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A Retrospective Assessment of Occupational Exposure to Elemental Carbon in the U.S. Trucking Industry

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The widespread use of diesel engines has raised concerns regarding the potential health effects from diesel exhaust (DE) exposure. We recently published four papers on the historical exposure assessment of DE in eight non-metal mining facilities (Coble et al. 2010; Stewart et al. 2010; Vermeulen et al. 2010a, 2010b) as part of a cohort and lung cancer case-control study among non-metal miners. Davis et al. (2011) commented recently that our exposure assessment may have had exposure misclassification bias because of our use of carbon monoxide (CO) for historical extrapolation of current respirable elemental carbon (EC) exposure levels. Here we clarify our use of CO to back-extrapolate underground EC levels. Although our estimates are subject to random variation, there is no evidence that there were systematic biases that would have caused differential exposure misclassification.

Similar to Davis et al. (2011), we used recent EC measurements collected at the study mines in 1998–2001 as the primary basis for current EC exposure estimates. Because very few EC measurements were available for years prior to the exposure surveys, we modeled past average CO concentrations for each mine using annual average diesel engine usage in horsepower (hp), overall exhaust flow rates expressed in cubic feet per minute (cfm), and an adjustment for cleaner engine technologies in the early 1990s. The resultant modeled trends in the average CO concentrations for all previous years—relative to CO levels measured in 1998–2001—were then used to adjust the average measured EC levels in 1998–2001 in order to obtain annual EC exposure estimates for each job and prior year at each mine. Thus, we did not use CO estimates to estimate job-specific mean EC levels but simply to provide a basis, along with DE determinants, for back extrapolation.

As indicated by Davis et al. (2011), we reported a moderate positive correlation between side-by-side CO and EC area

measurements from our 1998–2001 exposure surveys (Vermeulen et al. 2010b). This, however, does not mean that the historical exposure extrapolation led to significant exposure misclassification or bias. The magnitude of the survey-based correlation depended on the specific daily circumstances in the immediate sample environment, was subject to the variability associated with individual samples, and reflected the limited range in hp and cfm existing at the time of our surveys (the maximum:minimum ratio was 8 for hp and 7 for cfm). In contrast, the temporal data were based on annual mean data (reducing the associated variability in individual measurements) and involved a much wider range in hp and cfm (ratios were > 1,000 and 18, respectively). Accounting for the larger range in the historical hp/cfm ratio compared with that for the 1998–2001 survey, the hp/cfm range would lead to a marked increase in the correlation between CO and EC concentrations. The increase exists because the magnitude of any correlation depends not only on the random variability in the data but also on the range of the independent variables. Thus, we believe that our extrapolation models based on primary determinants of DE (i.e., hp and cfm) resulted in credible annual EC exposure levels.

We agree with Davis et al. (2011) that

... historical exposure reconstruction remains a demanding and time-consuming process ... that is driven primarily by the available data ..., which are often incomplete or missing for important historical exposure periods

In the face of these challenges, solutions must be developed that best fit each unique situation. Both study teams have devoted considerable effort and resources to develop the best estimates for their investigations based on available information, and both studies will be informative for further elucidation of the quantitative exposure-response association between EC and lung cancer.

The authors declare they have no actual or potential competing financial interests.

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Editor's note: In accordance with journal policy, Davis et al. were asked whether they wanted to respond to this letter, but they chose not to do so.

ERRATUM

On the first page of the June 2012 “At a Glance” (Environ Health Perspect 120:A218–A222), the summary title for the article by Frisbie et al. was incorrect. “Magnesium in Drinking Water” should have been “Guidelines for Manganese in Drinking Water.”

EHP regrets the error.