Long-term exposure to elemental components of fine particulate matter and all-natural and cause-specific mortality in a Danish nationwide administrative cohort study

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BACKGROUND: Fine particulate matter (PM(2.5)) is a well-recognized risk factor for premature death. However, evidence on which PM(2.5) components are most relevant is unclear. METHODS: We evaluated the associations between mortality and long-term exposure to eight PM(2.5) elemental components [copper (Cu), iron (Fe), zinc (Zn), sulfur (S), nickel (Ni), vanadium (V), silicon (Si), and potassium (K)]. Studied outcomes included death from diabetes, chronic kidney disease (CKD), dementia, and psychiatric disorders as well as all-natural causes, cardiovascular disease (CVD), respiratory diseases (RD), and lung cancer. We followed all residents in Denmark (aged >/=30 years) from January 1, 2000 to December 31, 2017. We used European-wide land-use regression models at a 100 x 100 m scale to estimate the residential annual mean levels of exposure to PM(2.5) components. The models were developed with supervised linear regression (SLR) and random forest (RF). The associations were evaluated by Cox proportional hazard models adjusting for individual- and area-level socioeconomic factors and total PM(2.5) mass. RESULTS: Of 3,081,244 individuals, we observed 803,373 death from natural causes during follow-up. We found significant positive associations between all-natural mortality with Si and K from both exposure modeling approaches (hazard ratios; 95% confidence intervals per interquartile range increase): SLR-Si (1.04; 1.03-1.05), RF-Si (1.01; 1.00-1.02), SLR-K (1.03; 1.02-1.04), and RF-K (1.06; 1.05-1.07). Strong associations of K and Si were detected with most causes of mortality except CKD and K, and diabetes and Si (the strongest associations for psychiatric disorders mortality). In addition, Fe was relevant for mortality from RD, lung cancer, CKD, and psychiatric disorders; Zn with mortality from CKD, RD, and lung cancer, and; Ni and V with lung cancer mortality. CONCLUSIONS: We present novel results of the relevance of different PM(2.5) components for different causes of death, with K and Si seeming to be most consistently associated with mortality in Denmark.

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