged 0-5 years with no prior asthma incidence, and the second group included children aged 6-16 years with no prior asthma incidence, unless it was registered before their 6th years birthday.

Incident asthma was obtained from the Danish National Patient Register and the Danish National Prescription Registry dating back to 1977 and 1994, respectively.

Yearly average levels of NO<sub>2</sub> from the Copenhagen Air View Data measured at street level between October 2018 and March 2020, were used to assign exposure to each residential address.

NO<sub>2</sub> concentrations were categorized into 4 exposure groups. For each group, asthma incidence rates for the four exposure groups were estimated by applying a generalized linear model. The model was adjusted for parents' asthma status.

**Results:** The study included 166,913 children, with 2,996 and 1,236 asthma cases, for age group 0-5 years and 6-16 years, respectively. Exposure to the highest NO<sub>2</sub> concentration (> 20 µg/m<sup>3</sup>) increased the risk of asthma compared to those exposed to the lowest level (9-12 µg/m<sup>3</sup>), with an incidence rate ratio of 1.25 (95% CI: 1.10; 1.41) for children aged 0-5 years and 1.20 (95% CI: 1.00; 1.45) for children aged 6-16 years.

**Conclusion:** We found an association between NO<sub>2</sub> levels at street level and increased risk of asthma. However, exposure misclassification and years of Covid-19 might have influenced the results.

### Long-Term Exposure to Ambient Air Pollution and Lower Respiratory Infection in Adults: A Danish National Cohort Study

Jiawei Zhang<sup>1</sup>, Youn-Hee Lim, Rina So, Zhebin Yu, Steffen Loft, Stephane Tuffier, Marie Bergmann, Thomas Cole-Hunter, Laust Hvas Mortensen, Erik Melén, Zorana Jovanovic Andersen  
<sup>1</sup>Section of Environmental Health, Department of Public Health, University of Copenhagen

#### Abstract

**Background:** Long-term exposure to air pollution has been linked with acute lower respiratory infections (ALRIs) in children, but the evidence in adults is still mixed and sparse. We aimed to examine the association between long-term exposure to air pollution and recurrent ALRIs in adults.

**Method:** We followed all adults aged 30 or older (3,083,227) in Denmark for hospital contacts due to ALRIs, pneumonia or influenza from 2000 to 2018. Annual mean concentrations of fine particulate matter (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>), and black carbon (BC), in 2010 were modelled using hybrid land-use regression models and assigned to baseline residential addresses. A marginal Cox model was used to assess the association between air pollution and recurrent ALRIs, pneumonia, and influenza. Interaction models were further applied to assess the effect modification by comorbidity and socioeconomic status.

**Results:** During an average of 16 years' follow-up, 624,867, 588,491 and 13,260 recurrent events due to ALRIs, pneumonia, or influenza, respectively, were detected. We detected a consistent association between the three pollutants and ALRIs, with hazard ratios (95% confidence interval) of 1.09 (1.09, 1.10) per 10 µg/m<sup>3</sup> for NO<sub>2</sub>; 1.08 (1.08, 1.09) per 0.5 10-5 m-1 for BC, and; 1.04 (1.04, 1.04) per 2 µg/m<sup>3</sup> for PM<sub>2.5</sub>. Such association was stronger in females, non-western immigrants, low-education/income individuals, and patients with prior cardiovascular disease or influenza history. We also detected stronger associations for pneumonia, and a null association for influenza.

**Conclusion:** Long-term exposure to air pollution may contribute to an increased risk of recurrent ALRIs, particularly pneumonia. Cardiovascular disease patients and socioeconomically disadvantaged individuals appeared most susceptible.

### Exposure to extreme weather events in the first year of life and infant wheezing occurrence

Giovenale Moirano<sup>1</sup>, Sofia Quaglia, Lorenzo Richiardi

<sup>1</sup>Cancer Epidemiology Unit, Medical Science Department, University of Turin and CPO Piemonte, Turin, Italy and University School for Advanced Studies IUSS Pavia, Italy

#### Abstract

**Introduction:** Climate change increases the intensity and frequency of extreme weather events. Although their health consequences are already of concern they are projected to impact the youngest generations the most. Within the NINFEA Italian birth cohort, we investigated

the relationship between extreme weather events exposure during the first year of life and infant respiratory health.

**Methods:** Combining geocoded addresses, collected through questionnaires, with satellite and climate reanalysis data, we derived the early-life exposure history of each child to common extreme weather events in Italy. We used different cutoffs to derive exposures, among which: the number of (i) 3 or more consecutive days, labeled as heat waves, with maximum temperature above 35°C (ii) days with PM<sub>2.5</sub> from wildfires above 15 µg/m<sup>3</sup> (iii) and cumulative precipitation exceeding 100 mm; (iv) months with exceptional drought (v) and the sum of any of these condition over the first year of life. We estimated the relationship between each exposure and wheezing occurrence between 6 and 18 months using logistic regression models, adjusted for both individual and contextual variables. Using data collected across 11 years in the whole Italian territory we aim to exploit the quasi-random climatic variations due to birthplace and birth time to give precise estimates of the exposure effect.

**Results:** The risk of wheezing increased for each additional heat wave exposure: Odds Ratio (OR) 1.17, 95% confidence interval (CI) 1.03;1.32. Wheezing was not associated with precipitations but with wildfire PM OR 1.32 [95% CI 0.76; 2.26]; exceptional drought OR 1.10 [0.96; 1.26], and exposure to any of the above extreme events OR 1.13 [95% CI 1.03; 1.22].

**Discussion:** We found a relevant impact of exposure to extreme events on early-life respiratory health of children. Those results emphasize the need to incorporate climate change mitigation policies into health prevention strategies to safeguard population health.

### Individual and location characteristics as modifiers of heat-related respiratory mortality at small area scale in Europe

*Sofia Zafeiratou<sup>1</sup>, Evangelia Samoli, Antonis Analitis, Antonio Gasparrini, Massimo Stafoggia, Francesca K. de' Donato, Shilpa Rao, Liliana Vazquez Fernandez, Siqi Zhang, Susanne Breitner, Pierre Masselot, Kristin Aunan, Alexandra Schneider, Klea Katsouyanni*  
<sup>1</sup>Department of Hygiene, Epidemiology and Medical Statistics, Medical School, University of Athens, Athens, Greece

#### Abstract

**Introduction:** Heat effects on respiratory mortality have been documented in studies based on city level data, while little attention has been given to non-urban regions or national level analyses. Furthermore, the potential impact of area-level characteristics on these effects has not been extensively studied. This study aimed to investigate the effects of heat on respiratory mortality at small administrative area levels in Norway, Germany, and England & Wales during the warm period (May-September) from 1996 to 2018, and their possible modification by individual or location characteristics.

**Methods:** Daily respiratory mortality counts and modeled air temperature data at small area level were used to assess the temperature-mortality association. A Poisson regression allowing for overdispersion, using Distributed Lag Nonlinear Models, was applied and a random-effect meta-analysis model was used to pool the estimates at the national level and overall. Age- and sex-specific models were also applied, as age and sex have been identified as potential individual-level effect modifiers. Location characteristics, such as socioeconomic area-level characteristics, land use and air pollution, were further considered as potential area-level effect modifiers, using multilevel random-effects meta-regression models.

**Results:** An increase in temperature from the 75th to 99th percentile was linked to a 27% (95% Confidence Interval (CI): 19%, 34%) increase in respiratory mortality, with females experiencing higher effects. The results indicated that areas with higher population density, increased PM<sub>2.5</sub> concentrations, and a lack of green spaces were associated with stronger increases in heat-related respiratory mortality.

**Discussion:** Our results strengthen the evidence on adverse effects of heat on respiratory mortality in Central-Northern Europe. Identified vulnerable population subgroups and subregions may inform optimal targeted policies to address the challenges posed by climate change.

### PRE- & PERINATAL EXPOSURE AND HEALTH EFFECTS IN LATER LIFE

#### Black Carbon Particles in Human Milk: Assessing Infant's Exposure

*Charlotte Cosemans<sup>1</sup>, Eva Bongaerts, Kenneth Vanbrabant, Brigitte Reimann, Ana Inês Silva, Eline Tommelein, Giulia Poma, Marcel Ameloot, Tim S Nawrot, Michelle Plusquin*  
<sup>1</sup>Centre for Environmental Sciences, Hasselt University, 3590 Diepenbeek, Belgium

#### Abstract

**Introduction:** Human milk is the recommended source of nutrition for infants due to its complex composition and numerous benefits, including a decline in childhood infection rates and a lower risk of obesity. An increasing number of studies reported the presence of environmental pollutants in human milk. Most of these studies focused on environmental chemicals rather than particles, such as black carbon (BC). As exposure to BC particles has adverse effects on health, this pilot study investigates the presence of these particles in human milk.

**Methods:** BC particles from ambient exposure were measured in eight human milk samples using a white light generation under femtosecond illumination. The carbonaceous nature of the particles was confirmed with BC fingerprinting. Ambient air pollution exposures (PM<sub>2.5</sub>, PM<sub>10</sub>, and NO<sub>2</sub>) were estimated using a spatial interpolation model based on the maternal residential address. Spearman rank correlation coefficients were obtained to assess the association between human milk's BC load and residential exposures. The milk fat content was determined using liquid-liquid extraction (with n-hexane:acetone; 3:1, vol/vol).

**Results:** BC particles were found in all human milk samples. BC loads in human milk were strongly and positively correlated with recent (i.e., one week) maternal residential NO<sub>2</sub> ( $r = 0.79$ ;  $p = 0.02$ ) exposure and medium-term (i.e., one month) PM<sub>2.5</sub> ( $r = 0.83$ ;  $p = 0.02$ ) and PM<sub>10</sub> ( $r = 0.93$ ;  $p = 0.002$ ) exposure. BC load and the fat content in human milk were not significantly correlated ( $r = 0.38$ ;  $p = 0.36$ ).

**Discussion:** BC particles are present in human milk and are associated with residential ambient air pollution levels. Our findings present insights into a novel pathway through which combustion-derived particles can permeate the delicate system of infants and could have important implications for public health policies aimed at promoting breastfeeding and protecting infants from the potential harms of these pollutants.

#### Prenatal particulate air pollution exposure and arterial stiffness in children entering their second decade of life

*Hanne Croons<sup>1</sup>, Thessa Van Pee, Nick Giesberts, Maartje Vangeneugden, Rossella Alfano, Michelle Plusquin, Tim S. Nawrot*

<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Hasselt, Belgium

#### Abstract

**Introduction:** The early-life environment is a crucial period for fetal programming. Exposure to particulate matter during pregnancy may entail an increased risk of long-lasting cardiovascular consequences. However, literature about the contribution of prenatal air pollution exposure to the development of arterial stiffness and cardiovascular health in childhood is limited. Therefore, we investigated whether prenatal exposure to PM<sub>2.5</sub> (particulate matter with a diameter  $\leq 2.5\mu\text{m}$ ) is associated with arterial stiffness in children.

**Methods:** In the ENVIRONAGE birth cohort, mother-child pairs were recruited at birth and followed-up at age 9 to 11 years. We assessed arterial stiffness using carotid-femoral pulse wave velocity (PWV). We modeled daily prenatal PM<sub>2.5</sub> exposure levels for each participant's home address using a high-resolution spatiotemporal model. All models were adjusted for necessary covariates and confounders.

**Results:** This study included 232 children with a mean (SD) age of 10.1 (0.8) years old. Of these, 131 children (56.7%) were girls and PM<sub>2.5</sub> during pregnancy averaged (SD) 14.1 (2.7) µg/m<sup>3</sup>. Prenatal PM<sub>2.5</sub> exposure during trimester 2 was positively associated with the PWV in childhood. Each 1 µg/m<sup>3</sup> increment in prenatal PM<sub>2.5</sub> exposure during trimester 2 was associated with a 0.02 m/sec (95% CI, 0.001 to 0.034;  $p = 0.036$ ) higher PWV. When we accounted additionally, for childhood PM<sub>2.5</sub> exposure over the 10-year period, trimester 2 exposure remained a significant predictor of PWV.

**Discussion:** In 10-year-old children, pulse wave velocity was significantly higher in association with prenatal air pollution, more specifically during trimester 2. According to the “Developmental Origins of Health and Diseases” (DOHaD) concept, this emphasizes the critical role of the early-life environment in fetal programming, highlighting the potential long-term consequences of ambient air pollution during gestation on the child's cardiovascular system.

### **Prenatal surrounding greenness and pollen is associated with infant wheezing: results from the PIPO birth cohort**

*Katrien De Troeyer<sup>1</sup>, Alessandro Grosso, Seppe Heyvaerts, Ben Somers, Hilbert Mendoza, Hayat Bentouhami, Margo Hagendorens, Kevin De Soomer, Ellie Oostveen, Willem Verstraeten, Andy Delcloo, Raf Aerts, Lidia Casas*

<sup>1</sup>*Social Epidemiology and Health Policy, Department Family Medicine and Population Health, University of Antwerp, Doornstraat 331, 2610, Wilrijk, Belgium*

#### **Abstract**

**Introduction:** Results of previous studies on the effects of green spaces on respiratory health are inconsistent. Potential explanations are the mechanisms (e.g. pollen) and timing of exposure. Here, we examine the effect of exposure to surrounding greenness and to pollen per trimester of pregnancy on wheezing from 1 to 3 years of age.

**Methods:** We used data from the Belgian PIPO birth cohort ( $n=755$ ). Wheezing was assessed through biannual questionnaires between the age of 18 and 36 months. Surrounding greenness per trimester was measured with the Normalized Difference Vegetation Index (NDVI) in a 100m buffer around the residential address. Modelled grass and birch pollen concentrations were categorized per trimester into no (ref.), medium or high, using the  $p50$  as cut-off for medium vs high. We used Generalized Estimated Equations to obtain odds ratios (OR) and 95% confidence intervals (CI). For NDVI, results are presented per interquartile range increase.

**Results:** By the age of 3, between 7.5-13.3% of infants had wheezing. Greenness in the 1st and 3rd trimesters was inversely associated with wheezing (OR=0.94, CI:0.89-0.99, and OR=0.85, CI:0.80-0.90, respectively), while in the 2nd trimester it increased the odds (OR=1.14, CI:1.08-1.20). Grass pollen exposure in the 3rd trimester was also inversely associated with wheezing, but directly in the 1st trimester (for medium levels OR=0.74, CI:0.64-0.85 and OR=1.34, CI:1.20-1.50, respectively). Associations for the 2nd trimester were not significant. Contrarily, birch pollen exposure before the 3rd trimester reduced the odds of wheezing (e.g. OR=0.75, CI:0.63-0.89 for high levels in the 2nd trimester), while in the 3rd trimester it increased it (OR=1.11 CI:1.00-1.24 for medium levels).

**Discussion:** Surrounding greenness and pollen exposure during pregnancy may impact the likelihood of wheezing in infancy, but differently depending on timing of exposure. This may be related to phases of the immune system development in utero.

### **Prenatal exposure to persistent organic pollutants and pubertal development among 12-year-olds children**

*Lola Menant<sup>1</sup>, Florence Rouget, H el ene Tillaut, Fabrice Lain e, Eric Gaudreau, Sylvaine Cordier, Ronan Garlant ezec, Christine Monfort, C ecile Chevrier*

<sup>1</sup>*Universit e de Rennes, Inserm UMR S 1085, Irset, France*

#### **Abstract**

The onset of pubertal development is subject to fluctuations compared to previous generations. Recent studies have reported the sex-specific impact of prenatal exposure to certain persistent organic pollutants (POP) on children's reproductive health. The present study aims to investigate this possible impact considering the pubertal development of 12-year-old girls and boys.

**Methods:** This study is based on the PELAGIE mother-child cohort conducted in Brittany, France. A cord blood sample was used to measure prenatal exposures to six polychlorinated biphenyls (PCB), three organochlorines and six perfluoroalkyl substances. Clinical follow-up of the children between 12.2 and 13.2 years old was performed by trained investigators, to assess pubertal development (breast (B) for girls, gonadal (G) for boys) using Tanner stages. For each exposure, categorized in tertiles, associations were estimated using multinomial logistic regressions adjusted for confounders identified by DAG method.

**Results:** 250 girls and 252 boys were examined. Among girls, risk of having reached a more advanced breast development stages (B4-B5vsB3) at this age, increased significantly with the prenatal exposure to  $\beta$ -hexachlorocyclohexane (OR2ndvs1st tertile=2.6[1.03-6.69]; OR3rdvs1st=2.02[0.80-5.06]). Intermediate levels of PCB118 were associated with statistically significant reduced risk of an earlier breast development stages (B1-B2vsB3). In boys, there was a statistically significant decreased risk of being at a more advanced gonadal development stages (G4-G5vsG3) in association with exposure to several compounds: PCB 170, 180, 187 and to perfluorononanoic, perfluorodecanoic and perfluorohexane (example for PFHxS: OR2ndvs1st=0.52[0.21-1.25]; OR3rdvs1st=0.31[0.12-0.77]).

**Discussion:** The study suggests delayed gonadal development associated with PCB and PFAS among boys, adding to the sparse literature. Potential advanced breast development was also slightly suggested with  $\beta$ -HCH and PCB118 among girl.

### **Placental epigenetic changes mediating the association between prenatal air pollution exposure and child lung function**

*Lucile Bros eus<sup>1</sup>, Ariane Guilbert, Anne Boudier, Jorg T ost, Sarah Lyon-Caen, R emy Slama, Sam Bayat, Claire Philippat, Olivier Fran ois, Val erie Siroux, Johanna Lepeule*

<sup>1</sup>*Team of Environmental Epidemiology Applied to Development and Respiratory Health, Institute for Advanced Biosciences (IAB), Universit e Grenoble Alpes, Inserm, CNRS, Grenoble, France*

#### **Abstract**

**Introduction:** Prenatal exposure to air pollution (PAPE) has been associated with impaired respiratory health and reduced lung function in offspring. This relationship may be partly mediated by air pollution-induced epigenetic alterations of the placenta. We aimed to investigate the potential mediating role of placental DNA methylation (DNAm) in the association between prenatal NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> exposure levels and child lung function in newborns and at 3 years of life.

**Methods:** Placenta DNAm levels were measured using the Infinium Methylation EPIC BeadChip in 395 participants from the French couple-child cohort SEPAGES. PAPE was estimated based on maternal residential address using an ambient dispersion model. Lung function (7 parameters overall) was assessed through tidal breathing analysis and nitrogen multiple breath washout test (2 months old) and airwave oscillometry (AOS; 3 years old). We conducted adjusted epigenome-wide mediation analyses using the new HDMAX2 method to identify genomic loci

(CpGs) and regions explaining the association between PAPE and child lung function (FDR<0.15).

**Results:** We identified 11 CpGs (resp. 13 CpGs) significantly mediating the association between PAPE and at least one respiratory outcome at 2 months of age (resp. at least one AOS parameter measured at 3 years of age). These included sites mapping to the genes *ITCH* (2 months respiratory rate with PM<sub>2.5</sub>) and *ITGB3* (3 years area under the reactance curve with PM<sub>2.5</sub> and NO<sub>2</sub>), involved in allergic sensitization and asthma susceptibility, and to the gene *B2M* (3 years resistance at 7-19Hz with PM<sub>2.5</sub> and NO<sub>2</sub>) implicated in the immune response.

**Discussion:** Our findings highlighted placental epigenetic biomarkers which might mediate the effect of PAPE on children's respiratory outcomes. These results could give clues about the epigenetic modifications through which PAPE affects early and later-life lung function.

### Ethylbenzene and styrene exposures among pregnant women are associated with decreased male newborns birthweight

Tal Michael<sup>1</sup>, Ori Hochwald, Liron Borenstein-Levin, Amalia Levy, Sharon Daniel, Elkana Kohn, Ariela Hazan, Matitahu Berkovitch, Anna Brik, Adi Malkoff Rabin, Moshe Betser, Miki Moskovich, Ayelet Livne, Rimona Keidar, Frieda Schwartzburd, Zeev Weiner, Ido Solt

<sup>1</sup>Ben-Gurion University of The Negev, Israel

#### Abstract

**Introduction:** Prenatal exposure to volatile organic compounds (VOCs) has been associated with adverse health outcomes among newborns in several studies. However, little is known about the effect of VOCs at relatively low concentrations on newborn outcomes. Hence, this study aimed to investigate associations between prenatal exposure to VOCs and VOCs mixtures with anthropometric measures of newborns.

**Methods:** We recruited 883 mother-term infant pairs who lived in urban areas in Israel and were admitted to the delivery rooms of two major hospitals between 2016 and 2020. Associations between VOC metabolites detected in maternal urine samples on the day of delivery with weight, length, and head circumference at birth were examined using linear and weighted quantile sum (WQS) models.

**Results:** Most urinary VOC metabolites examined in our study were observed in concentrations similar to those previously reported in international human biomonitoring projects conducted in Europe and North America. In the linear as well as the WQS models, decrease in male newborns birthweight was associated with higher levels of Phenylglyoxylic acid, ethylbenzene/styrene metabolite.

**Discussion:** Our findings enable us to examine the association between prenatal exposure to VOCs, in concentrations common for the general urban population and anthropometric measures of newborns. Ethylbenzene/styrene metabolite was suggested to be the most predominant VOC in the mixture analysis, and its associations with birth weight was negative. Since birthweight alterations could represent other disrupted developmental pathways yet to be detected, the suggested associations should be further investigated and could shed light on complex.

### Associations between prenatal PFAS exposure and preadolescents cardiometabolic health.

Naomi Lejeune<sup>1</sup>, Elke Rouxel, Christine Monfort, H el ene Tillaut, Florence Rouget, Nathalie Costet, Frank Giton, Eric Gaudreau, Fabrice Lain e, Ronan Garland ezec, Sylvaine Cordier, C ecile Chevrier, Charline Warembourg

<sup>1</sup>Univ Rennes, Inserm, EHESP, Irset (Institut de recherche en sante, environnement et travail)

#### Abstract

**Introduction:** A number of studies have examined the effects of prenatal exposure to per- and polyfluoroalkyl substances (PFAS) on childhood obesity, but report inconsistent results. Moreover, few studies have

integrated biological markers to achieve a more comprehensive view of cardiometabolic health. The aim of this study was to investigate the associations between prenatal exposure to PFAS and cardiometabolic health parameters at age 12, considering pubertal stage.

**Methods:** This study included 394 mother-child pairs enrolled in the PELAGIE mother-child cohort (France). Nine PFAS were measured in umbilical cord blood and the children participated in a clinical visit at age 12. Anthropometry, blood metabolic markers, and blood pressure were measured and used to build an internal cardiometabolic score. Linear regression models were used to study the associations between each PFAS and cardiometabolic health parameters, and mixture analyses are ongoing. All analyses were adjusted for confounding factors and stratified by sex and pubertal stage.

**Results:** No statistically significant association was observed between prenatal exposure to PFAS and cardiometabolic score at age 12. In menstruated girls, perfluorohexane sulfonate [PFHxS] was statistically significantly associated with a decrease in a number of adiposity parameters (e.g., Body mass index z-score:  $\beta$  [95%CI] = -0.37 [-0.67; -0.07]), as well as a decrease in leptin levels. A number of isolated associations have also been observed in specific population groups including higher systolic blood pressure, changes in cholesterol levels (high- and low-density lipoproteins), and lower adiponectin levels.

**Conclusion:** Overall, there is no clear evidence of an association between prenatal exposure to PFAS and the cardiometabolic score at age 12. However, the results observed in menstruated girls suggest the importance of considering the intricate relationship between sex and pubertal stage in these associations.

### AIR POLLUTION: FROM AIR QUALITY STANDARDS TO HEALTH IMPACTS AND BEYOND

#### Does modelled mobility matter for air pollution exposure assessment? An evaluation of mortality in Switzerland

Danielle Vienneau<sup>1</sup>, Benjamin Fl uckiger, Ayoung Jeoung, Oliver Schmitz, Kalliopi Kyriakou, Derek Karssenber, Roel Vermeulen, Nicole Probst-Hensch, Gerard Hoek, Kees de Hoogh  
<sup>1</sup>Swiss Tropical and Public Health Institute, Allschwil, Switzerland, and University of Basel, Basel, Switzerland

#### Abstract

**Introduction:** Large cohorts studying the health effects of air pollution traditionally only use residential location in the exposure assessment, ignoring space-time activity patterns that influence total exposure. We aimed to evaluate whether mortality associations based on mobility-enhanced (ME) exposures differed from those derived by the traditional approach.

**Methods:** Mobility from each residence was estimated with Agent-Based Modelling (ABM), based on commuting patterns to 50 randomized work locations for population profiles (combinations of age, sex, socio-economic and employment status) defined from census data. Exposure to NO<sub>2</sub> and PM<sub>2.5</sub> (hourly models) were estimated at the residence (RES) and including mobility (ME) for all adults in the Swiss National Cohort. With follow-up from 2010 to 2018, associations were determined using Cox proportional hazards models, adjusted for individual and neighbourhood factors.

**Results:** The cohort included 3.4 million adults (>30 years, 29.1 million person-years), with 375,545 natural deaths. RES and ME exposures were comparable and highly correlated (mean [SD] in  $\mu\text{g}/\text{m}^3$ : 17.0 [7.6] vs. 16.9 [6.7] for NO<sub>2</sub>; 13.5 [2.8] vs. 13.3 [2.5] for PM<sub>2.5</sub>, respectively;  $r=0.99$  by pollutant). Both pollutants were associated with natural mortality. Effect estimates were similar with 1.040 (1.030 - 1.041) for RES and 1.035 (1.029 - 1.042) for ME per 10  $\mu\text{g}/\text{m}^3$  NO<sub>2</sub>, and 1.020 (1.012 - 1.027) for RES and 1.018 (1.010 - 1.026) for ME per 5  $\mu\text{g}/\text{m}^3$  PM<sub>2.5</sub>.

**Conclusion:** At the population-level, ABM-based mobility did not notably alter the modelled exposure and effect estimates for the natural

mortality associations. This research suggests that air pollution exposure assessed at the residential location is valid in settings comparable to Switzerland.

### Long-term exposure to concentrations of air pollutants and incidence of cancer in the Sacco river cohort study

Letizia Leccese<sup>1</sup>, Emanuela Carloni, Chiara Badaloni, Matteo Renzi, Daniela D'Ippoliti, Ilaria Cozzi, Enrica Santelli, Paola Michelozzi

<sup>1</sup>Department of Epidemiology, Lazio region Health Service ASL Roma1

#### Abstract

**Introduction:** The River Sacco Basin (RSB) is a contaminated area located in the Lazio region, characterized by a strong industrial pressure which significantly affects air quality. Air pollution has been classified as group 1 carcinogen by IARC. Moreover, some studies have shown an effect on Trachea, Bronchus and Lungs, breast e other types of cancer. The aim of this study is to estimate the association between long-term exposure to air pollution and incidence of cancer in an administrative cohort of residents in the RSB area.

**Methods:** Residents living in the RSB area were enrolled during 2013-17 period. Health data from the Lazio Region Cancer Registry were used to define incidence of several outcomes: Trachea, Bronchus and Lungs (ICD0-3 codes:C33-C34), Breast (C50), Colorectal (C18-C21), Thyroid (C73) and Leukemia (C91-C95). Exposure to PM10, PM2.5, NO2 and C6H6 was defined at residential address for each subject by using dispersion models with a spatial resolution of 1 km2. Cox regression models adjusted for individual (age, sex) and area-level covariates (deprivation index) were used to estimate the hazard ratios (HRs) and 95% confidence intervals (95%CI) per pollutant-specific interquartile range (IQR) increases.

**Results:** We analyze 573721 subjects and 6620 incident cases. The results highlight an excess risk for each pollutant. We observe an excess risk for Breast cancer and Leukemia for PM2.5 exposure (HR=1.08;95%CI 1.02-1.14 and HR=1.17;95%CI 1.01-1.36). Benzene, a known air pollutant carcinogen is associated with an increased risk for Colorectal (HR=1.08;95%CI 1.04-1.12), Trachea, Bronchus and Lungs (HR=1.13;95%CI 1.03-1.23) and Thyroid cancer (HR=1.26;95%CI 1.11-1.42).

**Conclusions:** These results suggest an excess of risk of cancer incidence and air pollution exposure for the residents in the RSB area. The strongest associations were found for Colorectal, Lung and Thyroid cancers. Further comprehensive studies are needed to explore the evidence fouded.

### Urban Burden of Disease Estimation for Policy Making (UBDPolicy): Health Impact Assessment of environmental stressors

Georgia Dyer<sup>1</sup>, Sasha Khomenko, Mark Nieuwenhuijsen

<sup>1</sup>Instituto de Salud Global Barcelona

#### Abstract

**Introduction:** The Urban Burden of Disease Estimation for Policy Making (UBDPolicy) project aims to estimate the health impacts resulting from urban and transport planning related exposures in nearly 1000 European cities. So far, quantitative burden of disease assessments have been conducted for the year 2015, and estimated premature mortality due to current levels of environmental stressors: air pollution, noise, urban heat islands and lack of green space. Regularly reporting on environment-related impacts on disease burden is urgently needed to estimate the wider impacts and trends.

**Methods:** For almost 1000 cities, quantitative Health Impact Assessments (HIAs) will be conducted that employ the comparative risk assessment methodology. Baseline exposure levels of air pollution, noise, green space and heat for the years 2015, 2018, 2021 and 2024 will be estimated and preventable health impacts modelled using counterfactual exposure scenarios.

**Results:** Results are intended to shape evidence-informed urban planning and policies throughout Europe. By ranking cities according to environmental exposures and health impacts, cities are encouraged to address challenges and learn from successful urban design and planning policies in other cities.

**Discussion:** HIAs serve as an effective tool for identifying the health impacts of current and future urban policies. The provision of burden of disease estimates will provide policy-makers and practitioners robust data for informed decision-making and estimates over time will allow tracking of changes from implemented policies. To fully harness the potential of cities as key drivers of sustainable and healthy living, robust evidence must be at the forefront of this change.

### Outdoor air pollution and risk of testing positive for SARS-CoV-2: a test-negative case-control study in the Netherlands

Mariana Simões<sup>1</sup>, Jelle Zorn, Lenny Hogerwerf, Guus Velders, Lützen Portengen, Miriam Gerlofs-Nijland, Marieke Dijkema, Maciek Strak, José Jacobs, Lidwien Smit, Roel Vermeulen, Lapo Mughini Gras

<sup>1</sup>Institute for Risk Assessment Sciences (IRAS), Faculty of Veterinary Medicine, Utrecht University, Utrecht, the Netherlands

#### Abstract

**Introduction:** Air pollution is a known risk factor for several diseases, but the extent to which it influences COVID-19 compared to other respiratory diseases remains unclear.

**Methods:** We performed a test-negative case-control study among people with COVID-19-compatible symptoms who were tested for SARS-CoV-2 infection, to assess whether their long- and short-term exposure to ambient air pollution was associated with testing positive for SARS-CoV-2. We included all adult residents in the Netherlands tested for SARS-CoV-2 in June-November 2020, when only symptomatic people were tested, and modelled ambient concentrations of PM10, PM2.5, NO2 and O3 at residence location. Long-term exposure analysis included 1.7 million tests and considered average concentrations of PM10, PM2.5 and NO2 in 2017-2019 and different sources of PM (industry, livestock, other agricultural activities, road traffic, other Dutch sources, foreign sources). Short-term exposure analysis included 2.7 million tests and considered 1- and 2-week average concentrations of PM10, PM2.5, NO2 and O3 before testing day. We used mixed-effects logistic regression adjusted for several individual level confounders and for municipality and testing week to account for spatiotemporal variation in viral circulation.

**Results:** We found no statistically significant effect of long-term exposure to pollutants' overall concentrations on the odds of testing positive for SARS-CoV-2. However, we observed significant positive associations for PM10 and PM2.5 from foreign and livestock sources, and for PM10 from other agricultural sources. Short-term exposure to PM10 (adjusted for NO2) and PM2.5 were also positively associated with increased odds of testing positive.

**Discussion:** While these exposures seemed to increase COVID-19 risk relative to other respiratory diseases, the underlying biological mechanisms remain unclear. This study reinforces the need to continue to strive for better air quality to support public health.

### Recommendations for new air quality standards to protect health in Switzerland

Meltem Kutlar Joss<sup>1</sup>, Nino Künzli, the Swiss Federal Commission of Air Hygiene

<sup>1</sup>Swiss TPH and University of Basel

#### Abstract

**Background:** Switzerland's Environmental Protection Act calls for measures on ambient limit values and air pollution that appropriately protect the environment and the health of the entire population,

including particularly sensitive groups. Since the new air quality guideline by WHO in 2021 the current standards do not adequately reflect the current knowledge on adverse health effects.

**Methods:** Reflecting the WHO recommendations, the statutory mandate, and current levels of air pollution, the Federal Commission for Air Hygiene (FCAH) has assessed the situation. Additionally, a health risk assessment has estimated the health gains for Switzerland when reaching the WHO air quality guideline levels in Switzerland.

**Results:** The FCAH recommends amending the Air Pollution Control Ordinance (OAPC) for six pollutants (SO<sub>2</sub>, NO<sub>2</sub>, CO, O<sub>3</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>) to align the ambient air quality standards with the WHO's revised levels. Ultrafine particles, elemental carbon, dust storms as well as polycyclic aromatic hydrocarbons and metals in particulate matter are addressed as well. The health risk assessment revealed that an additional 2'200 premature deaths can be avoided compared to the current standards.

**Discussion:** National and international research over the past 20 years has shown that air pollutants have adverse health effects even at significantly lower concentrations. Therefore, more ambitious air quality standards are proposed promising additional health gains for the Swiss population.

### Systematic review on health effects of long-term exposure to UFP

Pascale Haddad Thoeke<sup>1</sup>, Haeran Jeong, Ron Kappeler, Hicran Altug, Zorana Jovanovic Andersen, Marie Bergmann, Hanna Boogaard, Meltem Joss Kutlar, Youn-Hee Lim, Steffen Loft, Tobias Pohl, Barbara Hoffmann

<sup>1</sup>Institute for Occupational, Social and Environmental Medicine, Centre for Health and Society, Medical Faculty, University of Düsseldorf, Düsseldorf, Germany

#### Abstract

**Introduction:** Due to their small size, ultrafine particles (UFP≤100nm) can reach deeply into the lungs and could exert higher toxicity on the body organs in comparison with fine particulate matter. Only 10 epidemiological studies examined long-term UFP exposure and health effects according to the most recent review from 2019 that included studies until 2017.

We systematically reviewed the literature on health effects of long-term exposure to UFP.

**Methods:** Epidemiological studies were searched comprehensively in PubMed and LUDOK (the Swiss literature database on air pollution and health) from January 2017 to September 2023. Original epidemiologic studies were included if they reported on the general or sub-populations, assessed long-term exposure of UFP measures, investigated clinical or preclinical health outcomes and reported a quantifiable measure of association. Internal validity of studies was evaluated with a risk of bias instrument. The project is funded by the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection and supervised by the German Environment Agency (FKZ 3721 61 202 0).

**Results:** We identified 53 original studies investigating long-term associations. The vast majority were cohort studies (79.2%) conducted in the general population (62.3%). Half (54.7%) were located in western Europe. UFP was measured and modelled in various ways; more than a third of the studies (41.5%) used land-use regression models. Thirty studies adjusted for at least one co-pollutant. Most identified outcomes were cardiometabolic (43.4%), respiratory (13.2%) and birth outcomes (13.2%). Positive associations with long-term UFP exposure were reported for cardiometabolic, respiratory and birth outcomes for 78.5%, 42.9% and 50.0% of studies, respectively.

**Conclusion:** The evidence base has increased substantially since the publication of the 2019 review. Positive associations were reported, in particular for cardiometabolic outcomes.

### Association between pollution and meteorological conditions, and age-related cataract in Israel. Nationwide study

Nitzan Sagie<sup>1,2</sup>, Ofira Zloto, Boris Knyazer, Lena Novack, Orly Weinstein

<sup>1</sup>Faculty of Health Sciences, Ben-Gurion University of the Negev, Beer-Sheva, Israel; <sup>2</sup>Negev Environmental Health Research Institute, Soroka University Medical Center, Beer-Sheva, Israel

#### Abstract

**Introduction:** Cataract is a medical condition characterized by gradual lens opacification, exhibiting increased prevalence with age. Consequently, studies have proposed the potential impact of environmental factors on cataract development.

**Methods:** We conducted a nationwide study in 2001-2022 involving 55% of Israel's population insured by Clalit HMO. We used a nested case-control approach to assess the association between environmental factors and cataract surgery using average annual estimates of temperature, humidity, solar radiation (SR), and exposure to particulate matter with a diameter less than 10 and 2.5 microns (PM<sub>10</sub>, PM<sub>2.5</sub>), sulfur dioxide (SO<sub>2</sub>), ozone (O<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and carbon monoxide (CO). Diagnosed patients were individually matched with two controls without disease by age, gender, and ethnicity. The individual data included demographics and clinical history for both study groups. Ambient exposure concentrations were estimated from monitoring stations. A spatial join assigned exposure estimates to each subject, Using one-year pre-cataract surgery averages as an extended exposure proxy. We applied direct acyclic graphs to select a minimal adjustment set.

**Results:** The study included 82,263 subjects with cataract surgery and 164,526 controls. Single-pollutant models identified independent associations with environmental factors measured in quartiles: PM<sub>10</sub> (relative risk (RR)=1.21, 95% confidence interval (CI):1.18-1.24), PM<sub>2.5</sub> (RR=1.22, 95%CI:1.18 to 1.25), O<sub>3</sub> (RR=0.80, 95%CI:0.78-0.83), CO (RR=1.28, 95%CI:1.24-1.32), temperature (RR=1.18, 95%CI:1.15-1.20), humidity (RR=1.10, 95%CI=1.08-1.12) and SR (RR=1.20, 95%CI:1.17-1.22) Multipollutant models and subgroup analysis indicating sensitive groups will be presented.

**Discussion:** Our findings emphasize the role of environmental factors in cataract pathogenesis, urging clinicians to consider prevention strategies, particularly in regions with high exposure to risk factors.

### Identification and spatiotemporal trends of PM2.5 hotspots in India: a nationwide approach

Suganthi Jaganathan<sup>1,2,3</sup>, Kevin Lane, Ajit Rajiva, Amruta Nori-Sarma, Anubhuti Dutta, Dorairaj Prabhakaran, Gagandeep Kaur Walia, Gregory Wellenius, Heresh Amini, Itai Kloog, Jeroen de Bont, Jyothi Menon, Massimo Stafoggia, Praggya Sharma, Shweta Dixit, Joel Schwartz, Poornima Prabhakaran, Petter Ljungman, Siddhartha Mandal

<sup>1</sup>Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden; <sup>2</sup>Centre for Health Analytics Research and Trends, Ashoka University, Sonapat, Haryana, India; <sup>3</sup>Centre for Chronic Disease Control, Delhi-NCR, India

#### Abstract

**Introduction:** Ambient air pollution is linked to mortality and chronic diseases globally. Identifying areas in cities and states of India where PM<sub>2.5</sub> levels are either historically high or increasing rapidly can guide mitigation policies.

**Methods:** We conducted a spatial analysis using Getis-Ord Gi statistics on annual levels of PM<sub>2.5</sub> for every state and 6 cities in India from 2008-2019 derived from a nationwide spatiotemporal model. Hotspots were identified annually using Gi\* score and p-value and temporal trends across 2 periods [T1:2008-2013 & T2:2014-2019]. Consistent



hotspots: hotspots for  $\geq 5$  years in T1 and  $\geq 3$  years in T2. Declining hotspots: hotspots for  $\geq 3$  in T1 &  $\leq 2$  in T2. Emerging hotspots: hotspots for  $\leq 3$  in T1 and  $\geq 4$  in T2.

**Results:** In India, we have identified 370057; 93114; and 98253 grids as consistent, emerging, and declining hotspots over 12 years respectively. Among states, Rajasthan had largest area share of consistent hotspots, and Maharashtra had both largest areas share of emerging hotspots and declining hotspots. PM<sub>2.5</sub> levels ranged from 23–81  $\mu\text{g}/\text{m}^3$ -consistent hotspots; 20–71  $\mu\text{g}/\text{m}^3$ -emerging hotspots; 18–70  $\mu\text{g}/\text{m}^3$ -declining hotspots. Uttar Pradesh (388mil) had greatest number of people living in consistent hotspots and Maharashtra (169mil) had greatest number of people living in emerging hotspots. Uttar Pradesh (108mil) had highest number of people living in declining hotspots. Among cities, Delhi had highest level of PM<sub>2.5</sub> (130  $\mu\text{g}/\text{m}^3$ ) for consistent hotspots, Chennai had highest % area within the city identified as a consistent hotspot, and Kolkata had most densely populated consistent hotspots (42mil) and emerging hotspots (19mil). The number of emerging hotspots was higher in Delhi with PM<sub>2.5</sub> level of 120  $\mu\text{g}/\text{m}^3$ .

**Discussion:** Identifying the hotspots can provide a strategic approach for targeted action in air quality management, appropriate resource allocation as well as a baseline for assessing the effectiveness of interventions and policies.

## ENVIRONMENTAL JUSTICE FROM DIFFERENT PERSPECTIVES

### A systematic review of the effectiveness of nature-based social prescribing practices to combat loneliness

Ashby Sachs<sup>1</sup>, Annika Kolster, Jordan Wrigley, Veronika Papon, Nerkez Opacin, Nicholas Hill, Michelle Howarth, Ursula Rochau, Laura Hidalgo, Cristina Casajuana, Uwe Siebert, Janina Gerhard, Carolyn Daher, Sibylle Puntsher, Jill Litt

<sup>1</sup>Barcelona Institute for Global Health (ISGlobal)

#### Abstract

**Introduction:** Loneliness is increasingly recognized as an urgent public health issue due to its impact on mental and physical health, and well-being. We lack comprehensive and evidence-based solutions to this global problem. Emerging evidence suggests contact with nature and green space may reduce loneliness by facilitating belonging and social cohesion. This review aimed to explore whether such positive outcomes can be enhanced via group-based interventions in nature.

**Methods:** We conducted a mixed-methods systematic review to evaluate and characterize literature on nature-based social interventions for their effectiveness in reducing loneliness. We included all age groups, in populations with or without reported health problems. Using the Mixed Methods Appraisal Tool, we assessed the quality of included qualitative, quantitative and mixed methods studies.

**Results:** The 38 studies identified describe a wide variety of interventions and target groups. The quantitative studies included mostly small sample sizes with small or moderate effects. The qualitative studies, however, showed more clearly that these interventions can reduce loneliness. Group-based activities including natural elements cultivated connectedness and belonging, which are key mechanisms to reducing loneliness. Specifically, longer interventions showed greater promise.

**Discussion:** Policy and practice recommendations include loneliness screening, more precise definitions of loneliness, and the need to evaluate intervention effectiveness over time. This review provides perspectives to inform policymakers, urban planners, and researchers on how group-based interventions in nature can facilitate social connection. By linking landscapes with public health concerns, municipalities can further promote and amplify the value of urban nature to the public.

### A Gap Analysis on heat adaptation measures targeted to vulnerable groups. Results from the ENBEL project

Elena Mazzalai<sup>1</sup>, Francesca De' Donato, Manuela De Sario,

Paola Michelozzi, Julian Natukunda, Sari Kovats

<sup>1</sup>Department of Epidemiology, Lazio Region Lazio regional health service - ASL Roma1, Italy

#### Abstract

**Introduction:** Europe is one of the regions most affected by climate change, and rising temperatures are an increasing concern. Heat prevention plans and responses to vulnerable groups have improved in recent years, but there still is a lack of evidence on their effectiveness. As part of the ENBEL Project (EU H2020 program), this study aimed at identifying gaps in evidence and barriers to the implementation of adaptation measures to heat to vulnerable groups.

**Methods:** A scoping review was performed to summarise the evidence on prevention measures towards the most at risk to heat exposure and semi-structured interviews with key informants involved in heat health adaptation to gather further insights on current practices and barriers to action were carried out. Gaps were categorised under four crosscutting themes (systemic/governance, technical & operational, communication, monitoring & evaluation) and ranked according to their priority.

**Results:** 49 of the 8608 articles retrieved were qualitatively synthesised. Prevention measures mainly addressed elderly persons, outdoor workers, athletes and were either preparatory (i.e. educational programs, information campaigns) or actions implemented during heatwaves (active outreach, opening of cooling centres, emergency protocols). Few evaluations of the prevention actions are available, and many vulnerable groups are not adequately covered. The gaps emerging from the eight interviews matched and integrated those from the literature. The limited policy commitment and necessary regulations were deemed as main barriers to ensure adequate action. Data regulation, insufficient resource allocation, lack of monitoring and evaluation and poor governance have also been pointed out as major obstacles to action.

**Discussion:** Collaboration between institutions, stronger engagement with local communities, and better contacts with social services and NGOs, could foster a more efficient use of services and enhance their uptake.

### Home (Un)Safe Home: A Mixed-Methods Exploration of the Impact of Housing Conditions on Maternal Mental Health in Lebanon

Emile Whaibeh<sup>1,2</sup>, Georges Abi Tayeh, Norma Aouad, Joway Abi Hanna, Nancy Yaghi, Hadiya Leya Affara, Myriam Mrad Nakhlé

<sup>1</sup>Institut Supérieur de Santé Publique, Faculté de Médecine, Université Saint-Joseph de Beyrouth, Beirut, Lebanon; <sup>2</sup>Department of Public Health, Faculty of Health Sciences, University of Balamand, Beirut, Lebanon

#### Abstract

**Introduction:** Housing conditions play an important role in shaping maternal mental health (MMH) and wellbeing. In Lebanon, MMH vulnerability was amplified by the COVID-19 containment efforts, political instability, and the protracted economic crisis. This comprehensive exploration underscores the association between indoor and outdoor environmental factors and the wellbeing of pregnant women as well as their pregnancy- and COVID-specific anxiety.

**Methods:** The study adopts an embedded mixed method design. Participants (N=83) were recruited from Hôtel-Dieu de France hospital in Beirut, as part of the Environmental Exposures in Lebanese Infants (EELI) pilot study. Prenatal wellbeing was assessed using WHO Wellbeing Index [WHO-5], pregnancy-relaxed anxiety questionnaire (PRAQ-R2) and COVID-specific anxiety scale (CAS). Bivariate and multivariate analyses were conducted to identify household characteristics linked to decreased MMH. Moreover, a qualitative component with 28 participants provided in-depth insights into how housing conditions affected the mental health of pregnant women in Lebanon.

**Results:** Poor maternal wellbeing was observed in 23.17% of the participants, while 47% screened positive for PRAQ-R2, with the fear of giving birth to a disabled child being the highest domain. COVID-19 anxiety scores were low. Lower WHO-5 scores correlated with factors like the presence of pets and proximity to heavy traffic roads, whereas higher PRAQ-R2 scores were associated with moldy smells and proximity to diesel generators. Household characteristics showed no significant difference in CAS scores. Qualitative analysis revealed economic and political instability as stressors affecting women's comfort, mobility, safety at home, and ability to provide essentials.

**Discussion:** In the perinatal period, marked by psychological changes, recognizing MMH vulnerability is key to developing interventions addressing their mental health needs, before, during, and after childbirth.

### Socioeconomic Disparity in Residential Greenspace Attributable COVID-19 Risk: A Nationwide Cohort Study in Denmark

Jiawei Zhang<sup>1</sup>, Youn-Hee Lim, Jie Chen, Samuel Hyman, Stéphane Tuffier, Marie Bergman, Tom Cole-Hunter, George Napolitano, Matthias Ketzler, Jørgen Brandt, Gerard Hoek, Steffen Loft, Zorana Jovanovic Andersen  
<sup>1</sup>Section of Environmental Health, Department of Public Health, University of Copenhagen

#### Abstract

**Background:** Identifying modifiable urban determinants of health is crucial in improving population's resilience to infectious disease. We aimed to examine the association between residential greenspace and COVID-19 morbidity and mortality using a Danish Nationwide Cohort, and to estimate the potential health benefits of greening initiatives across vulnerable groups by socioeconomic status (SES) and comorbidities.

**Methods:** We followed all Danish adults aged 50 or older (N=2,111,233) using the Danish National COVID-19 Surveillance System for COVID-19 related events, including infection, hospitalization and mortality, from 1 March 2020 to 26 April 2021. Greenspace was characterized using Normalized Difference Vegetation Index (NDVI) at 300m resolution and linked to residential addresses. Cox regression model was used to assess the association between residential greenspace and COVID-19 risk. Health impact assessment was applied to estimate the preventable burden.

**Results:** During an average of 14 months' follow-up, 62,880 participants were infected with SARS-CoV-2. Among them, 8,759 were hospitalized and 2,382 died with COVID-19. We observed a consistent negative association between residential greenspace and COVID-19 risk, with hazard ratio (95% confidence interval) of 0.96 (0.91, 1.01) for COVID-19 mortality, 0.97 (0.94, 0.99) for COVID-19 hospitalization, and 0.98 (0.97, 0.99) for incident SARS-CoV-2 infection per 0.08 unit increase in NDVI. Stronger associations were observed in the elderly, those with lower SES and cardiometabolic diseases. We further found that improving in residential greenspace would have prevented 8%-14% of COVID-19 events during the 14 months, with the most benefits accruing to socially disadvantaged groups by age, income, education and employment.

**Conclusion:** Improving residential greenspace could prevent respiratory infections disease, including COVID-19, particularly with socially disadvantaged groups benefiting most.

### Environmental and socioeconomic contextual factors and cognitive function: results from the Heinz Nixdorf Recall Study

Katherine Ogurtsova<sup>1</sup>, Grace M Christensen, Vanessa J Soppa, Martha Jokisch, Lilian Tzivian, Christian Weimar, Nico Dragano, Børge Schmidt, Anke Hüls, Barbara Hoffmann  
<sup>1</sup>Katherine Ogurtsova, Grace M Christensen (GC)2,3, Vanessa J Soppa (VS)1, Martha Jokisch (MJ)4, Lilian Tzivian (LT)1,5, Christian Weimar

(CM)6, Nico Dragano (ND)7, Børge Schmidt (BS)6, Anke Hüls (AH)2,3, Barbara Hoffmann (BH)1

#### Abstract

**Introduction:** Area level social deprivation, heightened noise and air pollution contribute to health disparities, with a particularly concerning impact on cognition in aging societies. Our study employs cutting-edge methods to analyze the impact of correlated contextual factors on cognitive function in German participants aged 50 and above.

**Methods:** In the German cohort of Heinz Nixdorf Recall study, participants underwent 5 neuropsychological tests (2006–2008). A global cognitive score (GCS) sums standardized test scores. Long-term exposure to air pollution was estimated by the land-use regression and chemistry transport models. Road traffic noise was assessed as outdoor weighted 24h and nighttime means. 7 neighborhood-level socioeconomic status (nSES) characteristics were linked from administrative data. The joint effects of exposure mixture on GCS were estimated using principal component (PC) analysis, quantile-based G-computation (QGC), and self-organizing maps (SOM).

**Results:** Overall, 3748 individuals were included (mean age 64.3 years; 49.4% men). Higher PM2.5 and NOx exposure, higher proportion of welfare recipients in the neighborhood, and higher number of residents per m2 were negatively associated with GCS. The first PC of the total exposure mixture, positively correlated with social disadvantages and higher environmental burden, was associated with lower GCS. SOM revealed associations with lower cognitive scores for 3 of 6 exposure clusters. Clusters characterized by low nSES, high environmental exposure and all exposures being moderately elevated were associated with lower GCS. QGC showed no conclusive results.

**Discussion:** Our findings demonstrate harmful joint effects of environmental and socioeconomic exposures on cognitive function. Considering these joint effects is crucial for informing targeted interventions to address environmental injustice.

### Do environmental and social inequalities amplify heat exposure during pregnancy? An analysis of 4 French birth cohorts

Lucie Adélaïde<sup>1,2</sup>, Aurélie Nakamura, Ariane Guilbert, Nolwenn Regnault, Stéphanie Vandentorren, Morgane Stempfelet, Ian Hough, Emie Seyve, Sam Bayat, Marie-Aline Charles, Cécile Chevrier, Barbara Heude, Rémy Slama, Itai Kloog, Johanna Lepeule\*, Mathilde Pascal\*

\* These authors contributed equally to this work.<sup>1</sup>Santé publique France, 12 rue du Val d'Osne, 94415 Saint-Maurice Cedex, France; <sup>2</sup>Université Grenoble Alpes, Inserm, CNRS, IAB, Site Santé, Allée des Alpes, 38700 La Tronche, France

#### Abstract

**Objective:** Pregnant women are vulnerable to climate change, especially heat. Yet, studies on heat health effects neglect co-exposures like vegetation and air pollution that may be further exacerbated by social stressors. We characterized heat, air pollution and vegetation co-exposure according to social position (SP) and socioeconomic context (SC) among pregnant women in 4 French mother-child cohorts.

**Methods:** Analyses focused on summer exposures of EDEN (2003-2006; Nancy-Poitiers), PELAGIE (2002-2006; Brittany), SEPAGES (2014-2017; Grenoble) and ELFE (2011; France) participants.

Daily temperatures, PM2.5, PM10, NO2 and O3 concentrations, were estimated at home address using high spatial resolution model. Classes of exposure to heat (combination of severity, intensity and duration), air pollution (combination of the 4 pollutants) and individual SP (combination of father's and mother's socio-professional category, education, region of birth, employment, relationship status) were created through multivariate analysis and unsupervised clustering. Lack of vegetation was assessed using Normalized Difference Vegetation Index

and an indicator of greenspaces exposure. The SC was assessed with the European Deprivation Index at home address.

**Results:** The 12,243 pregnant women were classified into low, intermediate, or high level for each exposure and SP. Participants with high exposure to heat, air pollution, green spaces or low SP were often concentrated in densely populated urban areas (respectively 47%, 81%, 56% and 40%) compared with intermediate density and rural areas. Women with high SP had more severe and longer heat exposure than those with low SP (110.6°C vs 105.5°C of cumulated degrees above reference temperatures; 42.0 days vs 41.6 days of overexposure).

**Conclusion:** This study lays the groundwork for future epidemiological studies investigating the combined effects of heat, air pollution and vegetation on pregnancy complications, considering social factors.

### Exploring the gap of environmental and socioeconomic data in the French overseas departments and regions

Marie GRANDJEAN<sup>1</sup>, Mathilde PASCAL, Morgane STEMPELET, Johanna LEPEULE, Lucie ADELAIDE

<sup>1</sup>Santé publique France, 12 rue du Val d'Osne, 94415 Saint-Maurice Cedex, France

#### Abstract

**Objective:** French overseas departments and regions are characterised by very unfavourable socio-economic and health conditions compared with continental France. Yet, little is known on environmental exposures and their health effects in these areas. It can be explained by the scarcity and/or difficulty of identifying and accessing environmental and socio-economic data. This study aimed to map the local and national producers of environmental and socio-economic data, identify the type of data, and assess their quality, accuracy, and relevance regarding the local context of each territory.

**Material and methods:** The areas investigated were Guadeloupe, French Guiana, Martinique, Mayotte, and Réunion. The data sought were temperature (measured or modeled data), humidity, air pollution (measured or modeled data of PM10, PM2.5, NO<sub>2</sub>, and O<sub>3</sub> concentrations), vegetation (land use maps, satellite images), and socioeconomic data. Two investigation methods were used. First, open data research was conducted on the Internet. Then, a map of local and national data producers and publishers was drawn up, followed by qualitative survey method based on interview grids to identify available data and its quality.

**Results:** Fewer data was available in the French overseas departments and regions than in continental France, and when available, it was often difficult to access (lack of open data, poor online visibility, difficulty downloading the data), of lower quality (poor spatial and temporal resolution), or not adapted to the local context (socio-economic indicators based on continental France specificities rather than overseas France ones). Moreover, there was an asymmetry of data between the different overseas territories (fewer data available in Mayotte).

**Conclusion:** It is necessary to develop the production and accessibility of data in French overseas, in order to encourage health-environment studies in these territories and tackle social and territorial health inequalities.

### Quantifying visible, functional, and accessible green and impacts of socioeconomic status: The case of Leuven, Belgium

Melissa Lee<sup>1</sup>, Raf Aerts, Jos Van Orshoven, Ben Somers

<sup>1</sup>Division of Forest, Nature and Landscape, KU Leuven, Leuven, Belgium

#### Abstract

**Introduction:** Early research regarding the role of green space for health focused mainly on green quantity, though recent research suggests visible, functional and accessible green have different and often complementary impacts on health. The “3-30-300 rule” popularizes

this approach, suggesting every resident view 3 trees from their home, have 30% neighborhood canopy cover, and a maximum of 300m to their nearest green space. This research investigates the extent to which these exposure thresholds are met in Leuven, Belgium, a compact city with 1,800 inhabitants/km<sup>2</sup> (2022) and strong green space gradients. Further, we investigate whether socioeconomic status (SES) gradients impact these green space exposures.

**Methods:** We used machine learning to count trees from Streetview images, high resolution vegetation maps to calculate canopy cover, and urban green accessibility maps to calculate distance to nearest accessible green space. We calculated the exposures for randomly selected residences (n=1326) within Leuven and averaged for each census tract (n=118) to pair with SES data (2017-2022). We used generalized linear mixed-effects models, adjusting for confounders and spatial autocorrelation, to evaluate associations of SES with the green exposures.

**Results:** An average of 3-22-323 was found for the Leuven municipality. Only 9 of 118 census tracts met the full rule, with 50%, 19%, and 53% of tracts meeting individual 3, 30, and 300 thresholds, respectively. Census tracts with older (60+) and non-European residents were less likely to meet the rule, while tracts with residents of higher average income and education levels more often met the full rule.

**Discussion:** Exposure and access to green space needs to be fairly distributed for residents to benefit, but improving nearby green space poses challenges for urban planners, given greater difficulties in creating new green spaces compared to increasing visible trees or overall canopy cover.

### Critical Epidemiology meets Environmental Humanities. What will planetary health gain?

Núria Pujol Furelos<sup>1</sup>, Valentina Gallo, Rina Knoeff, James Kennaway  
<sup>1</sup>Department of Sustainable Health, Campus Fryslân/Department of (Early Modern) History, Faculty of Arts (University of Groningen)

#### Abstract

**Introduction:** Since the 1970s Critical Epidemiology (CE) advocated for the need for alternative ideas of health at odds with the hegemonic neoliberal model, with a special sensibility on the scarcity of resources, a claim that resonates with discourses in environmental humanities (EH). In tandem, Planetary Health (PH) urges us to find solutions to global challenges from an interdisciplinary perspective.

**Methods:** The methodology is a hybrid conceptual framework that aims to nuance the concept of ecology in planetary health, which will consequently have a direct impact on conceptual frameworks of critical and environmental epidemiology. It draws on two forerunners of CE and EH, Bruno Latour and Nancy Krieger respectively.

**Results:** Bruno Latour and Nancy Krieger share a common idea of the relevance of the relationship between the idea of Anthropocene-like problems. Nancy Krieger's Ecosocial theory argues that we, humans, embody the inequalities of the environments we inhabit. Although Krieger's framework values ecology, it may benefit from Bruno Latour's principle to decenter humans from the focus through a process of “transference”. Latourian ecology is a horizontal relationship between human and non-human actors, a non-hierarchical symbiotic relationship. This symbiosis cannot only benefit Krieger's theory but it can also be extrapolated to the wider framework of PH.

**Discussion:** PH is described by the Planetary Health Alliance as “a solutions-oriented, transdisciplinary field and social movement”. However, academically speaking, it has mostly been studied from a natural sciences perspective, e.g. epidemiology, and environmental scientists. This paper argues that a theoretical framework for PH is urgent. The case of Latour-Krieger shows the potential of radical interdisciplinarity between the natural sciences and the humanities. Interdisciplinary theory attends to pragmatics and power dynamics which are usually hidden in research.

## Social Inequalities in Noise Annoyances from Neighbors in Denmark in 2021

Stine Kloster<sup>1</sup>, Michael Davidsen, Anne Illemann Christensen, Annette Kjær Ersboll

<sup>1</sup>National Institute of Public Health, University of Southern Denmark

### Abstract

**Objective:** To examine the distribution of noise annoyances from neighbors across socioeconomic status (SES) among people living in multi-storey housing.

**Material and Methods:** Cross-sectional data from the Danish Health and Morbidity Survey in year 2021 were used and linked at an individual level with information about SES (home ownership, educational level, and household income) from Danish administrative Registers. The study included a random sample of 3,157 individuals living in multi-storey housing. Information on noise annoyance from neighbors during the past two weeks was obtained from self-administered questionnaires. Differences across SES were tested using logistic regression adjusted for age and gender.

**Results:** A total of 34.4% of individuals living in multi-storey housing reported noise annoyances from neighbors. Noise annoyances were reported more frequently among individuals with lower household income compared to higher household income (35.3%, 36.7% 34.2% and 26.1% for 1st, 2nd, 3rd, and 4th household income quartile, respectively, OR 1.62 ( $p<0.001$ ), 1.70 ( $p<0.001$ ), 1.42 ( $p=0.02$ )) and among individuals living in rented apartments compared to owned apartments (36.1% vs. 23.9%, OR 1.74 ( $p<0.001$ )). The opposite pattern was seen across educational level, where annoyances were reported more frequently among individuals with a higher educational level (31.9%, 34.8% and 35.5% for elementary, upper secondary or vocational and higher education, respectively, OR 1.12 ( $p=0.28$ ) and 1.14 ( $p=0.15$ )). Insignificantly though.

**Conclusion:** Noise annoyances from neighbors were frequently reported among individuals living in multi-storey housing. Furthermore, individuals of lower SES reported noise annoyances from neighbors more frequently when SES was assessed by income and home ownership whereas no association was seen when SES was assessed by educational level.

## Occupational exposures in low- and middle-income countries: a scoping review

Valentina Quintero Santofimio<sup>1</sup>, Andre FS Amaral, Johanna Feary

<sup>1</sup>National Heart and Lung Institute, Imperial College London, London, UK

### Abstract

**Objective:** Accurate exposure assessment of occupational agents is important to investigate their impact on workers' health and particularly in low- and middle-income countries (LMICs) where rapid economic transformations is occurring, and unregulated industries are common. Our aim was to describe the quantitative exposure measurements of different occupational agents across industries within LMICs.

**Methods:** We conducted a scoping review of peer-reviewed publications available on Web of Science and PubMed from inception to 1 September 2023. We selected publications reporting quantitative occupational exposure measures in LMICs.

**Results:** Our review identified a total of 8,676 publications. Following screening, we retained 58 studies from 25 LMICs for final review. China, Iran, and Tanzania contributed the most studies. Exposure measures included vapour, gases, dust, and fumes (VGDF), solvents, metals, pesticides and particulate matter. Occupational exposure levels varied widely across geographical regions, for example, VGDF exposure from 0.04 to 7,026 mg/m<sup>3</sup> and metal exposure from 0.089 to 4,738 mg/m<sup>3</sup>. We also observed a decrease in the number of relevant publications in recent years.

**Conclusion:** Occupational exposure levels differ widely in LMICs. This study should encourage future research reporting measured exposure levels. This in turn, may contribute to adaptation of research tools such as job exposure matrices to use in assessment of the risk of occupational exposures in working populations in LMICs.

## CLIMATE & HEALTH

### Temperature-related mortality during the COVID-19 pandemic: a continental analysis in 805 European regions

Blanca Paniello-Castillo<sup>1,2</sup>, Marcos Quijal-Zamorano, Elisa Gallo, Joan Ballester

<sup>1</sup>ISGlobal, Barcelona, Spain; <sup>2</sup>Universitat Pompeu Fabra (UPF), Barcelona, Spain

### Abstract

**Introduction:** Some studies have investigated the effect of temperature and relative humidity on the transmission of SARS-CoV-2. However, none has assessed the relationship between temperature and mortality during the pandemic period. In this study we aimed to estimate the changes in the short term effects of temperature on mortality before and after the onset of the COVID-19 pandemic.

**Methods:** We analyzed the Eurostat mortality database, covering 805 contiguous regions in 32 European countries with a total of 49,478,919 counts of deaths. We applied distributed lag non-linear models (DLNM) with a two-stage approach, calculating the location-specific associations, followed by a multivariate meta-regression model. We used a reference fitting period from 2015 to 2019 to estimate the vulnerability before the onset of the COVID-19 pandemic, and a post-pandemic fitting with data from the period 2020-2023 to analyze changes in relative risks. We adjusted for COVID-19 by increasing the degrees of freedom (df) for specific time windows corresponding to pandemic waves in each region as per the WHO COVID-19 database. Departing from the standard choice of 8 df per year, we increased the degrees of freedom as necessary to effectively control for those waves.

**Results:** After adjusting for the COVID-19 waves, the relative risks and attributable mortality decreased in both heat and cold-related mortality during the period of 2020 to 2023 in Europe. Estimates derived from the reference fitting were lower than the ones from the post-pandemic fitting capturing the actual situation during COVID-19 era.

**Discussion:** Recent studies quantifying post-pandemic mortality burdens have chosen pre-pandemic periods to fit the associations. Our study demonstrates the need for both, the utilization of post-pandemic periods for predictions, and the adjustment of COVID-19. This represents more reliably the current vulnerability stemming from societal response changes of the post-pandemic period.

### Temperature and Inflammation: Investigating the Impact of Air Temperature on Biomarkers of Inflammation in Elderly Women

Bo Sun<sup>1</sup>, Ashtyn Areal, Nidhi Singh, Christian Herder, Tamara Schikowski

<sup>1</sup>Department of Epidemiology, IUF-Leibniz Research Institute for Environmental Medicine, Düsseldorf, Germany

### Abstract

**Introduction:** Despite the known influences of air pollution and lifestyle factors on subclinical inflammation, research on the potential effects of temperature in the elderly is limited. This study addresses this gap by examining the association between air temperature (AT) and biomarkers of subclinical inflammation in a cohort of elderly German women.

**Methods:** In this cross-sectional study, we analysed the relationship between daily AT (sourced from the German Weather Service's COSMO-REA6) and 11 plasma inflammatory biomarkers levels in 359

participants collected from the German SALIA cohort during the 2007–2010 follow-up examination. We focused on the effects of AT on these biomarkers over a 0 to 14 days lag of blood collection. A generalized additive model (GAM) was used to assess this association, adjusting for age, smoking status, medical history (cardiovascular or respiratory disease), and alcohol consumption.

**Results:** Participants had an average age of 74.1 years ( $SD \pm 2.6$ ). Among the 11 biomarkers studied, statistical significance between AT and C3C, MCP-1, ICAM-1, and TGF- $\beta$ 1 was observed at lag 0 in the adjusted model. Specifically, for every 1 °C increase in AT, there was a decrease in C3C (relative risk (RR) = 0.9932, 95% confidence intervals (CI): 0.9869–0.9995), ICAM-1 (RR = 0.9922, 95%CI: 0.9848–0.9997), and an increase in MCP-1 (RR = 1.018, 95%CI: 1.010–1.026), and TGF- $\beta$ 1 (RR = 1.033, 95%CI: 1.015–1.051). After accounting for lag effects, significant associations were also observed in soluble E-selectin, IL-6, and TNF- $\alpha$  over different lag days.

**Conclusion:** This study demonstrates that varying temperatures significantly affect biomarkers of inflammation, indicating diverse biological responses to climate changes. These findings suggest a potential link between ambient temperature and the regulation of immune mediators related to cardiometabolic disease risk, highlighting the importance of environmental factors in influencing inflammatory processes.

### Stroke risk associated with cold spells occurring during the warm season

Cheng He<sup>1</sup>, Susanne Breitner, Siqi Zhang, Markus Naumann, Claudia Traidl-Hoffmann, Gertrud Hammel, Annette Peters, Michael Ertl, Alexandra Schneider

<sup>1</sup>Institute of Epidemiology, Helmholtz Zentrum München - German Research Center for Environmental Health (GmbH), Neuherberg, Germany

#### Abstract

**Background:** Recent changes in climate have resulted in a rising frequency of extreme cold events that take place during the warm season. Few studies have investigated the impact of these warm-season cold spells on cardiovascular health.

**Objectives:** We aimed to estimate the association between the occurrence of stroke and exposure to cold spell events during the warm months in Augsburg, Germany.

**Methods:** We conducted a time-stratified case-crossover study using a validated, complete, and detailed registration of all stroke cases in the region of Augsburg, Germany, from 2006 to 2020 to assess the association between the occurrence of stroke and exposure to cold spell events during the warm months (May to October). Six cold spell definitions were created using different relative temperature thresholds (1st, 2.5th, and 5th percentiles) and durations (more than 1–2 consecutive days). Conditional logistic regression with distributed lag models was then applied to assess the accumulated effects of these warm-season cold spells on stroke risk over a lag period of 0–6 days, with adjustments for daily mean temperature.

**Results:** Warm-season cold spells were significantly linked to an elevated risk of stroke with significant effects that could persist three days after exposure. The cumulative odds ratio (OR) estimates for the cold spells using the 2.5th percentile as air temperature threshold reached 1.29 (95% confidence interval (CI): 1.09–1.53) and 1.23 (95%CI: 1.05–1.44) for durations more than one and two days, respectively. Warm-season cold spells also had significant associations with both transient ischemic attacks and ischemic strokes. The stratified analysis showed that the elderly population (aged  $\geq 65$  years), females, and stroke cases characterized by minor symptoms demonstrated a significantly increased stroke risk of the effects of warm season cold spells.

**Discussion:** This study presents strong evidence for a connection between warm-season cold spells and an increased

### How heat affects human health in Serbia: a review of evidence

Daniela Arsenović<sup>1</sup>, Stevan Savić, Jelena Dunjić, Zorana Lužanin

<sup>1</sup>University of Novi Sad, Faculty of Sciences, Trg Dositeja Obradovića 3, 21000 Novi Sad; email: daniela.arsenovic@dgt.uns.ac.rs

#### Abstract

**Introduction:** Climate change has caused a rise in global temperatures, producing more frequent and intense heat and heatwave periods. Heatwaves are already recognized as one of the most important climate-related causes of hospital admissions and mortality.

**Methods:** This paper aimed to present evidence about the effects of high temperatures and heatwaves on human health in Serbia, applying a scoping review of findings from selected studies revealing the association between high temperatures and hospital admission and mortality.

**Results:** The evidence consistently reported a link between high temperatures and mortality, and heatwaves were associated with increased mortality risk. Regarding the hospital admission, the most hazardous was the temperature change between neighboring days. Vulnerable groups also included the older population over 65 years, gender, and persons with pre-existing cardiovascular and respiratory disorders.

**Discussion:** To prevent adverse effects of high temperatures on mortality and hospital admissions, most vulnerable groups should be targeted. Our findings also indicate regional-specific action and policies as required for reducing exposure to heatwaves.

**Acknowledgement:** The research and assessments are supported by the project entitled: “Improving the environment in Vojvodina in order to adapt to climate change and reduce the risk of natural disasters” (no. 142-451-3485/2023-01), financed by the Autonomous Province of Vojvodina (regional government).

### Quantifying the anthropogenic contribution to heat-related mortality events with Extreme Event Attribution methods

Thessa Beck<sup>1</sup>, Lukas Gudmundsson, Dominik Schumacher,

Sonia Seneviratne, Hicham Achebak, Joan Ballester

<sup>1</sup>ISGlobal, Barcelona, Spain

#### Abstract

Heat, as the primary contributor to weather-related mortality on the European continent, has caused more than 61,000 heat-related deaths in Europe during the 2022 summer. We carry out this proof-of-concept study in which we apply Extreme Event Attribution methods combined with epidemiological models to quantify how anthropogenic warming has influenced extreme heat-related mortality events in Europe. In contrast to most health impact studies, we utilize open-access mortality data from Eurostat, which is available in near-real time. Because of the complex, non-linear relationship between temperature and mortality, we conduct separate Extreme Event Attribution analyses for (i) temperature extremes and (ii) associated heat-related mortality events in 232 distinct administrative regions spanning over 35 European countries. Our findings reveal that the probability of the maximum weekly values observed in 2022 has increased 12-fold [95th CI 3.51–147.15] for temperature and tripled [95th CI 1.02–18.63] for mortality compared to the pre-industrial baseline. Notably, we identify significant geographical disparities, e.g. in Spain the mortality risk is even 30 times higher due to anthropogenic warming. We find a statistically significant trend in 70% of all regions at the 0.95 significance level, and across all age and sex groups, except for women aged 65 years or less, indicating that anthropogenic warming affects almost the entire European population. This study establishes a foundation for subsequent analyses, not only for heat-related mortality events observed on different temporal and spatial scales but also for enabling an examination of other weather events and associated health impacts. This transdisciplinary work has to potential to provide key information for climate-related health lawsuits

and opens the door to inter- and transdisciplinary perspectives on how to integrate geoscience and epidemiology insights in litigation.

### Heat-related mortality in Europe in 2023: Exploring the contributions of adaptation on reducing mortality burden

Elisa Gallo<sup>1</sup>, Marcos Quijal-Zamorano, Raúl Fernando Méndez Turrubiates, Cathryn Tonne, Xavier Basagaña, Hicham Achebak, Joan Ballester

<sup>1</sup>Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain

#### Abstract

**Introduction:** The year of 2023 was the warmest on record globally, and second warmest in Europe, with almost half of the days exceeding the 1.5°C threshold established in the Paris Agreement. The previous episode of heat-related mortality happened in 2022 raised doubts about the role of adaptation in preventing deaths since prevention plans were developed, and what would have been the mortality burden in recent years without the effect of these actions.

We thus aim at quantifying the heat-related mortality burden in 2023, and calibrating epidemiological models in factual-counterfactual scenarios to evaluate the effectiveness of adaptation in protecting health in a context of rising temperatures.

**Methods:** We applied a two-stage approach to first estimate the location specific temperature-lag mortality relationship in each of the 823 contiguous regions of 35 European countries, and secondly pooled the coefficients using a multivariate multilevel meta-regression analysis to estimate sex- and age-specific heat-related mortality in Europe during the year of 2023. We also quantified the mortality burden avoided by climate change adaptation trends since the year 2000.

**Results:** We estimated 47,690 (95% CI = 28,853-66,525) heat-related deaths in 2023, the second highest mortality burden during the study period 2015-2023, only surpassed by 2022. Results stratified by sex showed higher heat-related mortality rate in women (women-to-men ratio = 1.55) and the elderly (ratio between 80+ and 65-79 years equal to 8.68). We also estimated that the heat-related mortality burden would have been +80.0% higher in absence of present-century adaptation, especially in women (+83.1%) and the elderly (+100.7% in people aged 80+ years).

**Discussion:** Our results highlight the importance of historical and ongoing adaptation in saving lives during recent summers, and the urgency for more effective strategies to reduce the mortality burden of forthcoming warmer summers.

### Heat-related deaths in England and Wales under climate change: contributions of adaptation, GHGs and aerosols

Kai Wan<sup>1</sup>, Shakoor Hajat, David Gampe

<sup>1</sup>London School of Hygiene and Tropical Medicine, London, UK

#### Abstract

The increase in temperature and the associated health impact is one of the most significant climate change effects. In addition to Greenhouse Gases (GHGs), aerosols also contribute to climate change. The global atmospheric aerosol emissions and concentrations have been increasing in the 20th century with an overall cooling effect on the earth's surface. In the early 21st century, global aerosol concentrations have started decreasing and is projected to continue decreasing until the end of the century, which has an overall warming effect and hence contributes to global warming in addition to GHGs. Although the warming effect of declining aerosols can lead to higher heat-health burden, there may also be positive health effects from improved air quality. This study aims to estimate the heat-related mortality burden in England and Wales and quantify the contribution of climate change in both the historical period of 1981-2019 and the future by the end of the 21st century. Furthermore, this research will distinguish the impact of GHGs from that of aerosols on the heat-health burden under climate change. In addition to temperature change, the heat-health burden is

largely affected by the extent to which people and society could adapt to heat, the contribution of which is also investigated in this research. This research fills the research gap of understanding the heat-health burden and attributing the change of it to GHGs, aerosols and population heat adaptation. The findings will provide valuable evidence for decision-makers in taking climate change mitigation and adaptation action plans.

### Effects of the Occurrence of Heatwaves on Stillbirth in Mombasa, Kenya

Katharina Wieser<sup>1</sup>, Tobias Monthaler, Chloe Brimicombe

<sup>1</sup>Wegener Center for Climate and Global Change

#### Abstract

**Introduction:** Exposure to extreme heat in pregnancy can increase the risk of stillbirth. Traditional studies often focus on heat exposure using daily temperature values, overlooking the potential effects of periods of elevated temperature lasting longer than one day. By using the occurrence of heatwaves as exposure metrics we aim to account for those effects shedding new lights on the potential health related risks posed to the health of mother and fetus.

**Methods:** A search algorithm to identify heatwaves on a country level is developed using different heatwave definitions defined by thresholds and length of heat occurrence. This will enable us to determine the number of heatwaves per month in a given area. By linking the results of our algorithm to stillbirth data from Aga Khan Mombasa Hospital, using epidemiological methods such as time-series-regression, we aim to determine the relative risks of stillbirth posed by heatwave exposure during pregnancy.

**Discussion:** The findings can inform public health policy and help to adapt to future heatwaves to safeguard maternal and fetal well-being.

### Projecting the risk of Aedes mosquito-borne disease in Switzerland by 2060 according to various climate change scenarios

Ioannis Magouras<sup>1,2</sup>, Ana Maria Vicedo Cabrera, Julien Riou

<sup>1</sup>Institute of Social and Preventive Medicine, University of Bern, Bern, Switzerland; <sup>2</sup>Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

#### Abstract

**Introduction:** Mosquito-borne diseases such as dengue, Zika and chikungunya are emerging in Europe, and vector-competent Aedes mosquito species have been spreading in Switzerland over the last decade. Our project aims to study the future risk of diseases transmitted by these invasive mosquitoes for the Swiss population by 2060, accounting for various climate change scenarios.

**Methods:** We propose to employ a compartmental epidemiological model integrating the thermal dependency of parameters associated with the mosquito life cycle and host-vector interactions (e.g., oviposition rate, biting rate). A key parameter to this approach is the mosquito-to-human ratio, which will be estimated using an abundance model accounting for temperature and precipitation patterns to quantify the mosquito population while incorporating demographic projections for human populations. The sensitivity to climate change scenarios will be addressed by using 68 downscaled regional climate model simulations from the CH2018 dataset, reflecting a range of RCP/SSP scenarios. Bayesian analysis of controlled laboratory experiments will provide uncertainty intervals of parameters associated with vector survival and behaviour, that will be propagated into the results. We will integrate three different fine-scale projections for human populations and validate mosquito abundance models against ovitrap data. We will also consider scenarios of mitigation strategies.

**Result:** Outputs will consist of daily 2x2km grid maps of basic reproduction number estimates over Switzerland, informing about the local potential for disease transmission. These can in turn be transformed into

estimates of ranges of disease incidence in humans over long periods with respect to climate change and mitigation scenarios.

**Discussion:** These results will provide valuable insights into the evolving dynamics of mosquito-borne diseases in a changing climate, contributing to public health planning and disease prevention strategies.

### Addressing Vulnerable Populations' Healthcare Needs During Climate Shocks: A Qualitative Case Study in Emilia-Romagna

Giorgia Soldà<sup>1</sup>, Helle Mölsted Alvesson, Marco Montalti, Chiara Reali, Johan von Schreeb, Petter Ljungman

<sup>1</sup>Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden; Department of Biomedical and Neuromotor Science, Alma Mater Studiorum - University of Bologna, Bologna, Italy

#### Abstract

**Introduction:** Climate change is increasing the frequency and severity of extreme weather events worldwide. Vulnerable groups face disproportionate health burdens during floods and heatwaves, yet preparedness planning research is limited, particularly addressing healthcare provision.

Our objective was to investigate how the healthcare system in Emilia-Romagna, Italy, plans for and manages vulnerable populations' needs pre- and post-climate shocks.

**Methods:** Through document analysis and semi-structured interviews, we conducted a qualitative case study examining the May 2023 floods and summer 2023 recurring heatwaves in the Forlì-Cesena local health district. Documents included national and local civil protection plans, regional resolutions, and internal procedures. The 10 face-to-face interviews were conducted in September 2023 and involved key informants who usually deal with preparedness and response during natural disasters. They cover key positions at the municipality level, civil protection, prefecture, and firefighters local offices and local health district, primary care, and nursing management offices.

**Results:** Preliminary analysis identified successes and gaps in mapping and integrating vulnerable groups' specific needs. Overall, the flood was perceived and managed as a catastrophic event while the heatwaves as routine health management. Flood plans lacked healthcare detail compared to heatwave actions targeting these populations. However, floods allowed for more dynamic choices, adaptability to specific and evolving situations, and potential space for revision processes.

**Discussion:** Overall, a shared need for an inclusive revision process in procedures for mapping and dealing with vulnerable populations and their needs during the floods came across. Heatwave management's lack of monitoring data does not allow for a comprehensive evaluation process however the system seems to have adapted to meet vulnerable population needs during the past 20 years.

### Analyzing the Saharan oscillation index and its correlation with climate indices

Kenza Khomsi<sup>1</sup>, Mohamed Khalis

<sup>1</sup>Climate and Health

#### Abstract

**Objective:** The purpose of this summary is to clarify the complex relationships and climate context associated with the (SaOI) and to assess its impact on air quality and human health. By examining correlations with key climate indices, this study attempts to reveal the broader impact of SaOI on atmospheric circulation patterns, regional climate change, and dust and particulate matter transport.

**Materials and Methods:** The study used long-term climate data from 1950 to 2022, focusing on the SaOI and its relationship with key climate indices such as the North Atlantic Oscillation (NAO), Mediterranean Oscillation (MO), El Niño-Southern Oscillation, and others. Statistical analysis, including annual and seasonal lagged correlations, is used to identify patterns and enhance understanding of the impact of SaOI on global atmospheric teleconnections. Air quality data, including dust and

particulate matter concentrations, will be integrated to assess the impact of SaOI on pollutant transport.

**Result:** SaOI exhibits moderate to weak annual correlations with various climate indices, requiring detailed investigation using seasonally lagged correlations. These analyzes reveal subtle relationships between SaOI and climate indices and reveal seasonal variations in their relationships. Notably, SaOI exhibits varying degrees of correlation with NAO, MO, ENSO, and other indices, revealing different patterns and dependencies in different seasons. The study also identified correlations between SaOI and air pollution indicators and highlighted its role in transporting dust and particulate matter.

**Conclusion:** The results highlight seasonal nuances in the correlation of SaOI with key climate indices and its role in influencing atmospheric dynamics, pollutant transport, and climate change. Insights gained from this study contribute to a more nuanced understanding of the impact of SaOIs on atmospheric and environmental processes, as well as potential implications on Health

## RESPIRATORY HEALTH

### Long-term exposure to air pollution and hospital admission for acute lower respiratory infections in Catalonia.

Anna Alari<sup>1,2,3</sup>, Otavio Ranzani, Carles Milà, Sergio Olmos, Xavier Basagaña, Payam Davvand, Talita Duarte-Salles, Mark Nieuwenhuijsen, Cathryn Tonne

<sup>1</sup>Barcelona Institute for Global Health, ISGlobal, Barcelona, Spain;

<sup>2</sup>Universitat Pompeu Fabra (UPF), Barcelona, Spain; <sup>3</sup>CIBER

Epidemiología y Salud Pública (CIBERESP), Madrid, Spain

#### Abstract

**Introduction:** Evidence is limited regarding the role of air pollution in acute Lower Respiratory Infections (LRIs) among adults. We assessed the influence of long-term air pollution exposure on hospital admission for LRIs and vulnerable subgroups.

**Methods:** Our study utilized the COVAIR-CAT cohort in Catalonia, Spain, comprising 5,127,059 adults residing in Catalonia as of January 1, 2015. Air pollution exposure was assigned to individual's residential address using locally-developed models. We characterized the concentration-response functions for the association between long-term air pollution exposure and hospital admission for LRIs in the 2015-2019 period. We assessed interaction between exposure and clinical and socio-economic factors on multiplicative and additive scales.

**Results:** An interquartile range increase from the 1st quartile of NO<sub>2</sub>, PM<sub>2.5</sub>, PM<sub>10</sub> and O<sub>3</sub> was associated with 8% (95% CI: 5%-11%), 10% (95% CI: 8%-13%), 5% (95% CI: 3%-7%) and 3% (95% CI: 1%-5%) increases in hospital admissions for LRIs. Estimated risks then flattened until the higher tail of concentrations range. The effect of air pollution (except ozone) on hospital admission for LRIs was consistently greater for individuals over 65 years and males.

**Discussion:** Long-term exposure to NO<sub>2</sub>, PM<sub>2.5</sub> and PM<sub>10</sub> was positively associated with hospital admission for LRIs. Individuals who were older than 65 years, male, or lived in a more deprived area were most vulnerable.

### Lung function differences in preadolescent children in two Polish cities with different air pollution levels.

Artur Badyda<sup>1</sup>, Piotr Dąbrowiecki, Łukasz Adamkiewicz, Dominika Mucha, Piotr Oskar Czechowski, Andrzej Chciałowski

<sup>1</sup>Warsaw University of Technology, Department of Informatics and Environment Quality Research

#### Abstract

**Introduction:** Children are particularly susceptible to the negative effects of air pollution (AP) exposure and are at risk of impaired lung function in polluted areas. Air quality in Poland is still poor, although

the concentrations are lower in some locations. We compared lung function in children living in Zabrze (located in the Upper Silesian Industrial Region) with high AP levels and in Gdynia (on the Baltic coast), where the air quality is much better.

**Methods:** Lung function (FVC, FEV1, FEV1/FVC index, PEF) and frequency of respiratory/allergic symptoms (RAS) in children were measured. 258 children from Gdynia and 512 children from Zabrze aged 9–15 years, who were able to correctly perform spirometry test, were examined. A survey about the frequency of RAS was also completed. The cohorts from both cities were similar in age, sex ratio, weight, and height.

**Results:** The whole-life exposure to PM10, NO2 and SO2 was higher in Zabrze, while in case of O3 it was higher in Gdynia. Mean values of FVC, FEV1, and PEF were statistically significantly higher among children in Gdynia than in Zabrze ( $p < 0.01$ ,  $p = 0.032$  and  $p = 0.018$  respectively). The frequency of seasonal rhinorrhea ( $p = 0.015$ ) and cough episodes ( $p = 0.022$ ) were higher in Zabrze. In case of allergic skin reactions slightly higher occurrence was noticed in Gdynia, but the differences were statistically insignificant ( $p = 0.067$ ). The incidence of other RAS was similar in both cities.

**Discussion:** Preadolescent children living in Zabrze, where the air quality is among the worst in Europe, had significantly lower spirometry parameters compared to their peers from Gdynia on the Baltic coast. These findings are in line with other studies. Bergstra et al. showed decreased FVC and FEV1 due to increased NOx concentrations among children aged 9–13 years living in an industrialized area. Gehring et al. demonstrated decrease in FVC and FEV1 among children aged 6–8 years with rising concentrations of PM2.5 and NO2 in ambient air.

### Meteorological effects of mean temperature on lung function and airway obstruction in elderly women.

Ashtyn Tracey Areal<sup>1,2</sup>, Nidhi Singh, Tamara Schikowski  
<sup>1</sup>IUF-Leibniz Research Institute in Environmental Medicine, Düsseldorf, Germany; <sup>2</sup>Medical Research School, Heinrich-Heine-University Düsseldorf, Düsseldorf, Germany

#### Abstract

**Background:** The effects of air pollution on respiratory health in the elderly have been extensively assessed, but little is known about the impact of meteorological factors, such as temperature, on respiratory health in the elderly. We evaluated the effect of short-term temperature on airway obstruction and lung function in a cohort of elderly women from Germany.

**Method:** Using data from the second clinical follow-up (2007–2010) of the German SALIA cohort study, we investigated the effect of short-term (Lag02) mean temperature (Tmean; COSMO-REA6) on airway obstruction diagnosis and lung function. Categorical Airway obstruction, defined according to the Global Initiative for Chronic Obstructive Lung Disease criterion (FEV1/FVC < 0.70), and continuous z-scores of lung function were used. Adjusted multivariable Logistic regression was used in this analysis. The main model was adjusted for long-term trends (interaction term: month and year), age, body mass index (BMI), socioeconomic status, and smoking status. Sensitivity analysis included relative humidity and nitrogen dioxide (UBA air pollution models).

**Results:** A total of 735 elderly women with a mean age of 73.46 (standard deviation (SD)) = ±3.09 years and a mean BMI of 27.28 (SD) = ±4.47 were included. There was a decrease in airway obstruction per 1°C increase in Tmean (odds ratio (OR)) = 0.905; 95% confidence interval (CI): 0.823, 0.995). In the pollution and humidity adjusted model, we found a decrease in airway obstruction per 1°C increase (OR) = 0.902, 95%CI: 0.819, 0.993). Similar significant results were found at Lag0 and Lag01 for Tmean. No significant findings were found for continuous lung function.

**Conclusion:** Cold temperatures cause the normally warm and humidified internal structures in the lungs to cool and become dry, triggering inflammation. Our study results are biologically plausible, as a

short-term increase in Tmean was associated with a decrease in airway obstruction in elderly German women.

### Long-term deleterious effects of household use of green cleaning products on the evolution of asthma symptoms

Emilie Pacheco Da Silva<sup>1</sup>, Raphaëlle Varraso, Léopold K. Fezeu, Pilar Galan, Serge Hercberg, Mathilde Touvier, Christophe Paris, Orianne Dumas, Nicole Le Moual

<sup>1</sup>Université Paris-Saclay, UVSQ, Univ. Paris-Sud, Inserm, Équipe d'Épidémiologie Respiratoire Intégrative, CESP, 94807 Villejuif, France

#### Abstract

**Objective:** The household use of irritant and sprayed cleaning products is an established asthma risk factor. Consumers might seek for potentially less harmful alternatives, and turn to green products. However, only few studies (cross-sectional) evaluated their respiratory health effects and the results were inconsistent. Therefore, we investigated long-term effects of household use of green products on the evolution of asthma symptoms over 2 years based on longitudinal data from the French population-based NutriNet-Santé cohort.

**Methods:** Using standardized questionnaires, the asthma symptom score and the use at home of irritants/sprays and green products were evaluated in 2018 and 2020. The evolution of weekly use (persistent, increased versus no weekly use in 2018–2020) was studied in association with (i) the incidence of asthma symptoms between 2018–2020 (incidence vs. asymptomatic in 2018 & 2020); (ii) the evolution of asthma symptoms between 2018–2020 (improvement, deterioration vs. symptomatic stable) by logistic regressions. Models were adjusted for gender, age, smoking status, body mass index, educational level and for the evolution of weekly use of irritants/sprays when studying green products.

**Results:** Our study was based on 24,836 adults (mean age: 58 years, 73% women). For irritants/sprays, a persistent use (43%) was associated with incidence (adjusted OR [95% confidence interval] = 1.30 [1.14–1.49]) and deterioration (OR = 1.59 [1.20–2.09]) of symptoms, and an increased use (28%) with deterioration (OR = 1.44 [1.06–1.94]). For green products, a persistent (22%) and increased (13%) use was associated with symptom incidence (OR = 1.19 [1.03–1.37] & OR = 1.19 [1.00–1.40], respectively). Significant associations of an increased use with symptom deterioration (OR = 1.46 [1.03–2.06]) were observed only in women ( $p$ -interaction < 0.05).

**Conclusion:** Persistent and increased weekly use of green cleaning products over time may lead to symptom incidence and deterioration.

### Occupational exposures and lung cancer risk in women: A population-based case-control study in France (the WELCA study)

Lisa Leung<sup>1,2</sup>, Loredana Radoi, Anita Koushik, Pascal Guénel  
<sup>1</sup>Center for Research in Epidemiology and Population Health (CESP), Team Exposome and Heredity, U1018 Inserm, University Paris-Saclay, Institut Gustave Roussy, Villejuif, France; <sup>2</sup>Université de Montréal Hospital Research Centre (CRCHUM) and Université de Montréal School of Public Health, Montreal, Quebec, Canada

#### Abstract

**Introduction:** Aside from smoking as a major risk factor, workplace factors are also known to contribute to lung cancer risk. Despite the abundance of past occupational studies on lung cancer, few have been based on female workers. This exploratory analysis examines associations between occupation, specific workplace exposures, and lung cancers in women.

**Methods:** In a population-based study conducted in the Paris area (2014–2017), information on sociodemographic characteristics, tobacco consumption, and lifetime occupational history was collected for 727 incident cases and 733 controls. Specific workplace exposures were identified by linking job codes to the Canadian job-exposure matrix. Thirty-six agents with either relatively high prevalence or are suspected/known lung carcinogens were selected. Occupations were examined by



comparing participants employed in an occupation for  $\geq 10$  years vs. never employed in that occupation. For the 36 specific exposures, ever and cumulative exposure were assessed. Odds ratios (OR) and 95% confidence intervals (CI) were estimated using logistic regression, adjusting for smoking and other covariates.

**Results:** Elevated ORs, above 2, with wide CIs were observed for participants employed  $\geq 10$  years as Special Education Teachers, Stock Clerks, Material and Production Planning Clerks, Library and Filing Clerks, Working Proprietors (Wholesale and Retail Trade; Catering and Lodging Services), and Building Caretakers. For specific exposures, positive associations, with ORs between 1.3-6.94, were suggested for high cumulative exposure to abrasives dust, metallic dust, carbon monoxide, formaldehyde, natural gas combustion products, inorganic acid solutions, hypochlorites, lead, chlorinated alkanes, asbestos, diesel engine emissions, iron, welding fumes, and paints.

**Discussion:** Several workplace exposures previously classified as carcinogenic in studies of men were suggestively associated with increased lung cancer risk in women in our study.

### Chemical-wide and metabolome-wide analysis of asthma in the PIAMA birth cohort study

Max J. Oosterwegel<sup>1</sup>, Dorina Ibi, Ulrike Gehring, Gerard H. Koppelman, Judith M. Vonk, Jelle Vlaanderen, Douglas I. Walker, Roel Vermeulen

<sup>1</sup>Division of Environmental Epidemiology, Institute for Risk Assessment Sciences, Utrecht University, Utrecht, 3584 CM, The Netherlands

#### Abstract

**Introduction:** Asthma is a common disease in childhood. Yet relatively little is known on its relationship with environmental chemicals.

**Methods:** We analyzed 628 blood samples from 523 participants in a case-control study nested in the PIAMA birth cohort study. Asthma was defined based on follow-up questionnaires at 8, 11, and 16 years old. Blood samples of cases at 8, 12, 16 years old ( $n = 165$ ) were matched on sex and follow-up round to controls ( $n = 463$ ). These samples were analyzed using untargeted liquid chromatography high resolution mass spectrometry (LC-HRMS). All annotated features were analyzed as predictor with case-status of the blood sample as outcome in separate logistic regression models for each feature. The false discovery rate (FDR) was controlled using the Benjamini-Hochberg procedure.

**Results:** Preliminary annotations of the HRMS data, resulted in a set of biomarkers of pesticides (16 metabolites), per- and polyfluoroalkyl substances (PFAS) (16 metabolites), phenol (3 metabolites), phthalate (3 metabolites), plastics (2 metabolites), and personal care products (PPCP) (1 metabolite) that were detected. Monocyclohexyl phthalate was associated with asthma status, but was not statistically significant after multiple testing correction.

**Conclusion:** We assessed cross-sectional associations between various biomarkers of exposures in blood and asthma status. The preliminary findings provide no evidence of children with asthma having experienced different exposure levels of pesticides, PFAS, phenol, phthalate, plastic, and PPCP.

### Associations between greenness exposure and rhinitis and asthma multimorbidity in the Constances cohort

Marine Savouré<sup>1</sup>, Emeline Lequy, Jean Bousquet, Marcel Goldberg, Kees de Hoogh, Bénédicte Leynaert, Céline Ribet, Danielle Vienneau, Mohammad Javad Zare Sakhvidi, Marie Zins, Rachel Nadif, Bénédicte Jacquemin

<sup>1</sup>Univ Rennes, Inserm, EHESP, Irset (Institut de recherche en santé, environnement et travail) - UMR\_S 1085, F-35000 Rennes, France

#### Abstract

**Introduction:** Asthma and rhinitis often coexist. Studies that have investigated their associations with greenness exposure have only

considered them separately. We aimed to study the cross-sectional associations between Normalized Difference Vegetation Index (NDVI) and current rhinitis (CR) and current asthma (CA) multimorbidity in adults.

**Methods:** Data from the French adult population-based cohort Constances at inclusion (2012-19) were used. CR was defined by the report of sneezing, runny or blocked nose in the last 12 months. CA was defined by the combined report of lifetime asthma and in the last 12 months use of asthma medication, or occurrence of an asthma attack, wheezing, waking with breathing discomfort, shortness of breath (SOB) at rest or exercise, or woken by an attack of SOB. Four categories were considered: no-CR/no-CA (reference), CR alone, CA alone, and CR+CA. Greenness exposure was estimated using NDVI within 300 meter around each participant's residential address. Cross-sectional analyses were stratified by urbanicity (rural area, suburbs, isolated town, central town and Paris) and were performed using a multinomial logistic model adjusted for age, sex, smoking, diploma and French deprivation index.

**Results:** Among the 173,419 participants (mean age: 47, 46% men), 63% were classified as no-CR/no-CA, 28% CR alone, 4% CA alone, and 6% CR+CA. In isolated town, a 0.1 increase of NDVI was significantly associated with a reduced risk of CR alone (OR: 0.89 (0.85, 0.92)), and CR+CA (0.91 (0.84, 0.98)). Similar results were found in center town and suburb strata. An increase in NDVI was also associated with a reduced risk of CA alone but only significantly in the suburban (0.96 (0.92, 1.00)) and rural (0.88 (0.81, 0.97)) strata. Whatever the phenotype, no significant associations were found in Paris stratum.

**Conclusion:** Our results suggest a protective effect of greenness on rhinitis and asthma mostly in urban areas and with a higher impact for CR alone.

### Ambient pollen exposure and pollen allergy symptom severity in the EPOCHAL study

Axel Luyten<sup>1,2</sup>, Alexandra Bürgler, Sarah Glick, Marek Kwiatkowski, Regula Gebrig, Minaya Beigi, Karin Hartmann, Marloes Eeftens

<sup>1</sup>Swiss Tropical and Public Health Institute, Basel, Kreuzstrasse 2, 4123 Allschwil, Switzerland; <sup>2</sup>University of Basel, P.O. Box, CH-4003 Basel, Switzerland

#### Abstract

**Introduction:** Ambient pollen exposure causes nasal, ocular and pulmonary symptoms in allergic individuals, but the shape of the exposure-response association is not well characterized. We evaluated this association and determined (1) whether symptom severity differs between sub-populations; (2) how the association changes over the course of the pollen season; (3) which pollen exposure time lags affect symptoms.

**Methods:** Adult study participants ( $n=396$ ) repeatedly scored severity of nasal, ocular and pulmonary allergic symptoms, resulting in three composite symptom scores. We calculated hourly individually-relevant pollen exposure to seven allergenic plants (alder, ash, birch, hazel, grasses, mugwort, ragweed) considering personal sensitization and exposure time lags of up to 96 hours. We fitted generalized additive mixed models, with a random personal intercept, adjusting for weather and air pollution as potential time-varying confounders.

**Results:** We identified a clear non-linear positive association between pollen exposure and ocular and nasal symptom severity in the pollen allergy group: symptom severity increased steeply with increasing exposure initially, but attenuated beyond approximately 80 pollen/m<sup>3</sup>. We found no evidence of an exposure threshold, below which no symptoms occur. While recent pollen exposure in the last approximately five hours affected symptoms most, associations lingered for up to 60 hours. Grass pollen exposure (compared to tree pollen) and younger age (18-30 years, as opposed to 30-65 years) were both associated with higher nasal and ocular symptom severity.

**Conclusion:** The lack of a threshold and attenuated dose-response curve may have implications for pollen warning systems, which may be revised to include multi-day pollen concentrations in the future.

### Environmental exposure to pesticides and chronic respiratory diseases

Nolwenn Jestin-Guyon<sup>1</sup>, Chantal Raheison-Semjen

<sup>1</sup>Inserm UMR1219 Bordeaux Population Health Research Center, Bordeaux University, Bordeaux, France

#### Abstract

**Introduction:** Pesticides are chemical substances to which the world's population is exposed (agricultural field, manufacturing, residential, consumption of fruits and vegetables, etc...). Exposure to pesticides, to the extent that it does not occur in a professional setting, could be related to chronic respiratory diseases.

**Objective:** The aim of this general review was to summarize knowledge about the relation between pesticides environmental exposures and chronic respiratory diseases.

**Material and Methods:** Our work was to synthesize the literature since the publication of the French National Health and Medical Research Institute (Inserm) report in 2021 called "Pesticides and Health Effects: new data". Health events discussed were: impaired respiratory function (FEV1, FVC, etc...), chronic obstructive respiratory disease (COPD), asthma, respiratory symptoms (coughing, wheezing, etc...), among children, adolescents and adults.

**Results:** Organophosphates and pyrethroids insecticides are incriminated in harmful effects on child's respiratory health, during both pre- and postnatal periods. Two meta-analysis suggest a relation with pesticides exposures and respiratory outcomes: multiple exposures and asthma (OR=2.14; CI95%[1.26 – 3.64]) (Rodrigues MDB, 2022) and prenatal organophosphates insecticides exposure with wheezing or bronchitis symptoms (RR=1.14; CI95%[1.03 – 1.26]) (Gascon M, 2014). Few studies found relations with respiratory health and pesticides among adults in specific contexts of exposure (e.g. home use of pesticides). However, further studies are needed to conclude on COPD and respiratory function.

**Conclusion:** Pesticide exposure during pregnancy and childhood can affect respiratory health and development. More studies, especially among adults, are needed to identify specific substances affecting lung functions. Implementing preventive measures and raising people awareness about pesticides risks are needed to protect respiratory health of the most vulnerable.

## CHEMICAL EXPOSURES

### Unravelling the Immunomodulatory Puzzle: PFAS Exposure and Gene Expression Patterns in Czech Populations

Barbora Rudzanová<sup>1</sup>, Vojtěch Thon, Hana Vespalcová, Christopher J. Martyniuk, Pavel Piler, Martin Zvonař, Jana Klánová, Luděk Bláha, Ondřej Adamovský

<sup>1</sup>RECETOX, Faculty of Science, Masaryk University, Kotlarska 2, 602 00, Brno, Czech Republic

#### Abstract

**Introduction:** Per- and polyfluoroalkyl substances (PFASs) are emerging environmental contaminants with multiple hazardous properties including immunomodulation potency. We aimed to investigate the expression of genes associated with PFAS exposure in two Czech populations, specifically in the cohort of young adults and the mother-child cohort.

**Methods:** This study employed data from two cohorts of the Czech Central European Longitudinal Study of Parents and Children (CELSPAC), specifically the CELSPAC: Young Adults (YA) cohort counting 288 participants and the CELSPAC: The Next Generation

(TNG) cohort involving 560 mother-child pairs. 12 PFASs were measured by HPLC-MS/MS in participants' serum samples (i.e. YA participants and mothers from TNG). Transcriptomic analysis was first performed on the YA cohort and the same pipeline will be applied to the cord blood samples of TNG cohort. To identify transcriptomic profiles of YA participants, isolated RNA from peripheral mononuclear blood cells was sequenced (Next-Generation Sequencing) and analysed. Significantly expressed genes associated with multiple PFASs (at least with 4 PFASs) were employed for enrichment analysis by Pathway Studio. All analyses were adjusted for relevant confounders.

**Results:** In the YA cohort, 166 statistically significant genes ( $p < 0.05$ ) were associated with multiple PFAS exposure. Enrichment analysis of these genes showed involvement of B cell signalling and development, specifically processes such as B cell receptor signalling, germinal centre reactions, and plasma cell development, which are all crucial in the maturation of antibody-secreting cells.

**Discussion:** Our results contribute to the body of literature that observes the immunomodulatory effect of PFAS exposure and further brings new information about underlying deregulatory mechanisms. Furthermore, data from the mother-child cohort will contribute to the understanding of the impact of prenatal PFAS exposure on a child's immunity.

### Development of a Job-Task-Exposure Matrix for disinfecting and cleaning chemicals in French healthcare workers

Franziska Bright<sup>1</sup>, Bakari Ibrahim, Marcel Goldberg, Bénédicte Leynaert, Rachel Nadif, Céline Ribet, Nicolas Roche, Raphaëlle Varraso, Marie Zins, Nicole Le Moual, Orianne Dumas  
<sup>1</sup>Université Paris-Saclay, UVSQ, Univ. Paris-Sud, Inserm, Équipe d'Épidémiologie Respiratoire Intégrative, CESP, Villejuif (France)

#### Abstract

**Objective:** Occupational exposure to disinfectants and cleaning products in healthcare workers raise health concerns. The improvement of exposure assessment methods for specific chemicals is still needed, as there is only one Job-Task-Exposure Matrix (JTEM) among nurses. In the French population-based cohort CONSTANCES, we investigated exposures to specific chemicals by healthcare workers with the aim of creating a JTEM.

**Methods:** Participants from the French cohort CONSTANCES identified as healthcare or laboratory workers at inclusion (2012-2020) were invited in 2022 to respond to a questionnaire about the frequency of cleaning tasks and chemicals used at work (current/last held job). Weekly use of 10 chemicals was described across combinations of 12 jobs and 8 tasks.

**Results:** Among 5037 healthcare/laboratory worker respondents, nursing (43%) was the most common job, followed by nursing assistants (17%) and physicians (16%). Cleaning surfaces (64%), medical instruments (56%) and other medical equipment (52%) were the most commonly reported tasks. Quaternary ammonium compounds (QAC), alcohol and glutaraldehyde were the most commonly reported chemicals used weekly, by 71, 42 and 20% of participants respectively. QAC and alcohol were reported in every job-task category involving at least one task. Overall, cleaning endoscopes and operating rooms were tasks for which, across jobs, chemical use most differed, especially with a weekly use of ortho-phthalaldehyde, peracetic and acetic acids by 10-28% of participants (chemicals otherwise rarely used).

**Conclusion:** Using data from this broad population of healthcare workers, including nurses, with a diversity of cleaning tasks, we were able to identify chemicals commonly used in a combination of jobs/tasks. The JTEM will aim to minimize exposure misclassification in order to provide a more accurate assessment of health effects of specific chemicals.

### Geostatistical analysis of geomasked PFAS food contamination data in Veneto Region (Italy)

Giorgia Stoppa<sup>1</sup>, Dolores Catelan, Zamboni Michela, Fin Giuliano, Scatton Naike, Laura Facciolo, Annibale Biggeri, Emanuele Giorgi

<sup>1</sup>Unit of Biostatistics, Epidemiology and Public Health, DCTVPH, University of Padova, 35131 Padova, Italy

#### Abstract

**Introduction:** Veneto Region sponsored a PFAS food contamination monitoring campaign on vegetables and animal matrices in 2016-2017. Veneto Region negated data disclosure and citizens' committees raised legal litigation. We aim to employ a geomasking technique to determine an appropriate displacement distance that safeguards confidentiality, allows data disclosure and assures the integrity of geostatistical inference.

**Methods:** We analysed 886 samples (430 vegetables, 456 animals) collected from 692 agro-livestock in the study area. Model-based geostatistics was performed to predict the probability of positive sample specimens in 24 municipalities with contaminated water. A simulation study was conducted to balance privacy protection and analytical accuracy. We calculated the relative percentage difference of the root-mean-integrated-square error (RMISE) criterion using uniform geomasking at different maximum displacements (50 m, 100 m, 1 km, 2 km, 3 Km, 4 Km, 10 km, 15 km) and the original unperturbed coordinates.

**Results:** There was a higher probability of being positive in the towns in the north-central part of the contaminated aquifer. The simulation study shows that up to 3 km RMISE Relative Percent Difference is close to zero, thus suggesting negligible differences between the predictive probability generated using the geomasked and unperturbed data.

**Discussion:** When carefully implemented case-by-case, geographical masking protects geoprivacy while making georeferenced, individual-level data available to researchers. We proposed a simple procedure, applicable in various settings, through a simulation study to calculate the displacement required for georeferenced data to protect privacy and ensure the right to access information.

### Early-life exposure to endocrine-disrupting chemicals and general health in children

Ines Amine<sup>1</sup>, Alicia Guillien, Sam Bayat, Sarah Lyon-Caen, Marion Ouidir, Azemira Sabaredzovic, Amrit Kaur Sakhi, Cathrine Thomsen, Rémy Slama, Claire Philippat, Valérie Siroux

<sup>1</sup>Team of Environmental Epidemiology Applied to the Development and Respiratory Health, Institute for Advanced Biosciences, Inserm U 1209, CNRS UMR 5309, Université Grenoble Alpes, 38700 La Tronche, France

#### Abstract

**Introduction:** Early exposure to endocrine-disrupting chemicals (EDCs) is suspected to impact children's health. To date, most studies have focused on one health domain. Using a child general health score, this study examined the overall impact of in-utero and early-life exposure to phenols, phthalates and non-phthalates plasticizers on child health.

**Methods:** The analysis involved 372 children from the SEPAGES cohort. A general health score at 3 years was established by synthesizing twenty-three health parameters (encompassing cardiometabolic, respiratory/allergic and mental health). By construction, a child with a low score has poor general health. Twenty-four phenol, phthalate and DINCH metabolites were measured in pools of repeated urine samples collected during pregnancy (up to 21 samples in both the second and third trimesters), and childhood (up to 7 samples at 2 months (phenols only) and one year of age). Adjusted mixture models (quantile g computation) as well as unipollutant models (linear regressions) were used

to assess the association between these chemicals and the general health score.

**Results:** Preliminary results indicate that cumulative exposure to phthalates, or parabens from pregnancy to 1 year of age was significantly associated with a poorer general health score at 3 years ( $p < 0.05$ ). When studying pollutants individually, one third of them were significantly associated with a poorer general health score for at least one exposure timepoint. No specific susceptibility window was highlighted.

**Conclusion:** By using a general health score that summarizes three health domains, this study reinforced the potential widespread risks associated with early-life exposure to EDCs for child's health. In particular, cumulative exposure to phthalates or parabens during pregnancy and early life appears to be a risk factor for the general health of young children.

### Prenatal dietary exposure to mixtures of chemicals and allergic or respiratory diseases up to 5 years

Manel Ghozal<sup>1</sup>, Manik Kadauathagedara, Rosalie Delvert, Amandine Divaret-Chauveau, Chantal Raberison, Marie Aline Charles, Karine Adel-Patient, Blandine de Lauzon-Guillain

<sup>1</sup>Université Paris Cité and Université Sorbonne Paris Nord, Inserm, INRAE, Centre for Research in Epidemiology and Statistics (CRESS), Paris, France

#### Abstract

**Introduction:** Diet is the major source of exposure to environmental chemicals in pregnant women. The aim of this study was to assess associations between prenatal dietary exposure to mixtures of chemicals and development of allergic or respiratory diseases in childhood.

**Methods:** Analyses were based on 11,638 children from the French birth cohort ELFE. Prenatal dietary exposure to chemicals was previously assessed by combining maternal food intake during pregnancy and concentration levels of 219 chemicals in food products. Eight mixtures of chemicals were also identified by sparse nonnegative matrix under approximation. Allergic and respiratory diseases (eczema, food allergy, wheezing, and asthma) were reported by parents between 2 months and 5.5 years. The associations between dietary exposure to the 8 mixtures and the risk of ever allergic or respiratory diseases up to 5.5 years were analyzed using logistic regression models adjusted on maternal characteristics (including education, smoking and diet quality), child's characteristics and family history of allergies.

**Results:** Maternal dietary exposure to a mixture composed mainly of metals, furans and polycyclic aromatic hydrocarbons was positively associated with the risk of eczema (OR [95% CI]=1.10 [1.05; 1.15] per sd of the mixture). Maternal dietary exposure to one mixture of pesticides was positively associated with the risk of food allergy (OR [95% CI]=1.10 [1.02; 1.18]), whereas the exposure to another mixture of pesticides was slightly but positively related to the risk of wheezing (OR [95% CI]=1.05 [1.01; 1.08]). Maternal dietary exposure to a mixture composed by perfluoroalkyl acids, PAHs and metals was negatively associated with the risk of asthma (OR [95% CI]=0.89 [0.80; 0.99]).

**Conclusion:** In this large birth cohort, we evidenced associations between perinatal dietary exposure to some mixture of chemicals and increased risk of self-reported allergic symptoms. More studies are needed to confirm these result

### Prenatal exposure to persistent organic pollutants (POP) and steroid hormone levels in boys at age 12 in PELAGIE cohort

Mareva Geslin<sup>1</sup>, Maximilien Génard-Walton, Christine Monfort, Florence Rouget, Charline Warembourg, Frank Giton, Fabrice Lainé, Eric Gaudreau, Sylvaine Cordier, Cécile Chevrier, Ronan Garlantézec

<sup>1</sup>Univ Rennes, Inserm, EHESP, Irset (Institut de recherche en santé, environnement et travail) - UMR\_S 1085, F-35000 Rennes, France

**Abstract**

**Introduction:** Even though most persistent organic pollutants (POPs) exhibit endocrine disruption properties, their prenatal exposure effects on sexual hormones later in life have been poorly studied. We investigated whether prenatal POP exposures were associated with steroid hormone levels in boys at age 12.

**Methods:** We included 250 boys from the PELAGIE cohort study. Concentrations of 47 POPs (14 polychlorinated biphenyls (PCB), 14 organochlorine pesticides, 8 perfluoroalkyl substances and 10 brominated flame-retardants) were measured in umbilical cord blood samples. At age 12, boys had a clinical exam with serum sample collection for the measurement of 15 steroids. Associations between single POP exposure and hormone levels (log-transformed) were analyzed using multivariate linear regressions adjusted on potential confounders.

**Results:** Nineteen POPs were measured in at least 20% of samples. Increased levels of several PCB were significantly associated with a decrease in dehydroepiandrosterone (DHEA) (PCB138, 153), androstenedione (4dione) (PCB118), estrone (E1) (PCB170, 180, 183), progesterone (PG) (PCB153, 170, 180, 194) and with an increase in inhibin B (PCB118, 153, 170, 180, 187). For organochlorine pesticides, increased levels of Hexachlorobenzene and p,p'-DDE were respectively associated with a decreased of DHEA and 4dione whereas increased levels of Beta-HCH was significantly associated with reduced E1. Increased levels of several PFAS were associated with a decrease in sulfate-DHEA (PFNA), 4dione (PFNA); dihydrotestosterone (PFDA), E1 (PFDA, PFOS, PFHxS), estradiol (PFDA); and FSH (PFOS). No associations were found for LH, androstenediol and total testosterone.

**Discussion:** We reported several associations between prenatal POPs and steroid hormone levels. Additional analyses will be performed using mixture models. These findings need to be replicated in other mother-child cohorts.

### **Prenatal Phenol Exposure and Child Behavior: Direct Associations and Cortisol Mediation Analysis in BiSC-Sepages cohorts**

Matthieu Rolland<sup>1</sup>, Paulina Jedynek, Mariona Bustamante, Sarah Lyon-Caen, Remy Slama, Sam Bayat, Payam Davvand, Claire Philippat

<sup>1</sup>University Grenoble Alpes, Inserm, CNRS, Team of Environmental Epidemiology Applied to Reproduction and Respiratory Health, Institute for Advanced Biosciences (IAB), Grenoble, France

**Abstract**

**Objective:** This study investigates the relationship between prenatal exposure to synthetic phenols and toddler behavioral outcomes, with a focus on the potential mediating role of cortisol.

**Material and Methods:** Our study included data from the BiSC and Sepages cohorts, involving pregnant women recruited in Grenoble (France) and in Barcelona (Spain) between 2014 and 2021. The primary outcomes were internalizing and externalizing behavior assessed by the Child Behavior Checklist (CBCL) between 18 and 24 months. Exposure to 12 phenols was assessed in two within-subject pools of urine samples collected in the second and third trimesters of pregnancy. Each pool contained between 12 and 21 samples. Cortisol and its metabolites (20 $\alpha$ - and 20 $\beta$ -dihydrocortisol) was measured in maternal hair during the third trimester or at birth, and molar sum was computed. Uni-pollutant (linear regression) and mixture models (Bayesian Kernel Machine Regression) were used to investigate direct associations between phenols and behavior scores. Mediation analysis was performed following the Baron Kenny approach when an association between phenols and CBCL score was evidenced ( $p < 0.1$ ).

**Results:** Of 1,024 patients with CBCL and phenol urinary concentrations (607 BiSC, 417 Sepages), 853 had cortisol measures. Third trimester exposure to methylparaben showed positive associations with both externalizing ( $\beta = 0.045$ , 95% CI [0.009, 0.081]) and internalizing

behavior ( $\beta = 0.049$ , 95% CI: 0.013, 0.084). A negative association (close to statistical significance) was observed between second trimester exposure to bisphenol S and externalizing behavior ( $\beta = -0.12$ , 95% CI: -0.26, 0.023,  $p = 0.09$ ). Associations were consistent across cohorts. No mixture effect was observed, and  $\Sigma$ cortisol did not mediate the associations with methylparaben and bisphenol S ( $p > 0.4$ ).

**Conclusion:** The study suggests a direct link between prenatal phenol exposure and child behavior, independent of maternal cortisol level.

### **Exposure to mixtures of persistent organic pollutants among women in France the '90s**

Pauline Frenoy<sup>1</sup>, Vittorio Perduca, Francesca Romana Mancini

<sup>1</sup>Université Paris-Saclay, UVSQ, Inserm, Gustave Roussy, CESP, 94805 Villejuif, France

**Abstract**

**Objectives:** 1) To describe persistent organic pollutants (POPs) levels in blood samples collected between 1994 and 1999 among women in the French E3N cohort, 2) To identify the main POPs exposure profiles, 3) to explore the individual characteristics associated with these profiles.

**Methods:** Biomarkers of 74 POPs, including 28 per- and poly-fluoroalkyl substances (PFAS), 27 organochlorine pesticides (OCP), 14 polychlorinated biphenyls (PCB) and 4 polybrominated diphenyl ethers (PBDE), were measured for 468 women of the French E3N cohort who donated their blood in 1994-1999. POPs levels were compared with levels measured in two more recent French studies conducted by the French National Public Health Agency, the ENNS and Esteban studies. A total of 41 POPs with less than 25% of undetected values were included in the principal component analysis (PCA) to identify the main exposure profiles. Linear regression models were used to estimate the associations between individual characteristics and exposure to these profiles.

**Results:** Women were aged 45 to 73 years at blood collection. Levels of most of the pollutants which were also measured in the Esteban or ENNS studies have decreased over time, with the exception for some PFAS (PFUnDA, PFDA and PFNA), PCB-28 and 101, and PBDE-153. Six profiles of POPs were retained with the PCA, explaining 62.1% of the total variance: the "PCB and nanochlors" profile (16.0% of the variance), the "OCP and DL-PCB" profile (13.9%), the "PFAS" profile (11.0%), the "DL-PCB and NDL-PCB" profile (8.7%), the "PBDE" profile (8.0%) and the "DDT metabolites" profile (4.6%). Almost all the individual factors studied (age, level of education, place of residence, breastfeeding history, parity, variation in BMI, time since menopause and eating habits) were associated with exposure to one or more POPs profiles.

**Discussion:** This study highlighted that most of the pollutants for which a comparison was possible decreased over the past 10-20 years.

### **Temporal and spatial exposure variability of pesticide biomarkers in South African children sampled over two years**

Regina Molomo<sup>1</sup>, Mohamed Aqiel Dalvie, Adriana Fernandes Veludo, Christian Lindb, Martin Röösl, Samuel Fuhrmann

<sup>1</sup>Swiss Tropical and Public Health Institute (Swiss TPH), 4123 Allschwil, University of Basel, 4002, Basel, Switzerland

**Abstract**

**Introduction:** Pesticides are widely used in pest control. This longitudinal study investigates the temporal exposure variability of organophosphate (OPs) and pyrethroid (PYR) urinary biomarkers among children.

**Methods:** We used data from 194 children aged 9 - 16 years from three agricultural intensive areas (Grabouw, Hex River Valley and Piketberg), in Western Cape, South Africa from 2017 to 2019. Spot urine samples and questionnaire-based pesticides exposure information were collected from children over a period of three years. Six

pesticides biomarkers [3,5,6-trichloropyridinol (TCP), 4-bromo-2-chlorophenol (BCP), 2-isopropyl-4-methyl-6-hydroxypyrimidine (IMPy), 3-phenoxybenzoic acid (3PBA), 3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid (cis/trans DCCA) and 4-fluoro-3-phenoxybenzoic acid (4F-3PBA)] were measured using liquid chromatography tandem mass spectrometry and adjusted for specific gravity. Intraclass correlation coefficients (ICCs) evaluated temporal agreements between repeated urine samples. Linear mixed-effects models were used to assess the effect of farm status and residential area on biomarker concentrations, adjusting for age and sex.

**Results:** Detection frequency of urinary biomarkers ranged from 28% (4F-3PBA) to 99% (TCP). The highest levels detected were those of TCP (median = 3.67 µg/L, interquartile range (IQR) = 4.27 µg/L), followed by 3PBA (median = 1.08 µg/L, IQR = 1.23 µg/L). Farm children had higher levels than non-farm children, except for BCP, 3PBA and 4F-3PBA, although mostly not significant. Highest levels were found in Grabouw compared to other areas for five pesticides. For IMPy, highest concentrations were found in Piketberg. Levels of TCP biomarker in urine (ICC = 0.51) showed moderate temporal agreement between the five cycles.

**Discussion:** Overall, children located were exposed to multiple pesticides. Different exposure patterns were observed between the residential settings and this should be investigated further.

### Exploring the link between metal and trace element exposure and dementia risk in a prospective Italian cohort

Teresa Urbano<sup>1</sup>, Tommaso Filippini, Annalisa Chiari, Chiara Carbone, Alessandro Marti, Marcella Malavolti, Roberta Bedin, Bernhard Michalke, Giovanna Zamboni, Marco Vinceti

<sup>1</sup>CREAGEN - Environmental, Genetic and Nutritional Epidemiology Research Center, Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Modena, Italy

#### Abstract

**Introduction:** Mild Cognitive Impairment (MCI) is regarded as a transitional state between normal aging and clinically overt dementia. The strongest risk factor for MCI and dementia is age, although exposure to air pollutants, metals, and metalloids might affect dementia risk. This study aimed to assess whether selected metals and metalloids (cadmium, copper, iron, manganese, selenium, zinc) concentrations in serum and cerebrospinal fluid (CSF) may predict MCI conversion to different forms of dementia in young onset MCI individuals.

**Methods:** 144 individuals newly diagnosed with MCI were recruited at Neurology Memory Clinics at Modena and Reggio Emilia Hospitals (Italy) from 2019-2022. The concentrations of metals and metalloids in paired serum/CSF were determined using inductively coupled plasma mass spectrometry. Follow-up visits were conducted after 18 months from baseline to assess the progression rate. Multi-adjusted (for age, sex, and educational attainment) restricted cubic splines models implemented in the Cox regression analyses were performed to assess the relation between the serum/CSF concentrations and dementia risk.

**Results:** The cohort comprised 62 men and 84 women, with a median age of 61 years (interquartile range: 56-65 years). Generally, median serum and CSF concentrations of metals and metalloids were higher in men, except serum copper and CSF iron which were higher in women. Notably, selenium levels in both CSF and serum, along with specific CSF selenium compounds, were linked to an elevated risk of dementia conversion. Furthermore, higher serum manganese levels and increased copper and zinc content in CSF were associated with heightened disease hazard risks. Several of the associations observed were non-linear.

**Discussion:** These results strengthen the hypothesis that exposure to selected metals and trace elements, particularly manganese and selenium, could be associated with increased dementia risk.

### Dietary intake of non-dioxin like polychlorinated biphenyls is associated with an increased risk of type 2 diabetes

Xuan Ren<sup>1</sup>, Geneviève Nicolas, Pauline Frenoy, Keren Papier, Conchi Moreno-Iribas, Giovanna Masala, Christina C. Dahm, Jie Zhang, Franziska Jannasch, Matthias B. Schulze, Elisabete Weiderpass, Paolo Chiodini, Claudia Vener, Paolo Vineis, Alicia K. Heath, Fulvio Ricceri Sandra M. Colorado-Yohar, Chloé Marques, Thibault Fiolet, Gianluca Severi, Inge Huybrechts, Francesca Romana Mancini

<sup>1</sup>Université Paris-Saclay, UVSQ, Inserm, Gustave Roussy, CESP

#### Abstract

**Introduction:** Dioxins and polychlorinated biphenyls (PCBs) are organic, ubiquitous, and persistent environmental contaminants. Due to their lipophilic properties, dioxins and PCBs bio-accumulate in the food chain so that the diet represents the main source of exposure for the general population. Dioxins and PCBs are suspected to cause various negative health effects in humans and, according to previous studies, exposure to dioxins and PCBs could play a role in the risk of developing of type 2 diabetes (T2D). Nevertheless, population-based studies have led to inconsistent results.

**Objective:** The objective of this study was to investigate the association between dietary exposures to dioxins and PCBs and the incidence of T2D in the European Prospective Investigation into Cancer and Nutrition (EPIC) cohort.

**Methods:** The study included 318,416 individuals recruited in 21 centers in eight countries and the median duration of follow-up was 11.7 years. Overall, 14513 incidents T2D cases were identified during follow-up. Associations between dietary intake of dioxins and PCBs and T2D were evaluated using multivariable Cox regressions.

**Results:** Higher T2D risk was observed for higher estimated dietary intake of non-dioxin like PCBs (NDL-PCBs; HR 1 SD increment = 1.03 (95%CI 1.01-1.04), and HR (Q4 vs Q1) = 1.15 (95%CI 1.08-1.22), p-trend<0.001). The results were consistent in analyses stratified by gender, BMI, country, median follow-up, or self-reported hypertension and hyperlipidemia, as well as when adjusting for fats intake. No consistent association was observed between dioxins+ dioxin like PCBs (DL-PCBs) intake and T2D risk.

**Conclusion:** Results obtained in this large European prospective study indicate a positive and linear association between dietary intake of NDL-PCBs and risk of T2D. This association remained consistent across various stratified and sensitivity analyses. Further studies are warranted to better understand the biological mechanisms underlying this association.

## CHILD AND ADOLESCENT HEALTH

### A study of the Georgian population's awareness of climate change with the involvement of adolescents

Ani Khachidze<sup>1</sup>, Lela Kazarashvili, Robizon Tsiklauri, Dali Kekelidze, Nana Gabriadze, Maiko Chokhbeli

<sup>1</sup>National Center for Disease Control and Public Health Georgia, Environmental Health Department

#### Abstract

**Introduction:** The purpose of the study was to identify the level of awareness of the Georgian population regarding climate change with the involvement of 16–18-year-old adolescents. The objectives of the study included training of adolescents to conduct research and become climate change advocates. Implementation of survey, analysis, dissemination of results.

**Methods:** The methodology was tailored to align with the study's objectives and the capacities of the researchers, using a cross-sectional research design and convenience sampling. Respondent selection criteria included gender, individuals over 16 years of age, resident of

Georgia. The sample size was set at 50-60 participants per interviewer. In-person survey was utilized.

**Results:** Totally 1115 respondents were surveyed. The majority of respondents were aware of climate change as a threat; however, 11% of rural respondents remained uninformed. Additionally, 25% expressed disagreement regarding the impact of climate change on human health. 88% of respondents identified rapid increase in average temperatures as a personal threat, while 68% identified a reduction in water resources. Notably, 14.4% of respondents named climate change as the global issue, with 44.9% prioritizing poverty. Regarding preferences for renewable energy sources, 68% expressed a desire to use them but faced financial constraints.

**Discussion:** The survey indicates that there is a certain level of awareness regarding climate change, however, this alone did not suffice to motivate individuals towards mitigation actions. Notably, the younger generation exhibits interest in engaging in mitigation efforts and continue in-depth research. Additionally, respondents express a clear inclination towards implementing energy-saving measures however, the public policy is required. The findings underscore i) the importance of targeted awareness campaigns, particularly among rural residents; ii) the need to provide information to the population on the effects of climate change on health.

### Childhood exposure to air pollution in different microenvironments and cognitive and fine motor function in children

Alan Domínguez<sup>1</sup>, Sarah Koch, Sandra Marquez, Montserrat de Castro, Jose Urquiza, Jorin Evandt, Bente Oftedal, Gunn Marit Aasvang, Mariza Kampouri, Marina Vafeiadi, Mark Mon-Williams, Dan Lewer, Johanna Lepeule, Sandra Andrusaityte, Martine Vrijheid, Mònica Guxens, Mark J Nieuwenhuijsen

<sup>1</sup>Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain

#### Abstract

**Objective:** To analyze the association between childhood outdoor air pollution exposure in different microenvironments and cognitive and fine motor function from six European birth cohorts.

**Methods:** We included 1,301 children from six European birth cohorts aged 6-11 years from the HELIX project. Outdoor air pollutants concentrations (NO<sub>2</sub>, PM<sub>2.5</sub>) were estimated using land use regression models for different microenvironments (home, school, and while commuting), for 1-year before the outcome assessment. Attentional function, cognitive flexibility, non-verbal intelligence, and fine motor function were assessed using the Attention Network Test, Trail Making Test A and B, Raven Coloured Progressive Matrices test, and the Finger Tapping test, respectively. Adjusted linear regressions models were run to determine the association between each air pollutant from each microenvironment on each outcome in pooled and cohort-by-cohort analysis.

**Results:** In pooled analysis we observed high correlation between air pollution exposures levels at home and school. However, the cohort-by-cohort analysis revealed correlations ranging from low to moderate. Air pollution exposure levels while commuting was higher than at home or school. Exposure to air pollution in the different microenvironments was not associated with working memory, attentional function, non-verbal intelligence, and fine motor function. Results remained consistently null in random-effects meta-analysis.

**Conclusions:** No association was observed between outdoor air pollution exposure in different microenvironments (home, school, commute) and cognitive and fine motor function in children from six European birth cohorts. Future research should include a more detailed exposure assessment, considering personal measurements, time spent in each microenvironment, and overall effect of the exposure to air pollution in the different microenvironments.

### Telomere length in early childhood and its association with cognitive performance: a study in 4-6 year old children

Hanne Croons<sup>1</sup>, Dries S. Martens, Charlotte Vanderstukken, Hanne Sleurs, Leen Raskings, Martien Peusens, Eleni Renaers, Michelle Plusquin, Tim S. Nawrot

<sup>1</sup>Hasselt University

#### Abstract

Telomere length (TL), a marker of cellular aging, has been studied in adults with regard to its connection to cognitive function. However, little is known about the association between TL and cognitive development in children. This study investigated the interplay between TL and cognitive functioning in 283 Belgian children aged four to six years of the Environmental Influence on Aging in Early Life (ENVIRONAGE) birth cohort. Child leukocyte TL was measured using qPCR, while cognitive functioning, including attention and memory, was assessed using the Cambridge Neuropsychological Test Automated Battery (CANTAB). Linear regression models were employed to examine the association between TL and cognitive outcomes, adjusting for potential confounders. We found an inverse association between TL and the spatial errors made during the Motor Screening task ( $p=0.017$ ), indicating a higher motor accuracy in children with longer telomeres. No significant associations were found between TL and other cognitive outcomes. Our results suggest a specific link between TL and motor accuracy but not with the other cognitive domains.

### Electronic Media, Radiofrequency Fields and Cognitive Function in Swiss Adolescents: Preliminary Cohort Study Findings

Irina Wipfl<sup>1</sup>, Laura Tincknell, Valentin Waibl, Lena Steck, Adriana Fernandes Veludo, Nekane Sandoval Diez, Hamed Jalilian, Stefan Dongus, Mònica Guxens, Martin Rössli

<sup>1</sup>Swiss Tropical and Public Health Institute

#### Abstract

**Introduction:** The use of electronic media (eMedia) is an integral part of many adolescents' lives, but exposes them to radiofrequency electromagnetic fields (RF-EMF). Adolescents are in a sensitive phase of cognitive development and there is concern that RF-EMF exposure may affect their cognitive function. This study analyses the relationship between eMedia use, RF-EMF exposure, and cognitive performance in adolescents.

**Methods:** HERMES3 (Health Effects Related to Mobile Phone Use in Adolescents) is a prospective cohort study with a one-year follow-up period and is part of the multinational GOLIAT consortium that aims to monitor RF-EMF exposure and its potential impact on health. As of January 2024, 134 adolescents from Central and Northwestern Switzerland have filled in online questionnaires concerning their eMedia use and related factors. In addition, they have taken six standardized, computerized cognitive tests in school to measure their performance across various cognitive domains, including short-term memory and deductive and verbal reasoning. In a preliminary analysis, we explore the association of cognitive test scores with self-reported screen time and voice call duration. We model the relationship with cognitive performance using a mixed linear model adjusted for age, sex, and potential clustering by school.

**Results:** Recruitment and data collection are ongoing. So far, we observe no significant associations between cognitive score, screen time, and voice call duration. Preliminary analysis shows a 2.5 point decrease in grammatical reasoning score (mean 10.98, standard deviation  $\pm$  5.37) for participants reporting more than 30 minutes of daily voice calls (95%-CI: -4.39 to 0.08,  $p<0.06$ ).

**Discussion:** We plan to include 900 adolescents in the HERMES3 study and disentangle the effects of RF-EMF and eMedia use. Along with other GOLIAT cohorts, HERMES3 complements previous studies by including more cognitive domains and new technologies such as 5G.

### Mobile phone use and hand grip and pinch strength in the SCAMP study of adolescents

Rachel B. Smith<sup>1,2,3</sup>, Lan Cheng, Nicole Curtis, Rhiannon Thompson, Chen Shen, Mireille B. Toledano

<sup>1</sup>Mohm Centre for Children's Health and Wellbeing, School of Public Health, Imperial College London, UK; <sup>2</sup>National Institute for Health Research Health Protection Research Unit in Chemical and Radiation Threats and Hazards, Imperial College London, UK; <sup>3</sup>MRC Centre for Environment and Health, Department of Epidemiology and Biostatistics, School of Public Health, Imperial College London, UK

#### Abstract

**Introduction:** Weaker hand strength is associated with worse general health and premature all-cause and cardiovascular disease mortality. Mobile phone use may impact hand strength, however research in this field is cross-sectional, generally poor quality, and lacking adjustment for confounding, providing very weak evidence for associations. Given the amount of time young people spend on mobile phones, high quality longitudinal research is needed.

**Methods:** 649 participants from the Study of Cognition, Adolescents and Mobile Phones (SCAMP) with baseline (11-12 years) and follow-up (13-15 years) data were included. Mobile phone use including years of phone ownership, daily duration of social networking and internet use, and frequency of text and instant messaging were self-reported via questionnaire. Grip and pinch strength (tip, key and palmar) on dominant and non-dominant hands were measured using validated hand dynamometer and pinch gauge. Multilevel linear regression was used to estimate longitudinal associations between mobile phone use at baseline and hand strength outcomes at follow-up with adjustment for age, sex, ethnicity, socioeconomic status, self-rated health, duration of other device use, height and weight z-scores and school cluster effects.

**Results:** Preliminary results indicate higher frequency of text messaging is positively associated with grip strength, key and palmar pinch strength on dominant hand ( $p < 0.05$ ), e.g. mean grip strength 2.95 kg (95%CI: 0.19, 5.7) greater in highest vs. lowest text messaging tertile. Longer phone ownership at baseline was associated with weaker non-dominant hand grip strength, particularly in males ( $p < 0.01$ ). Positive associations between text and instant messaging frequency and tip pinch strength on non-dominant hand were observed in males ( $p < 0.03$ ).

**Discussion:** Text and instant messaging on a phone typically involves rapid repeated thumb movements whilst holding the phone which may increase hand grip and pinch strength.

### Exposure to sunlight and allergic morbidity in children from the PARIS birth cohort

Léa Lefebvre<sup>1</sup>, Héléne Amazouz, Céline Roda, Fanny Rancière, Isabelle Momas

<sup>1</sup>Université Paris Cité, Sorbonne Paris-Nord, INRAe, INSERM, UMR 1153-CRESS, HERA Team, Paris, France

#### Abstract

**Background:** Sunlight relationship with allergies is poorly studied in children. Thus, we examined how early exposure to solar radiation is associated with allergic morbidity in the PARIS birth cohort.

**Methods:** This study dealt with children who attended at least one of the two health check-ups: 18 months ( $n=2012$ ) and 8/9 years ( $n=1080$ ). Early exposure (prenatal and during the first year of life) to solar radiation was assessed using meteorological data (solar radiation, temperature, relative humidity). Children with similar exposure trajectories were grouped by longitudinal and multidimensional cluster analysis. Association of solar radiation exposure with allergic morbidity (i.e. allergic sensitisation at 18 months and 8/9 y., current asthma, rhinitis, and eczema at 8/9 y.) was quantified by multivariable logistic regression models adjusted for potential confounders. The effect modification of maternal vitamin D (VitD) supplementation during pregnancy was also tested.

**Results:** Four exposure trajectories were found. The trajectory with the highest exposure to early solar radiation had a reduced risk of sensitisation at 8/9 y. compared to the trajectory with the lowest exposure ( $p=0.06$ ). The association was statistically significant in the VitD supplemented group. Solar radiation during pre- and post-natal period was significantly associated with a lower risk of sensitisation at 8/9 y. (for the augmentation of one IQR, aOR: 0.47; 95%CI: 0.25-0.87 and 0.84;0.70-1.00, respectively). Increased prenatal exposure to solar radiation was significantly associated with a lower asthma risk at 8/9 y. (for the augmentation of one IQR, 0.32; 0.10-0.96).

**Conclusions:** Early sunlight exposure may reduce the risk of sensitisation and asthma in school-aged children, especially in those prenatally exposed to VitD intake. These findings highlight the importance of VitD in preventing allergic diseases in children, either through supplementation or sunlight exposure.

### The impact of greening playgrounds on children's BMI z-score, cognitive performance and pro-social behavior

Lore Verheyen<sup>1</sup>, Bo van Engelen, Kenneth Vanbrabant, Onno van Schayck, Michelle Plusquin

<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Belgium

#### Abstract

**Objective:** It has been shown that spending time in a green environment improves cognitive development and the emotional and general health of children. Here, the contribution of green playgrounds and biodiversity to BMI, cognitive performance, and well-being among children aged 8 – 12 is analyzed using a two-year follow-up study.

**Material and Methods:** This study was based on 170 schoolchildren in the fourth to sixth grades of four primary schools in Belgium and the Netherlands. Two schools greened their schoolyard between baseline and four follow-up visits. Appreciation of the schoolyard, general well-being, and quality of life were assessed by self-reported questionnaires. Cognitive performance was assessed using five tests of the Minds Test Manager for Psychological Testing. Mixed-effects models were used to examine the associations between school greening and BMI z-scores, cognitive performance, and well-being.

**Results:** The results indicate a significant improvement in selective attention in the intervention group after greening ( $\beta = -0.01$ ,  $p = 0.03$ ). BMI z-scores show a significant decrease in the intervention group after greening compared to the control group ( $\beta = -0.07$ ,  $p = 0.03$ ). Additionally, a significant increase in pro-social behavior was observed in the intervention group after greening ( $\beta = 0.24$ ,  $p = 0.02$ ). Other indicators did not show any significant results.

**Conclusion:** The results of this study show that greening schoolyards may positively influence certain aspects of well-being and may enhance the cognitive performance of children. Our findings not only generate scientific insight into the impact of greening schoolyards and its benefits on children, but they can also inspire policymakers to implement natural environments as an easily accessible and low-cost method to boost mental health in schools.

### Organic foods might be protective against sensitization to aeroallergens at school age: the PARIS birth cohort

Maëlys Pernin-Schneider<sup>1</sup>, Héléne Amazouz, Guillaume Lezmi, Mélisande Bourgoïn-Heck, Jocelyne Just, Isabelle Momas, Fanny Rancière

<sup>1</sup>Université Paris Cité, Inserm U1153 CRESS, Inrae, HERA team, Paris, France

#### Abstract

**Introduction:** The role of diet in childhood on the development of allergy has received increasing attention. However, studies focusing on organic food consumption are scarce. We aimed to study the relationships between organic food consumption and respiratory/allergic morbidity at school age in the PARIS cohort.

**Methods:** Diet was assessed using a food frequency questionnaire completed by the parents at 8 years. Dietary patterns were identified by cluster analysis based on the frequency of consumption of 30 foods (either organic or conventional) and 19 organic foods. Associations between dietary patterns and respiratory/allergic morbidity (asthma, rhinitis, eczema, sensitization) were studied using multivariable logistic regression models adjusted for potential confounders including family socioeconomic status and adherence to Mediterranean diet as a proxy of dietary balance.

**Results:** Among the 1,297 children included, three dietary patterns were identified which differed according to the frequency of consumption of organic foods: low for the G0 group (51% of children), moderate for the G1 group (28% of children) and high for the G2 group (21% of children). No association was found between dietary patterns and asthma, eczema, rhinitis or sensitization to food allergens. However, compared with G0, children from G2 had lower likelihood of sensitization to any allergen (aOR=0.60; 95% CI: 0.40–0.91), in particular to inhalant allergens (aOR=0.64; 95% CI: 0.42–0.99).

**Discussion:** Our findings suggest that frequent organic food consumption may be protective against allergic sensitization at school age. Further research is warranted to explore the underlying mechanisms for this association, including nutritional and/or environmental exposures.

### Air pollution exposure and metabolomic markers in children and young adults

Shizhen He<sup>1</sup>, Baninia Habchi, Erik Melén, Anna Bergström, Anne-Sophie Merrit, Inger Kull, Kristina Eneroth, Matteo Bottai, Romanas Chaleckis, Simon Kebede Merid, Sophia Björkander, Zhebin Yu, Craig E. Wheelock, Olena Gruzieva, Susanna Klevebro<sup>1</sup>  
*Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden*

#### Abstract

**Objective:** Few epidemiological studies have examined the metabolome in children and young adults in relation to long-term air pollution. This study explored associations between early and recent air pollution exposure and urinary metabolites in children and young adults.

**Material and Methods:** In the Swedish BAMSE population-based birth cohort, urine samples were collected at the 4-year (n=612) and 24-year follow-ups (n=846). Non-targeted screening based on high-resolution mass spectrometry was applied to acquire the metabolomic profile. Among the measured features, 260 metabolites were identified based on standard matching to in-house compound libraries. Residential time-weighted average exposure to air pollutants, i.e., NO<sub>x</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> during the first year of life and the year prior to bio-sampling was estimated using validated dispersion models. For 4- and 24-year cross-sectional analyses respectively, exponential regression was conducted to estimate associations between air pollution and urinary metabolites. Pathway enrichment was conducted based on top hits from analyses of all identified features.

**Results:** At the 4-year follow-up, first year and prior year air pollution exposures were associated with 4 metabolic pathways, i.e., caffeine metabolism, 3-oxo-10R-octadecatrienoate beta-oxidation, TCA cycle and vitamin B7 metabolism; prior year air pollution was additionally associated with 11 other pathways including galactose metabolism. At the 24-year follow-up, early life and prior year air pollution was associated with 10 and 11 pathways respectively, with 2 overlapping pathways: Vitamin B6 metabolism and androgen and estrogen biosynthesis and metabolism.

**Conclusions:** Some endogenous metabolic pathways previously reported to be associated with air pollution were replicated and new metabolic pathway associations were identified. Both early life and recent long-term air pollution exposures were linked to urinary metabolites in childhood and young adulthood.

### Exploring the impact of lifestyle and environmental exposures on appetite hormone levels in childhood and adolescence

Thaïs De Ruyter<sup>1,2</sup>, Dries S. Martens, Esmée M. Bijmens, Stefaan De Henauw, Tim S. Nawrot, Nathalie Michels<sup>1</sup>  
*Centre for Environmental Sciences, Hasselt University, Hasselt, Belgium; <sup>2</sup>Department of Public Health and Primary Care, Ghent University Ghent, Belgium*

#### Abstract

**Introduction:** Impaired appetite hormones levels have been associated with overweight and obesity. However, further insights in the drivers of appetite hormone levels are lacking and might be of interest in obesity prevention.

**Objective:** To assess whether lifestyle and environmental exposures are associated with appetite hormone levels in children and adolescents.

**Methods:** 534 participants of the Belgian ChiBS (Children's Body composition and Stress) cohort (age=4-16y, 50% boys) were included, of whom glucagon-like peptide-1 (GLP-1), peptide YY (PYY), pancreatic polypeptide (PP), leptin and ghrelin were measured in fasting serum. Exposures included dietary quality (fiber-rich food intake, sugar and fat propensity), psychosocial stress (happiness, negative emotions, negative life events and emotional problems), sleep duration, physical activity and environmental quality (long term black carbon (BC), particulate matter <2.5 μm (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>) exposure, and green space in a 100 m and 2000 m radius around the residence). A multi-exposure score was computed which integrates all exposures at study. Linear mixed regressions, adjusted for potential confounders, were used to assess associations between the exposures and appetite hormone levels.

**Results:** GLP-1 was associated with air pollution exposure (NO<sub>2</sub> β\*=-0.13, BC β\*=-0.15, PM<sub>2.5</sub> β\*=-0.16, all p<0.001). Leptin was associated with green space in 100 m radius around the residence (β\*=-0.11; p=0.002). Ghrelin was associated with negative emotions (active ghrelin β\*=-0.16; p=0.04, total ghrelin β\*=-0.23; p=0.0051) and happiness (active ghrelin β\*=0.25; p<0.001, total ghrelin β\*=0.26; p<0.001). Total ghrelin levels were associated with the multi-exposure score, reflecting unhealthy exposures and lifestyle (β\*=-0.22; p=0.036).

**Conclusions:** Our findings provide new insights in the associations of environmental exposures with appetite hormone levels, which are of high interest for preventive obesity research.

### The association of tranquil environment with sleep disturbance in adolescents: a cohort study

Xing Jiang<sup>1</sup>, Nekane Sandoval-Diez, Danielle Vienneau, Martin Rössli<sup>1</sup>  
*Swiss Tropical and Public Health Institute (Swiss TPH), Kreuzstrasse 2, CH-4123, Allschwil, Switzerland; <sup>2</sup>University of Basel, CH-4003, Basel, Switzerland*

#### Abstract

**Objective:** A tranquil environment, characterized by quietness or green spaces, may improve sleep quality. This study explores the association between tranquility and sleep disturbance in a Swiss cohort of 887 adolescents (10-17 years), evaluated cross-sectionally and after a one-year follow-up.

**Material and Methods:** The Sleep Disturbances Score (SDS, 0-12) was derived from standardized four-point Likert scale questions, with a score of 7 or higher indicating disturbed sleep. The quietness scale, derived from nighttime road traffic noise (Leq), converts values above 70 decibel to 1, below 25 decibel to 0, and linearly scales the intermediate values. Greenness exposure within a 500m buffer around residences was assessed using the mean Normalized Difference Vegetation Index (NDVI), which ranged from 0 to 1. We employed multilevel linear and logistic regression models to assess the fixed effects and interactions of quietness and greenness exposure on SDS.



**Results:** We observed that SDS increased between baseline and follow-up by 1.12 units (95% CI 0.25, 1.98) per 0.1 increase in the quietness scale and by 0.97 units (95% CI 0.21, 1.73) per 10% increase in mean NDVI, although at the same time, statistically significant negative interaction terms indicated a reduction of sleep disturbance with high exposure to both factors. Cross-sectional analyses found no associations. In a subset without sleep disturbance at baseline (n=751) and a model without interaction, odds of sleep disturbance after one-year were not significant associated with quietness (OR 1.16, 95% CI 0.95, 1.44), and greenness (OR 0.94, 95% CI 0.63, 1.41). Sensitivity analyses with a 150m greenness buffer yielded similar results.

**Conclusion:** Our findings indicate a complex interaction between quietness, green space and sleep disturbance, which partly contradicted our hypotheses. Further investigations are needed to explore additional facets of tranquility affecting adolescents' sleep quality.

### Decreased polyunsaturated fatty acids link Pb exposure with behavioral and emotional problems in preschool children

Yifeng Dai<sup>1,2,3</sup>, Zhibeng Cheng, Marijke M Faas, Xia Huo

<sup>1</sup>Laboratory of Environmental Medicine and Developmental Toxicology, Guangdong Key Laboratory of Environmental Pollution and Health, School of Environment, Jinan University, Guangzhou, 510632, Guangdong, China; <sup>2</sup>Department of Global Public Health and Bioethics, Julius Center for Health Sciences and Primary Care, University Medical Centre Utrecht, The Netherlands; <sup>3</sup>Department of Pathology and Medical Biology, University of Groningen, University Medical Center Groningen, Hanzeplein 1, 9713 GZ Groningen, the Netherlands

#### Abstract

**Background:** Exposure to lead (Pb) can interfere with fatty acid metabolism and affect neurodevelopment. However, a toxic link of Pb on polyunsaturated fatty acids (PUFAs) to neuropsychological development in preschool children is unknown.

**Objectives:** To explore the mediation role of PUFAs between Pb exposure and neuropsychological development in preschool children.

**Methods:** A total of 524 healthy preschool children, 3-7 years of age, were recruited from China. Child behavioral and emotional problems were evaluated using the Strengths and Difficulties Questionnaire (SDQ). We measured blood Pb and seven kinds of omega-3 and omega-6 PUFAs in plasma. A quantile regression model was used to investigate the non-linear association between blood Pb and plasma PUFAs. The parallel multiple mediator models were performed to assess the mediation effect of PUFAs between Pb exposure and child behavioral and emotional problems.

**Results:** Compared with the normal group, children in the borderline/abnormal group had higher blood Pb and lowered PUFAs. Blood Pb levels were inversely correlated with PUFAs and positively associated with behavioral and emotional problems in children. A non-linear relationship between blood Pb and ln-transformed PUFAs was found. Compared with the 1st tertile, blood Pb in the 3rd tertile was significantly inversely associated with eicosapentaenoic acid (EPA) (B = -0.705), docosahexaenoic acid (DHA) (B = -0.705), and arachidonic acid (AA) (B = -0.501), respectively. In addition, plasma DHA mediated the positive association between blood Pb and child emotional symptoms (B = 0.587) or total difficulties score for the SDQ (B = 1.834).

**Conclusions:** The exposure of preschool children to high Pb could affect DHA content in plasma, hence DHA-mediated behavioral and emotional problems. Thus, we suggest that appropriate increases in omega-3 PUFAs are essential to the neurodevelopmental potential of early to middle childhood with high blood Pb.

## EXPOSOME AND URBAN EXPOSURES

### Health co-benefits of sustainable mobility interventions: a scoping review of policies and a systematic review protocol

Alessio Perilli<sup>1</sup>, Simona Vecchi, Federica Parmagnani, Manuela De Sario, Francesca de' Donato, Paola Michelozzi

<sup>1</sup>Department of Epidemiology, Lazio Regional Health Service, Rome 00147, Italy

#### Abstract

**Objective:** Public transportation and active mobility serve as climate mitigation solutions and achieve health co-benefits through higher physical activity and reduced air pollution. Within the Italian climate change and health project (PNC CLIMA), we carried out a scoping review of sustainable urban mobility plans (SUMP) in Italian cities and aim to perform a systematic review (SR) of studies on health co-benefits of sustainable mobility measures.

**Material and methods:** We identified SUMP through web searches and summarized results narratively. We developed a search strategy and used MEDLINE, Embase and PsycInfo databases (via Ovid) and Web of Science to search for systematic reviews on the topic. Two reviewers will independently screen the search results. Results will be summarized narratively and meta-analysis will be performed where appropriate. All types of SM interventions will be considered, including public/private sectors, freight transport, economic policies, physical policies and soft policies. A specific focus will be on equity and vulnerable groups, such as youth, elderly, persons with disabilities, who are exposed to transport poverty. We will use PRISMA guidelines for the report of this SR.

**Results:** Among the 78 SUMP, the most frequent policies were active mobility, public transport and urban logistics. The SR search strategy resulted in 8254 records from inception to January 2024. We will present results categorized by single- and multi-component interventions and by target population group. Both direct and indirect health co-benefits will be considered. The SR is underway and results will be finalized by mid-march.

**Conclusion:** Only part of Italian SUMP are operational. The planned SR is expected to provide pathways of co-benefits of low-carbon transport solutions and the basis to set up transport shift scenarios for health impact analysis at national level, thus identifying policy setting priorities.

### Neighborhood influence on youth alcohol behaviors: A mediation analysis

Albert J. Ksinan<sup>1</sup>, Gabriela K. Jiskrova, Andrea Dalecká, Martin Bobak, Hynek Pikhart

<sup>1</sup>RECETOX, Masaryk University, Brno, Czechia

#### Abstract

**Introduction:** Previous studies on the association between neighborhood disadvantage and alcohol use have found mixed results, especially with adolescent samples. The current study sought to evaluate the effect of neighborhood on adolescent alcohol use and test mechanism explaining this hypothesized association.

**Methods:** Data from a longitudinal cohort study ELSPAC were used. Specifically, we focused on timepoint when adolescents were 15 years old (N = 1,353). Neighborhood disadvantage was rated by mothers. Data on adolescent alcohol use, peer alcohol use, spending time with peers, and allowance were provided by adolescents. Other covariates included adolescent sex, parental alcohol use, and maternal education. Structural equation modeling was used to evaluate the effect of neighborhood disadvantage on adolescent alcohol use, with hypothesized mediators being peer alcohol use, unstructured time with peers, and allowance.

**Results:** The results showed a significant negative effect of neighborhood disadvantage on adolescent alcohol use ( $\beta = -.10$ ,  $p = .021$ ), showing that adolescent alcohol use was associated with neighborhood advantage. Child allowance was positively associated with adolescent alcohol use ( $\beta = .17$ ,  $p < .001$ ), yet no association between neighborhood disadvantage and allowance was found. On the other hand, adolescents in more advantaged neighborhoods spent more unstructured time with peers ( $\beta = -.10$ ,  $p = .007$ ); spending more unstructured time with peers was associated with higher likelihood of peers who get drunk (OR = 1.31,  $p < .001$ ); this was then associated with more alcohol use ( $\beta = .34$ ,  $p < .001$ ). The indirect effect from neighborhood disadvantage to adolescent alcohol use was statistically significant,  $B = -.04$ , 95% BcCI [-0.08, -.02].

**Discussion:** A positive effect was found where more advantageous neighborhoods were associated with more adolescent alcohol drinking. This association was partly explained by adolescents spending unstructured time with peers.

### Newborn insulin-like growth factor 1 protein is associated with prenatal green space exposure

Anna E Soerensen<sup>1</sup>, Esmee Bijmens, Yinthe Dockx, Janneke Hogervorst, Dries Martens, Michelle Plusquin, Tim S Nawrot  
<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Hasselt, Belgium

#### Abstract

**Introduction:** Green space exposure has been shown to benefit cognitive functioning across different age groups. Particularly early life green space exposure has a large potential for an impact due to the active brain development in this time period. However, little is known on the molecular basis behind this phenomenon. Neurotrophic factors, such as insulin-like growth factor 1 (IGF1), play an important role in brain development and cognitive functioning. We therefore examined the association between IGF1 levels in cord blood and prenatal green space exposure.

**Methods:** From 824 mother-child pairs from the ENVIRONAGE birth cohort, cord blood IGF1 measurements were measured using the Modular E170 automatic analyzer. Prenatal, residential total green space exposure was calculated using the Green Map of Flanders in radii of 50 – 2000 m. Generalized linear models were used to associate IGF1 with green space exposure, adjusting for a priori selected covariables, including maternal age, education, parity, date of delivery and newborn sex, gestational age and birthweight. Significant green space exposure radii were stratified for vegetation above and below 3 m in height.

**Results:** An IQR increase in prenatal, residential green space exposure within 50 and 100 m was significantly associated with a 2.50 ng/mL (95% CI: 0.33 to 4.68,  $P = 0.024$ ) and a 2.36 ng/mL (CI = 0.14 to 4.59,  $P = 0.038$ ) increase in cord blood IGF1 concentration, respectively. Stratifying for vegetation height indicated that vegetation lower than 3 m was significantly associated with newborn IGF1 within 50 m of the residence (95% CI = 0.01 to 4.71,  $P = 0.049$ ).

**Discussion:** Our findings show that prenatal, residential green space exposure might have an influence on newborn IGF1 levels, a neurotrophic factor. This suggests that prenatal green space exposure could potentially affect brain development and cognitive functioning.

### Cooling potential of evaporative mist systems in urban outdoor environments: a case study of Novi Sad, Serbia

Jelena Dunjić<sup>1</sup>, Stevan Savic, Daniela Arsenovic

<sup>1</sup>University of Novi Sad, Faculty of Sciences, Chair of Geoecology

#### Abstract

**Introduction:** Increased intensity and frequency of extreme heat events are especially pronounced in urban areas. These events demand proper response of authorities and businesses to improve thermal

comfort and mitigate the heat. Many outdoor areas of restaurants and cafes have evaporative mist systems implemented as a mitigation strategy for improving thermal comfort of the guests and employees during hot summer days.

**Methods:** We performed micrometeorological measurements in the different outdoor areas of three restaurants during the midday hours (1300-1600 CEST) in July 2023. Microclimate parameters ( $T_a$ , RH,  $v$  and  $T_g$ , 1 min. temporal resolution) were measured using Kestrel 5400 Heat Stress Trackers, in four different exposures: misted sun, misted shade, shade and sun only. Based on measured parameters, mean radiant temperature ( $T_{mrt}$ ), and physiological equivalent temperature (PET) were calculated with RayMan software, for the four exposures. Simultaneously, we conducted a survey among restaurant guests and managers to investigate their perceptions of the effectiveness of cooling misters, and motivations to use such systems.

**Results:** The results show that evaporative misters performed best when combined with shade. In sun-exposed locations, the differences in  $T_a$ ,  $T_{mrt}$ , and PET between misted and non-misted locations were minimal. Occasionally, even higher values of  $T_a$  and  $T_{mrt}$ /PET were recorded in misted and sun-exposed locations compared to non-misted and sun-exposed locations. Survey results show that both guests and managers consider that cooling misters are effective in improving the thermal comfort.

**Discussion:** The results of this and previous studies show that evaporative cooling misters can be effective in improving thermal comfort, only when located properly and combined with shade. Psychological effect of the cooling mist systems is undoubtedly high, since majority of respondents said that their comfort is significantly improved with the misting system.

### Leisure gardening and health: an overview of reviews to inform integrated environmental health assessments

Eugénie Albert<sup>1</sup>, Anne Roué-Le Gall, Philippe Glorenec

<sup>1</sup>EHESP School of Public Health, Irset (Institut de recherche en santé, environnement et travail) - UMR\_S 1085, Univ Rennes F-35000 RENNES, French Agency for ecological transition F-49004, ANGERS

#### Abstract

**Objective:** In the context of growing land pressure, new uses are projected on contaminated soils. In order to inform a comprehensive health assessment of gardening, this work aims to synthesise both quantitative and qualitative findings on the links between gardening and health, taking gardeners' motivations and practices into account.

**Methods:** A rapid overview of reviews was conducted. Both therapeutic and commercial gardening were excluded, as was data from developing countries. Reviews describing at least one link between leisure gardening and health or well-being were included. Pubmed and Web of Science were searched for reviews published up to February 2023. The results were summarised in the form of a conceptual model, to support a comprehensive assessment of the links between health and gardening.

**Results:** Gardening has been shown to impact i) quality of the environment through supporting and providing ecosystem services and raised ecological awareness, ii) mental well-being through stress relief, positive affect and the provision of meaning and purpose, iii) social capital through increased and stronger relationships, iv) physical activity through enjoyable, low-to- moderate-intensity activities, v) diet through improved food literacy and access to fruit and vegetables, and vi) (potentially) economic status through food savings. Gardening is associated with lower Body Mass Index (BMI) and better self-reported health. Evidence on other health indicators is too scarce for conclusions to be drawn. We propose a framework aggregating these results.

**Discussion:** As a health-oriented review of reviews, some data may be missing as a result of topic classification or loss from duplicate removal.

Some health determinants and contexts are less well documented; caution is needed when addressing these specific issues. Despite these limitations, the evidence gathered is sufficient to support an assessment of the health benefits of leisure gardening.

### **Reconstruction of the radiological component of the exposome in the CONSTANCES cohort: first step of the CORALE project.**

*Justine Sauce<sup>1</sup>, Sophie Ancelet, Corinne Mandin, Philippe Renaud, Jean-Michel Métivier, Abdulhamid Chaik, Eric Blanchardon, David Broggio, Claire Gréau, Caroline Vignaud, Marie-Odile Bernier, Enora Cléro, Marcel Goldberg, Christelle Huet, Stéphane Le Got, Emeline Lequy, Aurélie Isambert, Afi Henryoh, Géraldine Ielsch, Célian Michel, Choisie Mukakalisa, Mireille Cœuret-Pellicer, Hervé Roy, Céline Ribet, Lionel Saey, Marie Zins, Olivier Laurent*  
<sup>1</sup>Institut de Radioprotection et de Sécurité Nucléaire (IRSN), PSE-SANTE/SESANE/LEPID, F-92260, Fontenay-aux-Roses, France

#### **Abstract**

**Introduction:** The aim of the CORALE project is to integrate for the first time, year by year, the exposures to ionising radiation (IR) received by individuals since birth and to study their associations with chronic diseases, in the French population-based CONSTANCES cohort. The present work focuses on reconstructing the IR doses to organs at several stages of life.

**Methods:** A questionnaire was sent to 76,693 volunteers from the CONSTANCES cohort. Some environmental exposures are reconstructed by linking residential histories since birth with radioactivity maps (radon, terrestrial gamma and cosmic rays, and artificial sources) and other through a questionnaire (e.g. on their dwelling – type, floor; on their diet – unfiltered tap water, local mushroom and seafood consumption; on their flights). Occupational exposures will be reconstructed based on a national registry dedicated to IR exposure at work. Medical exposures to IR will be identified through the National Health Data System from 2007 onwards and by a questionnaire for the pre-2007 period.

**Results:** So far 28,730 participants replied to the questionnaire. In terms of lifestyles linked to environmental exposure, 60.5% of respondents ate shellfish and 37.6% ate local mushrooms and 79.1% have flown at least once in their lives. Regarding medical exposure prior to 2007, 30.6% of respondents reported having had at least one scanner and 16.8% an X-ray with contrast agent. Among women, 43.1% reported having had at least one mammogram. Dose estimates to 6 organs (brain, thyroid, lung, breast, colon, and prostate) are currently being derived.

**Discussion:** The survey remains open, allowing responses from other participants to be recorded. These data are essential to the CORALE study, allowing for the most exhaustive reconstruction of IR as possible throughout life, and will be precious for epidemiological analyses.

### **Chrono-metabolism of xenobiotics and the utility of exposomic tools: evidence from behavioral change studies**

*Konstantinos C. Makris<sup>1</sup>*

<sup>1</sup>Cyprus International Institute for Environmental and Public Health, School of Health Sciences, Cyprus University of Technology

#### **Abstract**

**Introduction:** The influence of chronos temporal dimensions in dictating the recurrence of typical environmental stressors, such as shift work, jet lag and irregular lifestyles (abnormal sleep patterns and fasting/feeding cycles) hint to changes in circadian clock functionality. Desynchronizing the interface that links external exposome components with the periodic resilience of circadian clock oscillators and metabolic regulators and with that of downstream biological systems (internal

exposome) would potentially lead to excess toxicity. However, this has received little attention in human studies.

**Methods:** The human exposome's methodological features and tools as part of a suite of chronos-based interventions of behavioral change, relying upon the chrono-metabolism of environmental chemicals (xenobiotics) were used. Intervention treatments were those of: i) exposure to disinfectants/ disinfection byproducts in adults performing household cleaning activities in different times of the day, ii) consumption of a time-restricted (day vs night) five-a-day vegetables/fruits schedule, including the unintentional intake of pesticides as food contaminants, and iii) exposure to BTEX during night shift work vs day shift schedules in gas station workers.

**Results:** Depending on the time of day that exposure took place, the interventions consistently showed the effect of a chrono-differential metabolism of xenobiotics on their body burden of participants, including an associated biological response in the form of biomarkers of genotoxicity and/or oxidative stress.

**Discussion:** Randomized controlled trials delivering treatments of personalized nature at the right time that are well powered, with high repeated measures sampling frequency and long intervention duration are most promising to support natural/green solutions, to promote behavioural change and to support tertiary or secondary prevention schemes based on personalized medicine approaches.

### **The application of the urban exposome framework in the CONSTANCES/Paris cohort (Paris UrbanEX)**

*Nadine Haddad<sup>1</sup>, Emeline Lequy-Flahault, Marie Zins, Marcel Goldberg, Konstantinos C. Makris*

<sup>1</sup>Cyprus International Institute for Environmental and Public Health, School of Health Sciences, Cyprus University of Technology, Limassol, Cyprus

#### **Abstract**

**Introduction:** The complexity of urban ecosystems and populations presents with challenges in studying how urban settings could shape populations' well-being over space and time. The urban exposome methodological framework was defined as continuous spatiotemporal monitoring of population indicators associated with urban external and internal exposome domains, using small area-level analysis. We aim to showcase the use of an urban exposome study protocol and its exposomic tools in a longitudinal setting, such as the population-based CONSTANCES cohort in Paris urban population.

**Methods:** Adults (18-69 years) enrolled during 2012-2020, followed-up annually to date, and residing in urban Paris were considered. Based on exposome domains groups of variables, we selected from inclusion and follow-up: intrinsic variables; bioclinical data at inclusion and after 5 years; and variables available at 3 or more time points. We described urban exposome profile dynamics and investigated association between urban exposome profile and BMI, using small area (IRIS) analysis.

**Results:** 30906 participants from the 992 IRIS of urban Paris were included. 638 human exposome variables were selected: 109 from general external domain; 143 from specific external and 386 from internal. For clustering participants into exposome-based networks, hierarchical clustering on principal components will be applied using inclusion data, considering spatial constraints. This method combines dimension reduction using PCA, followed by hierarchical clustering and K-means clustering. Bayesian Kernel Machine Regression – Lagged distribution models will be used to estimate mixture effects of co-occurring and time-changing exposome variables.

**Discussion:** Novel exposomic tools in characterizing complex spatiotemporal features of Paris urban exposome will be highlighted. Applying such urban exposome study protocols in longitudinal settings would advance understanding disease process in complex urban ecosystems.

### Exposome measurements in the Precision Medicine for more Oxygen (P4O2) COVID-19 cohort.

Laura Houweling<sup>1,2</sup>, Judith C.S. Holtjer, Lizan D. Bloemsa, Emma R. Gijsbers, Eveline E. de Waard, Roel C.H. Vermeulen, Anke-Hilse Maitland-Van der Zee, George S. Downward

<sup>1</sup>Department of Environmental Epidemiology, Institute for Risk Assessment Sciences (IRAS), Utrecht University, Utrecht, Netherlands;

<sup>2</sup>Department of Pulmonary Medicine, Amsterdam UMC, Amsterdam

#### Abstract

**Introduction:** Despite the WHO's declaration of the end of the global SARS-CoV-2 emergency, concerns persist about long COVID. While prior research emphasized biological mechanisms and risk factors, the role of environmental factors has been underexplored. The P4O2 COVID-19 study investigates the impact of the exposome at the individual level on the progression of long COVID. Here, we present the design and the first findings of the exposome measurements conducted within the P4O2 COVID-19 cohort.

**Methods:** The P4O2 COVID-19 study consisted of two clinical study visits at 3-6 and 12-15 months post-infection with exposome measurements being collected from participants' homes between these visits. Measurements included real-time residential PM2.5 monitoring using sensors and up to four 24-hour time-weighted personal PM2.5 measurements were conducted with a wearable device. Additionally, chemical exposure was assessed with silicon wristbands and physical activity was monitored with activity trackers.

**Preliminary Results:** The study included 95 long COVID patients, with 79 participating in the exposome measurements. 73 real-time PM2.5 sensors were deployed to an outside window for an average of 131 days to measure residential exposure and 291 personal PM2.5 measurements were conducted. The geometric means(GM) for residential and personal PM2.5 exposure were 8.68(geometric standard deviation(GSD):1.39)µg/m<sup>3</sup>, and 17.06(GSD:2.15)µg/m<sup>3</sup> respectively. A correlation of 0.29 was identified between personal and residential PM2.5 concentrations.

**Discussion:** The measurements conducted in the P4O2 COVID-19 study contribute to the understanding of the role of the exposome in the long-term health effects of COVID-19. In addition, this study demonstrates the effectiveness of individual-level measurements at participants' homes for objectively determining the exposome, particularly PM2.5 exposure.

### Effect of different green spaces and urbanization types on daily temperature risks and noise pollution

Stevan Savic<sup>1</sup>, Jelena Dunjic, Milos Bjelic, Tatjana Miljkovic, Daniela Arsenovic

<sup>1</sup>Novi Sad Urban Climate Lab, Faculty of Sciences, University of Novi Sad, Serbia

#### Abstract

**Introduction:** Cities are under the pressure of intensive urbanization and modified environmental conditions, which are expressed due to climate change, intensification of traffic and industry, and constant reduction of green areas, and that lead to more intense urban heat island (UHI) effect. Furthermore, some research has shown that a large number of people (over 60% of European population) are permanently exposed to noise levels that exceed some established limit values. As a consequence of these processes, there is a threat to the urban ecosystem, increased thermal risk, as well as threats to public health.

**Methods:** The idea of this study is to assess the effects of different green/urbanized environments on temperature risks and noise pollution in two micro-locations. An analysis of the ambient conditions and noise in the urban environment was conducted at two locations in Belgrade, which differed in configuration. Simultaneous measurements of temperature (Ta and Tg), humidity, wind speed, and equivalent noise level were taken during a hot summer day (maximum temperature over 30°C).

**Results:** It was shown that the noise level exceeds the prescribed noise level values for the analyzed acoustic zone. The noise level values differ for the two locations due to the different traffic densities in the environment and different urban characteristics.

**Discussion:** This study showed that the concept of green space, but also of built-up type in urban planning could has importance impact in regulating thermal and noise conditions and obtained improved urban environments.

**Acknowledgement:** The research and assessments are supported by the project entitled: "Improving the environment in Vojvodina in order to adapt to climate change and reduce the risk of natural disasters" (no. 142-451-3485/2023-01), financed by the Autonomous Province of Vojvodina (regional government).

## BRAIN AND NEURODEVELOPMENT

### Associations between traffic noise and incident dementia in UK Biobank

Enock Havyarimana<sup>1,2</sup>, Xiangpu Gong, Calvin Jephcote, Sarah Johnson, Sana Suri, Wuxiang Xie, Charlotte Clark, Anna Hansell, Samuel Cai

<sup>1</sup>Centre for Environmental Health and Sustainability, Department of Population Health Sciences, University of Leicester, Leicester, United Kingdom; <sup>2</sup>NIHR Leicester Biomedical Research Centre, Leicester General Hospital, Leicester, United Kingdom

#### Abstract

**Background and Objective:** Transport noise is a major public health concern, ranking the second worst environmental cause of poor health in Europe. Evidence linking noise pollution and brain health, particularly at mid-to-late life, remains scarce. We investigated the associations between long-term exposure to traffic noise and incident dementia in UK Biobank cohort.

**Methods:** During a median 12.2 years of follow-up, 7,668 incident dementia cases were identified from record-linkages of 502,416 participants enrolled at baseline 2006-2010. This translated to a crude incidence rate of 11.6 cases per 10,000 person-years. Residence-based road traffic noise from both minor and major roads were calculated in accordance with CNOSSOS-EU framework; railway noise estimates were created by Extrium, with the raster datasets representing noise contributions from major rail corridors. Cox regression was used to quantify the relationships between traffic noise and incident dementia (and its subtypes) adjusting for potential confounders (age, sex, education, household income, employment status, townsend deprivation, and cardiovascular risk factors), air pollution, and greenness.

**Results:** Unadjusted analyses indicated a moderate but adverse association between railway noise and all-cause dementia, with statistically significant effects being seen with Parkinson's disease. Following adjustments for a range of key confounders, associations remained for Parkinson's disease, with 10 dB higher railway noise exposure (Lden, 24hrs) being associated with 4.2% (95% CI: 0.5% - 8.1%) increased risk of Parkinson's disease. Those over the age 60 were particularly at risk (HR: 7.4%, 95% CI: 2.3% - 12.7%). No associations were observed with road noise, nor with any other dementia subtypes.

**Conclusion:** We report, for the first time in the UK, a moderate association between long-term exposure to railway noise and incident dementia, particularly Parkinson's disease.

### Environmental Exposures in Lebanese Infants (EELI): Birth Cohort Examining the Effects on Neurocognitive Development

Joway Abi Hanna<sup>1,2</sup>, Georges Abi Tayeh, Emile Whaibeh, Lina Jaalouk, Alicia Abi Nader, Jessica Saliba, Norma Aouad, Cassandra Fares, Nanor Kechkelekian, Myriam Mrad

<sup>1</sup>Doctoral School of Health and Sciences (EDSS), Faculty of Medicine, Saint-Joseph University of Beirut, Beirut, Lebanon; <sup>2</sup>Public Health Department, Faculty of Health Sciences, University of Balamand, Beirut, Lebanon

#### Abstract

**Objective:** The Environmental Exposures in Lebanese Infants (EELI) Study is a longitudinal birth cohort aiming to investigate the impact of environmental exposures on the neurocognitive and psychomotor development in Lebanese infants residing in Beirut and the Mount Lebanon areas. The study builds on the work of a previous pilot study of the same name, and it specifically focuses on indoor and outdoor air pollution, particularly particulate matter 2.5 (PM<sub>2.5</sub>), heavy metals, per and poly-fluoroalkyl substances, and the impacts of climate change.

**Material and Methods:** The recruitment of pregnant women takes place during first trimester at the partner hospital in Lebanon. Once the consent forms are signed, a house visit is conducted to collect biological samples from the prospective mother, complete pre-natal questionnaires, and measure the level of indoor PM<sub>2.5</sub>, temperature, and humidity. Clinical, delivery, and birth data are obtained from hospital records. One-year post-birth, a second house visit is implemented to gather data on the baby's health, the mother's post-birth parameters. Collection of biological samples, indoor measurements, and assessment of the four psychomotor development axes: cognitive, emotional, motor, and social skills of the child, IQ test for the parents is conducted. During the study, outdoor air pollution levels, humidity, and temperature will be documented using satellite data.

**Results:** The EELI study involved recruiting 1000 mother-child dyads from Beirut and Mount Lebanon Governorates. The assessment of air pollution, chemicals, as well as the impact of climate changes from in-utero life, along with the collected biological samples and data at different critical time points provides insight of the role of exposures in relation to the neurocognitive development.

**Conclusion:** Given the lack of research on environmental exposures and child development in the region, EELI explores the link between the exposome and neurocognitive development.

#### Use of machine learning to identify key predictors of severe sleep disturbance due to nocturnal railway vibration

Jurriaan Hoekstra<sup>1</sup>, Elise van Kempen, Sendrick Simon, Arnaud Kok, Nick Mabjaia, Harm van Wijnen, Irene van Kamp  
<sup>1</sup>National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

#### Abstract

**Introduction:** Nocturnal rail traffic is a source of noise and vibration that may affect the sleep of people living near railway lines. However, in contrast to noise, there is a lack of field studies investigating the effects of vibration exposure on sleep and which co-determinants could influence these effects. We conducted an untargeted analysis using machine learning (ML) techniques to identify key predictors of severe sleep disturbance (SSD) due to railway vibration, and to explore the relationship between SSD and different measures of vibration intensity.

**Methods:** In 2021, we distributed an online survey to people of 16 years and older living within 300 meters of a railway line in the Netherlands. The survey measured SSD due to railway vibrations and its potential co-determinants. We enriched the survey data with various assessments of nocturnal railway vibration levels, (using the Dutch railway vibration calculation model), noise levels and other environmental exposures (final dataset: n = 4,351, n variables = 73). Least Absolute Shrinkage and Selection Operator (LASSO) regression and Random Forest (RF) were used to identify key predictors of SSD. The individual contributions of exposure to vibration and noise were examined using accumulated local effect (ALE) plots.

**Results:** In both LASSO and RF, sleep disturbance by railway noise, concerns about structural damage due to railway vibration and attitudes towards rail transport were the strongest predictors of SSD due to railway vibrations. Factors related to vibration intensity were less predictive compared to these attitudinal and situational predictors. The ALE plots show a non-linear relationship between SSD due to railway vibration and nocturnal exposure to both railway vibrations and noise.

**Discussion:** This study shows that both non-acoustic factors and environmental stressors contribute to SDD from railway vibrations. We also demonstrate the potential of using ML techniques for environmental studies.

#### Accumulation of ambient black carbon particles within key memory-related brain regions

Kenneth Vanbrabant<sup>1</sup>, Debby Van Dam, Eva Bongaerts, Yannick Vermeiren, Hannelore Bové, Niels Hellings, Marcel Ameloot, Michelle Plusquin, Peter Paul De Deyn, Tim S. Nawrot  
<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Agoralaan building D, B-3590, Diepenbeek, Belgium

#### Abstract

**Introduction:** Ambient air pollution poses a global health concern, not only contributing to respiratory and cardiovascular diseases, but is also linked to neurodegenerative disorders. Despite the recognized pathways through which air pollutants may impact the brain, direct evidence of the presence of ambient (nano)particles in the adult human brain is lacking. This study investigates the translocation of ambient black carbon (BC) particles to the brain and explores their biodistribution in different brain regions.

**Methods:** We used the label-free and biocompatible detection technique of non-incandescence related white-light generation under femtosecond-pulsed illumination to screen different regions of four postmortem and neuropathologically confirmed Alzheimer brains of four individuals from Flanders, Belgium, including three women and one man, with a mean age of 86 ± 13 years on the presence of BC particles. A Kruskal-Wallis test was utilized to compare black carbon loads across these regions, followed by Dunn's multiple comparison tests.

**Results:** Direct visualization revealed the presence of BC particles in the human brain. Screening of the different brain regions shows a significantly higher median number of BC particles present in the thalamus (433.6; 95%CI:246.8-570.5), the prefrontal cortex including the olfactory bulb (420.8; 95%CI:287.6-489.7), and the hippocampus (364.7; 95%CI:339.1-471.9) compared to cingulate cortex (192.3; 95%CI:159.8-301.0), amygdala (217.5; 95%CI:131.3-246.2), and the superior temporal gyrus (204.9; 95%CI:162.7-240.2).

**Discussion:** This study provides evidence that ambient air pollution particles are able to translocate to the human brain, accumulating in multiple brain regions associated with cognitive functioning. Our study provides compelling evidence to further support the link between air pollution and the potential negative effects of ambient air pollutants on central nervous system disorders.

#### Nurturing Attention through Nature

Nitika Singh<sup>1,2</sup>, Clemens Baumbach, Mikolaj Compa, Dorota Buczyłowska, Jakub Bratkowski, Yarema Mysak, Maja Wierzbna-Łukaszyk, Katarzyna Sitnik-Warchulska, Krzysztof Skotak, Małgorzata Lipowska, Bernadetta Izydorczyk, Marcin Szwed, Iana Markevych  
<sup>1</sup>Institute of Psychology, Jagiellonian University, Kraków, Poland; <sup>2</sup>Doctoral school of social sciences, Jagiellonian University, Kraków, Poland

#### Abstract

**Background:** Previous studies suggest an association between increased exposure to nature and improved attention. However, no studies explored the underlying mechanisms or considered bluespace,

and none were based on Polish data. We investigated the association between exposure to greenspace and bluespace and attention, and whether this association was mediated by physical activity, nature perception, and sleep duration.

**Methods:** Data derived from the case-control NeuroSmog study comprised 195 participants with attention deficit hyperactivity disorder (ADHD) and 457 non-ADHD participants aged 10 to 13. Attention networks and impulse control were evaluated using computerized attention network test and continuous performance test. Lifelong and concurrent greenspace and bluespace exposure, determined by percentage of grass and tree cover and water presence within 500m around residences, as well as domestic garden, were examined through linear and negative binomial regressions. Psychosocial pathways and their interplay were explored using structural equations.

**Results:** Increased exposure to tree cover was associated with improved orienting ability and reaction time in ADHD, and decreased alertness and improved orienting ability in non-ADHD participants. Increased exposure to grass cover was associated with reduced target discrimination ability, fewer correct rejections, and less risky response style in ADHD and increased reaction time and better hit rate, more risky response style in non-ADHD participants. Water presence was linked to improved orienting ability, fewer mistakes, and better hit rate in non-ADHD participants. Garden presence was related to elevated target discrimination ability and hit rate, more risky response style in non-ADHD participants. No mediation was observed.

**Conclusion:** Tree cover and presence of garden and water were generally associated with improved attention in Polish children while grass tended to have negative impact.

### The association between nighttime traffic noise annoyance and self-rated health within the German National Cohort (NAKO)

S. Claire Slesinski<sup>1,2</sup>, Kathrin Wolf, Sida Zhuang, Tobia Lakes, Gabriele Bolte, Annette Peters, Alexandra Schneider

<sup>1</sup>Institute of Epidemiology, Helmholtz Centre Munich, German Research Centre for Environmental Health, Neuherberg, Germany;

<sup>2</sup>Institute for Medical Information Processing, Biometry, and Epidemiology (IBE), Faculty of Medicine, LMU Munich, Pettenkofer School of Public Health, Munich, Germany

#### Abstract

**Objective:** At night, traffic noise can cause stress and disturb sleep, impacting health across biological functions (endocrine, metabolic, etc.), mental health, academic/work performance, and social relationships. However, few large studies on this topic exist. We investigated the association between subjectively reported nighttime traffic noise annoyance and self-reported health (SRH) within the German National Cohort (NAKO).

**Methods:** NAKO is a national cohort of >200,000 adults ages 20-74 enrolled at 18 sites in Germany. Using a subsample of NAKO's baseline data (n = 173,393), we used logistic regression to test whether slight/moderate or strong/extreme nighttime traffic noise annoyance was associated with higher odds of reporting fair/poor SRH, as compared to odds of reporting good, very good, or excellent health. We calculated these associations 1) within the full sample, 2) stratified by sex, and 3) stratified by age group (≤39 years, 40-59 years, ≥60 years). We adjusted analyses by study site, age (except in grouping 3), sex (except in grouping 2), marital status, education level, and migration background.

**Results:** In the full sample, slight/moderate annoyance was associated with 30% higher odds of reporting fair/poor health (95% CI: 1.25-1.36), and strong/extreme annoyance with 78% higher odds (95% CI: 1.69-1.86). Males and females had similarly increased odds of fair/poor health when reporting strong/extreme annoyance, while males had slightly higher odds of fair/poor health if reporting slight/moderate

annoyance (males: OR 1.33, females: OR 1.27). The 40-59 age group had the highest odds of fair/poor health if reporting both slight/moderate (OR 1.34, 95% CI 1.27-1.40) and strong/extreme annoyance (OR 1.86, 95% CI: 1.75-1.98).

**Conclusion:** These findings suggest that nighttime traffic noise should be investigated further as an important public health issue and can provide insights for decision-makers developing policy related to noise protection.

### Dietary exposure to chemical contaminants and risk of dementia in older persons

Sophie Lefèvre-Arbogast<sup>1</sup>, Pauline Duquenne, Catherine Helmer, Véronique Sirot, Cécilia Samieri

<sup>1</sup>Univ Bordeaux, Inserm, Bordeaux Population Health Research Center, UMR 1219, F-33000 Bordeaux, France

#### Abstract

Diet is a major source of exposure to chemicals in the general population, originating from food production (pesticides) or environmental contamination by industrial (polychlorinated biphenyls [PCB]) or naturally-occurring substances (metals). Many are present at non-negligible levels in human biofluids, and some reach the human brain. Since many chemicals are lipophilic, the dietary composition, especially the fat content, likely modifies their toxicokinetic. We explored the link between dietary exposure to chemicals and dementia risk in older adults, considering effect modification by dietary fat content.

We included 1,288 non-demented participants of the French Three-City cohort who completed a food survey in 2001 and were followed for incident dementia. Dietary exposure to 167 chemicals (9 families) was assessed by combining individual food intakes with food chemical levels measured in Total Diet Study. We assessed the relation of each chemical with dementia risk using Cox models adjusted for age, sex, education, ApoE-ε4 and Mediterranean diet adherence and explored effect modification by a high-fat diet, as defined by >35% of energy from fat.

Participants were 76y on average at baseline, 62% were women, 30% had a high-fat diet. Over a median follow-up of 10y, 314 individuals developed dementia. No chemical was related to dementia risk in the whole sample, but having a high-fat diet was a strong effect modifier for 85 chemicals (FDR-corrected p<0.05 for interaction tests). Higher intakes of these chemicals were significantly related to higher dementia risk among high-fat diet consumers only. The strongest hazard ratios were for contaminants of seafood and meat, including perfluorooctane sulfonate, the brominated flame retardant hexabromocyclododecane-α and PCB-77 (HR>1.40 for 1 SD-increase in intake). In summary in our study, dietary exposure to specific chemicals was related to higher dementia risk in older adults having >35% of energy from fat in their diet.

### NeuroEpiTool – a research digital tool to ascertain neurological outcomes in population-based studies by a non-ex

Vasco Ribeiro Ferreira<sup>1</sup>, Esther Metting, Valentina Gallo

<sup>1</sup>Department of Sustainable Health, University of Groningen, Campus Fryslân, Leeuwarden, the Netherlands

#### Abstract

**Introduction:** Epidemiologists studying neurological diseases often face struggles such as a lack of resources (e.g., personnel and equipment) to properly capture signs and symptoms of neurological diseases within the research environment. eHealth is suggested as an alternative to guide the researcher through a neurological examination, and also to perform it in a low-resource context. We aimed to develop an eHealth research tool that can detect signs and symptoms and be used by a non-neurologist.

**Methods:** A systematic review (SR) to capture existing eHealth that assesses neurological impairment in research was performed to set the

grounds for conceptualisation. A subsequent Delphi study was conducted in preparation for tool development, to identify the minimum neurological tests that can rule out the most impairment. After development, two validations are currently planned; one that assesses inter-rater reliability between a non-neurologist against a neurologist, and a further validation at population level in a cohort study.

**Results:** 42 eHealth tools were captured in the SR, most being limited to assessing a narrow range of signs and symptoms of neurological diseases; approximately half disregarded proper maintenance strategies and have since been discontinued. The Delphi study achieved consensus on 10 neurological tests and 7 anamnestic questions to be implemented into the tool. Consensus items were then connected through a logic flowchart in which if tests are negative, impairment is ruled out; when positive, further tests need to be administered to explore potential outcomes. The tool is currently being developed through feedback loops between health and IT experts, and the interim results will be showcased at the conference.

**Discussion:** The described tool may be promising in aiding epidemiological research, by ascertaining neurological outcomes in population-based studies. Future work entails finalising tool development and properly validating it in the field.

### Surrounding greenness and mental health: Findings from the French CONSTANCES cohort

*Zeinab Bitar<sup>1</sup>, Emeline Lequy, Cédric Lemogne, Kees de Hoogh, Marcel Goldberg, Antoine Lafontaine, Danielle Vienneau, Mohammad Javad Zare Sakhvidi, Marie Zins, Baptiste Pignon, Emilie Burte, Bénédicte Jacquemin*

<sup>1</sup>University of Rennes, Inserm, EHESP, Irset (Institut de recherche en santé, environnement et travail) - UMR\_S 1085, F-35000 Rennes, France

#### Abstract

**Introduction:** Exposure to surrounding greenness has been associated with improved mental health, but most of the studies have focused on urban areas. We aimed to assess the cross-sectional association between greenness and mental health according to degree of urbanity in a large French national sample.

**Methods:** 117,685 participants with available data from the 2019 follow-up questionnaires of the French CONSTANCES cohort were included. Mental health was assessed using the General Health questionnaire (GHQ-12) continuous score. Surrounding greenness data were estimated using the normalized difference vegetation index (NDVI), in buffers of 100m and 300m around each participant's residential address in 2019. Negative binomial regression models, adjusted on age, sex, education, season (hot season: spring/summer and cold season: fall/winter), health center of inclusion and fDep, were performed to assess the association between GHQ-12 and NDVI, separately for each degree of urbanity (rural, peri-urban (i.e., suburban and isolated areas), urban and Paris) and each buffer. Stratified analyses by age (18-45, 45-60 and 60+), sex, and season were performed.

**Results:** An increase of 0.1 in 300m-NDVI exposure was associated with a better mental health in urban areas (IRR=0.81; 95% CI: 0.69 – 0.95) and peri-urban areas (IRR=0.84; 95% CI: 0.72 – 0.98). No associations were found in rural areas and Paris. Similar results were found when considering 100m-NDVI exposure. No systematic effect modifiers were found, but some stronger associations during summer/spring season, elderly and men in urban and peri-urban areas respectively

**Discussion:** Proximity to surrounding greenness was associated with better mental health in urban areas but not in rural areas, probably related to the differences in type and uses of greenspaces in different degrees of urbanity. Our results contribute to the emerging evidence to implement surrounding greenness guidelines adapted according to each urbanity degree.

### AIR POLLUTION: FROM SOURCE TO SOLUTION IN OCCUPATIONAL AND ENVIRONMENTAL SETTINGS

#### Personal exposure of goat farm workers to particulate matter and endotoxin. Parallel sampling and repeated measurements

*Aniek Lotterman<sup>1</sup>, Ifeoluwa Olufotebi, Inge Wouters, Alex Bossers, Lidwien Smit, Myrna de Rooij*

<sup>1</sup>Institute for Risk Assessment Sciences, Utrecht University, Utrecht, the Netherlands

#### Abstract

**Introduction:** Farm workers are frequently exposed to bioaerosols generated by livestock farming. Despite the relevance to occupational health, research on bioaerosol exposure in livestock farms is limited especially for goat farming. We aimed to study personal exposure of goat farm workers to inhalable dust (PM<sub>100</sub>), PM<sub>10</sub> and endotoxin therein.

**Methods:** Personal exposure sampling was performed with 42 farm workers across 15 Dutch goat farms in 2021. Per worker, PM<sub>100</sub> and PM<sub>10</sub> samples were collected in parallel during two working days. PM concentrations were determined using gravimetric analysis, endotoxin concentrations were quantified using Limulus amoebocyte lysate assay. Workers completed questionnaires about their job tasks, farm characteristics and management practices. Associations between log-transformed exposure and working tasks were analyzed using mixed modelling.

**Results:** In total, 73 PM<sub>100</sub> samples were included. Geometric means of PM<sub>100</sub> mass and endotoxin concentrations were 1.0 mg/m<sup>3</sup> (range: 0.2-3.1) and 523 EU/m<sup>3</sup> (range: 48-7818). Recommended Dutch endotoxin occupational exposure limit (90 EU/m<sup>3</sup>) was exceeded in 92% of samples. Correlation between PM<sub>100</sub> and endotoxin concentrations was moderate (Pearson, r=0.61). Job tasks milking goats (p=0.045) and direct animal contact (p=0.043) were associated with increased endotoxin exposure. Straw handling showed a trend (p=0.062) with increased PM<sub>100</sub> exposure. Analysis of the PM<sub>10</sub> samples are currently being finalized.

**Discussion:** This study reveals first insights into considerable personal exposure of goat farm workers to PM<sub>100</sub> and endotoxin, including concentrations above recommended Dutch occupational exposure limits. Goat farm workers could thus be at risk of adverse respiratory health effects. This study is informative for setting up a larger study investigating source reduction of exposure for specific tasks.

#### Predicting Particulate Matter (PM<sub>10</sub>) Levels in Morocco: A 5-Day Forecast Using the Analog Ensemble Method.

*Anass Houdou<sup>1</sup>, KENZA Khomsi, Luca Delle Monache, Weiming Hu, Fayed Abdulla, Wael Al-Delaimy, Mohamed Khalis*

<sup>1</sup>Mohammed VI Center for Research & Innovation, Rabat, Morocco; International School of Public Health, Mohammed VI University of Sciences and Health of Morocco

#### Abstract

**Introduction:** Accurate prediction of Particulate Matter (PM<sub>10</sub>) levels is crucial for public health and environmental planning. This study aims to provide accurate forecasts of PM<sub>10</sub> over Morocco for five days.

**Methods:** The Analog Ensemble (AnEn) technique was employed to postprocess PM<sub>10</sub> forecasts produced by the Copernicus Atmosphere Monitoring Service (CAMS) global atmospheric composition forecasts, using CAMS reanalysis data as a reference. Forecasts of seven variables produced by the CAMS forecasts model were included as predictors alongside PM<sub>10</sub>. Additionally, bias correction technique (AnEnBc) was applied to enhance AnEn's performance for rare events.

**Results:** The results shows substantial prediction improvements: the Root Mean Square Error (RMSE) decreased from 63.83 µg/m<sup>3</sup> in the original forecasts to 44.73 µg/m<sup>3</sup> with AnEn and AnEnBc, while the Mean Absolute Error (MAE) reduced from 36.70 µg/m<sup>3</sup> to 24.30 µg/m<sup>3</sup>.

m<sup>3</sup>. Additionally, the coefficient of determination (R<sup>2</sup>) increased notably from 29.11% to 65.18%, and the Pearson correlation coefficient increased from 0.61 to 0.82.

**Discussion:** The integrating reanalysis data and the utilization of the AnEn substantially improved the accuracy of PM10 5-day forecasting in Morocco. This is the first use of this approach for Morocco and the Middle East and North Africa and has the potential for translation into early and more accurate warning of high PM10 pollution events. The application of such approaches into environmental policies and public health decision making can minimize air pollution health impacts.

### Unveiling Morocco's Potential: Assessing Health and Economic Benefits through Ambient Air Quality Enhancement

*Imane Sekmoudi<sup>1</sup>, Kenza Khomsi, Laila Idrissi, Meryem Tanarhte*

*<sup>1</sup>Process and Environment Engineering Laboratory, Faculty of Sciences and Technologies, Mohammed VI University, Casablanca, Morocco*

#### Abstract

As Morocco moves forward in its energetic improvement, the foreboding nearness of air pollution casts an approaching shadow over health, the environment, and the economy. This spearheading ponder presents a comprehensive approach to assessing the transformative health and economic impacts of improving air quality in Morocco, capitalizing on an interesting point of view given by the Covid-19 lockdown.

Our strategy coordinates state-of-the-art tools, enveloping concentration-response and valuation functions, population datasets, and health and economic measurements through the Environmental Benefits Mapping and Analysis Program (BENMAP).

The findings convey a compelling message – a targeted reduction in PM<sub>2.5</sub> concentrations by an average of -4.7 µg/m<sup>3</sup> might anticipate 187 deaths from ischemic heart disease and 89 deaths from lung cancer, with considerable estimated saving measuring USD 226 million (USD 153 million for ischemic heart illness and USD 73 million for lung cancer). This ponder unveils the significant health and economic benefits anticipating Morocco through the improvement of air quality, with a granular center on each region.

Presenting an inventive approach, this ponder utilizes a specialized tool to evaluate the health and economic advantages of improving ambient air quality, particularly in the Moroccan setting. This tool empowers the modeling of different particulate pollution improvement scenarios, serving as an important decision-support asset for environmental policies. By adopting this approach, policymakers can not only elevate health outcomes and achieve significant economic savings but also effectively address the environmental risks posed by air pollution in Morocco.

### Human Exposure to Diesel Exhaust and Its Impact on Olfactory Detection Ability and Cognitive Function: A chamber study

*John Andersson<sup>1</sup>, Ala Muala, Thomas Sandström,*

*Daniel Oudin Åström, Steven Nordin, Pasi Jalava, Katja Kanninen, Bertil Forsberg, Anna Oudin*

*<sup>1</sup>Sustainable Health, Public Health and Clinical Medicine, Umeå University*

#### Abstract

**Introduction:** Extensive research has established the adverse health impacts of long-term exposure to air pollution, potentially affecting cognitive and olfactory functions. However, the influence of short-term air pollution exposure on these functions remains unclear. This study seeks to investigate such effects under controlled conditions within an exposure chamber.

**Methods:** Twenty-six healthy participants underwent two separate exposure sessions, one to filtered air and the other to diluted diesel engine

exhaust in randomized order, with a diesel exhaust concentration of 300 µg/m<sup>3</sup>. Olfactory function was evaluated using “sniffin’ sticks,” while a Letter-Digit Substitution task served as a marker for cognitive function. These functions were measured as two scores, where higher values indicate better function. Diesel exposure effects were analyzed using non-parametric tests, with analyses stratified by sex (16 women and 6 men).

**Results:** Following diesel exposure, the mean odor threshold was 5.44 in women compared to 5.94 after exposure to clean air (p-value for difference = 0.03). No distinct difference was observed in men, nor in the number of correct exchanges.

**Discussion:** This study revealed some evidence of acute effects on olfactory function after high levels of diesel exposure, particularly in women, although the male sample size was smaller. No discernible effects on cognitive function, measured by the letter-digit substitution task, were observed. These findings suggest potential short-term impacts on the olfactory system, which, given its close connection to the brain, warrants consideration in the context of environmental insults and brain health.

### Development of a universal home sampler and protocol for the collection of airborne fungal spores.

*Robin Wroblewski<sup>1</sup>, Thiphonie Riveron, Jack Satchwell, Fiona Symon, Leah Cuthbertson*

*<sup>1</sup>University of Leicester*

#### Abstract

**Objective:** Bioaerosols in the indoor environment can have a significant impact on human health due to their role in allergic and infectious disease. This project aims to develop a robust and universal home sampler and sampling protocol to collect fungal spores from homes for identification and analysis.

**Material and Methods:** A 3D printed sampler was developed to hold a standard adhesive PCR film. A preliminary study was devised to test the sampler design. Testing was carried out at a single site under various conditions including type of adhesive film, sampling height, sampling room, and sampling time to determine the ideal sampling conditions.

Bioaerosol concentration was explored by excising a 1cm by 4cm section of film using sterile technique, this was then loaded onto a microscope slide and stained with lactophenol cotton blue, finally fungal spore counts were recorded using a longitudinal transverse method at 400x magnification.

**Results:** Analysis of adhesive film (Starlab and Thermofisher) and sampling height had no significant impact on spore count (film type: F(1)=0.029, P=0.87 Height: F(1)=0.042, P=0.84). Sampling time (1 week, 48 and 24 hours) demonstrated a significant impact on spore count (F(2)=42.54, P=3.26e-09). A Tukey's posthoc test showed that the only significant increases were 24 hours to 1 week (P<0.001) and 48 hours to 1 week (P<0.001). Finally, the room sampled had no significant impact on spore count (F(2)=1.189, P=0.32).

**Conclusion:** This validation study has provided insight into optimal sampling conditions using this passive sampling method. Overall, the sampler has demonstrated to be consistent in varying conditions although further work is required to validate across sites. This sampling method has proved to be a robust, unintrusive and cost-effective method for sampling bioaerosols in homes.

### Evaluation of the effects on cause-specific mortality of industrial facilities in the Sacco River area: a cohort study

*Chiara Badaloni<sup>1</sup>, Matteo Renzi, Alessandro Trentalange, Letizia Leccese, Daniela Porta, Paola Michelozzi*

*<sup>1</sup>Department of Epidemiology, Lazio Regional Health Service, Italy*

#### Abstract

**Introduction:** The River Sacco Basin (RSB) is characterised by high industrial pressure that significantly affect air quality emitting pollutants



into atmosphere. Studies suggest that in areas heavily exposed to industrial pressures the residents show an increased susceptibility to health outcomes (cause-specific mortality and morbidity). In this study we assess the association between exposure to air pollution from industrial plants and long-term effects on non-accidental, cardiovascular, respiratory and cancer mortality.

**Methods:** A cohort of 301681 individuals living nearby 14 industrial plants in the RSB was enrolled during 2006 and 2018. We evaluated non-accidental, cardiovascular, respiratory and cancers mortality. Industrial plants were grouped in 5 domines based on their location. The cumulative annual average concentrations of NO<sub>x</sub> and PM<sub>10</sub> was simulated with Lagrangian SPRAY particle model at fine resolution 1km<sup>2</sup> and was assigned to the residential addresses. Cox regression models was used to estimate associations with mortality adjusted for individual and area characteristics. The cumulative exposure of the industrial plants was assessed summarizing the health effect of the domines with a meta-analysis.

**Results:** Meta-analysis showed an overall excess risk for high levels of PM<sub>10</sub> exposure for respiratory mortality (HR=1.34, 95%CI 1.00-1.79). For non-accidental, cardiovascular and cancer mortality was not found an overall excess risk for PM<sub>10</sub> and NO<sub>x</sub>, but we observed some excess risk in specific domines. In particular, strongest associations were found for non-accidental and cancer mortality and PM<sub>10</sub> in the domine 3 (respectively HR=1.28, 95%CI 1.10-1.49 and HR=1.41, 95%CI 1.25-1.59) and for cardiovascular mortality in the domine 4 (HR=1.46, 95%CI 1.21-1.75).

**Discussion:** Critical health issues emerged in subjects who lived nearby industrial plants in the RSB. The study suggests the need of monitoring the health status and plan prevention interventions.

### Occupational health effects of exposure to PM<sub>2.5</sub> on the London Underground

Justie Mak<sup>1,2,3</sup>, Johanna Feary, Andre Amaral, Emma Marczylo, Paul Cullinan, David Green

<sup>1</sup>MRC Centre for Environment and Health, Environmental Research Group, Imperial College London, London, United Kingdom; <sup>2</sup>National Heart and Lung Institute, Imperial College, London, United Kingdom; <sup>3</sup>HPRU in Environmental Exposures and Health, Imperial College London, London, United Kingdom

#### Abstract

Over 19,000 London Underground (LU) staff are exposed to elevated PM<sub>2.5</sub> concentrations on the LU, which can be 15 times higher than outdoor PM. The health impacts of subway PM<sub>2.5</sub> are largely unquantified due to physicochemical differences to outdoor PM<sub>2.5</sub>. The study aimed to quantify staff LU PM<sub>2.5</sub> exposure and assess its impact on sickness absence (SA) and mortality.

A job exposure matrix to quantify occupational subway PM<sub>2.5</sub> exposure was developed through undertaking a measurement campaign across the LU. Mixed effect models were used to evaluate the association between exposure and SA; while multiple regression assessed the association between historical staff exposure and mortality.

Staff PM<sub>2.5</sub> exposure was heterogenous and dependent on their job, grade, and location. Drivers had the highest exposure (mean: 261µg/m<sup>3</sup>) over a shift.

Non-office staff had higher rates of all-cause and respiratory infection SA than office staff. While drivers on five of eight lines had higher rates of all-cause SA, there was no evidence of a dose-response relationship. Drivers on the Central line had higher rates of respiratory infection SAs (incidence rate ratio: 1.24, 95% confidence interval 1.10-1.39). Higher grade customer service (CS) staff had lower rates of all-cause and respiratory infection SA than lower grade CS staff. There were no associations between occupational PM<sub>2.5</sub> exposure and SA due to non-infection related respiratory or cardiovascular causes.

The highest rate of all-cause mortality was in bus drivers, followed by LU staff, engineers, and then office staff who had the lowest rate. The most common causes of death across all staff were cardiovascular, respiratory, and cancer.

Some highly exposed staff report higher rates of SA and are at greater risk of all-cause mortality. However, subway PM is unlikely to be the sole contributing factor to SA and mortality. This is the largest study on occupational PM<sub>2.5</sub> exposure and health effects among subway workers.

### Establishing inhalation Toxicity Reference Values for particulate matter to improve risk assessment

Margaux Sanchez<sup>1</sup>, Bénédicte Jacquemin, Miora Andrianjafimasy, Myriam Blanchard, Anne Chevalier, Marion Keirsbulck, Jean-Ulrich Mullot, Marine Savouré, Matteo Redaelli

<sup>1</sup>French National Agency for food, environmental and occupational Health and Safety (Anses), Risk assessment department, Maisons-Alfort, France

#### Abstract

**Introduction:** Toxicity reference values (TRV), also called Reference Concentrations or Inhalation Unit Risks, are indicators used to qualify or quantify a risk to human health. Despite being available for several chemicals found in air pollution as well as for Diesel particulate exhaust, they have not been established for ambient particulate matter (PM), challenging health risk assessment. Until now, such assessments only compared concentration data to regulatory or WHO guidance values. Our aim was to establish inhalation TRVs for PM<sub>2.5</sub>, PM<sub>10</sub>, and black carbon (BC) for short- and long-term exposures.

**Methods:** Following the Prisma statement, we selected a pool of epidemiological studies investigating health outcomes of interest, chosen based on the weight of the available evidence. We assessed the quality and the relevance of the studies for our objective. Assuming a no-threshold effect, we used the linear or nonlinear exposure-risk functions (ERF) to derive a set of unit excess risks. At equivalent quality and relevance, the highest (i.e. most protective for health) unit excess risk was selected as the recommended TRV for each pollutant-exposure duration pair.

**Results:** For instance, for long-term exposure to PM<sub>2.5</sub>, we selected 41 publications from which we were able to derive unit excess risks for 11 health outcomes including mortality, respiratory and cardiovascular morbidity, and birth outcomes. The recommended TRV of 1.28.10<sup>-2</sup> (µg.m<sup>-3</sup>)-1 was obtained from an ERF reported by Strak et al. (BMJ 2021;374:n1904) for all-cause mortality within Europe.

**Discussion:** The present work fills the gap left by the absence of TRVs for ambient PM<sub>2.5</sub>, PM<sub>10</sub>, and BC. The recommended TRVs enable to move beyond a simple comparison of concentration data to air quality guidance values or regulatory limit values when performing health risk assessment. We expect that these TRVs will provide a useful tool for risk assessors and stakeholders involved in air quality assessment.

### Integrated approach to assess individual exposure to ultrafine particles (UFPs) for epidemiological purposes

Sabyne Audignon-Durand<sup>1</sup>, Audrey Roudil, Céline Gramond, Olivier Ramalho, Stéphane Ducamp, Corinne Pilorget, Patrick Brochard, Aude Lacourt, Fleur Delva

<sup>1</sup>University of Bordeaux, INSERM U1219 BPH Research Center - EPICENE team, 33000 Bordeaux, France

#### Abstract

**Introduction:** UFPs (< 100 nm) are emitted by many processes such as engines, welding and cooking, suggesting their presence outdoors, at home and in the workplace. Although the potential toxicity of these particles has been demonstrated, evidence of their effect on human health is limited by the complexity of their measure. Thus, we propose a global approach to estimate exposure to UFPs in all settings.

**Method:** A job-exposure matrix (MatPUF) and an activity-environment exposure matrix (MA2E) were developed based on the identification of UFP release processes. They are presented like tables, with the rows of MatPUF showing jobs defined by a combination of occupation and sector of activity, and the rows of MA2E showing domestic activities and processes. In the columns, the corresponding exposure was estimated according to semi-quantitative parameters (probability and intensity or frequency), chemical families of UFPs and historical periods of exposure.

**Results:** Half of the jobs in MatPUF are exposed to UFPs between 1950 and 2014, mainly very probable and at occasional and regular frequencies. In the MA2E matrix, cooking and passive smoking are the most exposed activities, while heating and office work are the least exposed. Regarding domestic processes, one in two leads to very probable exposure of mainly medium or high intensity. Whether occupational or domestic, exposure is most often associated with carbonaceous UFPs. Questionnaires were set up to apply the matrices to individuals and adjust exposure as closely as possible to each individual's real situation.

**Discussion:** The matrices developed provide the past or current UFP exposure of each individual in their jobs and home activities. By combining them with outdoor exposure modeling in collaboration with the ambient air monitoring network, an integrated approach for assessing UFP exposure in all settings will be available. Its use will contribute to a better knowledge of the exposome and the health effects of UFPs.

### Characterisation of fungal species and spore concentration in British dwellings

Thiphanie Rivéron<sup>1</sup>, Rebecca Cordell, Jack Satchwell, Anna Hansell, Leah Cuthbertson

<sup>1</sup>Centre for Environmental Health and Suitability, University of Leicester, University Road, Leicester, LE1 7RH, United Kingdom

#### Abstract

The detrimental impacts of fungal spore inhalation on human health are well described. Fungal spores have been associated with allergies, infections, asthma and rhinitis. However, studies characterising fungal concentration in dwellings via sampling are rare. This study aimed to improve knowledge of fungal concentrations in the indoor environment by collecting fungal spores, rather than the more common approach collecting information on damp and mould through surveys.

32 dwellings of different types and building age were sampled between November and March 2021/2022 and 2022/2023. Air samples were collected over 24 hours using the Burkard multi-vial cyclone sampler. Dust samples were collected into a DUSTREAM filter by vacuuming 1 m<sup>2</sup> of floor for five minutes. The samples were analysed by target qPCR for *Alternaria alternata*, *Aspergillus fumigatus* and *A. niger*, *Cladosporium cladosporioides* and *C. herbarum*, and *Penicillium chrysogenum*.

Fungal composition was different in air and dust samples. Air samples were mostly dominated by *A. fumigatus* and *A. niger*. However, their abundance was lower in dust samples, which were dominated by *P. chrysogenum* and *C. herbarum*. *A. alternata* was detected only in dust samples. Fungal spore concentration was higher in dust samples than the air samples. *P. chrysogenum* had the highest spore concentration detected, at 175 757 CFU/mg-1, in a dwelling where recent water-damaged was reported. Additional analysis showed that *P. chrysogenum* spore concentrations in air samples were positively associated ( $P=0.00129$ ) with the temperature of the dwellings, ratio of urban area in a 1km buffer around the dwellings ( $P=0.000149$ ).

In conclusion, air samples were more representative of current fungal spore concentrations in dwellings, while, dust samples gave indication of the long-term spore concentration and diversity. *P. chrysogenum* was the fungal species the most affected by dwelling environment.

### Combination of Concentration-Response Functions for PM2.5 and NO2 in Quantifying Air Pollution Mortality Burden

Xuan Chen<sup>1</sup>, Ulrike Gehring, Gerard Hoek

<sup>1</sup>Institute for Risk Assessment Sciences, Utrecht University, the Netherlands

#### Abstract

**Objective:** This study aims to investigate approaches to apply concentration-response functions (CRFs) from single- and two-pollutant models in Health Impact Assessments (HIAs) assessing the health impact of the air pollution mixture, considering both particulate matter with a diameter below 2.5 µm (PM2.5) and nitrogen dioxide (NO2).

**Methods:** A systematic literature search of MEDLINE and EMBASE identified cohort studies employing both single- and two-pollutant models of long-term exposure to PM2.5 and NO2 with natural-cause mortality. Pooled CRFs were calculated through random-effects meta-analyses. Coefficient reductions were calculated from the differences between single- and two-pollutant models. Population-attributable fractions (PAF) were calculated using CRFs from single-pollutant models, the sum of single-pollutant models, and the sum of two-pollutant models to assess the health impact of the mixture.

**Results:** Seventeen papers published between 2013 and 2023 were selected, with the majority of studies conducted in Europe (N=10). Pooled relative risks (RR) for natural-cause mortality for a 5 µg/m<sup>3</sup> increase in PM2.5 were 1.05 (95%CI: 1.03-1.07) for single-pollutant models and 1.04 (1.01-1.06) for two-pollutant models. For a 10 µg/m<sup>3</sup> increase in NO2, the RRs were 1.03 (1.01-1.05) and 1.02 (1.04-1.06) for single- and two-pollutant models, respectively. Using CRFs from single-pollutant models, the estimated PAF is 0.05 for PM2.5 and 0.03 for NO2, resulting in a combined PAF of 0.09 for the sum of the single pollutant estimates. Using the CRFs from the two-pollutant model, the PAF was estimated as 0.03 for PM2.5 and 0.02 for NO2, leading to a combined PAF of 0.06 for the mixture.

**Conclusion:** Utilizing CRFs from two-pollutant models can mitigate the potential overestimation of mixture health impact. The difference in coefficients between single- and two-pollutant models can be combined with a meta-analysis of the larger body of evidence in future HIA.

## EARLY LIFE EXPOSURES AND BIRTH OUTCOMES

### Residential radon exposure during childhood and late health effects at adult age, in the CONSTANCES cohort

Olivier Laurent<sup>1</sup>, Choisie Mukakalisa, Emeline Lequy, Marcel Goldberg, Corinne Mandin, Céline Ribet, Marie Zins, Enora Cléro

<sup>1</sup>Institut de Radioprotection et de Sécurité Nucléaire (IRSN), PSE-SANTE/SESANE/LEPID, BP17, 92262 Fontenay-aux-Roses cedex

#### Abstract

**Introduction:** Radon exposure is an established risk factor for lung cancer. Over the recent decades, a growing number of epidemiological studies have investigated other possible health effects of radon exposure, but results are inconsistent. No study has focused on radon exposure during childhood and health outcomes at adult age. The objectives of this project are: 1/ to carry out a reconstruction of residential radon exposure from birth until 2019 in a large cohort; 2/ to estimate the risks of cancers and other chronic diseases at adult age potentially associated with radon exposure and doses to specific organs, especially during childhood.

**Methods:** Individuals were selected from the French CONSTANCES population-based adults cohort recruited between 2012 - 2017. We included in our study participants with a completed residential history since birth, and who gave their consent to the use of data concerning them from the French national health system (SNDS). Radon exposure was reconstructed by linking residential histories with a map of indoor

radon concentrations by municipalities. Incident case of chronic diseases were identified over the period 2010-2021. Cancer and non-cancer risks will be estimated using survival models.

**Results:** Initially 58,697 participants provided a residential history since birth, and 57,571 (46% males) of them were identified in the SNDS. Mean age at recruitment was 48.8 years. The median annual radon exposure during childhood (0 -15 years) was 59 Bq/m<sup>3</sup>. At this stage, incident cases for the following diseases have been identified: 104 lung, 406 colorectal, 1251 breast and 735 prostate cancers, 612 strokes, 291 heart failures, and 1703 coronary heart diseases.

**Discussion:** Statistical analyses adjusting for potential confounders will be undertaken to investigate the relationships between these diseases and radon exposure as well as related organ doses, especially during childhood but also considering the influence of doses at later ages.

### Maternal lifestyle factors during pregnancy and the risk of childhood lymphoma - The ESCALE and ESTELLE studies (SFCE)

Elissa Msallem<sup>1</sup>, H  l  ne Pacquement, Laura Olivier, Laurence Brugieres, Judith Landman Parker, Nathalie Garnier, Anne Lambilliotte, Laure Faure, Jacqueline Clavel, Audrey Bonaventure

<sup>1</sup>Universit   Paris Cit   and Universit   Sorbonne Paris Nord, Inserm, INRAE, Center for Research in Epidemiology and Statistics (CRESS), Epidemiology of childhood and adolescent cancer (EPICEA) team, Paris, France

#### Abstract

**Introduction:** There is much interest in parental prenatal exposures in relation to childhood cancer aetiology, with most studies focussing on childhood leukaemia. This work aimed to investigate whether maternal smoking, coffee and alcohol consumption during pregnancy were associated with the risk of childhood lymphoma.

**Methods:** We conducted a pooled analysis of two French national population-based case-control studies. Data on sociodemographic and lifestyle factors were collected through standardised maternal interviews. Odds ratios (OR) and 95% confidence intervals (CIs) were computed using adjusted logistic regression models, separately for non-Hodgkin lymphoma (NHL) and Hodgkin lymphoma (HL). Specific analyses also investigated Burkitt NHL and nodular sclerosis HL, two common histological types in children.

**Results:** 305 NHL, 328 HL and 2,415 controls were included. No association was observed with maternal smoking during pregnancy and childhood NHL or HL. Maternal coffee consumption during pregnancy was associated with childhood NHL (>2 cups/day, OR 1.5 [95% CI 1.1-2.1]), with a dose-response relationship; and maternal alcohol consumption was associated with Burkitt NHL without a trend (OR 1.5 [95% CI 1.1-2.2]).

**Discussion:** Maternal coffee and alcohol consumption during pregnancy might increase the risk of childhood NHL. While few previous studies investigated the associations between maternal consumptions and childhood lymphoma, positive associations were repeatedly reported for childhood leukaemia and maternal alcohol and coffee consumptions during pregnancy. While warranting replication, these findings could have important implications in terms of prevention.

### A Colombian approximation between spatial concentration of particle matter and birth defects.

Stefany Guarnizo<sup>1</sup>, Herney Rengifo

<sup>1</sup>Universidad el Bosque

#### Abstract

**Introduction:** The 94% of cases of congenital anomalies occur in Low and Middle Income Countries (LMIC) where environmental pollution has been linked to a greater extent as an etiological risk factor for

congenital anomalies. Representing a disproportionately greater undetermined environmental factors in behavior and tendency.

**Objective:** Describe the spatial relationship between the number of cases of congenital anomalies in children born in hospitals in Bogot   and Cali and the behavior in pre-pandemic, pandemic and post-pandemic pollution levels.

**Methods:** a cross-sectional descriptive study was carried out. Birth databases from the Northern Subnet in Bogot   and the Hospital Universitario del Valle (HUV) in Cali in association with the Universidad El Bosque and open data on air pollutants from the SISAIRE portal were used. Cases born living in the locality close to the reference hospital were included. A descriptive analysis of cases, average pollution exposure, spatial and geographic cluster analysis (NNI index and cluster) was carried out. Trend analysis was sought with mixed effect variables.

**Results:** A slight association is observed between high levels of pollution and the increase in the number of congenital anomalies, with possible behavior of clusters in the events.

### Placental transcriptome reveals downregulation of AMPK signaling in association with gestational air pollution exposure

Joline Millen<sup>1,2</sup>, Dries Martens, Florence Debacq-Chainiaux, Tim Nawrot

<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Belgium;

<sup>2</sup>Laboratory of Cellular Biochemistry and Biology (URBC), Namur Research Institute for Life Science (NARILIS), University of Namur, Belgium

#### Abstract

**Objective:** Prenatal ambient air pollution exposure is able to reach and cross the placenta, a highly metabolically active organ. The adenosine monophosphate-activated protein kinase (AMPK) signaling pathway is a crucial regulator of the placental cellular metabolism, necessary for normal placental and fetal development. This study investigates the association between in utero exposure to BC, NO<sub>2</sub>, and PM<sub>2.5</sub>, and differences in placental gene expression of the AMPK signaling pathway at birth.

**Material and Methods:** Transcriptome data from 182 placentas from the ENVIRONAGE birth cohort was obtained through microarray analysis. Exposure levels were estimated using a spatio-temporal model for the mother's residential address during pregnancy. The associations between 76 genes, clustered by the cascades of the AMPK signaling pathway, and the air pollution exposures during different time windows of pregnancy were analyzed using a mixed-effects model.

**Results:** Depending on the time window, increases in prenatal BC, NO<sub>2</sub>, and PM<sub>2.5</sub> exposure were mainly associated with downregulated gene expression of the central AMPK gene cluster and upstream and downstream cascades of the AMPK signaling pathway. Moreover, the clusters affected by the air pollution often differed between newborn boys and girls.

**Conclusion:** This study provides new insights into the adverse effects of ambient air pollution exposure on placental and fetal development, affecting the placental metabolism at the transcript level. Whether reduced placental AMPK signaling may play a role in air pollution-induced birth outcomes and its long-term consequences needs to be further addressed.

### Evidence on environmental exposures and smoking effects on the reproduction of Eastern Mediterranean couples: a review

Kassandra Fares<sup>1,2</sup>, Georges Abi Tayeh, Emile Whaibeh, Lina Jaalouk, Yara Matar, Myriam Mrad

<sup>1</sup>Higher Institute for Public Health, Faculty of Medicine, Saint Joseph University of Beirut, Beirut, Lebanon; <sup>2</sup>Saint Joseph Fertility Center, Beirut, Lebanon

**Abstract**

**Introduction:** Infertility affects more than 70 million couples worldwide and has become an ascending medical and social challenge. Awareness regarding Assisted Reproductive Techniques (ART) has prompted researchers to investigate risk factors. Previous research tackled one or limited groups of risk factors and published little data about their effect on the embryological and clinical outcomes. This review summarizes 52 papers discussing: climatic factors, environmental exposures, trace elements and smoking in the Eastern Mediterranean region (EMR).

**Methods:** The literature search was conducted using PubMed and Scopus databases. Publication date was restricted from January 2012 till April 2022.

**Results:** Males exposed to high temperatures, Bisphenol A (BPA) and air dust were more likely to have poor sperm qualities. Phthalates and pesticides are known to negatively influence male endocrine reproductive health. Trace elements showed both positive and negative effects on reproduction. As for regular smokers, some publications found a small impact on semen parameters in contrast to heavy smokers.

**Discussion:** Current evidence on environmental exposures and smoking habits and ART outcomes among the Eastern Mediterranean couples is still insufficient and unevenly distributed among the affiliated countries. More investigations are needed to set instructions for the daily routines of patients and to put guidelines for the use of chemicals.

### **Description and predictors of serum concentrations of poly- and perfluoroalkyl substances (PFAS) in French pregnant women**

Nicolas Jovanovic<sup>1</sup>, Anne Lise Brantsæter, Sarah Lyon-Caen, Blandine Duval, Valérie Siroux, Rémy Slama, Sam Bayat, Inger-Lise Steffensen, Line Småstuen Haug, Claire Philippat  
<sup>1</sup>University Grenoble Alpes, Inserm U-1209, CNRS-UMR-5309, Environmental Epidemiology Applied to Reproduction and Respiratory Health Team, Institute for Advanced Biosciences, 38000, Grenoble, France

**Abstract**

**Introduction:** Perfluoroalkyl substances (PFASs), prevalent environmental contaminants, are associated with adverse health outcomes. This study aims to identify factors influencing serum PFAS levels in pregnant women.

**Methods:** The study examined 450 pregnant women from the Grenoble area, France (July 2014 - July 2017, within the SEPAGES cohort). It encompassed detailed sociodemographic, dietary, water consumption, lifestyle choices, and medical history data, collected through questionnaires. Maternal serum samples, collected at around the 19th week of gestation, were analyzed for 26 PFAS compounds. Adjusted linear regression was used to identify potential predictors of PFAS levels. Additionally, cluster analysis categorized participants into three exposure groups (low, medium and high) based on PFAS levels during pregnancy. Adjusted multinomial regression models estimated the impact of various predictors on the odds of belonging to each exposure group.

**Results:** The frequency of PFAS detection varied, with five compounds present in all samples, three detected in 50-98% of the samples, and the rest in fewer than 20%. Maternal age showed positive correlations with PFNA, PFOS, PFDA, PFUnDA, and PFHPS. Parity was negatively associated with PFOS, PFOA, PFNA, PFHxS, and PFHPS. Dietary factors, particularly the consumption of liver, eggs, fish, and crustaceans, were linked with elevated PFUnDA levels. Cluster analysis revealed that maternal age and parity mirrored associations seen in linear regression models. The date of blood sampling was associated with a reduced likelihood of being in the moderately or highly exposed groups. Liver consumption significantly increased the risk of high PFAS exposure.

**Conclusion:** This research highlights maternal age, parity, and specific dietary preferences as influential factors in serum PFAS levels among pregnant women. These findings are crucial for understanding and managing PFAS exposure, emphasizing the role of lifestyle and diet.

### **Pregnancy exposure to ambient air pollution and risk of term low birth weight: a systematic review and meta-analysis**

Rachel B Smith<sup>1,2,3,4</sup>, Sharon Sridhara, Eleanor Sykes, Debbie Jarvis  
<sup>1</sup>Mohn Centre for Children's Health and Wellbeing, School of Public Health, Imperial College London, UK; <sup>2</sup>National Institute for Health Research Health Protection Research Unit in Environmental Exposures and Health, Imperial College London, UK; <sup>3</sup>MRC Centre for Environment and Health, School of Public Health, Imperial College London, UK; <sup>4</sup>Department of Epidemiology and Biostatistics, School of Public Health, Imperial College London, UK

**Abstract**

**Introduction:** An increasing number of studies suggest an association between air pollution and term low birth weight (TLBW). However, existing systematic reviews and meta-analyses are often of poor quality. We aim to produce updated meta-analyses for pregnancy exposure to PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, NO<sub>x</sub>, and O<sub>3</sub> and TLBW, tackling methodological limitations such as population overlap, quality assessment, and lack of transparency.

**Methods:** Studies published up to Sept 2021 were identified via EMBASE, MEDLINE, SCOPUS and Web of Science. We used the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies, with bespoke modifications. Population overlap between primary studies was quantified. Study selection for meta-analysis is undertaken according to various algorithms, prioritising study characteristics according to different hierarchies (e.g. population size, quality score). Random effects meta-analysis is conducted for each pollutant and exposure window. Sensitivity analyses explore heterogeneity sources (e.g. geography, smoking adjustment).

**Results:** 2895 studies were retrieved. After screening 100 remained, almost half from North America. Preliminary pooled effect estimates (from initial selection algorithm prioritising population size) indicate increased risk of TLBW associated with whole pregnancy PM<sub>2.5</sub> and PM<sub>10</sub> exposure (9% increase per 10 µg/m<sup>3</sup> PM<sub>2.5</sub> and 7% per 20 µg/m<sup>3</sup> PM<sub>10</sub>), and with specific trimester exposures. For NO<sub>2</sub> and NO<sub>x</sub> elevated risk (4-5% per 20 ppb) was observed with whole pregnancy exposure only, and no associations were observed with O<sub>3</sub>.

**Discussion:** Numerous recent studies in this field have not been included in previous systematic reviews/meta-analyses. Our tailored approach to quality assessment, in-depth evaluation of population overlaps between studies, and exploration of different study selection approaches should offer a well-justified selection of studies for inclusion in meta-analyses, and robust quantification of associations.

### **Exploring the Associations of Exposure to Ambient Temperature across Pregnancy with Preterm Birth: When and Who?**

Selin Girgin<sup>1</sup>, Offer Erez, Daniel Nevo, Lena Novack, Itai Kloog, Raanan Raz  
<sup>1</sup>Braun School of Public Health and Community Medicine, The Hebrew University of Jerusalem, Israel

**Abstract**

**Introduction:** Literature shows associations between ambient temperature and preterm birth, but susceptible exposure windows and groups are unclear. We aimed to explore critical exposure weeks and vulnerable groups in the context of ambient temperature and the risk of preterm birth.

**Methods:** We conducted a historical cohort study of 131,599 singleton live births in Southern Israel, 2005-2019, using electronic health

records. We assessed weekly mean ambient temperature exposures across gestation based on maternal residential address and a hybrid spatiotemporal model at 1 km resolution in Israel. We fit Cox proportional hazards models with time-dependent covariates and distributed lag non-linear models by adapting them for the methodological challenges of examining exposures during gestation. The models were adjusted for ethnicity, seasonality, and socioeconomic status based on a directed acyclic graph. Possible effect modifiers were added to the models as interaction terms and associations were stratified when the interactions were significant.

**Results:** Exposures to high temperatures between gestational weeks 10–32 were associated with an increased risk of preterm birth. The highest hazard ratio (HR) was 1.13 (95% CI: 1.08–1.18) in weeks 19 to 22, for the 99th percentile (31°C) compared with the minimum risk temperature (14°C). Conversely, high temperatures in weeks 1 to 4 were associated with decreased risk of preterm birth (HR = 0.88, 95% CI: 0.81–0.96, 31°C vs 14°C in week 1). Associations were significantly stronger in female fetuses, Arabs, mothers with lower socioeconomic status, and underweight mothers.

**Discussion:** Our results demonstrate that exposure to high temperatures in mid-pregnancy is more critical regarding preterm birth risk. The study also suggests that the efforts to mitigate the health effects of climate change should be focused on disadvantaged socioeconomic and ethnic groups.

### A systematic review and meta-analysis of the effect of gestational PM2.5 exposure and the risk of preterm birth

Shawn Lee<sup>1,2</sup>, Rachel B Smith, Karen Exley, Heather Walton

<sup>1</sup>Environmental Research Group, MRC Centre for Environment and Health, Imperial College London, London, UK; <sup>2</sup>NIHR HPRU in Environmental Exposures and Health, UK

#### Abstract

Numerous systematic reviews and meta-analyses have provided a synthesis of the literature on the effect of gestational PM2.5 exposure and the risk of preterm birth (PTB), but their findings remain mixed. Methodological shortcomings were found in areas of study selection and quality assessment.

A systematic literature search was performed in April 2022 on major English and Chinese databases. Random-effects meta-analyses were conducted on the 74 eligible studies retrieved after screening and quality assessment using a tailored framework developed specifically for studies of this research area. Study dependencies were tackled by selecting studies with lower risk of bias (RoB) then with larger sample size. Primary studies reporting odds ratios (ORs)/risk ratios (RRs) vs. hazard ratios (HRs) were analysed separately. Heterogeneity and publication bias were assessed. Sensitivity analyses were performed.

The risk of PTB (<37 weeks gestation) increased from 1%, 3%, 5% to 8% per 10 µg/m<sup>3</sup> increase for PM2.5 exposure across Trimester 1, 2, 3, and whole pregnancy PM2.5 exposure. However, only the effect of whole pregnancy exposure was statistically significant. No statistically significant associations were found for studies reporting HRs. The effect was consistent when restricted to studies conducted in the Western Pacific, and studies with low or moderate RoB. The effect decreased when analysis was restricted to studies that used research cohorts. Marginally statistically significant positive effects were found for trimester 2 PM2.5 exposure on the risk of delivering very PTB (28–31 weeks gestation) and moderate-to-late PTB (32–36 weeks gestation).

This work has provided a robust concentration-response function for whole pregnancy PM2.5 and the risk of general PTB that can be used in health-impact assessments. Caution must be exercised when interpreting the effects of trimester-specific exposures and on PTB subtypes as there are much fewer studies available.

### Cord blood proteomic profiles of birth weight and its relation with early life growth trajectories

Thessa Van Pee<sup>1</sup>, Dries S. Martens, Rossella Alfano, Liesa Engelen, Hanne Sleurs, Leen Rasking, Michelle Plusquin, Tim S. Nawrot

<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Agoralaan Building D, 3590 Diepenbeek, Belgium

#### Abstract

**Introduction:** The cord blood proteome, a repository of proteins derived from the mother and fetus, offers valuable insights into the physiological and pathological state of the fetus. However, its association with birth weight and growth trajectories early in life remains unexplored.

**Methods:** This study involved 288 mother-child pairs from the prospective birth cohort study ENVIRONAGE (recruited between February 2010 and November 2017). 368 Inflammation-related cord blood proteins were quantified via the proximity extension assay with next-generation sequencing readout. Through generalized linear models, we explored their association with birth weight and the birth weight ratio (BWR). Identified proteins were further investigated for their long-term predictive effect on early life growth trajectories (i.e., rapid growth at 12 months old, and weight, body mass index z-score, waist circumference, and overweight at four-to-six years old).

**Results:** After multiple testing correction, two cord blood proteins (AFM and SFRP4) were positively associated and five proteins (CELSR2, EPHA4, SLITRK1, TCN1, and UNC5D) were negatively associated with birth weight and BWR (absolute coefficients per doubling in protein level ranging from 209 to 366 g (birth weight) and from 0.07 to 0.11 (BWR)). Further evaluation of these seven proteins showed that two were predictive for rapid growth at 12 months old (AFM and TCN1) and that five were predictive for at least one of the four growth-related outcomes measured at four-to-six years old (AFM, CELSR2, EPHA4, SLITRK1, and UNC5D).

**Conclusion:** We found robust cord blood proteomic signatures related to birth weight, and the majority of these proteins were still associated with weight and growth in four-to-six-year-old children. Our findings imply that stressors that affect the cord blood proteome during pregnancy might have long-lasting effects on weight and body composition.

### Association of Maternal Inhaled Dose of Traffic-Related Air Pollution in Different Microenvironments with Fetal Growth

Ya-Na Luo<sup>1</sup>, Sarah Koch, Toni Galmes, Joren Buekers,

Xavier Basagaña, Marta Cirach, Alan Domínguez, Pol Jimenez,

Bruno Raimbault, Antònia Valentín, Maria Foraster, Mireia Gascon,

Xavier Querol, Maria Dolores Gómez-Roig, Elisa Llorca, Jordi Sunyer,

Ioar Rivas, Payam Dadvand

<sup>1</sup>Barcelona Institute for Global Health, ISGlobal, Barcelona,

Spain; Universitat Pompeu Fabra (UPF), Barcelona, Spain; CIBER

Epidemiología y Salud Pública (CIBERESP), Madrid, Spain

#### Abstract

**Introduction:** Traffic-related air pollution (TRAP) is one of the most studied environmental exposures during pregnancy, yet no study has explored the association between maternal inhaled dose of TRAP and fetal growth.

**Objective:** Exploring associations between maternal TRAP inhaled dose and offspring's birth weight (BW) and risk of small for gestational age (SGA).

**Methods:** The study was based on the Barcelona Life Study Cohort, includes 1,080 pregnant women residing in Barcelona, Spain (recruitment: 2018–2021). TRAP levels - nitrogen dioxide (NO<sub>2</sub>), black carbon (BC), fine particulate matter (PM<sub>2.5</sub>), and its three constituents (Cu, Fe, and Zn) - in microenvironments (home, workplace and commuting route) were estimated by land use regression models. We integrated

microenvironmental TRAP levels with physical activity data collected at the first and third trimesters using a personal physical activity monitor to estimate the personal inhaled dose in each microenvironment during the entire pregnancy. We used linear and logistic mixed effects models with hospital a random effect to assess associations of TRAP inhaled dose with BW and SGA, respectively.

**Results:** We found statistically significant inverse associations between inhaled dose of NO<sub>2</sub> and PM<sub>2.5</sub>-Fe at home (NO<sub>2</sub>: -47.5g, 95% CI: -85.5, -12.2; PM<sub>2.5</sub>-Fe: -32.8g, 95% CI: -62.4, -2.0) and all microenvironments combined (NO<sub>2</sub>: -52.0g, 95% CI: -90.5, -16.2; PM<sub>2.5</sub>-Fe: -36.1g, 95% CI: -68.3, -2.5) and PM<sub>2.5</sub>-Cu in all microenvironments combined (-34.9g, 95% CI: -65.8, -3.3) and BW. We also observed significant increase in the risk of SGA in associations with inhaled dose of NO<sub>2</sub> in all microenvironments combined (1.40, 95% CI: 1.04, 1.88) and PM<sub>2.5</sub>-Fe (1.35, 95% CI: 1.01, 1.79) and PM<sub>2.5</sub>-Cu (1.41, 95% CI: 1.03, 1.91) at workplace.

**Conclusion:** Higher prenatal inhaled dose of NO<sub>2</sub>, PM<sub>2.5</sub>-Fe, and PM<sub>2.5</sub>-Cu at home, at workplace and all microenvironments combined were generally associated with impaired fetal growth.

## EXPOSURE ASSESSMENT AND METHODS

### Long-term exposure assessment to drinking water trihalomethanes and nitrate in the French CONSTANCES cohort

Antoine Lafontaine<sup>1</sup>, Sewon Lee, Bénédicte Jacquemin, Philippe Glorennec, Barbara Le Bot, Dominique Verrey, Marcel Goldberg, Marie Zins, Emeline Lequy, Cristina M Villanueva  
<sup>1</sup>Univ Rennes, Inserm, EHESP, Irset (Institut de Recherche en Santé, Environnement et Travail) - UMR\_S 1085, Rennes, France

#### Abstract

**Introduction:** Trihalomethanes (THMs) and nitrate (NO<sub>3</sub>) are widespread chemicals in drinking water. Estimating long-term exposure is challenging and evidence of its association with cancer risk remained inconclusive so far, possibly due to potential exposure misclassification. We estimated exposure to drinking water nitrate and THMs in CONSTANCES, a French population-based cohort, using a public regulatory monitoring database (SISE-Eaux).

**Methods:** We obtained 26,322,366 measurements in drinking water parameters from 2000 to 2020 in SISE-Eaux. After excluding missing or implausible values and duplicated measurements, correcting and imputing sampling locations geocodes, we computed annual median concentrations of NO<sub>3</sub> and THMs by surveillance area. To predict missing concentrations, linear mixed models with random intercept using surveillance area as a clustering variable were developed for each parameter and region. Remaining missing values were imputed using the annual median from the corresponding water distribution unit. We linked annual concentrations in surveillance area closest to home addresses for 64,813 participants with residential history geocoded between 2000 and 2020.

**Results:** Median concentrations of total THMs and NO<sub>3</sub> at study participants' home for 2000-2020 were, respectively, 15.7 µg/L (IQR: 15.2) and 15.2mg/L (IQR: 20.8). Among these annual concentrations, 35% were based on measurements for NO<sub>3</sub> (16% for THMs), 44% (46%) were predicted, and 21% (38%) were based on distribution unit median values. Conditional R<sup>2</sup> predictive models ranged from 0.71 to 0.91 (median: 0.85) for NO<sub>3</sub>, and from 0.48 to 0.80 for total THMs (median: 0.68).

**Discussion:** Around 99% of THMs and NO<sub>3</sub> concentrations at this study participants' home were below the WHO guidelines (sum of ratios "THM component values: guideline values" ≤ 1 and 50mg NO<sub>3</sub>/L), with higher levels in specific areas. These concentrations will allow future association analyses with risk of breast and colorectal c

### How exposures of environmental factors correlate across different Euclidean buffer sizes

Csilla Vámos<sup>1</sup>, Tian Tian, Simon Scheider, Roel Vermeulen  
<sup>1</sup>Utrecht University

#### Abstract

**Introduction:** Environmental factors used for exposure measurement are diverse in terms of domains and methods of measurement. However, when investigating the effect of multiple environmental factor exposures to a health outcome, it is likely that some of these may correlate, causing multicollinearity in statistical models, and thus problems when assessing the impact of these environmental factors. Furthermore, multicollinearity can also be influenced by how exposures are measured due to spatial aggregation effects. Estimations of environmental exposure make use of a range of spatial measurement methods including Euclidean buffer analysis. This study aims to investigate to what extent Euclidean buffer models of exposure effects are influenced by the types of environmental factors taken into account, and by how exposures are quantified.

**Methods:** Exposure measurements for 84 environmental factors were calculated for residential addresses across The Netherlands using four Euclidean buffer sizes: 100, 250, 500, and 1000 meters. Co-variance of the different measurements of exposure to different environmental factors were assessed to determine how sensitive correlations were to varying study area sizes.

**Results:** Results show that the correlation (and thus multicollinearity) is heavily affected not only by the choice of environmental factors but also by how they were measured. The characteristics of the original environmental factor data also influenced how its exposure was culminated.

**Discussion:** This research demonstrates the importance of considering how the characteristics of a variable's raw data will impact exposure and performance in models, as well as the importance of being aware of how different exposure sizes and methods of exposure can influence the models' results. This study also demonstrates that it is important to be aware of multicollinearity in models, and how it can impact model results.

### Modelling outdoor volatile organic compounds in Leicester, UK: improving spatial resolution of exposure assessment tools

Connor Young<sup>1</sup>, Rebecca Cordell, Kevin Wyche, Emmanuel Aboagye-Nimo, Paul Monks  
<sup>1</sup>Centre for Environmental Health and Sustainability, University of Leicester, Leicester, United Kingdom

#### Abstract

**Introduction:** Volatile organic compounds (VOCs) are poorly regulated constituents of air pollution with sparse monitoring networks existing in the UK. Benzene, toluene, ethylbenzene, and xylene, a group of VOCs called BTEX, have relatively high ambient outdoor concentrations, and originate from known anthropogenic sources, including vehicle exhausts and industrial processes. Human health effects include; short-term central nervous system irritation, and long-term neurological impairment and cancer.

**Methods:** 22 were sites selected across Leicester, UK, for a 6-week winter campaign of VOC passive sampling. Sites selected represent a range of land-use types, and were co-located with existing continuous air pollution monitors. Sampled sorbent tubes were analysed via thermal desorption gas chromatography-mass spectrometry to identify and quantify VOCs. Land-use variables including road features, land cover type, and distances from point sources, were utilised to inform a regression model. Optimisation of the model was performed through statistical tests and validation methods, including principal components analysis, Moran's I, and 4-fold cross-validation.

**Results:** Measured concentrations of benzene (1-3 µg/m<sup>3</sup>) provide valuable data for government regulatory targets, whilst toluene (1-5

µg/m<sup>3</sup>), ethylbenzene (0.2–1 µg/m<sup>3</sup>), and xylene (0.2–2 µg/m<sup>3</sup>) concentrations offer insight into concentrations of unregulated, potentially harmful compounds. The land-use regression modelling was found to effectively explain 73% BTEX spatial variability, and 64% during 4-fold cross-validation, making it comparable to existing VOC models produced in Europe, Canada and USA.

**Discussion:** Prediction surfaces created at 100 m<sup>2</sup> resolution provide a valuable exposure assessment tool for comparison to postcode-level health and social data in Leicester, UK. This work represents a novel VOC land-use regression model within the UK, and a unique tool for assessing health impacts of VOC exposure.

### Volatile Organic Compound (VOC) emissions from resin 3D printers and operator exposure scenarios

Danielle A Baguley<sup>1</sup>, Rebecca L Cordell, Gareth Evans, Delphine Bard, Paul S Monks

<sup>1</sup>University of Leicester, University Rd, Leicester LE1 7RH, UK

#### Abstract

**Introduction:** Desktop 3D printers are becoming increasingly popular in schools, homes, businesses, and healthcare centres, however, there is limited data detailing the VOCs that are released during their use, or the impact they may have on health. Preliminary studies have detected VOCs which have been linked to adverse respiratory symptoms and skin sensitisation. Resin-bed 3D printers have been particularly poorly studied.

**Methods:** To identify and quantify VOC emissions from resin 3D printers, a printer was placed into an experimental chamber with a controlled airflow and samples were collected and analysed by thermal desorption coupled gas chromatography-mass spectrometry. User exposure scenarios were also investigated using a printer in a room, and the impact of ventilation and active extraction was assessed.

**Results:** 2-Hydroxyethyl methacrylate, 2- and 3-hydroxypropyl methacrylate were the dominant VOCs released by all tested resins (reaching a maximum chamber concentration of 68 mg/m<sup>3</sup> for white resin, and room concentration of 50 µg/m<sup>3</sup> for clear resin), whilst elastic resin emitted isobornyl acrylate also as a dominant compound.

VOC concentrations increased non-linearly through the printing process and remained high for an hour after printing ended within the chamber. Within the room scenarios, the VOCs increased in concentration through the printing cycle, with peaks observed as the print ended, before returning to the baseline within two hours.

**Discussion:** Only a few of the resin compounds identified had defined exposure limits, known as workplace exposure limits (WELs, HSE). The concentrations of the compounds identified were below these WELs by up to 2 orders of magnitude in the scenarios tested; therefore, the likely health impacts are low when adequate ventilation is present. This may, however, not be the case for smaller rooms or offices without added extraction/ventilation.

### Domestic indoor radon exposure in Lubumbashi, DR Congo

Elodie Lwendela Kalasa<sup>1</sup>, Christian Mwamba Kalombo, Gilbert Alpha Byadunia, Desiré Mundali Shimbi, Trésor Carsi Kuhangana, Joseph Pyana Kitenge, Tony Kayembe Kitenge, Célestin Banza Lubaba Nkulu, Benoit Nemery, Paul Musa Obadia

<sup>1</sup>School of Public Health, University of Lubumbashi

#### Abstract

**Background:** The (former) Katanga province of DR Congo hosts many copper-cobalt mines and refining plants that are past and current sources of environmental pollution. The cobalt deposits are also rich in uranium, the decay of which leads to emissions of gaseous radon. We investigated indoor radon exposure in urban neighborhoods with different degrees of pollution from metal refineries.

**Methods:** In a cross-sectional study (June–August 2023), we measured indoor radioactivity using a radon detector device with instant reading (RadonEye RD200) in 180 houses in neighborhoods with industrial pollution (Ruashi and CDM) and 350 control houses in neighborhoods without refineries (Kalubwe and Maramba). Households were selected by convenience sampling.

**Results:** Geometric Mean radon concentrations (Bq/m<sup>3</sup>) with ranges were 89 (15–1071) in exposed neighborhoods and 55 (7–531) in the control area. In the exposed area, 40% of homes exceeded the WHO acceptable limit in the general environment (100 Bq/m<sup>3</sup>), compared to 21% in the control area. In a multivariable analysis, households with indoor radon >100 Bq/m<sup>3</sup> were significantly associated with proximity to metal refineries (1000 m) [aOR 3.3 (2.1–5.4), P<0.001].

**Discussion:** In this cross-sectional study, we found evidence of high exposure to radon in households close to metal refineries in Lubumbashi. The health impact of this exposure to ionizing radiation must be further investigated.

### Comparison of long-term air pollution exposure predictions of eight modelling methods

Femke Bouma<sup>1</sup>, Kees de Hoogh, Nicole Janssen, Joost Wesseling, Sjoerd van Ratingen, Jules Kerckhoffs, Ulrike Gehring,

Wouter Hendricx, Kees Meliefste, Roel Vermeulen, Gerard Hoek

<sup>1</sup>Institute for Risk Assessment Sciences, Utrecht University, Utrecht, the Netherlands

#### Abstract

**Introduction:** Assessment of long-term exposure to outdoor air pollution remains a major challenge. Different approaches are used to characterize the fine-scale spatial variation of ambient air pollutants. Little is known about their agreement and relative performance, which may affect health effect estimates in epidemiological studies.

This study aimed to develop long-term ambient air pollution exposure estimates for the Netherlands based on empirical models based on data from mobile and stationary monitoring and dispersion modelling and compare their agreement and predictive performance.

**Methods:** Annual average air pollution estimates were compared using eight exposure assessment methods, differing in modelling and monitoring data. Three model development algorithms were tested for empirical models: supervised linear regression (SLR), Random Forest (RF) and Lasso. Model predictions were compared at 20,000 random addresses across the Netherlands and tested on external validation data from a new campaign and existing data from different years (2002–2019).

**Results:** The different exposure models generally resulted in highly to moderately correlated exposure predictions (R>0.7 for BC, NO<sub>2</sub> and UFP; R>0.5 for PM<sub>2.5</sub>). However, the predicted exposure (contrast) could differ substantially between methods and between model algorithms with interquartile ranges varying from 0.8 to 2.18 µg/m<sup>3</sup> for BC and from 1.7 to 13.0 µg/m<sup>3</sup> for NO<sub>2</sub>. Generally small differences were found in explaining spatial variation at external validation sites (R<sup>2</sup> between 0.50 and 0.74 for NO<sub>2</sub>).

**Discussion:** Different air pollution exposure assessment methods resulted in highly correlated exposure estimates with different exposure contrasts. When applied in epidemiological studies, differences in exposure assessment method may contribute to heterogeneity in health effect estimates.

### Estimating residential PM concentrations in the Netherlands using low cost sensors.

Judith Holtjer<sup>1</sup>, Laura Houweling, George Downward, Lizan Bloemsma, Anke-Hilse Maitland-Van der Zee, Gerard Hoek, Roel Vermeulen

<sup>1</sup>Department of Environmental Epidemiology, Institute for Risk Assessment Sciences (IRAS), Utrecht University, Utrecht, Netherlands

**Abstract**

**Introduction:** Accurate air quality assessment at the residential level is crucial for epidemiological studies on air pollution-associated health risks. Low-cost, easily operable sensors have rapidly gained adoption to enhance monitoring precision. The Precision Medicine for more Oxygen (P4O2) study employed a real-time air quality monitor with a Sensiron SPS30 dust sensor to monitor residential particulate matter (PM2.5) concentrations. This study aims to examine the validity of this sensor in estimating residential PM2.5 concentrations in the Netherlands.

**Methods:** In total, 73 sensors were deployed at participants' residences (one per participant) over a 15-month period. PM2.5 concentrations were measured every minute. Data cleaning included removing erroneous data points, outliers, and error codes. Accuracy, including performance over time for each sensor, was evaluated by comparing daily time-series to that of regulatory measuring stations.

**Results:** The average deployment period was 131 days per sensor. PM2.5 measurements were not affected by temperature and humidity. Therefore, we did not correct the PM2.5 data for meteorological conditions. The Pearson correlation was 0.72 and 0.87, when compared to regulatory station data, for the hourly and daily average PM2.5 concentrations, respectively. The sensors measured a mean PM2.5 concentration of 8.68 µg/m<sup>3</sup> over the deployment period. Notably, peak values were registered in both March and December 2022.

**Discussion:** This study focused on evaluating a real-time PM2.5 sensor, demonstrating its reliability and strong correlation with regulatory measuring stations. The study's strengths lie in its extensive deployment time and broad coverage across the country. Our findings show the potential of using low-cost sensors for residential PM2.5 exposure assessment in epidemiological studies.

### **A prototype platform for mapping cohort metadata with environmental data: the MetaMap<sup>3</sup> project**

*Kathrin Wolf<sup>1</sup>, Marco Dallavalle, Ronny Gey, Jeroen Staab, Marie Standl, Jan Bumberger, Hannes Taubenböck*

*<sup>1</sup>Institute of Epidemiology, Helmholtz Zentrum München, German Research Center for Environmental Health, Neuherberg, Germany*

**Abstract**

**Introduction:** The environment plays an increasingly important role for human health and efficient linkage of epidemiological cohorts with environmental data is crucial to quantify human exposures. We aimed to ease the search for appropriate exposure data for subsequent epidemiological analyses by generating and enriching interoperable and machine-readable metadata for exemplar cohort and exposure data and by mapping these metadata so that they can be jointly queried and searched.

**Methods:** Our use case for cohort metadata consisted of the two German prospective, population-based birth cohorts GINIplus and LISApplus which were conducted in four study regions across Germany and included up to seven examination rounds since 1995. As use cases for environmental data, we considered land cover classification available for a single time point (06/2015-09/2017 mean) and daily soil moisture index data for the entire study period. Since both factors influence air temperature, they are of specific interest when investigating the effects of temperature extremes on human health. We reviewed several standards, strategies and tools and developed an approach to align the heterogeneous metadata to a common structure and format.

**Results:** We identified spatial and temporal coverage as the main mapping criteria. For the environmental metadata and the epidemiological metadata that have a spatial component (study centers, recruitment districts) we converged to the international standard for geographic information ISO 19115 and to the eXtensible Markup Language (XML). Based on our conceptual work, we identified the catalog application GeoNetwork as the best tool for our application and set up a test instance on a local server for our use cases metadata.

**Discussion:** We are currently populating the mapping platform with further metadata and testing the full functionality of the tool, especially the filtering and search options of the application to enable the intended mapping.

### **A machine learning framework for modeling the associations between various environmental features and health**

*Nikolaos Nikolaou<sup>1</sup>, Donatella Cea, Mahyar Valizadeh, Jeroen Staab, Marco Dallavalle, Marie Piraud, Annette Peters, Alexandra Schneider, Hannes Taubenböck, Kathrin Wolf*

*<sup>1</sup>Institute of Epidemiology, Helmholtz Munich, German Research Center for Environmental Health, Neuherberg, Germany*

**Abstract**

**Introduction:** Human health has been associated with the exposure to several environmental variables as well as socio-economic and neighborhood settings. Yet, their interplay is not adequately analyzed and consequently not well understood. We aimed to build a machine learning (ML) pipeline, able to sufficiently identify the driving environmental, socio-economic and individual factors for cardiovascular health.

**Methods:** For our use case, we included midterm data from the baseline examination of the largest German population-based cohort study NAKO conducted between 2014-19 in 18 study centers. We assigned environmental exposures (e.g., air pollution, air temperature, greenness) and neighborhood factors (e.g. urbanization) based on the participants' residential addresses. We compared traditional regression approaches (Logistic Regression, Elastic Net) with multiple ML algorithms, e.g. neighbour-based methods (K-Nearest Neighbour), Statistical Learning (Support Vector Machine), Ensemble Learning (Random Forest, XGBoost) and Neural Networks to identify the main risk factors for hypertension.

**Results:** Of 101,601 participants included in our analysis, 45% were classified as hypertensive. Most models performed well and comparable with an accuracy ranging from 0.68 (K-Nearest Neighbour) to 0.73 (Support Vector Machine) in our test set. The different approaches identified similar factors as the main drivers for hypertension with highest feature importance for individual characteristics (age, Body Mass Index, sex) followed by environmental (non-optimal temperature, air pollution) and individual socio-economic (income, education) factors. Further neighborhood socio-economic factors (e.g. deprivation, household income) are currently assigned and will be incorporated in the next runs.

**Discussion:** The ML pipeline shall be openly accessible soon for use in epidemiological analysis, specifically with binary health outcomes, but we also plan to incorporate continuous outcomes

### **Noise annoyance in various acoustic zones in Belgrade, Serbia - a pilot survey**

*Katarina Paunović<sup>1</sup>, Branko Jakovljević, Ana Jovanović, Katarina Djurdjević*

*<sup>1</sup>Faculty of Medicine, University of Belgrade*

**Abstract**

**Introduction:** The city of Belgrade, Serbia, has been divided into six acoustic zones in 2021, but the strategic noise maps are still under construction. Road traffic noise is one of the largest problems in the city, apart from air pollution. We present the proportion of highly annoyed population in various acoustic zones.

**Methods:** Day, evening, and night noise levels were measured at 35 measurement points across the city in spring and autumn. We obtained data from 2020 to 2022 to calculate the average noise level Lden and the proportion of highly annoyed population.

**Results:** The average Lden in Belgrade ranges from 51 to 59.5 dB. There are no significant differences between spring and autumn in each year. The proportion of highly annoyed population ranges from 14% in the residential acoustic zone, to 22% in the city center zone, to 28%



in the industrial acoustic zone. The proportion of highly annoyed was similar at spring and autumn in all respective years.

**Discussion:** Road traffic is the dominant noise source in the city. The average noise levels in all acoustic zones exceed guideline values in the observed timeline. The observed proportion of people highly annoyed by roads traffic noise in Belgrade calls for immediate operational and public health actions to protect human health across the city. Further studies are needed to assess individual noise exposure.

**Conclusion:** The average noise levels in spring and autumn in Belgrade are high and exceed national guidelines. On average, one in five urban residents is highly annoyed by noise; fewer inhabitants are annoyed in the residential acoustic areas, more residents are annoyed if living in the city center or the industrial acoustic zones. We call for urgent road traffic abatement measures and public health actions against urban noise.

### Comparison between aerial and pedestrian-level greenery in contrasting typologies within Basel, Switzerland

Shoukai Sun<sup>1,2</sup>, Anke Huss, Derrek Karsenberg, Oliver Schmitz, Danielle Vienneau, Yuantong Jiang, Nicole Probst-Hensch, Kees de Hoogh

<sup>1</sup>Swiss Tropical and Public Health Institute, Allschwil, 4123, Switzerland; <sup>2</sup>University of Basel, Basel, 4051, Switzerland

#### Abstract

**Introduction:** Urban greenery, as a critical urban landscape component, plays an important role in improving the living environments and residents' well-being. Previous studies evaluating beneficial effects of urban greenery have often focused on satellite-based assessed presence of vegetation, not taking ground-level diversity of vegetation into account.

**Methods:** We collected Google Street View (GSV) images locating on 59,647 sampling points, and applied a deep learning technique to quantify green view index (GVI) from the pedestrian perspective, and investigated the correlations (in a range of buffers) and spatial heterogeneity (using geographically weighted regression (GWR)) between GVI and normalized difference vegetation index (NDVI) in different typologies of Basel, Switzerland.

**Results:** Street-level greenery was spatially diverse, and greenery measurements evaluated using both NDVI and GVI were lower in urban areas than those in intermediate and rural areas. GVI and NDVI averages in buffers with different radii had strong positive correlations, with a Spearman coefficient maximum of 0.787 for the 15 m buffer (by typology the values were: Urban (0.778), Intermediate (0.755), Rural (0.721)). However, correlations between GVI and NDVI decrease with increasing buffer sizes. GWR analysis showed spatial heterogeneity between GVI and NDVI (GWR coefficients between -0.26 and 2.31 across the sampling points).

**Discussion:** We conclude that GVI and NDVI are positively correlated but mismatches occur due to the difference between the aerial and pedestrian perspective. This study contributes to a better understanding of the effect of features in the built-environment to two different methods to assess green exposure. The semantic segmentation method applied here, to model GVI using open-source data, is transferable to other cities.

### Big data and machine learning-based nutritional and health assessment of dietary patterns

Teresa Rebelo<sup>1</sup>, Lei Huang, Bu Zhao, Vy Nguyen, Olivier Jolliet

<sup>1</sup>Quantitative Sustainability Assessment, Department of Environmental and Resource Engineering, Technical University of Denmark

#### Abstract

Given the projected rise in life expectancy, it is crucial to prioritize science-based paths to healthy lifestyles, particularly by systematically

studying the relationship between dietary choices and changes in mortality risk. However, characterizing the intricate interactions across consumption patterns and mortality poses a significant challenge.

In this study, to explore the linear and non-linear effects of multiple dietary intake variables on all-cause mortality, we constructed two penalized Cox proportional hazards models – LASSO and adaptive elastic net (AENET) – and a random survival forest (RSF), using age as the time scale. The data consisted of 26 dietary intake variables as well as serum cotinine level and demographic indicators for 59,312 respondents from the 1988-2018 National Health and Nutrition Examination Survey (NHANES) paired with National Death Index mortality data. The models calculated hazard ratios (HR) associated with each predictor and we compared these to pinpoint the most influential variables in mortality. Additionally, we obtained a visualization method to elucidate the importance of each variable on mortality across the study population.

Results are mostly in agreement between the Cox regression and RSE, with beneficial dietary factors being dietary fiber, vitamins E and A as well as omega-3 fatty acids docosahexaenoic acid (PFA 22:6) and alpha-linolenic acid (PFA 18:3). Interestingly, eicosenoic acid (MFA 20:1) was identified as having a positive effect solely by the Cox regression. As for detrimental dietary factors, hexadecenoic acid (MFA 16:1), cholesterol, stearic acid (SFA 18:0), sodium, starchy vegetables and palmitic acid (SFA 16:0) were identified. These results may provide valuable insights for nutritional guidelines. Moreover, while this study focused on dietary patterns related to mortality, this approach could potentially employ other exposome risk factors to explore how exposures can influence mortality risk.

### CARDIOMETABOLIC AND CARDIOVASCULAR OUTCOMES

#### Residential proximity to major roads and the prevalence of gestational diabetes mellitus in Belgrade, Serbia

Ana Jovanovic<sup>1</sup>, Katarina Paunovic, Dragana Davidovic,

Vera Kujundzic, Sladjana Mihajlovic, Ivana Savkovic, Milan Lackovic, Ljiljana Bogdanovic

<sup>1</sup>Institute of Hygiene and Medical Ecology, Faculty of Medicine, University of Belgrade, Belgrade, Serbia

#### Abstract

**Introduction:** A significant rise in the prevalence of gestational diabetes mellitus (GDM) has been noticed in recent years. Apart from the well-known risk factors, such as obesity, advanced maternal age, and unhealthy diet, recent studies indicate a significant role of exposure to certain air pollutants. This study aimed to determine the differences in exposure to traffic-related air pollution, through proximity to major roads as a proxy, among women with healthy pregnancies and women with GDM.

**Methods:** This case-control study included 80 women with GDM (mean age 32.8 years ±4.9) and 80 healthy women (mean age 30.4 years ±5.1) residing in Belgrade, Serbia. Data on age, Body Mass Index (BMI), weight gain during pregnancy, parity, and gestational age was obtained through the medical chart. Residential addresses, residential mobility, and education level were acquired using a questionnaire. The categorization of roads in Belgrade was done according to the Act on the classification of municipal roads and streets in the territory of Belgrade. Maternal residential addresses were geocoded in ArcGIS Pro and the shortest distance to major roads was measured using the Measure tool.

**Results:** Median proximity to major roads in the healthy group was 185.3 m (IQR 235.7 m) and in the GDM group 188.3 m (IQR 258.8 m). After adjusting for confounding factors (age, BMI, weight gain, parity, gestational age, and education level) we found no significant difference in proximity to major roads among GDM and healthy groups ( $p > 0.05$ ).

**Discussion:** Although this study showed no significant difference in proximity to major roads among women with and without GDM, it is important to note that a large urban area could have various air pollution sources, other than traffic, which could affect overall individual exposure to air pollution. There is a need for further studies that would assess individual exposure to common air pollutants.

### Air pollution and body composition in overweight and obese adults

Ariadna Curto<sup>1</sup>, Jadwiga Konieczna, Antoni Colom, Kees de Hoogh, Gerard Hoek, Jordi Salas-Salvadó, J Alfredo Martínez, Vicente Martín-Sánchez, Ramón Estruch, Josep Vidal, Miguel Ángel Martínez-González, Dora Romaguera  
<sup>1</sup>Health Research Institute of the Balearic Islands, University Hospital Son Espases, Palma de Mallorca, Spain

#### Abstract

**Objective:** We examined cross-sectional associations of air pollution exposure, including fine particulate matter (PM<sub>2.5</sub>), black carbon (BC), and nitrogen dioxide (NO<sub>2</sub>), with proportions (%) of total fat mass, visceral fat mass, and lean mass in overweight and obese adults with the metabolic syndrome.

**Material and Methods:** Study participants included 1,357 overweight/obese adults (age: 54–75 years, 51% men) from the PREDIMED-Plus cohort in Spain, who underwent DXA scans (Dual-energy X-ray absorptiometry) at baseline (2013–2016). Annual air pollution exposures were assigned by linking residential addresses to hybrid land-use estimates of air pollutant concentrations at 100 m resolution. We used linear regression models to examine associations between air pollution and body composition measures. Models were adjusted by relevant covariables such as study site (7 in total), height, energy intake, physical activity, and sedentary time.

**Results:** Mean residential PM<sub>2.5</sub>, BC, and NO<sub>2</sub> exposures were 14.2, 2.2, and 31.7 µg/m<sup>3</sup>, respectively. After adjusting for confounders, a 5 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> and a 1 µg/m<sup>3</sup> increase in BC were associated with 0.83% (95% CI: 0.30%, 1.36%) and 1.49% (0.68%, 2.30%) higher proportion of fat mass, and 0.80% (0.29%, 1.30%) and 1.43% (0.65%, 2.20%) lower lean mass, respectively. Similar associations were observed for NO<sub>2</sub>, albeit with weaker strength. No association was found for visceral fat mass for any pollutant.

**Conclusion:** Our analyses revealed adverse associations between long-term exposure to PM<sub>2.5</sub>, BC, and NO<sub>2</sub> and body composition in older adults with overweight or obesity and metabolic syndrome, underscoring the potential contribution of air pollution to cardiometabolic risk in this population. Continued follow-up is warranted to confirm the long-term consequences of these changes.

### Long-term exposure to air pollution and incidence of peripheral arterial disease, in the Rome Longitudinal Study

Chiara Di Blasi<sup>1</sup>, Federica Nobile, Paola Michelozzi, Alberto Maria Settembrini, Massimo Stafoggia, Marina Davoli, Pier Mannuccio Mannucci, Matteo Renzi

<sup>1</sup>Department of Epidemiology, Lazio region Health Service/ASL Roma1

#### Abstract

**Introduction:** Despite many studies provided evidence of the relationship between air pollution and cardiovascular diseases (CVD), only few focused on the association with Peripheral Arterial Disease (PAD), notwithstanding it is a predictor of CVD mortality and it affects quality of life. This study aims to estimate the association between long-term exposure to air pollutants and the incidence of PAD in the Rome population-based cohort in the period 2011–2019.

**Methods:** We identified incident cases as individuals with a first hospital discharge for PAD (ICD-9 codes: 440.20–24; 444.0; 444.21;

444.22; 444.81; 447.1), surgery (ICD-9 codes: 38.18; 39.29; 84.11; 84.12; 84.15; 84.17; 39.50; 39.90) or drug prescription (ATC code: B01AC23) in the study period, and excluded prevalent cases based on hospitalizations, surgery or drug prescriptions in the 10 years before enrolment. One-year average concentrations of PM<sub>2.5</sub>, NO<sub>2</sub> and black carbon (BC) from the ELAPSE Europe-wide hybrid land-use regression (LUR) models at 100 m<sup>2</sup> spatial resolution were assigned to the baseline residential addresses.

We applied Cox regression models adjusted for individual and area-level covariates to estimate hazard ratios (HRs) and 95% confidence intervals (95% CI) per pollutant-specific interquartile range (IQR) increase. We also analyzed effect modification by socio-demographic variables.

**Results:** We analyzed 1,719,475 subjects and identified 14,629 incident cases for PAD. An IQR (1.13 µg/m<sup>3</sup>) increase in PM<sub>2.5</sub> was associated with a HR of 1.011 (95% CI: 0.988, 1.034). Positive results were also obtained for NO<sub>2</sub> ([IQR 7.86 µg/m<sup>3</sup>] HR: 1.022 (95% CI: 0.998, 1.048)) and BC ([IQR 0.39 µg/m<sup>3</sup>] HR: 1.020 (95% CI: 0.994, 1.047)). Effect modification analysis underlined stronger associations when considering subjects in the 55–69 age class.

**Discussion:** These results suggest that long-term exposure to PM<sub>2.5</sub>, NO<sub>2</sub> and BC is associated with an increased incidence of PAD, and middle-aged subjects are more at risk.

### Association between changes in Serum Lipids and changes in Serum PFAS

Tony Fletcher<sup>1</sup>, Gisella Pitter, Filippo da Re, Francesca Russo, Andrea di Nisio, Cristina Canova

<sup>1</sup>Unit of Biostatistics, Epidemiology and Public Health, Dpt. of Cardio-Thoraco-Vascular Sciences and Public Health, University of Padova, Padova, Italy

#### Abstract

**Introduction:** Perfluoroalkyl substances (PFAS) are widely used, ubiquitous and highly persistent man-made chemicals. Previous cross-sectional studies have consistently linked PFAS exposure to alterations in lipid profiles. However, longitudinal investigations are preferred to mitigate issues related to reverse causation and confounding. Hence, we aimed to investigate the association between changes in serum PFAS and changes in serum lipids.

**Methods:** We used data from a health surveillance program offered to residents of a vast area of the Veneto Region (North-Eastern Italy), who had been exposed to PFAS via contaminated drinking water until 2013. We included subject aged ≥ 20 years that provided two blood samples over an average 4-year period (n=8,101). We examined the relationships between changes in PFOA, PFOS and PFHxS and changes in total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C). Linear models were fitted for change in the natural logarithm (ln) of each lipid in relation to the change in the ln of PFAS. From the estimated regression coefficients, we calculated the predicted percentage change in the response for a ln-decrease in PFAS serum concentrations.

**Results:** Overall concentrations of PFOA, PFOS, PFHxS fell by 62.1%, 24.4% and 35.4% from baseline, while small increases in lipids were observed. Declines in PFAS concentrations were associated with decreases in all lipids. For a ln-decrease in PFOA HDL-C decreased by 1.99% (95% CI: 1.28, 2.70), TC by 1.49% (95% CI: 0.88, 2.10), and LDL-C by 1.40% (95% CI: 0.45, 2.37).

**Conclusions:** We found a positive association between changes in PFAS concentrations and changes in cholesterol levels, observing the most marked contrasts across sexes and age groups. Our findings support the reversibility of the associations identified in cross-sectional analyses, emphasizing the importance of water treatment measures in mitigating adverse health effects.

### Ambient air pollution and hypertensive disorders of pregnancy in Rome (Italy)

Federica Nobile<sup>1</sup>, Paola Michelozzi, Leslie Thomas Stayner, Kees de Hoogh, Jørgen Brandt, Massimo Stafoggia, Marie Pedersen  
<sup>1</sup>Department of Epidemiology, Lazio Region Health Service/ASL Roma, Rome, Italy; Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden

#### Abstract

**Introduction:** We aimed to study the association between the long-term exposure to ambient air pollutants and all and specific subtypes of hypertensive disorders of pregnancy (HDP) in a population-based study from Rome, Italy.

**Methods:** We analysed 130,470 singleton pregnancies resulting in a liveborn child to women with geocoded residence in Rome during 2014–2019. Spatiotemporal land-use random-forest models at 1 km spatial resolution assigned to the maternal residential addresses were used to estimate the exposure to PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, and O<sub>3</sub>, considering several exposure periods before and during pregnancy. Adjusted logistic regression models were used to estimate the associations fitting single-pollutant and two-pollutant models. Finally, the shape of exposure-response curves was evaluated and potential effect modification by maternal age, parity, education, and deprivation index was tested.

**Results:** For PM<sub>2.5</sub>, PM<sub>10</sub> and NO<sub>2</sub>, there was no evidence of increased risk for all subtypes of HDP (n=2,297) and gestational hypertension (GH, n=1,901), but suggestive evidence of increased risk of pre-eclampsia (PE, n=442). Increased risks for HDP and GH were suggested for O<sub>3</sub> in single-pollutant models and for PM after adjustment for NO<sub>2</sub>, but all other associations were stable or attenuated in two-pollutant models. For instance, regarding PE, an interquartile range (IQR) of 7.0 µg/m<sup>3</sup> increase in PM<sub>2.5</sub> exposure during the first trimester of pregnancy was associated with an odds ratio (OR) of 1.14 (95% confidence interval: 0.91, 1.44) and 1.06 (0.81, 1.39) after adjustment for NO<sub>2</sub>.

**Discussion:** The results of our study suggest that PM<sub>2.5</sub>, PM<sub>10</sub> and NO<sub>2</sub> increase the risk of PE and that these effects are stable after adjustment for O<sub>3</sub>. Otherwise, the increased risks for GH and HDP suggested for O<sub>3</sub> tend to attenuate when adjusted for PM or NO<sub>2</sub>. Additional studies are needed to evaluate the effects of source-specific component of PM on HDP and would help to target preventive actions.

### Prenatal exposure to persistent organic pollutants and body mass index trajectories from birth to age 12

Nathalie Costet<sup>1</sup>, Elke Rouxel, Christine Monfort, Renaud Balestra, Hélène Tillaut, Eric Gaudreau, Florence Rouget, Sylvaine Cordier, Cécile Chevrier, Charline Warembourg  
<sup>1</sup>Univ Rennes, Inserm, EHESP, Irset (Institut de recherche en santé, environnement et travail) -UMR\_S 1085, Rennes, France

#### Abstract

**Introduction:** Several studies have explored the association between prenatal exposure to persistent organic pollutants (POPs) and body mass index (BMI) at a given age but very few have evaluated the dynamic of growth across ages. Our objective was to study the associations between prenatal exposure to multiple POPs and growth BMI trajectories from birth to adolescence.

**Methods:** This study included 430 mother-child pairs enrolled in the PELAGIE cohort (France). Polychlorinated biphenyls (PCBs), organochlorine pesticides (OCs), and per- and polyfluoroalkyl substances (PFASs) were measured in cord blood. Latent class growth model was used to identify BMI z-score (zBMI) trajectories. Multinomial regressions evaluated the associations between each POP and the resulting zBMI trajectories, as well as Quantile G-computation to evaluate POP mixture effects. All analyses were stratified by sex and adjusted for confounders.

**Results:** Four classes of zBMI trajectories were identified and the “average zBMI at birth and lower zBMI up to age 12” trajectory was

considered as the reference. In single-exposure models, higher exposure to beta-hexachlorocyclohexane (β-HCH) was associated with a higher odds of following the “higher zBMI from birth to age 12” trajectory (OR=1.5 [1.1; 2.1]). In girls, higher exposure to all PCBs was associated with higher odds of following the trajectory “lower zBMI at birth with accelerated zBMI gain in early childhood before stabilization up to age 12”; this association was also observed in the mixture analysis (OR=1.2 [1.0; 1.5]). In boys, higher exposure to some PFASs was associated with higher odds of following the “higher zBMI from birth to adolescence” trajectory and lower odds of following the “lower zBMI from birth to adolescence” trajectory.

**Discussion:** POP prenatal exposure may be associated with some specific growth dynamics, known as risk factors for adult cardiovascular health.

### Firefighters' Exposure to Benzotriazoles and Benzothiazoles, and its Impact on Serum Lipids and Oxidative Stress

Nina Páležová<sup>1</sup>, Lucie Bláhová, Tomáš Janoš, Katarína Řiháčková, Aleš Pindur, Ludmila Šebejová, Pavel Čupr  
<sup>1</sup>RECETOX, Faculty of Science, Masaryk University, Kamenice 753/5, 625 00 Brno, Czech Republic

#### Abstract

**Introduction:** Benzotriazoles and benzothiazoles (BTs) are high-production volume chemicals and widely distributed emerging pollutants with potential health risks. Firefighters might be occupationally exposed due to their use in firefighting foams and their presence in fire smoke. However, information about firefighters' exposure to BTs and associated health outcomes is limited. We aimed to characterise exposure to BTs among Czech firefighters and age- and lifestyle-matched control group, exposure predictors, and its associations with serum lipids and oxidative stress.

**Methods:** Professional firefighters (male, n=52) and control group (male, n=55) provided urine and blood samples that were used to quantify the urinary levels of 8 BTs (HPLC-MS/MS), and cholesterol, low-density lipoprotein, triglycerides, catalase, and 8-hydroxy-2'-deoxyguanosine. Linear regression was used to assess associations with population characteristics and biomarkers of serum lipids and oxidative stress. Regression models were adjusted for potential confounding variables. Daily intake (EDI) was estimated by a steady-state kinetic model.

**Results:** The BTs ranged from undetected up to 46.8 ng/mL. 1-methylbenzotriazole (1M-BTR) was measured in human samples for the first time and it was the most predominant compound (detection frequency 80.4%; median 1.79 ng/mL). Professional firefighters had lower urinary 1M-BTR compared to the control group. Urinary 2-hydroxy-benzothiazole was positively associated with levels of cholesterol (β=15.63%; 95%CI: 2.41 – 30.56%) and low-density lipoprotein (β=14.86%; 95%CI: 2.51 – 28.71%). Median EDI was 0.14 µg/kg b.w./day.

**Discussion:** This is the first study investigating urinary BTs in firefighters. The findings showed a high prevalence of BTs in both firefighters and control groups, revealed their potential to disrupt cardiometabolic profile and pointed out an urgent need for further research into associated adverse health outcomes.

### Association of ambient air pollution with inflammatory and cardiometabolic markers in European children

Rajini Nagrani<sup>1</sup>, Philine Betker, Manuela Marron, Kees de Hoogh, Danielle Vienneau, Thais De Ruyter, Kirsten Mehlig, Dénes Molnár, Luis A Moreno, Paola Russo, Toomas Veidebaum, Krasimira Aleksandrova, Wolfgang Ahrens, Christoph Buck  
<sup>1</sup>Leibniz Institute for Prevention Research and Epidemiology - BIPS

#### Abstract

**Introduction:** Ambient air pollutants have been reportedly associated with inflammatory responses and may subsequently increase the

risk of cardiometabolic diseases. This study investigates associations between air pollution and selected inflammation and cardiometabolic biomarkers.

**Methods:** Over 4000 children from 8 countries in the IDEFICS/I. Family cohort were included. Annual ambient particulate matter (PM)<sub>2.5</sub>, NO<sub>2</sub>, and black carbon (BC) concentrations were assigned using land use regression models. Linear regression assessed cross-sectional associations between annual average ambient air pollutants and distances to major roads with inflammatory and cardiometabolic biomarkers. Outcome variables included C-reactive protein, interleukin-1Ra, 6, 8, 15, interferon-gamma-inducible protein 10, tumor necrosis factor-alpha, adiponectin, leptin, ghrelin, waist circumference, systolic and diastolic blood pressure (DBP), hemoglobin A1c (HbA1c), high- and low-density lipoprotein, triglycerides, fasting glucose, homeostatic model assessment for insulin resistance (HOMA-IR), and metabolic syndrome score.

**Results:** In multivariable-adjusted regression, annual average ambient PM<sub>2.5</sub> was associated with HOMA-IR ( $\beta=0.06$  per IQR, 95% CI=0.01; 0.12) and HbA1c ( $\beta=0.06$  per IQR, 95% CI=0.01; 0.10). Children living close to major roads ( $\leq 250$  m) had higher levels of HbA1c and DBP than those living farther away. Ambient air pollution was positively associated with the pro-inflammatory marker IL-15 and inversely associated with the anti-inflammatory biomarker adiponectin. Body mass index and pubertal status were identified as potential effect modifiers.

**Discussion:** Our findings support the hypothesis that higher exposure to air pollution is associated with biomarkers denoting disturbed inflammatory and metabolic processes in early life. The data pointed to the role of specific biomarkers and effect modifiers that deserve evaluation in future research.

### Air pollution exposure and incident cardiometabolic disease in Dutch adults: effect modification by dietary antioxidants

Shradha Mishra<sup>1</sup>, Ilonca Vaartjes, Esmée Bijmens, Yvonne T. van der Schouw, Tim S. Nawrot, Erik J. Timmermans  
<sup>1</sup>Centre for Environmental Sciences, Hasselt University, Hasselt, Belgium

#### Abstract

**Introduction:** While some antioxidants have been suggested to be protective against cardiometabolic diseases (CMDs), their effect on CMDs in the context of air pollution exposures remains unexplored. This study aims to investigate whether dietary antioxidants could potentially attenuate the associations between air pollution and CMDs.

**Methods:** The study population comprised participants from the Dutch arm of the European Prospective Investigation into Cancer and Nutrition (EPIC) study: EPIC-NL, recruited between 1993 and 1997. Ambient concentrations of particulate matter with an aerodynamic diameter  $<2.5$  and  $<10$   $\mu\text{m}$  (PM<sub>2.5</sub> and PM<sub>10</sub>) and nitrogen oxides (NO<sub>2</sub> and NO<sub>x</sub>) were predicted using land use regression models. Data on the incidence of non-fatal cardiovascular disease (CVD) events and Type 2 Diabetes Mellitus (T2DM) were obtained from medical registries until December 31, 2010. The intake of six dietary antioxidants (retinol, beta-carotene, zinc, selenium, vitamins C and E) was assessed via

a validated food frequency questionnaire. Multivariable binary logistic and Cox regression models were used to explore associations.

**Results:** Among the 25,342 participants (mean age: 50.3 years), 663 developed T2DM and 2,688 had an incident CVD event. No significant associations were found between air pollution and incident CMDs. Stratified analyses for low and high retinol intake groups showed non-significant negative and positive trends respectively for associations of PM<sub>10</sub>, NO<sub>2</sub> and NO<sub>x</sub> with T2DM (O.R. (95% C.I.) for PM<sub>10</sub>: 0.90 (0.80, 1.01) versus 1.04 (0.96, 1.13); NO<sub>2</sub>: 0.98 (0.95, 1.01) versus 1.01 (0.99, 1.03) and NO<sub>x</sub>: 0.99 (0.98, 1.00) versus 1.01 (1.00, 1.02)). The associations of air pollutants with CMD incidence did not differ by any other antioxidants.

**Discussion:** These findings suggest that dietary antioxidants may not be effective preventive strategies against the hazardous impact of air pollution on CMDs.

### ENVIRONMENTAL EPIDEMIOLOGY RESEARCH IN EAST AND WEST: COURSES, FUNDING OPPORTUNITIES AND CAREER PROSPECTS (PRESENTED IN AN EARLY MORNING SESSION)

#### Knowledge-based analysis providing ambitious AQ policies

Dominika Mucha<sup>1</sup>, Łukasz Adamkiewicz, Artur Badyda

<sup>1</sup>Warsaw University of Technology, The European Clean Air Centre

#### Abstract

**Introduction:** Implementing ambitious policies related to air quality management is not easy for decision-makers. Additional arguments based on knowledge and data obtained from analyses are often needed. The state institutions themselves - at all levels from the city to the country - despite their resources, are not in a position to carry out many dedicated studies. This is where specialist organisations like the European Clean Air Centre (ECAC) come in for support. The knowledge and experience gained from research work at the university and cooperation with other researchers enable the delivery of high-quality justifications. Contacts and cooperation with institutions built up over several years have brought the organisation several successes. It has succeeded in supporting emerging or updated legal documents in Poland with data and recommendations.

**Methods&Results:** Three examples of implementation are the subject of this study. The first is the revised AAQD. A scenario tool has been developed to support Poland's ambitious position. It is based on state data and the Steering Committee includes institutions responsible for air quality in the country, including the Ministry of Climate and Environment. A second example is the provision of arguments for updating the anti-smog resolution in the Mazowieckie Voivodeship. Successful implementation of a research-based information campaign resulted in the implementation of more ambitious provisions - a ban on coal burning in the Polish capital. A third analysis of the health effects of the actualised Air Quality Plan in the Małopolskie Voivodeship. The results of the analyses were widely distributed - even on billboards. The campaign resulted in a good result for the vote in the provincial assembly (the voivodeship sejmik). Based on these three examples, it is clear that decision-makers supported by knowledge-based arguments are able to achieve more ambitious air quality policies.