

Performance of different exposure assessment approaches in a study of bitumen fume exposure and lung cancer mortality

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The International Agency for Research on Cancer conducted a cohort study of mortality among asphalt workers in 8 countries (Denmark, Finland, France, Germany, the Netherlands, Norway, Sweden, Israel). One of the study's aims was to assess the occurrence of lung cancer among workers exposed to bitumen. This paper evaluates the performance of different exposure assessment approaches in achieving this goal. In the whole cohort, the use of job titles and semi-quantitative exposure scores failed to identify any positive associations. Quantitative exposure estimates were available for members of the cohort selected for the current analysis: males employed only in asphalt paving. An inception/entry sub-cohort was also identified among these persons. The Swedish cohort was excluded because duration of exposure could not be accurately estimated within it. An exposure matrix was developed, based on statistical models of exposure measurements and questionnaires on past production conditions. Three exposure indices were considered: duration of exposure (years), average exposure (mg/m^3) and cumulative exposure ($\text{mg}/\text{m}^3 \cdot \text{years}$). Two latency models were considered for the association between lung cancer and bitumen fume: one with a 15-year lag and one without. We examined rank correlation among bitumen fume exposure indices. Relative risk associated with bitumen fume exposure was estimated via Poisson regression. All models were adjusted for coal tar exposure (ever/never), age, calendar period and country. Competing exposure-response models were compared by using a log-likelihood ratio test (measure of model fit). We selected 12,367 workers for analysis. Among these persons, 10,060 belonged to the inception cohort. In the whole cohort, there were 135 deaths due to lung cancer. Only exposure ranks based on strata of duration and cumulative exposure indices were correlated. There was no association between lung cancer risk and either duration or cumulative bitumen exposure. However, there was the suggestion of an increase in lung cancer risk with rise in average exposure. Only models with average bitumen fume exposure (with or without lag) markedly improved model fit. Average bitumen fume exposure indices with and without a 15-year lag improved model fit to the same extent. Thus, no clear latency model emerged from analysis. We concluded that constructing different quantitative exposure indices was justified because (a) the uncertainties in the effect of exposure duration required valid and precise estimation of exposure intensity and (b) we identified statistically significant associations between bitumen fume exposure and lung cancer risk that require further investigation.