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**MORNING KEYNOTE**

**The challenges of Exposure Science in a world that is beyond recognition.**

**Yuri Bruinen de Bruin**, European Commission Knowledge Management Service, Ispra, Italy

**Abstract**

As Human Sapiens we are in the fourth revolution currently known as the digital revolution. Although it is difficult to predict what exactly will happen, it is clear lots of high-tech developments are ongoing of which for many of us the consequences are yet highly unknown. We way we work today will not be the same how we will work in 20 to 30 years from now. Technology is changing so fast that looking beyond 30 years is almost impossible to imagine. The development is not linear and a technological discovery may accelerate a whole new concept currently not yet existing. Most of our children will do jobs that today do not exist yet. This presentation will take the audience to a possible future and will stimulate the thinking and discussions about the current, medium and long term role of exposure science within a fast evolving world also focussing on both safety and security aspects.

**AFTERNOON KEYNOTE**

**How can we use existing cohort studies to further the links between epidemiology and exposure science?**

**Mark Pearce**, Newcastle University, Newcastle upon Tyne, United Kingdom

**Abstract**

Epidemiology studies are important to understand the causes of disease, and lead to prevention measures. The usual definition of an epidemiology study includes the words ‘outcome’ and ‘exposure’. Obtaining accurate exposure data, or as close to accurate as currently possible, is important to ensure that epidemiology studies have findings that are as accurate as possible. If not, we risk getting the wrong messages across to the public and the wrong evidence for public health interventions.

Increased use of technological advances means that we can include prospectively measured exposures, objective, such as physical activity, or subjective, such as electronic self-reporting of diet or alcohol consumption. For most exposures, however, the assessment is retrospective, even within a prospective study. With many exposures needed to be estimated as cumulative measure, we need to make use of the vast range of data and biological samples that epidemiology studies hold, and to make even more use of the collaborations between epidemiology and exposure science.

The Newcastle Thousand Families Study is a birth cohort that began in 1947 and is still under prospective follow-up over 70 years later. While little has been done so far in terms of environmental and occupational exposures, the individuals have been exposed to a huge range of factors across their lives. Examples of the work done so far and the potential ways to involve more multi-disciplinary work on exposure data in such studies will be presented, using the cohort as an example.

**INVITED IOM PRESENTATION**

**IOM’s Contribution to the Occupational and Environmental Exposure Science**

**Sotiris Vardoulakis**, Institute of Occupational Medicine

**Abstract**

In our daily activities, we are exposed to a wide range of chemical, biological and physical stressors present in our workplace, home, school or outdoor environment that can affect our health and wellbeing. Exposure science aims to characterise human contact with these stressors, e.g. dusts, fibres, chemicals, noise, heat and cold, in order to estimate their association with health effects and prevent or reduce impacts. Exposure science has been a core disciplines at the Institute of Occupational Medicine (IOM) since its establishment 50 years ago. Early pioneering work was undertaken within the Pneumoconiosis Field Research programme and this has influenced exposure assessment methods in many epidemiological studies. New experimental methods of measuring dust and airborne asbestos fibres developed by IOM have been adopted as standard approaches throughout the world, most notably the IOM inhalable dust sampler and the Walton-Beckett microscope eyepiece graticule. Exposure modelling has also been the focus of several research projects in IOM and has contributed to the reconstruction of historic workplace exposures and the development of tools to estimate human exposure for European chemical regulation. IOM scientists have also undertaken pioneering work on exposure to engineered nanomaterials in industry, dermal exposure to pesticides in farming and agriculture, thermal stress and dust exposure of workers in the London Underground, and more recently on sub-concussive head trauma and neurological health in professional footballers. Another key area is the evaluation of interventions aiming to reduce environmental and workplace exposures. This has recently included evaluation of the effectiveness of personal protective equipment, such as facemasks, as well as of wider policies to improve outdoor air quality in cities in the UK and overseas. IOM will continue to champion exposure science in the years to come, further developing the life-course “exposome” approach and other innovative research methods, such as biomonitoring, smart sensors, and Big Data analysis, for a wide range of occupational and environmental health studies.

### ORAL PRESENTATIONS

**Developing a model for residential indoor PM2.5 exposure estimation**

**Hanbin Zhang**1, Yunfei Fan2, Yiqun Han3,4, Li Yan3,5, Yutong Cai3,5, Bingling Zhou1, Wu Chen2, Queenie Chan1,5, Tong Zhu2, Frank Kelly1, Benjamin Barratt1

1Environmental Research Group, King's College London, London, United Kingdom. 2College of Environmental Sciences and Engineering, Center for Environment and Health, Peking University, Beijing, China. 3Environmental Research Group, King’s College London, London, United Kingdom. 4College of Environmental Sciences and Engineering, Center for Environment and Health, Peking University, Beijing, United Kingdom. 5Department of Epidemiology and Biostatistics, MRC PHE Centre for Environment and Health, Imperial College London, London, United Kingdom

**Abstract**

**Background:** Residential indoor PM2.5 can be divided into indoor and outdoor origins. Associated with different activities, they may have different health effects and thus should be separately modelled. We aimed to create an empirical model that allows translation of ambient PM2.5 measurements into residential exposure estimates, for application in panel and cohort studies in developing countries.

**Methods:** An automated classification algorithm was developed from twelve non-smoker participants in Beijing, with two-day paired indoor and outdoor exposure monitoring at their residential addresses during 2017. The model was then extrapolated to the study panel where indoor and ambient measurements were available.

**Results:** Among the twelve subject homes, the calculated indoor origin average and infiltration efficiency (Finf) has a median of 27.5  (IQR: 18.5-41.5 ) and a median of 0.85 (IQR: 0.71-0.89). There were no significant differences between using outdoor and ambient measurements as inputs, as for Finf (p = 0.1) and indoor origin averages (p > 0.1). The median Finf for all 33 subjects in rural Beijing was 0.9 (IQR: 0.71-0.1) during winter 2016 and 0.75 (IQR: 0.67-0.89) during summer 2017. The median Finf for all 38 subjects in urban Beijing was 0.65 (IQR: 0.41-0.81) during winter 2016, and 0.6 (IQR: 0.44-0.67) during summer 2017.

**Conclusions:** This developed method successfully separately residential indoor PM2.5 into indoor and outdoor origins and calculated of Finfs and indoor origin averages, which can be used later in longer-period residential exposure estimation. This new method can be extended both temporally and spatially beyond the homes where monitoring was carried out.

**Measurement of Potential Occupational Exposure to Diacetyl in the Coffee Industry using Thermal Desorption Tubes**

**Ian Pengelly**1, Gordon Smith2, Marie Coggins3

1Health and Safety Executive, Buxton, United Kingdom. 2Health and Safety Executive, Newcastle, United Kingdom. 3National University of Ireland, Galway, Ireland

**Abstract**

Diacetyl has been linked with serious obstructive lung disease and, since August 2018, has been subject to an 8-hour exposure limit of 20 ppb and a 15-minute exposure limit of 100 ppb in Europe. The aim of this work was to investigate the potential for exposure to diacetyl in the coffee industry. Measurement was carried out using thermal desorption (TD) tubes and gas chromatography-mass spectrometry (GC-MS).

Eight companies in the coffee industry participated in the study. The companies comprised three larger scale coffee manufacturers, two smaller scale roasters and three coffee shops. A total of 124 static and personal air samples were collected using pumped and diffusive sampling, with analysis by TD and GC-MS.

Diacetyl concentrations of < 0.1 ppb to 400 ppb were detected in the samples. Grinding beans after roasting showed the highest concentrations, with levels around roasting and packing operations significantly lower. Diacetyl concentrations in most of the samples collected from the manufacturing sites were well below the exposure limit, but at one site levels were significantly higher. Personal samples collected in coffee shops showed low levels of diacetyl; generally less than 1 ppb.

The results show significant variation in potential exposure to diacetyl in the coffee industry. Most of the samples showed levels of diacetyl below the exposure limit indicating that, with adequate exposure controls in place, compliance with the exposure limits is achievable. Diacetyl concentrations in coffee shops were low indicating that the potential risk of exposure in these workplaces is low.

**Quantifying personal exposure to PM2.5 and black carbon using portable monitors in the Chinese megacity, Beijing**

**Chun Lin**1, Dayu Hu2, Xu Jia2, Jiahui Chen2, Furong Deng2, Xinbiao Guo2, Mathew Heal1, Paul Wilkinson3, Mark Miller1, Miranda Loh4

1University of Edinburgh, Edinburgh, United Kingdom. 2Peking University, Beijing, China. 3London School of Hygiene & Tropical Medicine, London, United Kingdom. 4Institute of Occupational Medicine, Edinburgh, United Kingdom

**Abstract**

Exposure to particulate matter (PM) has been associated with cardiopulmonary morbidity and mortality. However, findings from previous air pollution and health research in North America and Europe may not be applicable to China, where the pollution chemical climate of its megacities may be significantly different. This study focuses on determining the contributions of different micro-environments, daily activities and pollution sources to the personal PM2.5 and black carbon (BC) exposure of the residents in Beijing.

A total of 95 university students from the 7 institutes around the Peking University (PKU) Health Science Centre were monitored for their real-time exposure to PM2.5 and BC in their daily activities, during one of the 24-h sessions between 12 December 2017 and 12 June 2018, using the following portable air quality monitors: RTI International (USA) MicroPEM for PM2.5 and AethLabs (USA) microAeth AE51 for BC. Manual time-activity diary and a GPS tracker (IceGPS Navigation Tech Co. Ltd., China) were used to associate exposure levels with microenvironments. Personal PM2.5 and BC measurements were corrected using MicroPEM filter weighing data from each monitoring session, and collocation data with a reference Aethalometer on the roof of the PKU School of Public Health, respectively. All data were synchronised to 1-min time steps.

Preliminary results showed great variability but clear diurnal fluctuation in personal PM2.5 and BC exposure, and often substantial difference from ambient concentrations. Participants were exposed to the highest PM2.5 and BC concentrations when cycling. Various factors contributing to personal exposure are examined by a regression model.

**The Impact of Environmental Tobacco Smoke Exposure on Cardiorespiratory Fitness in Children**

**Melissa Parnell**1, Ivan Gee1, Lawrence Foweather1, Greg Whyte1, Zoe Knowles1, John Dickinson2

1Liverpool John Moores University, Liverpool, United Kingdom. 2University of Kent, Kent, United Kingdom

**Abstract**

Environmental tobacco smoke (ETS) is a substantial risk factor for many health issues. Children are particularly susceptible to ETS with increased risk of asthma attacks, respiratory infections, and sudden infant death syndrome. The health effects of ETS are well researched in adults, but there are few studies that examine the impact on children’s cardiorespiratory fitness (CRF).  In adults, ETS has been shown to reduce CRF, and children may be at greater risk due to high respiration rates and developing organs. This preliminary research tests the hypothesis that ETS has a detrimental impact on CRF in children.

ETS exposure was determined by parental surveys and coupled with children’s exhaled carbon monoxide concentration. CRF was determined using an individually calibrated, VO2peak test using a continuous, incremental treadmill protocol. Lung function was assessed using standard spirometry and fractional exhaled nitric oxide (FeNO) as an indication of lung inflammation.

Initial results show children exposed to ETS had statically lower CRF scores and were more likely to be classified as ‘unfit’ compared to children not exposed. A negative correlation was found between the number of cigarettes smoked at home and children’s CRF, suggesting a possible dose-response relationship. Spirometry and FeNO values were not statistically different between groups.

Results highlight the need for further work, on a larger data-set that will allow more robust statistical analysis. To the author’s knowledge, this study is the first of its kind to use laboratory-based fitness measurements to explore associations between ETS and CRF in children.

**The new NERC urban air quality research supersites: Opportunities for exposure science.**

**James Allan**1,2, Hugh Coe1, Michael Flynn1, William Bloss3, David Beddows3,4, Louisa Kramer3, David Green5, Max Priestman5, James Hopkins6,7, Alastair Lewis6,7

1University of Manchester, Manchester, United Kingdom. 2NCAS, Manchester, United Kingdom. 3University of Birmingham, Birmingham, United Kingdom. 4NCAS, Birmingham, United Kingdom. 5King's College London, London, United Kingdom. 6University of York, York, United Kingdom. 7NCAS, York, United Kingdom

**Abstract**

As part of a £4.3M investment in infrastructure by the Natural Environment Research Council, three new research ‘supersites’ have been set up at urban background sites in Manchester, Birmingham and London, led by the National Centre for Atmospheric Science (NCAS). In addition to the standard monitoring metrics such as PMx, NOx, O3 and CO, a suite of state-of-the art automated instrumentation has been deployed to take continuous and comprehensive measurements of other aspects of air quality, including:

* Particulate composition (black carbon, semivolatile speciation and metals)
* Ultrafine particles (total number and size distributions)
* VOCs (using GC-FID)
* Other gases (ammonia, NOy, CO2, methane)
* Meteorology (including rainfall, actinic spectral radiometry, turbulence and boundary layer profiling)

In addition, the sites also have the facility for the collection of high-volume particulate samples for offline analysis. While these new data will in themselves be of use to the epidemiology and atmospheric science communities, the new supersites have been set up with a view to hosting and facilitating further scientific work. Envisaged applications include:

* Acting as a test bed for the development of new measurement technologies
* Calibration and validation of small sensors (e.g. personal exposure monitors)
* Intensive measurements of pollution composition and processes
* Instrument intercomparisons and benchmarking

This presentation will present the three new sites, the instrumentation and measurements taking place, preliminary data from the first measurements and discuss potential future applications.

More info: https://nerc.ukri.org/press/releases/2018/02-air/

**Arsenic in public water supplies in the United Kingdom: implications for exposure, public health and regulation**

**David A. Polya**1, Lingqian Xu1, Yifei Zhang1, Qian Li1, Jake D. Launder1, Daren C. Gooddy2, Matthew Ascott2

1University of Manchester, Manchester, United Kingdom. 2British Geological Survey, Wallingford, United Kingdom

**Abstract**

UK public water supplies have an outstanding compliance with regulatory standards, including with respect to the UK PCV (prescribed concentration value) for arsenic of 10 µg/L. Nevertheless, many UK public water supplies contain arsenic at concentrations within a factor of 10 of the PCV. In 2015, on the order of 100,000 consumers in the UK were supplied with drinking water with arsenic concentrations at or above 5 µg/L, 1,000,000 at or above 2 µg/L and 10,000,000 at or above 1 µg/L.

Epidemiological evidence seems currently insufficiently powerful to reliably quantify the detrimental health outcomes arising from such sub-regulatory exposures, but arsenic-attributable premature avoidable deaths in the UK on the order of 100 to 1000 per annum from combined cancer and cardiovascular disease are plausibly estimated here. These values are considerably lower than those ascribed to air pollution but are broadly equivalent to the number of annual fatalities of car occupants in road traffic accidents in the UK and therefore warrant concern. Uncertainties and limitations of the approach are discussed together with implications for stakeholders.

We acknowledge with thanks the data provided by the 24 largest water supply companies in the UK as well as their approvals to use their data for this research. Any views expressed here do not necessarily reflect those of any of these companies. This abstract is largely based on those presented previously elsewhere by DAP at the Arsenic 2018 (Beijing, July 2018) and IAH/Geological Society Ineson (London, November 2018) meetings.

**Risk perception of arsenic exposure from rice intake in a UK population**

**Debapriya Mondal**, Tasila Mwale

University of Salford, Manchester, United Kingdom

**Abstract**

In UK, many of us are regular consumers of rice and UK rice and rice-based products consumption is on the rise. In 2017, BBC News featured “Should I worry about arsenic in my rice?”. We aimed to determine the level of knowledge of arsenic as an environmental risk and whether or not this knowledge had an influence on rice-eating behaviour and/or preparation of rice amongst different ethnic communities.

A questionnaire was administered with 184 participants targeting different ethnic groups in Greater Manchester, UK.  Multivariate Generalized-linear model was used to determine the factors contributing to rice consumption, cooking practices and risk perception.

With highest percentage of White British (92%) knowing arsenic to be a toxic substance, followed by African/Caribbean (87%), Bangladeshi (42%) and Pakistani (11%) only 6.5% (n=12) of the total participants knew about arsenic exposure from rice intake. Those with general arsenic knowledge were more likely (OR:4.52; 95%CI:1.78-11.53) to change their rice eating behaviour, either consuming less or eating other grains. Knowledge of arsenic was significantly low in Pakistani (OR:0.006; 95%CI:0.00-0.03) and Bangladeshi (OR:0.064; 95%CI:0.01-0.25) compared to White British and Bangladeshis consumed three times (OR:2.92; 95%CI:1.73-4.93) more rice compared to White British. Rinsing rice before cooking, an effective arsenic removal technique was practised by 93% of the participants and most popular cooking method was use of adequate water but not excess water which is more effective is removing arsenic. Participants of this this survey did not associate arsenic, which they perceive as toxic to health with rice consumption.

**Historical reconstruction of PFAS exposure in a polluted community**

Tony Fletcher1,2, Christian Lindh3, **Estelle Larsson**3, Daniela Pineda3, Carina Nilsson3, Kristina Jakobsson3,4

1LSHTM, London, United Kingdom. 2PHE, Chilton, United Kingdom. 3University of Lund, Lund, Sweden. 4University of Gothenburg, Gothenburg, Sweden

**Abstract**

Background/Aim: The study of disease from chronic exposure necessitates the historical measurements or modelling of past exposure. One third of households in the municipality of Ronneby in Sweden have been exposed to perfluorinated alkyl substances (PFAS), via drinking water contaminated from fire fighting foams used in a nearby airfield. Exposure has lasted decades but no data are available on historic emissions or past contaminant concentrations. Only current and very recent water and biomarker measurements are available. To estimate past exposure and body burden two approaches are being taken, modelling groundwater pollution and directly assessing community exposure using archived blood samples as described here.

Methods: We have accessed an historical archive of blood spots for screening newborns, within which PFAS levels can be measured, going back to the 1980s when pollution started. Pilot tests have established that PFAS is above detection in sufficient samples. Five samples randomly selected per year will allow us to describe the time trend in body burden for infants. By benchmarking recent blood spot measurements to their mothers’ serum levels and other community samples, the time course of community exposure in terms of serum levels will be derived for the whole exposed population. Which can then be used for exposure assessment in the community cohort studies. Samples are currently being analysed and results of this exposure reconstruction approach will be presented.

**Knowledge and practice associated with pesticide use among farmers in Malaysia- a pilot study**

**Zulkhairul Naim Bin Sidek Ahmad**1, Daniel Brison 2, Martie Van Tongeren3, Andrew Povey3

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**Abstract**

Pesticides are commonly used in agriculture in Malaysia and this can lead to agricultural workers having significant pesticide exposures. Many strategies have been recommended to reduce such exposure including increased knowledge and safe practice in pesticide use. The aim of this pilot study was to assess the level of knowledge and practice associated with pesticide use among farmers.

A cross sectional pilot study was conducted among 18 farmers from  January to March 2018 in Ranau, Sabah and Bachok, Kelantan. Participants were asked 13 questions to assess knowledge of pesticides and their use and ranked 16 work practices  based upon their frequency of use. Answers were summed with a maximum score of 13 and 64 for the knowledge and practice questions respectively.

The mean (+/- SD) score for pesticide knowledge was 9.1+0.8. Knowledge varied in the two different states (p=0.05) but not  with other demographic or occupational factors. The mean (+/- SD) work practice score among participants was 59+4.5. There were no significant differences in score with demographic or occupational factors but there was a significant inverse association between work practices and farm size (P=0.006). There was also a significant negative association between knowledge and practice of pesticide use (p=0.03).

Results indicate that work practices were good but that knowledge level needs improvement.  However,the negative correlation between knowledge and practice suggests further research is needed to understand  the determinants of work practice in this population so that appropriate programs can be organised to prevent adverse health effects resulting from pesticide exposure

**Occupational exposures to glyphosate among amenity horticultural workers**

**Alison Connolly** 1, Ioannis Basinas2, Kate Jones3, Karen S. Galea2, Laura Kenny3, Marie A. Coggins1

1National University of Ireland, Galway, Galway , Ireland. 2Institute of Occupational Medicine (IOM), Edinburgh, United Kingdom. 3Health and Safety Executive (HSE), Buxton, United Kingdom

**Abstract**

Glyphosate, the highest volume used herbicide globally, is under international debate following its IARC classification as a ‘probably carcinogenic to humans’. A dearth of knowledge exists regarding exposures to glyphosate among amenity horticulturists. The objective of this study was to characterise glyphosate exposures among this occupational group, identify exposure pathways and determinants.

A biomonitoring study, in parallel to a dermal and inadvertent ingestion exposure assessment study, was completed. The sampling strategy involved the collection of urine samples over a 24 hour period. Wipe samples of the workers’ hands and perioral region, worker gloves and of potentially contaminated work surfaces were collected and analysed for glyphosate. Detailed contextual information was recorded. Linear mixed effect regression models were constructed to evaluate determinants of dermal, inadvertent ingestion and total glyphosate exposure.

205 urine samples and 351 wipe and glove samples were analysed for 69 work tasks performed by 29 workers. Urine glyphosate concentrations ranged from non-detectable levels (< 0.5 µg L−1) to 10.7 µg L−1. The human biological half-life of glyphosate was estimated to be 5 ½ to 10 hours. Peak exposure levels were identified in urine samples collected up to three hours after cessation of the work task. Combined hand and perioral region concentrations explained 40% of the variability in the urinary glyphosate concentrations (µg L-1).

Biomonitoring results showed glyphosate concentrations comparable with published agricultural studies and assessed the contribution of dermal and inadvertent ingestion routes to the uptake of glyphosate. The real-world kinetics data will also inform future sampling strategies.

### POSTER PRESENTATIONS

**Spatial-temporal air pollution models for national-scale health analysis**

**Weiyi Wang**1, Sean Beevers2, Daniela Fecht1, John Gulliver3

1Imperial College London, London, United Kingdom. 2King's College London, London, United Kingdom. 3University of Leicester, Leicester, United Kingdom

**Abstract**

**Background:** Air pollution epidemiological studies increasingly use pollution predictions from exposure models, although it remains difficult to produce accurate predictions at fine spatial and temporal resolution across large geographic areas. The aim of this study is to develop spatio-temporal models for four major health relevant air pollutants nitrogen dioxide (NO2), particulate matters including PM2.5 and PM10, and ozone (O3) on a 25m grid for Great Britain from 2010 – 2015.

**Method:** We used generalised additive model (GAM) with penalised splines to describe spatial and temporal variations in daily concentrations of the pollutants. The model used a rich set of variables, including routinely measured data, Geographic Information System (GIS)-derived predictors around monitoring sites, and daily estimates from a chemical transport model (CTM). Model validation was performed using five-fold cross-validation (CV).

**Results:** The spatio-temporal models of O3 had high predictive accuracy (CV R2 = ~0.82). The PM2.5 and PM10model performance were also strong (CV R2 = ~0.76 for both pollutants). The predictive ability of daily NO2 models was relatively low (CV R2 = ~0.59). For all pollutants, models performed consistently across study years, though the performance varied by site types, with a weaker performance at some traffic sites compared to background sites.

**Conclusion:** Our models overall performed well in estimating daily air pollution concentrations at fine spatial resolution in Great Britain. Daily values can be extracted from point of interest from the surfaces and used in air pollution exposure health studies (e.g. time-series analysis of daily hospital admissions).

**Classifying endocrine disrupting chemicals by hormonal effect for use in occupational exposure assessment**

**Radka Prichystalova**1,2, Lesley Richardson3, Martie Van Tongeren4, Vikki Ho3,5

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**Abstract**

Endocrine disrupting chemicals (EDCs) are exogenous substances that cause adverse health effects through interference with the endocrine system. Exposure to EDC occurs through occupational, dietary and environmental sources, and for some occupations exposures through work could contribute the highest dose. EDCs may directly affect the endocrine system via antagonizing and/or mimicking the effect of hormones, disrupting the production, metabolism and transport of hormones. The purpose of the study is to devise a feasible and affordable approach to assess occupational exposures to potential EDCs for use in an epidemiological study of occupational risk factors for colorectal cancer. Within this context, this review is focused solely on effects on sex hormones.

In the larger epidemiological study, occupational exposure to EDCs will be determined using the Canadian Job Exposure Matrix (CANJEM). In CANJEM, there are estimates of exposure for 50 potential EDC substances. To classify each EDC into categories of: estrogenic, anti-estrogenic, androgenic and anti-androgenic, we conducted a literature search in 3 waves, focussing on relevance to humans. First, national and international agency reports were prioritized, followed by published review articles and original papers.

Following the first 2 waves, BPA, PCB and cadmium were classified as estrogenic and androgenic. Phthalates, (BBP, DEHP, DBP, DCHP, DINP) were categorized as anti-androgenic, nonylphenol as estrogenic and aluminium as androgenic. The final search wave is ongoing.

The availability of an exposure assessment approach that incorporates estimates of specific sex hormone effects associated with EDCs exposure will add immeasurably to our understanding of EDCs in human health.

**Wearability assessment of selected respiratory protection following the recurrent eruption of Mt. Sinabung, North Sumatera**

**Karen Galea**1, Judith Covey2, Sari Mutia Timur3, Claire Horwell4, Fentiny Nugroho 5, William Mueller1

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**Abstract**

Inhalation of volcanic ash can be of great concern for affected communities. Agencies recommend and distribute various respiratory protection (RP). However, there is no evidence on how wearable they are or how protective wearers perceive them being against volcanic ash. Volunteers living near Mt. Sinabung, Sumatra, Indonesia, participated in a wearability study, which included a high-efficiency mask certified to industry standards (N95-equiv.); a standard, pleated surgical mask (Surgical); a Basic flat-fold mask (Flat-fold), and the surgical mask plus a scarf tied over the top (Surgical Plus) to improve fit. Thirty volunteers wore each mask for a 15-min walk before being asked to rate comfort, breathability and perceived protection and fit of each. After wearing all of the masks, volunteers compared and identified their preferred type of protection. Volunteers feedback suggested that the Surgical Plus and N95-equiv. masks were rated as being significantly hotter and more humid than other masks. The Flat-fold was rated to have better breathability than the other masks. The N95-equiv. mask was ranked as providing the best level of effectiveness of the four masks tested. Ultimately, when asked which type of mask they would choose to wear during ashfall, 33% selected the Flat-fold mask due to its comfort and simplicity, with the Surgical Plus being the least likely to be chosen. The study findings are of benefit to agencies who need to make informed decisions on the procurement of RP for use by those affected in eruptions and the provision of advice to communities on their usage.

**Novel blood collection and storage device-method development for lead and cadmium analysis**

**Jackie Morton**1, Florian Lapierre2, Pawanbir Singh2

1HSE, Buxton, United Kingdom. 2Trajan Scientific and Medical, Chester, United Kingdom

**Abstract**

The UK Control of Lead at Work (CLAW) regulations establish criteria for the frequency of collection of samples for biological monitoring. Workers within the remit of CLAW have to provide blood samples as required (at least annually).  This involves a venous blood sample being collected by a trained healthcare professional.   Having a personal blood sampling device where the worker could use it themselves, much like a glucose monitoring device, would reduce the need for an onsite phlebotomist as well as reducing the burden considerably on both the worker and industry.

Trajan Scientific has developed a blood collection device in a dried blood spot (DBS) format – hemapen®. A user-intuitive design in the shape of a pen allows easy collection of four blood aliquots (each 2.74 µL) concurrently onto four pre-punched specialised DBS paper discs housed in a cartridge. hemaPEN® exemplifies the advantages of DBS based sample stability whilst addressing the associated limitations of inconsistent volume, haematocrit variability and sample contamination.

The aim of this work has been to evaluate hemaPEN® and develop a method and sample protocol to use for workplace testing.  Initial work has involved the challenge of extracting low volume (2.7 µL) dried blood spots from filter paper and analysing for lead and cadmium concentrations.  The results show that a total digestion of the blood spot was possible.  The next stage of this project will be to undertake a pilot study in workplace settings to compare venous and dried blood spot results for lead and cadmium levels in workers.

**How reliable are low-cost air quality monitors? Implications for exposure science**

**Jake Launder**1, Samantha Hall2, Andrew Thorpe2, David Polya1, Jackie Morton2

1The University of Manchester, Manchester, United Kingdom. 2Health and Safety Executive, Buxton, United Kingdom

**Abstract**

The methods traditionally used to assess our exposure to particulate matter (PMx) are fraught with uncertainty, despite PMx being a leading contributor to global morbidity and mortality. Traditional methods are generally agreed to be non-standardised, often non-personal, and likely not optimal.

In reaction to the above, both professional and citizen scientists are increasingly using low-cost, easy-to-use, and wearable air quality monitors as an alternative. These monitors can provide information on personal exposures to PMxin environments not traditionally monitored (e.g. indoor and in transit microenvironments), as well as information on personal behaviours. Yet, their performance is not always thoroughly validated prior to their use.

This study evaluated several low-cost, easy-to-use, and wearable monitors by appraising their accuracy, bias and measurement repeatability through testing in a wind tunnel facility, with a known test dust - Spheriglass 7010.

Compared to the reference instrument, PMx mass concentration measurements made by all monitors tested were strongly and linearly correlated (r = 0.859 – 0.995), but possessed biases as high as -99.4 %. All monitors tested therefore systematically underestimated PMx mass concentrations in the wind tunnel facility, relative to the reference instrument.

These findings suggest that low-cost, easy-to-use, and wearable monitors require use-specific calibration against a recognised standard prior to their use, in order to ensure their reliability.

JDL’s work is funded by a NERC (NE/LE002469/1) CASE (Health and Safety Executive) PhD studentship.

This abstract is substantially based on that presented by JDL at his School’s Postgraduate Research Conference in Manchester, United Kingdom in December 2018.

**Workplace exposure to nanoparticles and the prevention technics**

**Sarka Bernatikova**1, Radka Prichystalova1, Petra Roupcova1,2, Lucie Kocurkova1, Karel Klouda2

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**Abstract**

The problematic of occupational exposures to nanoparticles and their potential impacts on human health is still highly actual, and it is an essential part of strategic and conceptual documents in the field of occupational health and safety (OHS). The development of OHS framework is dependent on the collection of reliable, timely and comparable statistics in OHS on working conditions, quality of working life, occupational injuries and occupational diseases, workplace exposure and work-related illnesses. The need for applied research in this area also arises from the implementation of strategic and conceptual documents of the EU, e.g. Improvement of statistics and creation of information base within OHS.

The purpose of this contribution is to disseminate the project, entitled "Evaluation of the Nanoparticle Hazards in Workplaces and Preventive Technics". The main aim of this project is to extend the information base about the possible exposure scenarios, potential risks, risk management measures and preventive technics across different sectors of manufacturing industry according to CZ-NACE classification of economic activities. Measurements of workplace exposures are planned for 20 different companies. Based on the results, the adequate risk management measures will be applied and its efficiency verified. The recommendations on preventive technics will be carried out for specific sectors of the manufacturing industry. The additional benefit of this project will be the overall improvement of the OHS level for workers who are exposed during the manufacture and use to nanoparticles.

**Developing a new chemical link between abundance, composition and sources of black carbon in an urban environment**

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**Abstract**

Black carbon (BC) is an air pollutant that is detrimental to the environment and human health. The IPCC report “Global Warming of 1.5 °C” 2018, states that reductions in short-lived climate forcers such as BC would have substantial benefits in reducing climate warming and improving health due to reduced air pollution. The overall aim of this project is to determine the sources of BC around Glasgow using a combination of measurement approaches. The new technique of hydropyrolysis in conjunction with gas chromatography-mass spectrometry (GC-MS) is being applied to examine the molecular composition of BC in various sample types such as aerosols, road dust and soils. Hydropyrolysis can isolate a chemically-consistent portion of the BC continuum (BChypy) whilst preserving the labile organic matter component (non-BChypy) which can then be analysed using GC-MS, returning structural information. Radiocarbon will also be used to distinguish between contemporary and non-contemporary BC sources.

Current work is focused on in-situ measurements of BC using a mobile microAethalometer. A low emission zone (LEZ) will be implemented in Glasgow on 31/12/18, with the aim of improving air quality. BC measurements are being made at various bus stops in Glasgow city centre prior to the introduction of the LEZ. A regular route was used, stopping for 5-minutes at each bus stand. Sampling will continue after the LEZ is in operation. A comparison of the data before and after the LEZ can help determine the extent to which this LEZ improves air quality from the perspective of BC exposure.

**Biological monitoring: evidence for reductions in exposure and risk**

**Craig Sams**, Jackie Morton, Liz Leese, Fiona Garner, Laura Kenny, Shahwaiz Iqbal, Kate Jones

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**Abstract**

HSE operates the leading UK laboratory for biological monitoring.  Since 1996 all results have been stored in a database that now has over 950,000 results from >120,000 workers in more than 8000 companies.

Since 1996, the laboratory analysed 900 - 2100 lead samples per year (Ʃ34,836).  The 90% value steadily decreased from 54 µg/dl in 1996 to 26 µg/dl in 2018.  Reductions were also seen for, mercury (24.5 µmol/mol in 1997 to 1.7 in 2018, Ʃ11,390), benzene (23.7 µmol/mol in 1996 to 1.5 in 2018, Ʃ8827). Hexamethylene diisocyanate (HDI, Ʃ22,101), used widely in the motor vehicle repair industry reduced from 2 µmol HDA/mol creatinine in 1995-2000 (prior to the national intervention study) to 0.6 in 2005-2010 but levels have since increased again to 1.1 (2014-2018), which may reflect the greater number of workers sampled and the turnover of workers since the national intervention with questions around whether those lessons are still current  in working practice.

Most of the samples come without any exposure information.   Data may be biased downwards if the samples come only from ‘good’ workplaces or could be biased high by companies with problems. Gradually reducing levels for lead, benzene and mercury show the impact of national, regional and global (Minamata) regulatory action, respectively.  The results for HDI show that whilst interventions can reduce exposures significantly, if the controls require worker training or behaviour change then the initiatives may need to be refreshed at intervals to maintain the reductions in exposure.

**The use of biomonitoring to assess exposure in the electroplating industry**

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**Abstract**

Workers in the electroplating industry are potentially exposed to a range of hazardous substances including nickel and hexavalent chromium (chromium VI) compounds. These can cause serious health effects, including cancer, asthma and dermatitis.

This research aimed to investigate whether repeat biological monitoring (BM) over time could drive sustainable improvements in exposure control in the industry. BM was performed on multiple occasions over 3 years, at 53 electroplating companies in Great Britain. Surface and dermal contamination was also measured, and controls were assessed. Air monitoring was undertaken on repeat visits where previous BM results were of concern.

There were significant reductions in urinary nickel and chromium levels over the lifetime of this work in the subset of companies where initially, control deficiencies were more significant. Increased risk awareness following provision of direct feedback to individual workers and targeted advice to companies is likely to have contributed to these reductions.

This study has shown that exposures to chromium VI and nickel in the electroplating industry occur via a combination of inhalation, dermal and ingestion routes; an ideal scenario for cost-effective assessment by biomonitoring. Surface contamination found in areas such as canteens highlights the potential for transferral from work areas, and the importance of a regular cleaning regime.  A follow-on survey is now underway to determine whether improvements have been maintained over the longer-term.

**Rice intake and dietary controls on inorganic arsenic exposure in some UK adults: an exploratory pilot study**

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**Abstract**

Adverse health outcomes arising from chronic inorganic arsenic (iAs) exposure are well documented. Whilst consumption of rice is a major iAs exposure route globally for over 3 billion people. The widely contrasting diets of those living in the UK, however, mean that the relative importance of rice as iAs exposure route is likely to be highly variable.

In this pilot study, 5 volunteers with contrasting diets (Western, Chinese, and Middle-Eastern) were asked to provide a detailed record of their food and drink consumption over a 7 day period. These data were combined with estimates of iAs contents from EFSA (2014) to determine both the absolute and relative contributions to iAs exposure from the various dietary elements.

Daily iAs intakes of 0.16 to 0.33 µg iAs/day/kg-bw were determined. These values are all lower than the (now withdrawn) JECFA provisional tolerable daily intake of 2.1 µg iAs/day/kg-bw but the highest value (for a volunteer with a Chinese-style diet) considerably exceeds the benchmark dose lower confidence limit (BMDL01) values of 0.3 µg iAs/day/kg-bw for cancers. The relative contributions of different drinks and foods on the iAs exposure varies. Rice/rice products are an important contributor, and particular so for those on a Chinese diet with almost 46% of total iAs intake derived from it. Nevertheless, other dietary items, notably composite foods and grains/grain-based products constitute between 11% and 54 % of total iAs intake and clearly cannot be ignored in exposure and public health risk modelling.

**CO uptake and elimination: a comparison of modelling and pulmonary function observations**

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**Abstract**

Carbon monoxide (CO) poisoning is an important public health issue globally. Mathematical models for predicting the uptake, distribution, and elimination of CO could help assess exposure scenarios. The best-known models are the Coburn-Foster-Kane (CFK) equation and the Bruce and Bruce multi-compartment model. Both produce acceptable predictions when compared with observations. However, several additional factors could improve the model, such as including variations with height, age, smoking, lung function and disease status.

We aim to investigate a simplified version of the compartment model for CO model by comparing its predictions against observed data.

As CO is routinely used to estimate lung function, observed data gathered from lung function testing can be used to estimate variations in model predictions. We analysed demographic variables and CO diffusion capacity (DLCO) in lung data from 212 patients who had a pulmonary function test at Tri-Service General Hospital, Taiwan, in August 2018. The patients’ data was characterised by the following means with standard deviations: age 55.9±15.8 yrs; height 165.0±7.8 cm; weight 65.9±13.7 kg; DLCO 18.3±5.6 mL/min/mm Hg. Each variable was divided into three categories (high, medium, low), to test variations of predicted exhaled CO for different ranges.

Following this calibration exercise, the multicompartment model for CO uptake and elimination can be modified to account for various parameters including height and age. Further work is needed to estimate the variation of COHb with some of the parameters, for example, smoking and disease status.

**Maternal vitamin D and E intakes in pregnancy and asthma to age fifteen years: a cohort study**

**Steve Turner**, Anthony Seaton, Leone Craig, Graham Devereux

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**Abstract**

**Introduction**: We investigated the associations between maternal vitamin D and E intakes during pregnancy and childhood wheeze/asthma outcomes throughout childhood to at age fifteen years.

**Methods**: 1924 children were recruited antenatally. Maternal vitamin D and E intakes during pregnancy were assessed by food frequency questionnaire. Respiratory questionnaires were completed throughout childhood to up to age fifteen years. Treatment for asthma at age fifteen was also ascertained using healthcare data. Maternal vitamin D and E intakes were also related to combined childhood wheeze/asthma data  collected at one, two, five, ten and fifteen years of age.

**Results:** Questionnaire were available at one, two, five, ten and fifteen years in 1512, 1374, 1145, 927 and 747 (39%) individuals respectively.  Healthcare data were available 1689 (88%). There were no associations between maternal vitamin D and E intakes and childhood wheeze and asthma outcomes at age fifteen.  Analysis of combined data collected between one and fifteen years of age demonstrated that higher maternal vitamin D and E intakes during pregnancy were associated with a reduced likelihood of being diagnosed with asthma in the first fifteen years: hazard ratio (95% CI) per quartile increase in vitamin intake of 0.87 (0.78,0.98) and 0.88 (0.78,0.98) respectively.

**Conclusions**: Lower maternal vitamin D and E intakes during pregnancy are associated with increased risk of children wheezing and being diagnosed with asthma in the first ten years but not after puberty, suggesting that post-natal exposures predominate in the aetiology of incident asthma as children transition through puberty into adulthood.

**Global Distribution of High Arsenic Groundwater Hazard – Association with Major Solute Sources and Tectonic Environment**

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**Abstract**

The widespread distribution of high-arsenic (As) groundwaters poses a great threat to human health. Several models have been developed to predict such occurrences and are necessary to calculate global-scale human exposures and associated health risks from such waters. This study explores the association of high As groundwaters to predominant source of major solutes (silicate or carbonate rock weathering) and type of tectonic environment.

Globally, high As groundwaters were found to be more commonly derived from dissolution of predominately silicate rocks (76 %) than of carbonate rocks (24 %), reflected in Na being the predominant cationic component in most (67 %) of the high As groundwaters collated. The observed distribution of silicate/carbonate source predominance is broadly consistent with the known global distribution and weathering fluxes from these rock types.

Globally, high As groundwaters are significantly associated with foreland basins, although on a regional scale the association is more nuanced. Notably, in the USA, where several tens of thousands of groundwater arsenic concentrations are available in the public domain, the association with either foreland basins or orogenic belts is poor. Notwithstanding this, two widely used predictive models (Amini, 2008; Ayotte, 2017) of global groundwater arsenic distribution do, in the USA, show an association with foreland basins and orogenic belts respectively.

This paradox is thought to arise because these models use as predictive variables parameters associated with foreland basins or orogenic belts

There is a clearly potential, therefore, to improve predictive models of high-As groundwaters and this will be the subject of further investigation.

**Investigation of Particulate Matter during a Haze Episode in Bangkok, Thailand**

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**Abstract**

**Background**: Air pollution, including haze episodes from biomass burning, is an important cause of illness and premature mortality in Bangkok, the capital city of Thailand.

**Objective**: To investigate the particulate matter concentration during a haze episode in Bangkok.

**Methods**: We collected data on PM10, and PM2.5from the Pollution Control Department (PCD) automatic monitoring stations across Bangkok during 2015 to 2017. Personal sampling using MicroPem monitors was also performed during a Haze episode.

**Results**: Average PM2.5particle concentrations measured at fixed monitoring stations in Bangkok have decreased from 41.5 to 18.5 µg/m3between 2011 and 2017. Our team collected the samples during the haze episode in Bangkok for two stations to analyse the PM2.5, PM10 and PAH content. The average ratio of PM2.5/PM10 was 0.6 and both parameters concentration exceeded the relevant PCD standards. The dominant PAHs were Indeno{1,2,3-cd]pyrene and Benzo[a]pyrene. The personal PM2.5 obtained from MicroPem in outdoor air was higher than that in indoor air, and outdoor concentrations were consistent with data from the PCD records.

**Conclusion**: The results indicate that exposure to PM2.5 in residential and working spaces were less than outdoor exposure levels. The obtained data on particulate matter and PAHs concentrations will be used in a health impact assessment and contribute to the additional health outcome.

**MyAir (East): Assessing individuals’ exposure to air pollution in East London**

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**Abstract**

The aim of this pilot study was contrast ambient, residential and personal air pollution exposure levels breathed by residents within an Air Quality Management Area in order to inform the representativeness of the Government’s Air Quality Management process.

Eight residents from East London were recruited to take part in the pilot study. Three sources of exposure were gathered into a study dataset: a personal air quality monitor, paired fixed particle and gas monitoring units located indoors and outdoors at the participant’s residence,and ambient monitoring sites operated within the London Air Quality Network (LAQN).

At all residences except one, indoor air pollution levels were lower inside residences than outside. In/out ratios were in the range 46-89%, 30-59% and 22-71% for BC, CO and NO2respectively. In all properties, NO2showed the largest differential between indoor and outdoor concentrations suggesting a relatively rapid deposition and reaction rate once exterior doors were closed. Indoor peaks in NO2from gas cooking also decayed more rapidly than those of CO and BC, which took many hours to disperse. While outdoor concentrations were generally lower than indoor, the two were closely correlated, indicating the dominant influence of outdoor sources on indoor air quality in most participants’ homes.

While this study demonstrated a clear association between ambient and personal exposure levels, individual behaviour and living conditions had a strong influence. Personal and residential monitoring can help to inform the Air Quality Management Process, but remains impractical for large scale deployment due to the significant resources required.

**Brominated Persistent Organic Pollutants in Plastics and Landfill Waste in Ireland**

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**Abstract**

The use of certain brominated flame retardants (BFRs) in consumer plastics has been cause for concern over the last few decades, several common mixtures having been listed as Persistent Organic Pollutants under the Stockholm Convention, i.e. polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane (HBCDD). This is of particular concern with regards to recycling practices, as EU-set legislative limits mean that plastics containing excess concentrations of PBDEs and HBCDD cannot be conventionally recycled.

Ireland has been shifting from landfill-based waste management to be more recycling-centric in the last two decades. However, given the barrier that BFRs can cause to recycling, it is imperative that the levels of BFRs in Irish waste streams are assessed and the implications for a circular economy addressed. To that end, a nationwide assessment of BFRs was carried out in recycling and waste streams to detect areas of concern and ways to improve waste management in Ireland.

Analysis of landfill leachate across 40 landfills in Ireland show low concentrations of BFRs, with higher concentrations in lined landfills (concentrated leachate) and lower in unlined sites. Of more concern are results from recyclable materials, with results showing that certain electronic equipment (e.g. TV and IT devices) along with furniture foams and upholstery are of particular concern with regards to recycling, due to large fractions of the waste containing excess concentrations of multiple hazardous BFRs. However, screening said materials for compliance with legislative limits using portable X-ray fluorescence successfully identified the compliance status of 95% of articles.

**Trihalomethanes in the Public Water Supply of England and Wales: Distribution and Modelled Public Health Risks**

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**Abstract**

The distribution of trihalomethanes (THMs), water disinfection by-products recognised as probable human carcinogens, in public water supplies in England and Wales has been mapped at a local authority level from secondary water supply zone (WSZ) level data for 2015 and 2017 kindly provided by the major water supply companies.

Simplified models of THM attributable bladder cancer risks associated withg the usage of public water supplies in England and Wales suggest (i) oral exposure is the dominant exposure route; (ii) several million consumers are exposed to model excess THM-attributable lifetime cancer risks marginally higher than the values (1 in a million) typically considered as the lower bound of acceptable such risks but considerably lower than the values (1 in ten thousand) typically considered as the upper bound of acceptable such risks.

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**Modelling the intra-urban variability of NO2 for estimating human exposure in Guangzhou, China**

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**Abstract**

NO2 concentrations within cities are known to have high spatio-temporal variation and estimating intra-urban variability of NO2 accurately is important for human exposure assessments. Land-use regression (LUR) and dispersion models (DM) are widely used for estimating air pollution exposure.  Few models have been developed in China on this scale due to scarcity of input data, especially observed concentrations of air pollutants. Integration of LUR with DM can help to overcome the lack of data. The aim of this study is to use both LUR and DM to simulate NO2 concentrations for the city of Guangzhou.

NO2 observations at 11 sites are obtained from <http://beijingair.sinaapp.com> for 2017. Hourly concentrations are averaged to annual mean values. The DM, ADMS-Urban is applied in Guangzhou using input data including emissions from Multi-resolution Emission Inventory for China (MEIC), road geometry from OpenStreetMap, and meteorological data from ERA5 <https://www.ecmwf.int/en/forecasts/datasets/archive-datasets/reanalysis-datasets/era5>.  The validated DM model is used to generate NO2 concentrations at preselected receptors as LUR model inputs. Using a geographic information system, spatially explicit predictor variables in different buffer zones are regressed against monitoring data. The predictor variables include road networks, land-use classification, and population density. A stepwise multiple regression approach is used with a priori-defined predictor variables. These predictor variables are selected to maximize the adjusted percentage explained variance (R2). Model performance is evaluated by leave-one-out cross-validation. An urban pollution map of NO2 is developed over the city to assess population exposure and health burden.