A Systematic Review and Analysis of Personal and Ambient PM$_{2.5}$ Measurements: Implications for Epidemiology Studies

In epidemiology studies, ambient measurements of PM$_{2.5}$ (e.g., from central-site outdoor air monitors) often are used as surrogates for personal exposures. However, estimating personal PM$_{2.5}$ from ambient measurements introduces uncertainty, and it is unclear the degree to which ambient PM$_{2.5}$ reflects personal exposures. We conducted a systematic review and statistical analysis of epidemiology studies to determine the extent to which ambient PM$_{2.5}$ is correlated with personal PM$_{2.5}$. We conducted a literature search in PubMed and Scopus for peer-reviewed studies reporting both personal and ambient measurements of PM$_{2.5}$ in North America published between January 1, 2009, and September 4, 2019. Two independent reviewers completed data extraction, which included recording geographic variables, sample characteristics, ecological variables, ambient PM$_{2.5}$ measurements, personal PM$_{2.5}$ measurements, and ambient-personal PM$_{2.5}$ correlations. Twenty-three studies were identified. Overall, personal PM$_{2.5}$ concentrations were higher than ambient concentrations. The median personal PM$_{2.5}$ concentration was 17.9 µg/m$^3$ (range: 2.0-92.2 µg/m$^3$), and the median ambient PM$_{2.5}$ concentration was 15.8 µg/m$^3$ (range: 6.0-33.3 µg/m$^3$). There was a moderate-to-strong relationship between personal and ambient PM$_{2.5}$ concentrations; median personal-ambient PM$_{2.5}$ correlation coefficients were 0.57 (range: 0.09-0.83). Stratified analyses suggest that geographic and other variables may influence the relation between personal and ambient PM$_{2.5}$. For example, studies that report controlling for environmental tobacco smoke (ETS) reported an approximate personal-ambient correlation of 0.78 on average, whereas studies that did not measure or did not report measuring ETS reported an approximate personal-ambient PM$_{2.5}$ correlation of 0.09 on average. Our study informs the interpretation of both past epidemiology studies in which health effects were associated with ambient PM$_{2.5}$ and future studies with regard to accounting for error in estimating PM$_{2.5}$ exposures.