EXPOSURE ASSESSMENT OF CONSTITUENTS OF AIR POLLUTION: A POOLED ANALYSIS OF NINE VALIDATION STUDIES

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Background and Aims: Exposure error has long been a concern in chronic air pollution health effect studies, which generally assess exposures using measures of ambient concentrations. This study develops statistical methods to adjust for bias due to measurement error based on regression calibration de-attenuation factors, using monthly averages of personal fine particulate ($PM_{2.5}$) exposures and ambient concentrations, and assesses to what extent these factors vary by city and season.
Methods: Personal and ambient $PM_{2.5}$ data were compiled from validation studies performed in eight US cities (one in 1995, seven between 1998-2002) and one in the Netherlands (2004-2005), with 416 participants in total. Corresponding elemental carbon (EC) levels were also obtained from five of these studies (n=208). Personal measurements were assumed as the 'gold standard'. Linear mixed effects models were employed to estimate the association between monthly-averaged ambient and corresponding personal exposures. City-specific effects were estimated, adjusting for season. The homogeneity of effects between cities was assessed and the pooled effects were estimated using random effects models.
Results: Monthly-averaged personal and ambient concentrations were significantly correlated, with Spearman correlation coefficients of 0.43 for $PM_{2.5}$ and 0.56 for EC, adjusted for city and season. Significant heterogeneity was observed between cities, with city-specific, personal-ambient $PM_{2.5}$ slopes ranging between 0.32-1.64. Random effects meta-analysis yielded a de-attenuation factor of 0.59 (0.38, 0.80). For monthly EC, significant personal-ambient slopes were observed only in three cities, with slopes ranging between 0.39-0.89. The pooled de-attenuation factor for EC was 0.46 (0.12, 0.79).
Conclusions: Exposure measurement error of this magnitude is likely to lead to appreciable bias in estimates of the effect of chronic PM exposure on human health. These de-attenuation factors will be used to develop a regression calibration model to adjust for bias due to measurement error in studies of chronic PM health effects.