

# Abstracts

## Biomarkers 1

### 098 TELOMERE LENGTH AND WORK SCHEDULE CHARACTERISTICS IN THE NIEHS SISTER STUDY

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**Objectives:** Telomeres are protective DNA sequences on the ends of chromosomes, which can shorten with repeated cell replication and contribute to senescence. Shorter telomere length has been associated with chronic stress, age and obesity in women, and with metabolic and cardiovascular disease outcomes. In combination with lifestyle and socioeconomic factors, work schedule may be a source of occupational stress in women. We hypothesised that cumulative lifetime years of full-time and over-time work, rotating shift-work or irregular hours, may be related to shorter telomere length in women.

**Methods:** Average leukocyte telomere length was estimated by quantitative PCR on a sample of 677 women selected for a study of biomarkers and perceived stress in the NIEHS Sister Study cohort (median age 55, range 35–75). Questionnaire data included lifetime job history and work schedule for each job reported. Age-adjusted regression models estimated associations with telomere length. We also examined whether associations were mediated or modified by education, age, and risk factors such as inadequate sleep, elevated stress and body mass index.

**Results:** Currently holding a full-time job and years of full-time work were significantly associated with shorter telomere length ( $\beta = -0.003$  per year,  $p = 0.002$ ) independent of the effects of age ( $\beta = -0.006$  per year,  $p < 0.0001$ ). These findings persisted in women currently working at enrolment and were not confounded by education, current sleep, BMI, perceived stress, smoking and health status. The odds of being in the shortest quartile of telomere length increased with increasing years of full-time work among women over age 55 (OR 3.4; 95% CI 1.4 to 8.2;  $\geq 24.5$  years vs  $< 5.2$  years), those with higher than average perceived stress (OR 3.7; 95% CI 1.5 to 9.3) and those with some college or a bachelors degree (OR 5.7; 95% CI 1.9 to 16.7) but not higher levels of education. Years in jobs characterised as over-time, shift-work and irregular hours were not consistently related to telomere length.

**Conclusion:** Telomere length may be associated with lifetime years of full-time work in some women. Further investigation is needed to understand the contribution of job strain, work-life balance and socioeconomic factors. Telomere length may provide a novel biomarker for studies of chronic occupational stress.

**Key words:** telomere length; stress; occupational

### 099 PAH EXPOSURE, URINARY MUTAGENICITY AND DNA ADDUCTS IN RUBBER WORKERS

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**Objectives:** Several studies have suggested that genotoxic risks might still be present in the contemporary rubber industry. Previously we observed elevated levels of urinary DNA adducts in rubber workers. In this study we investigated whether DNA adducts in lymphocytes and/or urothelial cells may be caused by PAHs or by other bioactivated genotoxic compounds.

**Methods:** Spot urine samples from 102 rubber workers were collected on Sunday and during the workweek on Tuesday, Wednesday, and Thursday at ~4 pm to determine 1-hydroxypyrene (1-HP) and mutagenicity levels. In addition, 24 h urine samples were collected from 52 non-smoking workers to measure the presence of urothelial cell DNA adducts. Lymphocyte bulky DNA adducts were measured in 65 workers.

**Results:** For all workers, urinary 1-HP levels were significantly higher in urine samples during the workweek compared to Sunday ( $p < 0.0001$ ). The increase in 1-HP levels was, however, not uniform across tasks and factories and only reached statistical significance for the production functions mixing, moulding (both  $p < 0.005$ ), and curing ( $p < 0.0001$ ). The overall higher weekday urinary 1-HP levels might be mostly due to rubber fumes measured as cyclohexane soluble matter (CSM;  $p < 0.005$ ), while among moulding workers dermal

exposure to CSM seemed to be the main cause. Weekday urinary mutagenicity (corrected for cotinine) was significantly increased in the mixing (+5%) and curing (+6%) workers when compared to the Sunday urine sample. Mixing and curing workers also showed higher amounts of four identified urothelial cell DNA adducts compared to the other rubber workers. No pattern in lymphocyte DNA adducts was observed for the several production functions. Total urothelial cell DNA adducts were significantly related to urinary 1-HP ( $p = 0.021$ ) and mutagenicity ( $p = 0.027$ ). No significant relationships were found between the identified lymphocyte and urothelial cell DNA adducts or urinary 1-HP and mutagenicity.

**Conclusion:** The results indicate that mixing and curing workers are at the highest genotoxic risk among rubber workers. Increased levels of 1-HP, urinary mutagenicity and urothelial cell DNA adducts were found in these workers. Urothelial cell DNA adducts were not related to lymphocyte DNA adducts, hinting possibly at the presence of specific bladder carcinogens present in the rubber industry.

**Key words:** rubber industry; 1-hydroxypyrene; DNA adducts

### 100 LIGHT INTENSITY AND URINARY MELATONIN LEVELS AMONG NURSES

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**Objectives:** To describe differences in light exposure and biomarkers of melatonin production among nurses, and to determine if light intensity during sleep and other variables are associated with peak melatonin levels.

**Methods:** 60 female clinical nurses at an acute care hospital who worked rotating day/night shifts consented to participate. During a 72 h period, nurses working either 2 days or 2 nights (age frequency matched) wore light intensity data loggers and completed a diary. The principal metabolite of melatonin, 6-sulfatoxymelatonin, was measured in a single urine void taken upon arising after sleep following their last shift.

**Results:** Nurses who worked the day shift experienced lower intensity of light during sleep than night workers, and night workers were four times more likely to have low melatonin levels than day workers (OR 4.35, 95% CI 1.43 to 13.20). Multivariable linear regression indicated that light intensity during sleep was inversely associated with urinary melatonin level ( $p = 0.001$ ). Of the other variables included, only age was independently associated with the outcome, and no variable confounded this association.

**Conclusion:** Recent epidemiological studies suggest that higher frequency of night shift work and increased light at night exposure could increase cancer risk. One hypothesised pathway is through the hormone melatonin: the presence of light inhibits its production, and decreased melatonin may increase reproductive hormone levels that may in turn increase the proliferation of hormone sensitive cells, potentially enhancing tumour development. In this study, there was a statistically significant inverse association between light intensity during sleep and metabolites of melatonin, as hypothesised. If light at night is associated with increased cancer risk, the mechanism may be through melatonin; however, longitudinal studies are needed. Since it is necessary that some nurses work at night, occupational policies must give more consideration to the implications of exposure to light at night.

**Support:** CIHR Transdisciplinary Cancer Training Program; Breast Cancer Action Kingston; Programme of Research in Environmental Etiology of Cancer, NCIC.

**Key words:** nurses; biomarkers; shift work

### 101 REPEATED MEASURES OF URINARY 1- AND 2-NAPHTHOL AMONG JET FUEL EXPOSED AIR FORCE PERSONNEL

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**Objectives:** The primary objectives of this study were to evaluate jet propulsion fuel 8 (JP8) exposure by examining potential differences in urinary 1- and 2-naphthols (absorbed dose) between a priori designated exposure groups and assess the relationship between absorbed dose and concurrent measurements of inhalation and dermal exposure levels.

**Methods:** The study population included 24 Air Force (AF) personnel from six to eight different job types from an active USAF base. Based on a review of job activities, the participants were recruited from three a priori designated exposure groups (low: six workers with administrative or office roles;

moderate: nine workers with fuel distribution jobs, and high: nine workers from fuel systems maintenance). In January 2007, urine samples (n=144) were collected pre- and post-shift over three consecutive workshifts and analysed for 1- and 2-naphthol via gas chromatography mass spectrometry (GC/MS). Personal air (n=72) and dermal tape-strip (n=72) samples were collected concurrently from each worker and analysed for benzene, toluene, ethylbenzene, xylene (BTEX) and naphthalene via GC/MS. Linear mixed effects models were used to evaluate the exposure data.

**Results:** In post-shift urine samples, the mean urinary 1-naphthol measurements in the high exposure group were sevenfold higher than in the moderate group (p=0.0005) and ninefold higher than in the low group (p=0.0004). Similarly, the mean urinary 2-naphthol measurements in the high exposure group were fourfold higher than both the moderate (p=0.0007) and low groups (p=0.002). However, the 1- and 2-naphthol measurements in the moderate group were not significantly higher than in the low group. Exposure group and smoking status explain 62% and 63% of the between-worker variability for 1- and 2-naphthol, respectively. Analyses of personal air and dermal samples are forthcoming and will be used to evaluate the effect of inhalation and dermal exposure on absorbed dose.

**Conclusion:** The a priori exposure categories and smoking status are significant determinants of urinary naphthols. Based on absorbed dose levels, the fuel systems maintenance workers experience higher JP8 exposures than the fuel distribution and office workers, while levels among fuel distribution workers are not significantly higher than the office workers.

**Key words:** jet fuel; biomarkers; inhalation and dermal exposure

### 102 SERUM DIOXIN LEVELS IN FORMER SAWMILL WORKERS 20 YEARS AFTER EXPOSURE TO PENTACHLOROPHENOL (PCP) CEASED

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**Objectives:** From the 1950s to the late 1980s fungicides containing pentachlorophenol (PCP) were widely used in the New Zealand sawmill

industry to prevent the proliferation of sapstain fungi. Workers involved in the treatment process or handling treated timber are known to have experienced significant PCP exposure. Commercial grade PCP contained contaminants including the 2,3,7,8-substituted polychlorinated dibenzo-p-dioxin (PCDD) and dibenzofuran (PCDF) congeners. The objectives of this study were to test serum dioxin levels in former sawmill workers 20 years after PCP use had ceased and to compare these with levels in the general population and also to establish whether elevated dioxin levels were the result of occupational PCP exposure.

**Methods:** Serum dioxin levels were analysed in two groups of former sawmill workers, 22 volunteers who had lodged claims for compensation (known as Sawmill Workers Against Poisons or SWAP) and 58 individuals randomly selected from surviving members of a cohort enumerated for a study of mortality and cancer incidence in former sawmill workers. This latter group was divided into 34 exposed and 24 non-exposed individuals based on work history. Age-adjusted serum dioxin levels in the general New Zealand population determined in a 1991 survey were compared with levels found in former sawmill workers with a correction based on a 7-year half-life. To establish the link with occupational exposure we compared dioxin congener profiles with those found in the general population and also in commercial grade PCP. We also tested the correlation between dioxin levels and known PCP in urine levels associated with different job titles.

**Results:** For SWAP members, both the WHO-TEQ and levels of specific hexa-, hepta- and octa-chlorinated congeners were at least 10 times those in the general population. Preliminary analyses of the randomly selected group suggest similar elevations in WHO-TEQ and the same specific congeners. Additional results of tests of the second group, and of the association with specific jobs, will be presented.

**Conclusion:** Serum dioxin levels in former sawmill workers in New Zealand are significantly elevated 20 years after the use of PCP ceased, and the congener profiles indicate that the source is past occupational exposure to PCP.

**Key words:** sawmill workers; dioxins; chlorophenols