The health burden and economic costs averted by ambient PM$_{2.5}$ pollution reductions in Nagpur, India


A R T I C L E   I N F O

Article history:
Received 19 October 2016
Received in revised form 1 February 2017
Accepted 16 February 2017
Available online 11 March 2017

Keywords:
Hazard and survival analyses
Life table
Urban, rural and peri-urban
Burden of disease assessment
Disability-adjusted life years (DALYs)

A B S T R A C T

National estimates of the health and economic burdens of exposure to ambient fine particulate matter (PM$_{2.5}$) in India reveal substantial impacts. This information, often lacking at the local level, can justify and drive mitigation interventions. Here, we assess the health and economic gains resulting from attainment of WHO guidelines for PM$_{2.5}$ concentrations – including interim target 2 (IT-2), interim target 3 (IT-3), and the WHO air quality guideline (AQG) – in Nagpur district to inform policy decision making for mitigation. We conducted a detailed assessment of concentrations of PM$_{2.5}$ in 9 areas, covering urban, peri-urban and rural environments, from February 2013 to June 2014. We used a combination of hazard and survival analyses based on the life table method to calculate attributed annual number of premature deaths and disability-adjusted life years (DALYs) for five health outcomes linked to PM$_{2.5}$ exposure: acute lower respiratory infection for children <5 years, ischemic heart disease, chronic obstructive pulmonary disease, stroke and lung cancer in adults ≥25 years. We used GBD 2013 data on deaths and DALYs for these diseases. We calculated averted deaths, DALYs and economic loss resulting from planned reductions in average PM$_{2.5}$ concentration from current level to IT-2, IT-3 and AQG by the years 2023, 2033 and 2043, respectively. The economic cost for premature mortality was estimated as the product of attributed deaths and value of statistical life for India, while morbidity was assumed to be 10% of the mortality cost. The annual average PM$_{2.5}$ concentration in Nagpur district is 34 ± 17 μg m$^{-3}$ and results in 3.3 (95% confidence interval [CI]: 2.6, 4.2) thousand premature deaths and 91 (95% CI: 68, 116) thousand DALYs in 2013 with economic loss of USD 2.2 (95% CI: 1.7, 2.8) billion in that year. It is estimated that interventions that achieve IT-2, IT-3 and AQG by 2023, 2033 and 2043, would avert, respectively, 15, 30 and 36%, of the attributed health and economic loss of those years, translating into an impressively large health and economic gain. To achieve this, we recommend an exposure-integrated source reduction approach.

© 2017 Elsevier Ltd. All rights reserved.