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Editorial

The air we breathe and lung disease

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About the authors: Dr. MB Rice served as Vice Chair of the Environmental Health Policy Committee of the American Thoracic Society and Dr. A Malhotra served as President of the American Thoracic Society while writing this editorial.

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While some of us may drink only bottled water and eat only organically-grown food, we all breathe the outdoor air. This notion has important implications for public health, because health effects of air pollution are exerted across entire populations. Many epidemiologic studies have associated exposure to air pollution with adverse pulmonary outcomes, including reduced lung function, hospitalization for respiratory causes, and cardiopulmonary mortality. Because these exposures affect everybody, air pollution remains a major public health concern in the United States (US), where air pollution levels are relatively low, and around the world.

The most important sources of outdoor air pollution that affect respiratory health are power plants and motor vehicles, which release a mixture of pollutants through the combustion of fossil fuels. Cooking and heating with biomass fuels or coal release harmful indoor air pollution. These processes emit particles that are defined by their size. For example, particles less than 10 microns in diameter (PM_{10}) include dust and pollen that deposit in the airways. Particles less than 2.5 microns in diameter ($PM_{2.5}$) include organic compounds and heavy metals, and are small enough to deposit in the alveolar spaces.

Epidemiologic research studies have increasingly focused on $PM_{2.5}$ as a major cause of respiratory health effects. Some preliminary studies suggest that ultrafine particles, also called nanoparticles, which measure less than 100 nm and deposit efficiently in the lung, may be even more harmful to the lung than fine particulate matter of the same substance (1-3), although this subject deserves further research. The US Environmental Protection Agency (EPA) began monitoring and regulating $PM_{2.5}$ levels nationwide in the year 1999. Between the year 2000 and 2013, average daily $PM_{2.5}$ levels declined by 34% in the US (4). Some have been estimated that US life expectancy has lengthened by more than half a year for every 10 $\mu g/m^3$ decrease in $PM_{2.5}$ levels, and that 15% of the overall increase in U.S. life expectancy between the early 1980s and early 2000s may be accounted for by improvements in $PM_{2.5}$ (5). China took the important step of monitoring and regulating $PM_{2.5}$ in the year 2013 and is in the process of making aggressive plans for air pollution control.

While improvements in air quality are likely to benefit everyone who breathes the air, certain populations are more susceptible to air pollution and therefore stand to benefit greatly. These groups include children, and people with existing chronic lung disease, in particular asthma and chronic obstructive pulmonary disease (COPD).

Children are particularly susceptible to respiratory effects of air pollution for a number of reasons: their lungs are still developing (and do not reach maturity until after adolescence), they have a larger lung surface area and breathe more air in relation to body weight than adults, and they generally spend more time outdoors than adults. Studies dating back as early as the 1980s have demonstrated that exposure to ambient air pollution is associated with acute respiratory symptoms and reduced lung function in healthy children and those with asthma (6-12). There is now strong longitudinal evidence to suggest that childhood air pollution exposure slows lung growth in children (13-15). Improvements in air quality may have immediate benefits for children's lung growth. A recent study in Southern

California found that declining levels $PM_{2.5}$ in the 1990s and 2000s were associated with improved lung function growth in school-aged children (16).

The relationship between asthma and outdoor air pollution has been extensively studied, in part because asthma is highly prevalent in the US and Europe. For example, in the US, the prevalence of asthma rose from 3.1% in 1980 to 8.4% in 2010 (17). Air pollution has been proposed as an exposure that may increase the risk of developing asthma. Research findings have been inconsistent on this issue, with most studies finding that air pollution slightly increases the risk of developing asthma (18-20). On the other hand, studies have consistently found that exposure to air pollution, including $PM_{2.5}$ and ozone, increases the risk of having an asthma attack among people who have asthma (21-23).

COPD is an incurable, progressive, and debilitating disease that affects 10-15% of persons above the age of 40 years in the US (24). Exposure to tobacco smoke plays a known role in the etiology of COPD. However, smoking has been estimated to explain less than 80% of the burden of COPD, and as little as 10% in some regions (25). In the developing world, indoor air pollution from open fire stoves is a top cause of COPD among women, many of whom are never-smokers (25,26). So far evidence is insufficient to determine if long-term outdoor air pollution is a cause of COPD (25). However, as in asthma, outdoor air pollution exposure clearly exacerbates COPD, and is a trigger for COPD hospitalizations and respiratory mortality (27,28).

As the prevalence of chronic respiratory disease, including both asthma and COPD, is rising world-wide, air quality will continue to be a serious health problem. The US experience has shown that reductions in air pollution can have immediate health benefits, such as improved children's lung growth and longer adult life expectancy. While the challenges of reducing air pollution levels are daunting, the benefits of cleaner air are enjoyed by all.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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