were employed at a single DOE nuclear site that implemented the DOE beryllium rule between 1999–2002. Workers were classified as BeS when they met one of the following definitions: two abnormal blood BeLPT results, one abnormal and one borderline blood BeLPT result, three borderline blood BeLPT results, or one abnormal lung lavage BeLPT result. Descriptive statistics, longitudinal analyses, and correlation analyses were utilized to evaluate the trends in incidence before and after implementation of the beryllium rule.

Results Results indicated a general decrease in exposure and BeS incidence rates, though there are some years with notable increases presumably due to increased clean-up activity, where construction and decommissioning workers had opportunity for exposure from legacy beryllium operation materials that were not part of normal current production activity.

Conclusion These findings provide support for the hypothesis that the DOE Beryllium Rule helps prevent beryllium sensitization. Future research will more precisely assess the relationship between beryllium exposure levels and beryllium incidence over time.

04D.3 BONE LEAD ASSOCIATIONS WITH BLOOD LEAD, KIDNEY FUNCTION, AND BLOOD PRESSURE AMONG U.S., LEAD-EXPOSED WORKERS IN A SURVEILLANCE PROGRAM

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Objectives Bone lead and past blood lead (BL) levels may be more strongly associated with current health effects than current BL, representing recent exposure. We examined whether current bone lead is correlated with maximum past BL, and compared three measures of lead as predictors for current blood pressure (BP) and kidney function among workers with past occupational exposure to lead.

Methods Adult men in a lead surveillance program living within 200 miles of New York City were enrolled in this observational study during 2016–2017. We gathered data on current bone and BL, BP, and estimated glomerular filtration rate (eGFR). Maximum past BL was obtained from prior surveillance program data. Regression models were used to determine associations of health endpoints with different measures of lead.

Results Among 211 participants, median (interquartile range) bone lead, maximum past BL, and current BL were 13.8 (9.4–19.5) µg of lead per gram of bone mineral, 29.0 (14.0–38.0) µg/dl, and 2.5 (1.5–4.4) µg/dl, respectively. Both maximum past and current BL were significantly associated with current bone lead in adjusted analyses ($p < 0.0001$ for both), with associations driven by those with the highest BL levels. Bone lead was associated with increased systolic BP ($p = 0.02$, model R-square = 0.16), but quartile analyses were not monotonic. Bone lead was also non-significantly associated with decreased (worse) eGFR (regression coefficient = -0.15, $p = 0.18$, model R-square = 0.28).

Conclusions Bone lead was significantly associated with past maximum and current BL. Bone lead, but not past maximum or current BL, was associated with elevated systolic BP.

04D.4 CHANGES IN KIDNEY FUNCTION AMONG SUGARCANE CUTTERS ON A MODERATELY HOT SUGAR PLANTATION IN SOUTH AFRICA

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Introduction Epidemic chronic kidney disease of unknown cause (CKDu) occurs among sugar cane workers, notably cane cutters doing heavy manual work in hot tropical environments in Mesoamerica. Repetitive dehydration consequent on strenuous work in heat is posited as the cause. A Nicaraguan cohort study showed remarkable kidney function decreases across six weeks of the cane cutting season consistent with the dehydration hypothesis. This Nicaraguan study was replicated on a sugar plantation in South Africa about 3 500 kms from the equator and cooler than previous study locations to examine whether less extreme ambient conditions resulted in reduced kidney stress.

Methods 38 cane cutters and 36 referents of similar socio-economic status but doing less strenuous work on the same plantations provided pre- and post-shift blood and urine samples for measures of kidney function and hydration on Day 1 and Week 9 of the cutting season. Frozen specimens were transported to a chemical pathology laboratory in Johannesburg for analysis. Parameters measured included cystatin C, eGFR (derived from cystatin C), serum creatinine, serum neutrophil gelatinase-associated lipocalin (NGAL), serum uric acid and osmolality.

Results Minimum and maximum temperatures were 20.9 and 26.5°C on Day 1 and 13.6 and 26.6°C on Week 9. There were clinically modest, albeit statistically significant, increases in mean cystatin C pre-shift values between Day 1 and Week 9 in the cane cutters: 0.847 to 1.011 mg/L ($p = 0.00$) which means a considerable decline in eGFR. Other results were not consistent among the various markers of effect on the kidneys. The magnitude of the increase in cystatin C among referents was similar to the cutters: 0.771 to 0.904 mg/L.

Conclusions Kidney function markers seemed to be much less affected in the cooler study location than in the hotter one.

04D.5 LEFT SIDED HEARING LOSS AMONG HEAVY EQUIPMENT OPERATORS (HEOS) IN MINING INDUSTRY

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Introduction Open surface mining is utilized to extract limestone for the production of cement. Using heavy motor vehicles (HMs) and other earthmoving equipment, skilled personnel [HEOs] perform this operation. HEOs are exposed to significant noise (80–90 dBA) emitted by these HMs for about 8 hours a day. We report the results of pure tone audiometry (PTA) conducted on HEOs as part of a health surveillance programme.

Methods In this observational study, 108 HEOs working in a large scale mining industry in South India were assessed for

noise induced hearing loss {NIHL}. Standard guidelines were followed and PTA was performed using a NIOSH approved audiogram machine. For this analysis, we selected HEOs between the ages of 45 and 57 years, with 10 or more years of service. These results were compared with 106 age matched employees, who were involved in non-mining activity in the same industry with the same amount of noise exposure but from different sources. Results were validated using standard statistical tools.

Result Results revealed 60% (64/108) of the HEOs suffered NIHL. Of these the impact on the left side was found to be more pronounced for 90% (58/64) versus 10% (6/64) in the right ear. In the comparative group of 106 non-mining employees 55% (59/106) had abnormal audiogram reports but with no specific inclination to the right or left side.

Discussion NIHL is common in the mining industry. The observed laterality in hearing loss among HEOs is likely multi-factorial and can be attributed to the presence of the engine on the left hand side in the Indian vehicles, the failure to sound proof the operator's cabin and/or comply with the issued personal protective equipment {PPE}. Our results underscore the importance of the need for compliance with the use of PPEs and vehicular upgrade and maintenance.

Methodological Issues

04E.1 CROSS-WALKING COUNTRIES' INDUSTRY CLASSIFICATIONS USING CONCORDANCE FILES COMPARED TO FUZZY DATA MATCHING, TO UTILISE AN INTERNATIONAL EXPOSURE DATASET

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Background Carcinogen exposure data can potentially guide the work of health and safety (H and S) regulators. This project aims to use CAREX Canada data to estimate carcinogen exposures in New Zealand industries. This requires the creation of a cross-walk between the countries' industry classifications.

Methods Agile and big-data-science methodologies were used to construct two versions of an industry classification cross-walk from the 2006 Australian and New Zealand Standard Industrial Classification (ANZSIC06) to the Canadian version of the 2002 North American Industrial Classification (NAICS2002), used by CAREX Canada.

Firstly, concordance files from government statistics bureaus cross-walked the path: ANZSIC06 -> International Standard Industrial Classification of All Economic Activities Rev4 -> NAICS2017->NAICS2012->NAICS2007->NAICS2002. The cross-walk accounted for 'one-to-many-to-one', non-machine formats, and missing/erroneous values.

Secondly, a fuzzy data matching pipeline was designed. Data preparation removed redundant, stop, and common domain words, and lemmatised using morphological analysis (e.g. fishing to fish). Data matching used a hybrid algorithm combining 'JaroWinkler-distance' and a token-sort approach (i.e. ignoring the positional occurrence of words in a sentence) to match descriptions. A trial-and-error approach was used to assign weightings and concatenate the hierarchical industry

classification levels to improve match accuracy. Python language was used for implementation.

For each method, random samples of 50 matches were manually classified as either poor or sufficient by two people. Disagreements were discussed and consensus reached.

Results The concordance cross-walk sample had 52% (95% C.I. 38%–66%) sufficient matches compared to 84% (95% C.I. 74%–94%) for the fuzzy data matching pipeline cross-walk sample.

Conclusions Cross-walking countries' industry classifications using a fuzzy data matching pipeline was more accurate than using a concordance cross-walk. The pipeline is modular enough to easily include more components. This work is part of a vision to design a semantic big-data lake, enabling integration of any data relevant to H and S.

04E.2 EFFICIENCY OF AUTOCODING PROGRAMS FOR CONVERTING JOB DESCRIPTORS INTO STANDARD OCCUPATIONAL CLASSIFICATION CODES

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Introduction Standard Occupational Classification (SOC) codes can link work exposure data to individual health outcomes, but manually assigning job codes is laborious. We tested two recently developed automatic coding programs.

Methods We entered self-reported job titles and industry from two existing cohorts into two publicly available autocoding programs, the NIOSH Industry and Occupation Computerized Coding System (NIOCCS) and the Standardized Occupation Coding for Computer-assisted Epidemiological Research (SOCcer), and assessed agreement between autocodes and manual coding. We also assessed agreement of several exposure values (from the Occupational Information Network, O*NET) linked by manual SOC codes versus those linked by autocodes, in order to examine how differences in coding might affect exposure assignments in general population cohort studies.

Results NIOCCS produced SOC codes for the majority of subjects (Cohort 1: 85%; Cohort 2: 79%). The level of detail for these codes varied slightly; 6-digit SOC codes (detailed occupations) were available for 84% and 76% of cohorts A and B respectively. Comparison to manual codes showed strong agreement at the major group level (kappa=0.8 for both cohorts) and weaker agreement at the 6-digit level (kappa $\geq$ 0.4 and 0.6). SOCcer produced 6-digit SOC codes for all subjects with good agreement at the 2-digit level (kappa $\geq$ 0.6 and 0.7) and slightly lower at the 6-digit level (kappa $\geq$ 0.3 and 0.4). Agreement for O*NET exposures was very high for most comparisons within both cohorts for both programs (many ICCs > 0.8).

Conclusion Both autocoding programs can be reliable tools to aid in assigning SOC codes that represent broad industry levels, with less agreement at finer levels of job codes. Given the availability of large public datasets with job information but no other work exposure data, autocoding of jobs provides exciting opportunities for analyzing work-related health outcomes in future studies.