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## Editorial

# Premature Deaths Attributable to Exposure to Ambient Fine Particulate Matter in the Republic of Korea: Implication for Future Environmental Health

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Ambient particulate matters have been growing concern in public health as a leading contributor to global disease including morbidity and mortality from cardiovascular and respiratory disease and lung cancer. According to a recent study by Global Burden of Disease (GBD) group,[1] exposure to particulate matter with aerodynamic diameter less than 2.5 μm ($PM_{2.5}$) caused 4.2 million (95% uncertainty interval [UI], 3.7 million to 4.8 million) deaths and 103.1 million (UI, 90.8 million to 115.1 million) disability-adjusted life-years (DALYs) in 2015, representing 7.6% of total global deaths and 4.2% of global DALYs. Premature deaths attributable to ambient $PM_{2.5}$ exposures in Korea for 2015 were estimated as 18,148 deaths by the GBD group.[2]

There are some issues in the estimation of the premature deaths due to $PM_{2.5}$ exposures. Uncertainties in the estimation of the $PM_{2.5}$-attributable mortality at national level can be caused by several factors such as $PM_{2.5}$ exposure assessment, concentration-response function (CRF), and cause-specific mortality rates. Recently, the CRFs based on the long-term effect of $PM_{2.5}$ exposures became to be used to estimate the burden with recommendation of the GBD group. Adopting the CRFs derived from long-term effect, a recent study by Kim et al.[3] estimated $PM_{2.5}$-attributable mortality based on long-term exposure in Korea which was assessed by combining data from ground monitoring with satellite observations and chemical transport models. They assessed the average of population-weighted $PM_{2.5}$ concentrations in Korea from 1990 to 2013 as 30.2 μg/m³. Estimated number of premature deaths attributable to $PM_{2.5}$ in 2013 was 17,203 (95% confidence interval [CI], 11,056–22,772); the most common cause of death was ischemic stroke (5,382; 95% CI, 3,101–7,403). Remarkably, they reclassified the cause of death to calculate the number of cause-specific deaths in 2013 by applying 'garbage code' redistribution algorithm devised by the Korean Burden of Disease Study Group.[3,4] The garbage code was known to be about 5% in Korea.[4] In result of the garbage code reclassification, code due to ischemic stroke, for example, increased by 32.3%, which means that without the reclassification of the cause of death, the premature death due to air pollution can be underestimated. The study also found that the number of premature deaths due to ambient $PM_{2.5}$ in Korea was mainly caused by exposure to higher $PM_{2.5}$ rather than by the number of deaths due to cardiovascular and respiratory diseases at older ages compared

to the European Union (EU) and Organisation for Economic Co-operation and Development (OECD) countries, implying that larger benefits may accrue from mitigating PM$_{2.5}$ in Korea.

The health burden attributable to PM$_{2.5}$ was considerably high and the high burden was concentrated at Seoul and Gyeonggi-do province due to high population density.[5] Although a previous study[5] addressed that premature deaths due to PM$_{2.5}$ has decreased in most of metropolitan cities and provinces of Korea since 2006, we cannot assure that health burden attributable to PM$_{2.5}$ will decrease in the future because Korea will become an aged society in the near future and the main cause of the premature deaths attributable to PM$_{2.5}$ was identified to be ischemic stroke in Korea. Furthermore, climate change is expected to change ambient air pollution including PM$_{2.5}$ in the future as air pollution is strongly related with meteorological factors which change in response to climate change.

For better understanding of the PM$_{2.5}$ effect on health in Korea for future, epidemiological studies on the long-term effect of PM$_{2.5}$ in Korea covering all the related disease and mortality; note that many other diseases such as respiratory diseases (e.g., chronic obstructive pulmonary disease [COPD]) were not included in the assessment of the premature deaths due to PM$_{2.5}$ conducted by Kim et al.[3] because long-term effect had not been investigated with sufficient evidence even though they are known to be associated with PM$_{2.5}$. With reliable CRF parameters for both morbidity and mortality, burden of disease attributable to PM$_{2.5}$ can be estimated. Prediction modeling of future PM$_{2.5}$ with spatial and temporal variation is also required to evaluate adverse health impact in the future. The health impact projection with spatiotemporal variation can practically contribute for policy makers to build efficient strategies to mitigate PM$_{2.5}$ and thus to reduce the health impact of PM$_{2.5}$ exposures in Korea.

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