were observed across the four different demand-control categories in the full sample. In stratified analysis, passive work environments (low control and low demands) and low-strain environments (high control and low demands) were associated with increased risk of heart disease (HR=1.94, 95% CI 0.99–3.81; HR=2.06, 95% CI 1.01–4.17), compared to active work (high demands and high control) among women. No similar relationship was observed among men.

Among a representative sample of Ontario workers, high strain work environments were not associated with increased risk of heart disease. Passive and low strain environments (both characterised by low psychological demands) were associated with increased risk of heart disease among women, but not men. Implications of these findings for assessment of the psychosocial work environment in Canada will be discussed.

Biomarkers of Exposure

06D.1 INFLAMMATORY MARKERS IN THE PLASMA OF FIREFIGHTERS HEAVILY EXPOSED TO PARTICULATES

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Introduction In 2016 firefighters from Alberta, Canada deployed to a catastrophic fire in Fort McMurray. In the first few days, firefighters experienced heavy smoke exposures during greatly extended work shifts. Blood samples were collected to determine whether inflammatory markers might constitute a useful biomarker of exposure. In first responders exposed during the World Trade Center disaster, inflammatory markers in serum samples collected within 6 months post-event were associated with poor recovery from exposure-related lung disorders.

Methods Blood samples were collected at two fire services. At Service A, first samples were drawn two weeks from the start of the fire and second samples after 3–4 months. At Service B samples were collected over 4 weeks, starting 4 months from the first exposure. Samples were immediately centrifuged and the plasma stored at –80°C before being evaluated for 42 cytokines or chemokines using a multiplex assay. A principal component analysis was carried out to reduce the number of correlated outcomes. Exposure to particulates was estimated for each firefighter using environmental PM_{2.5}, total hours exposed, tasks carried out and the use of respiratory protection. Respiratory symptoms immediately before the fire, immediately post fire and at 4 months were collected using visual analogue (VA) scales.

Results Inflammatory markers were assayed for 242 plasma samples from 175 firefighters. Six components were extracted of which only one, labelled the inflammatory marker component (IMC) was related to estimated exposure ($p < 0.001$): values decreased with time since last exposure ($p < 0.001$). All respiratory symptoms post-fire were greater in those with higher estimated PM_{2.5}. IMC scores were independently related to cough and wheeze at 4 months, but the biomarker did not contribute to models for these endpoints that also included PM_{2.5}.

Conclusions Inflammatory markers were related to exposure but did not improve prediction of symptoms in the first months post fire.

06D.2 EVIDENCE OF DNA METHYLATION CHANGES BY CARBON NANOTUBES IN A TRANSLATIONAL STUDY DESIGN

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Introduction While studies have addressed genotoxic effects of CNT, only limited information are available on epigenetic effects. We designed a study to investigate DNA methylation alterations *in vitro*, *in vivo* and in occupationally exposed workers.

Material and methods *In vitro* studies were performed in 16-HBE and THP-1 cells. For the *in vivo* study, BALB/c mice were administered intratracheally with single-wall CNT (SWCNTs) and multi-wall (MWCNTs) at high (2.5 mg/kg) and low (0.25 mg/kg) doses. For the cross sectional study, 24 workers exposed to aggregates of MWCNT of 500 nm–100 µm with concentrations of 4.6–42.6 µg/m³ and 43 unexposed referents were recruited. Global DNA methylation and demethylation patterns were analysed by LC-MS/MS. Methylation of specific genes was measured by Pyromark 24® (Qiagen). Genome-wide assessment of DNA methylation was performed with Infinium HumanMethylation450 BeadChip Array.

Results In general, we did not find global DNA methylation alteration for both CNTs. In 16-HBE cells, differentially methylated and expressed genes (MWCNTs>SWCNTs) from p53 signalling, DNA damage repair and cell cycle pathways were observed. In THP-1 cells, CNTs induced promoter-specific methylation of genes involved in several signaling cascade, vascular endothelial growth factor and platelet activation pathways. In lungs of BALB/c mice CNTs affected methylation of ATM gene. Finally, analysis of gene-specific DNA methylation in exposed workers revealed significant changes for DNMT1, ATM, SKI, and HDAC4 promoter CpGs.

Conclusions Epigenetic changes seem to occur at sub cytogenotoxic concentrations *in vitro*. Alteration in DNA methylation pattern could be a natural reaction of cells but could also silence critical genes and reprogram cellular functions.

06D.3 EVALUATION OF POLYCYCLIC AROMATIC HYDROCARBONS EXPOSURE ACROSS OCCUPATIONS IN KOREA USING URINARY METABOLITE 1-HYDROXYPYRENE

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Objectives Polycyclic aromatic hydrocarbons are a well-known carcinogen causing lung and skin cancers in exposed workers. Several occupations such as coke production have been reported to be associated with high PAHs exposure. However, previous reports have been

confined in several occupations. Thus, we aimed to evaluate PAHs exposure across a wide range of occupations using its urinary metabolite 1-hydroxypyrene (1-OHP).

Methods To evaluate PAHs exposure across occupations, we collected the urine 1-OHP data from the Korean National Environmental Health Survey which is a nationwide bio-monitoring survey. The data contained information about urine 1-OHP levels, cigarette smoking status, and standard occupational codes. We calculated summary statistics of urine 1-OHP levels for each occupation. In addition, we calculated the relative exposure indicators which are the proportions of exceeding the quartile levels. Since cigarette smoking is a single most influential factor of PAHs exposure, we repeated the analyses by excluding current smokers.

Results Overall geometric means (GM) of all populations and non-smoker populations were 0.13 µg/L and 0.10 µg/L, respectively. For the major group of occupation, 'Craft and Related Trades Workers' and 'Equipment, Machine Operating and Assembling Workers' showed the highest urine 1-OHP levels, while 'Homemaker' showed the lowest level. For the sub-major group of occupation, 'Video and Telecommunications Equipment Related Occupations' showed the highest percentage (61%) of exceeding the third quartile (Q3) level of all populations. While 'Legal and Administration Professional Occupations' showed the lowest percentage of exceeding the Q3 level of all populations. For the minor group of occupation, 'Horticultural and Landscape Workers' showed the highest percentage (64%) of exceeding the Q3 level of all populations. While 'Kindergarten teachers' showed the lowest percentage of exceeding the Q3 level of all populations.

Conclusions Our results will provide ancillary information about PAHs exposure across occupations, especially in occupations where PAHs exposure has not well known.

06D.4 ASSOCIATION OF OCCUPATIONAL EXPOSURES WITH EX VIVO FUNCTIONAL IMMUNE RESPONSE IN WORKERS HANDLING CARBON NANOTUBES AND NANOFIBERS

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Animal toxicology studies suggest that workers exposed to carbon nanotubes or nanofibers (CNT/F) may experience pulmonary or systemic health effects; however, direct human evidence is lacking. Our study's objective was to evaluate associations between CNT/F exposure and *ex vivo* responses of leukocytes challenged with secondary stimulants, adjusting for potential confounders, in a cross-sectional study. We measured multi-day exposure using CNT/F structure count (SC) and elemental carbon air concentrations among 102 U.S. workers. Demographic, lifestyle, and other occupational information was obtained via in-person interview. Workers' whole blood was incubated for 18 hours with and without two microbial stimulants

(lipopolysaccharide and staphylococcal enterotoxin type B) using TruCulture® technology to evaluate immune cell activity. Following incubation, collected supernatants were preserved and subsequently analyzed for cytokine and chemokine concentrations. The ratio of stimulant:null response for each protein was analyzed using multiple linear regression, principal components (PC) analysis, and Ingenuity® Pathway Analysis (IPA) to determine whether patterns of protein response were associated with CNT/F exposure. We found that CNT/F metrics (most consistently, the SC-based) were significantly ($p < 0.05$) inversely associated with stimulant:null ratios of GM-CSF, IFN- γ , interleukin (IL)-2, IL-4, IL-5, IL-10, IL-17, and IL-23. CNT/F metrics were significantly inversely associated with PC1 (a weighted mean of most biomarkers that explained 25% of the variance in the set of protein ratios) and PC2 (a biomarker contrast that explained 14%). Among other occupational exposures, only solvent exposure was significantly (and was inversely) related to PC2. IPA suggested a CNT/F-associated generalized inhibition of all leukocyte responses when challenged with a secondary stimulus. We found that CNT/F exposure metrics were uniquely related to a pattern of reduced stimulant responses in challenged circulating leukocytes. This approach, if replicated in other exposed populations, may present a relatively sensitive method to evaluate human response to CNT/F or other occupational exposures.

06D.5 ELECTRONIC WASTE RECYCLING EXPOSURE AND HORMONE LEVELS IN WORKERS

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Background and objective Electronic waste recycling (e-recycling) exposes workers to several contaminants, including flame retardants that are suspected endocrine disruptors. We aimed to explore the association between polybrominated diphenyl ethers (PBDEs) and hormone levels in the serum of Canadian e-recycling workers.

Methods In a cross-sectional study, blood samples were collected from 85 e-recycling workers (six facilities) and from 15 workers in other types of recycling (two facilities), at the end of a work shift. Socio-demographic information was obtained by questionnaire and body mass index (BMI) was calculated from measured height and weight. Serum concentrations of 13 PBDE congeners were measured as well as thyroid hormones (free and total thyroxine [T4], triiodothyronine [T3], thyroid stimulating hormone [TSH]) and testosterone (free and total). Linear regressions were stratified on sex and adjusted for age, BMI, seniority, smoking status, and type of recycling. Ten participants were excluded because of thyroid or testicular problems.

Results Participants were 23 women and 77 men (mean 40 years old, SD=12 years). Average hormone levels were within the laboratory normal range. In e-recycling, geometric mean concentrations of the most detected congeners were 11, 11 and 20 ng/g lipids for BDE47, BDE153 and BDE209, respectively. Only BDE209 concentrations were higher in e-recycling than in the control group. A two-fold increase in serum