

Implementing the WHO Air Quality Guideline for PM_{2.5} Worldwide can Prevent Millions of Premature Deaths Per Year

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Abstract : Outdoor air pollution by fine particles ranks among the top ten global health risk factors that can lead to premature mortality. Epidemiological cohort studies, mainly conducted in United States and Europe, have shown that the long-term exposure to PM_{2.5} (particles with an aerodynamic diameter less than 2.5µm) is associated with increased mortality from cardiovascular, respiratory diseases and lung cancer. Fine particulates can cause health impacts even at very low concentrations. Previously, no concentration level has been defined below which health damage can be fully prevented. The World Health Organization ambient air quality guidelines suggest an annual mean PM_{2.5} concentration limit of 10µg/m³. Populations in large parts of the world, especially in East and Southeast Asia, and in the Middle East, are exposed to high levels of fine particulate pollution that by far exceeds the World Health Organization guidelines. The aim of this work is to evaluate the implementation of recent air quality standards for PM_{2.5} in the EU, the US and other countries worldwide and estimate what measures will be needed to substantially reduce premature mortality. We investigated premature mortality attributed to fine particulate matter (PM_{2.5}) under adults ≥ 30yrs and children < 5yrs, applying a high-resolution global atmospheric chemistry model combined with epidemiological concentration-response functions. The latter are based on the methodology of the Global Burden of Disease for 2010, assuming a 'safe' annual mean PM_{2.5} threshold of 7.3µg/m³. We estimate the global premature mortality by PM_{2.5} at 3.15 million/year in 2010. China is the leading country with about 1.33 million, followed by India with 575 thousand and Pakistan with 105 thousand. For the European Union (EU) we estimate 173 thousand and the United States (US) 52 thousand in 2010. Based on sensitivity calculations we tested the gains from PM_{2.5} control by applying the air quality guidelines (AQG) and standards of the World Health Organization (WHO), the EU, the US and other countries. To estimate potential reductions in mortality rates we take into consideration the deaths that cannot be avoided after the implementation of PM_{2.5} upper limits, due to the contribution of natural sources to total PM_{2.5} and therefore to mortality (mainly airborne desert dust). The annual mean EU limit of 25µg/m³ would reduce global premature mortality by 18%, while within the EU the effect is negligible, indicating that the standard is largely met and that stricter limits are needed. The new US standard of 12µg/m³ would reduce premature mortality by 46% worldwide, 4% in the US and 20% in the EU. Implementing the AQG by the WHO of 10µg/m³ would reduce global premature mortality by 54%, 76% in China and 59% in India. In the EU and US, the mortality would be reduced by 36% and 14%, respectively. Hence, following the WHO guideline will prevent 1.7 million premature deaths per year. Sensitivity calculations indicate that even small changes at the lower PM_{2.5} standards can have major impacts on global mortality rates.

Keywords : air quality guidelines, outdoor air pollution, particulate matter, premature mortality

Conference Title : ICEPPH 2015 : International Conference on Environmental Pollution and Public Health

Conference Location : Berlin, Germany

Conference Dates : September 14-15, 2015