multiplying person-time accrued in the cohort by mortality rates for a reference population (ideally, a reference that represents the mortality rate in the cohort in the absence of exposure). However, if exposure is hazardous then this calculation will not consistently estimate the number of deaths expected in the absence of exposure. This is because exposure will have affected the distribution of person-time observed in the study cohort.

Methods This talk describes a simple way to consistently estimate the expected number of deaths and illustrates the approach using data from a cohort study of mortality among underground miners. In addition, the talk considers use of these simple counterfactual-based methods for calculation of years of life lost and demonstrate how this clarifies interpretation of results.

Results In a cohort of 3254 white male miners followed from 1960 through 2005, the observed number of deaths was 2428. A standard SMR calculation yields an estimate of 1693 expected deaths (SMR=1.4; 95% CI: 1.4, 1.5). The proposed counterfactual approach yields 2167 expected deaths (CMR=1.1; 95% CI: 1.1, 1.2). However, the effect of the exposure is reflected by evidence of life shortening.

Conclusions The proposed approach yields more interpretable estimates of excess deaths and years of life lost.

Oral Presentation

Exposure Assessment

0135 DEVELOPMENT OF CAREX SYSTEMS IN LATIN AMERICA AND THE CARIBBEAN

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Objectives To describe the process of building CAREX research capacity in Latin America and the Caribbean (LAC).

Methods In LAC, CAREX projects were previously developed in Costa Rica, Nicaragua, Panama, and Colombia based on adaptations of the European model. CAREX Canada recently engaged in a capacity development project to assist more local teams to implement the CAREX tool for their contexts, and to develop methods to prioritise carcinogens for assessment. Over a dozen LAC countries participated in a workshop describing the CAREX approach, knowledge translation, and applications of CAREX data in occupational cancer research. A detailed technical guide was prepared on CAREX methods and how they can be adapted. A network has been established to provide ongoing assistance to LAC countries currently developing CAREX projects.

Results Some of the key challenges identified by local partners are a lack of exposure measurement data, establishing appropriate proportion exposed values, and obtaining detailed labour force data. There is an opportunity to develop novel

methods to incorporate informal workers in exposure estimates, advancing upon what has been done in Central American CAREX projects. Countries with similar industrial composition, occupational carcinogen exposures, and/or worker demographics are collaborating on their national CAREX initiatives. New CAREX projects are underway in Peru and the Caribbean and Southern Cone.

Conclusions International collaboration has fostered the development of CAREX in LAC, where improved surveillance of occupational carcinogen exposures represents an important avenue for cancer prevention.

Poster Presentation

Cancer

0136 BREAST CANCER RISK ASSOCIATED WITH NIGHT SHIFT WORK: WHAT ARE THE META-ANALYSES TELLING US?

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Objectives To compare results and assess the quality of recently published meta-analyses of night shift work and breast cancer risk.

Methods A comprehensive search was conducted for English or French-language meta-analyses published from 2010–2017 that included at least one meta-risk estimate (mRE) for breast cancer associated with any night shift work exposure metric and that were accompanied by a systematic literature review. mREs from each meta-analysis were ascertained and organised by various study characteristics. Assessments of heterogeneity and publication bias were also extracted. An eight-point checklist was used to evaluate quality.

Results Seven meta-analyses, published from 2013–2016, collectively included 30 cohort and case-control studies spanning 1996–2016. Five meta-analyses scored ≥ 6 points on the quality assessment checklist. Of these, mREs for ever/never night shift work exposure ranged from 1.15 (95% confidence interval [CI]: 1.05–1.25, n=9 studies) to 1.40 (95% CI: 1.13–1.73, n=9 studies). In these 5 reports, mREs for duration, frequency, and cumulative night shift work exposure were inconsistent. Meta-analyses of cohort, Asian, and more fully-adjusted studies generally resulted in lower mREs than case-control, European, American, or minimally-adjusted studies. Most used random effects models due to statistically significant between-study heterogeneity. Publication bias was not evident in any of the 5 meta-analyses.

Conclusions Substantial heterogeneity is to be expected in epidemiological studies done in various settings, and among diverse populations. Future evaluations of shift work carcinogenic potential need to incorporate high quality meta-analyses that better assess and account for individual study quality.

Oral Presentation Methodology

0137 EXPOSURE-LAG-RESPONSE IN OCCUPATIONAL EPIDEMIOLOGY: APPLICATION OF DISTRIBUTED NON-LINEAR LAG MODELS IN A COHORT OF DIATOMACEOUS EARTH WORKERS EXPOSED TO CRYSTALLINE SILICA

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Occupational exposures extending over a long working life can have complex relationships with health outcomes, as timing, duration, and intensity of exposure are all potentially relevant. Simple measures of cumulative, or average intensity of exposure typically considered in occupational studies may not fully capture these relationships. We applied distributed non-linear lag models to examine the association of crystalline silica exposures with mortality from lung cancer and non-malignant respiratory disease. We fitted Cox proportional hazard models for each cause of interest to data from a cohort study of 2342 California diatomaceous earth workers exposed to crystalline silica. Our models combined various functions for exposure-response and lag-response including linear, piecewise constant and spline functions. Models with a spline function for exposure-response and a constant term for the lag-response appeared to have the best fit for lung cancer, while models with spline functions for both exposure-response and lag-response had the best fit for non-malignant respiratory disease. Hazard ratios (HR) from these best fitting models corresponding to average daily exposures of 275 µg/m³ during lag years 11–40 prior to the age of observed cases were 1.96 (95% confidence interval (CI) 0.95–4.06) and 2.01 (95% CI: 1.02–3.97) for the two outcomes respectively. HRs from simple models with linear exposure-response and constant lag-response terms for the same exposure scenario were 1.15 (95% CI: 0.88–1.49) and 1.21 (95% CI: 1.01–1.44) respectively. Occupational studies of longitudinal cohorts with detailed exposure histories could benefit from methods allowing for non-linearities and the disentanglement of intensity, duration and timing of exposure.

Oral Presentation Risk Assessment

0138 POOLED URANIUM MINERS ANALYSIS: GOALS AND CHALLENGES

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Epidemiological studies of uranium miners helped to establish radon as a human carcinogen. However, radon remains a leading occupational cause of cancer mortality, and many workers are exposed to radon at levels at which excess risk of lung cancer has been observed in occupational cohort studies. Prior pooled studies of underground miners provided important quantitative estimates of radon-associated lung cancer risk. Recently, efforts have been undertaken to strengthen uranium miner studies to address contemporary occupational safety concerns. New cohorts of underground miners have been enumerated, existing cohorts have been expanded, and follow-up of the major cohorts of miners has been extended substantially. An international collaborative study has been undertaken to combine information from many of the world's most informative cohort studies of uranium miners; the combined study cohort encompasses more than 1 00 000 miners. This talk will describe the major themes of this project, the goals of the collaborators and the challenges that we have encountered to date. We will describe similarities and differences between findings from these key cohorts and identify some major gaps in current knowledge about radon's effects on human health. Finally, we will discuss how international collaborative studies can strengthen our understanding of risks associated with occupational and environmental radon exposures.