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## Authors' response to: Qualitative job exposure matrix—a tool for the quantification of population-attributable fractions for occupational lung carcinogens?

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We thank Taeger *et al.* for their comments<sup>1</sup> on our article.<sup>2</sup> We take this opportunity to clarify some important points on the use of job-exposure matrices (JEMs) in occupational epidemiology. We agree that quantitative JEMs are a fundamental tool for estimating exposure-response associations. However, when the aim is to estimate the impact of selected carcinogens on cancer burden, we, as others,<sup>3–5</sup> believe a semi-quantitative JEM is fully appropriate.

With regard to specific criticisms, Taeger *et al.* firstly express concern over the discrepancy between the Population Attributable Fraction (PAF) for exposure to asbestos, crystalline silica and nickel-chromium estimated with the DOM-JEM (22.5%) and the one reported using a classic job-title approach in our previous article (4.9%).<sup>6</sup> As we stated in our article, this discrepancy should not be surprising. We re-emphasize that it was an expected finding due to the higher sensitivity of a JEM, as a method of exposure assessment, compared with the A and B lists approach, which accounts for all known high-risk jobs for lung cancer, but not for all jobs with exposure to lung carcinogens.

Secondly, Taeger *et al.* stated that the lack of time-scale and industry or country stratification in our study is a potential source of bias. Although there is a general decrease in exposure levels over time, this is mainly in absolute levels. The relative ranking of jobs in terms of exposure intensity will most likely not change over time, nor will it differ between countries. As such, we are convinced that the DOM-JEM does not result in a high rate of false positives. When constructing the DOM-JEM, we opted for specificity by

taking probability of exposure explicitly into account.<sup>7</sup> With regard to industry, most International Standard Classification of Occupations (ISCO) 1968 codes are uniquely nested within industry, and industry as such was considered within DOM-JEM. Regarding the criticism of Taeger *et al.* that our use of the DOM-JEM semi-quantitative score years to estimate the individual cumulative exposure was incorrect, we should recall that the common definition of cumulative exposure in the literature is 'the product of average exposure intensity and exposure duration'.<sup>8</sup> We assigned values of 0, 1 and 4 to the exposure intensity scores of none, low and high exposure to reflect the log-normal (multiplicative) nature of occupational exposure concentrations, so although we use arbitrary units, they reflect an appropriate spacing of the exposure groups, and the results can thus be viewed as cumulative exposure metrics.

Thirdly, Taeger *et al.* argue that the prevalence of some occupational carcinogens in our study was 'unrealistically high on a population level', in particular for asbestos exposure. They assert that this 'overestimated prevalence' signifies either that the study sample is not representative of the general population or that the JEM is biased. As stated in our article, the DOM-JEM had already been validated in comparison with other JEMs and individual expert assessments in previous international studies.<sup>9,10</sup> In fact, a recent study comparing the reliability of retrospective exposure assessment tools showed the DOM-JEM to have the highest level of agreement with the expert assessment for asbestos and polycyclic aromatic hydrocarbons (PAHs) among all the

JEMs evaluated.<sup>11</sup> Moreover, the assertion that our prevalence estimates are 'unrealistically high' is at odds with the evidence of previous similar studies, whose estimates were similar to or even higher than our own. For instance, in the multicentre population-based case-control study coordinated by the International Agency for Research on Cancer (IARC) in four European countries including Italy, Berrino *et al.*<sup>12</sup> estimated, among men enrolled in 1979–1982, using a JEM developed *ad hoc*, a prevalence of exposure to asbestos of 46.4% among controls and 68.3% among cases, compared with 32.2% and 41.1%, respectively, using the DOM-JEM in our study. When, as an exercise, we applied this *ad hoc* JEM to the Environment And Genetics in Lung cancer Etiology (EAGLE) study population, the estimated exposure prevalence to asbestos was 39.5% among controls and 51.2% among cases. More recently, a German population-based case-control study that used an expert assessment approach reported among men enrolled in 1988–1993 a prevalence of asbestos exposure almost identical to ours, 33.6% among controls and 41.0% among cases.<sup>13</sup> One further point of note is that Lombardy, even in the absence of ship-building and railroad repair industries, ranks fourth among Italian regions for incidence rates of pleural malignant mesothelioma,<sup>14</sup> providing indirect evidence of the high frequency of exposure to asbestos (banned only recently, in 1992) in the study region.

Finally, Taeger *et al.* claim that our 'overestimated prevalence estimates rather bias the PAF in an upward direction'. First of all, as just stated, our prevalence estimates are not inflated. Secondly, even if that were the case, we should remember that the PAF is based on the ratio of the difference between crude incidence rates between exposed and unexposed, divided by the crude incidence rate in the exposed. So, as long as the incidence rate in the unexposed is not underestimated, the PAF will not be overestimated.<sup>3</sup> Even if the DOM-JEM specificity is inevitably <100% (despite care in not assigning exposure to workers unlikely to be exposed or whose likely exposure is trivial), the PAF will not be biased.<sup>3</sup>

In summary, the available data indicate that our exposure estimates obtained with the DOM-JEM are not abnormally elevated and there is no reason to doubt the representativeness of our study base, which included incident cases and randomly sampled (from regional databases) population controls and obtained elevated participation rates. Therefore, our conclusion of an overall PAF of 22.5% for exposure to asbestos, crystalline silica and nickel-chromium is a fair estimate of the impact of these occupational carcinogens on lung cancer risk in this study population.<sup>2</sup>

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