

## PREVENTING DISEASE THROUGH HEALTHY ENVIRONMENTS

# EXPOSURE TO AIR POLLUTION: A MAJOR PUBLIC HEALTH CONCERN

Indoor air pollution from solid fuel use and urban outdoor air pollution are estimated to be responsible for 3.1 million premature deaths worldwide every year and 3.2% of the global burden of disease.<sup>1</sup> More than half of the global burden of disease from air pollution is borne by people in developing countries. Air pollutants have been linked to a range of adverse health effects, including respiratory infections, heart disease and lung cancer. Reduction of air pollution levels will decrease the global health burden related to these illnesses. Efforts to significantly reduce concentrations of air pollutants will also help to decrease greenhouse gas emissions and mitigate the effects of global warming.<sup>2</sup>

## Sources of exposure to air pollution

### *Indoor air pollution*

The major sources of indoor air pollution worldwide include indoor combustion of solid fuels, tobacco smoking, outdoor air pollutants, emissions from construction materials and furnishings, and improper maintenance of ventilation and air conditioning systems. Although some indoor air pollutants, such as environmental tobacco smoke, are of concern globally, profiles of indoor air pollutants and the resulting health risks are generally very different in developed and developing countries. In developing countries, the most significant issue for indoor air quality is pollutants released during the combustion of solid fuels—including biomass (wood, dung and crop residues) and coal (mainly in China)—that are used for cooking and heating. Households burning such fuels are generally located in poor rural communities and use open pits or poorly functioning earthen or metal stoves in kitchens that are not well ventilated. Although relatively clean sources of household energy predominate in developed countries, improvements in energy efficiency have led to homes being relatively airtight, reducing ventilation rates and raising levels of indoor air pollutants. In such circumstances, even minor sources of air pollution, such as gas cookers, new furnishings, damp conditions, household products or naturally occurring radon gas, can lead to significant exposures and recognized health effects.<sup>3,4</sup>

### *Outdoor air pollution*

Outdoor sources of air pollutants include vehicles, combustion of fossil fuels in stationary sources, such as power generating stations, and a variety of industries. Forest fires and deliberate biomass burning, although intermittent sources of air pollution, represent major sources of combustion pollution globally. Nature—including volatile organic compounds released from trees, wind-blown soil, dust storms and sea spray—can also be an important source of many trace gases and particles within the atmosphere.<sup>3</sup>

### World Health Organization (WHO) air quality guidelines<sup>2,3,5,6</sup>

Particulate matter with a diameter of 2.5 µm or less (PM <sub>2.5</sub> )	10 µg/m <sup>3</sup> (annual mean) 25 µg/m <sup>3</sup> (24 h mean)
Particulate matter with a diameter of 10 µm or less (PM <sub>10</sub> )	20 µg/m <sup>3</sup> (annual mean) 50 µg/m <sup>3</sup> (24 h mean)
Ozone	100 µg/m <sup>3</sup> (8 h mean)
Nitrogen dioxide	40 µg/m <sup>3</sup> (annual mean) 200 µg/m <sup>3</sup> (1 h mean)
Sulfur dioxide	20 µg/m <sup>3</sup> (24 h mean) 500 µg/m <sup>3</sup> (10 min mean)
Carbon monoxide	60 mg/m <sup>3</sup> (30 min mean) 30 mg/m <sup>3</sup> (1 h mean) 10 mg/m <sup>3</sup> (8 h mean)

## Health effects

### *Indoor air pollution*

- In the year 2004, indoor air pollution from solid fuel use was responsible for almost 2 million deaths (3% of all deaths) and 2.7% of the global burden of disease (expressed in disability-adjusted life years, or DALYs\*). This risk factor is the second largest environmental contributor to ill-health, behind the combination of unsafe water with poor sanitation. In low- and middle-income countries, 3.9% of all deaths are due to indoor air pollution. Worldwide, indoor smoke from solid fuel combustion causes about 21% of deaths from lower respiratory infections, 35% of deaths from chronic obstructive pulmonary disease and about 3% of deaths from lung cancer.<sup>1</sup>
- Carbon monoxide reduces the capacity of blood to carry oxygen. Symptoms associated with exposure to carbon monoxide include dizziness, nausea, headache, loss of consciousness and death. Persons with coronary artery disease and fetuses are particularly susceptible.<sup>6</sup>
- Exposure to biological contaminants of indoor air that are related to dampness and mould increases the risk of acute and chronic respiratory diseases, including asthma.<sup>9</sup>
- Radon is the second leading cause of lung cancer after smoking. Most cases of radon-induced lung cancer occur among smokers owing to the strong combined effect of smoking and radon.<sup>10</sup>

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\* The DALY combines the burden due to death and disability in a single index. Use of such an index permits the comparison of the burden due to various environmental risk factors with those from other risk factors or diseases. One DALY can be thought of as 1 lost year of healthy life.<sup>7,8</sup>

### ***Outdoor air pollution***

- In the year 2004, outdoor air pollution in urban areas was responsible for almost 1.2 million deaths (2% of all deaths) and 0.6% of the global burden of disease.<sup>1</sup> Transportation-related air pollution, which is a significant contributor to total urban air pollution, increases the risks of cardiopulmonary-related deaths and non-allergic respiratory disease. Some evidence supports an association of transportation-related air pollution with increased risks of lung cancer, myocardial infarction, increased inflammatory response and adverse pregnancy outcomes (e.g. premature birth and low birth weight).<sup>11</sup>
- Exposure to particulate matter, including metals, has been linked to a range of adverse health outcomes, including modest transient changes in the respiratory tract and impaired pulmonary function, increased risk of symptoms requiring emergency room or hospital treatment, and increased risk of death from cardiovascular and respiratory diseases or lung cancer. Particulate matter is estimated to cause about 8% of deaths from lung cancer, 5% of deaths from cardiopulmonary disease and about 3% of deaths from respiratory infections.<sup>1,12–14</sup>
- Short-term exposures to ozone are linked with effects on pulmonary function and the respiratory system, lung inflammation, increased medication usage, hospitalization and mortality. Reduced lung function has been associated with long-term ozone exposure.<sup>13,15</sup>
- Short-term exposures to nitrogen dioxide, an indicator for a complex mixture of mainly traffic-related chemicals, have been associated with effects on pulmonary function, increased allergic airway inflammation reactions, hospital admissions and mortality. Reduced lung function and increased probability of respiratory symptoms are associated with long-term exposure to nitrogen dioxide.<sup>13</sup>

## **Risk mitigation recommendations**

### ***General recommendations***

- Facilitate access to information on the health effects of indoor and outdoor air pollution and methods for reducing the risk.
- Conduct health impact assessments to determine the magnitude of the health effects associated with changes in air pollution. This information can be used to identify cost-effective measures to improve public health, identify critical uncertainties and suggest productive areas of research.<sup>3</sup>
- Facilitate country actions to strengthen air quality management. National governments have the responsibility to set needed policies and laws and implement them. Air pollution control regulations—especially those phasing out the use of leaded gasoline, controlling pollution from industrial processes and promoting the use of cleaner or renewable energy—should be enforced. National governments can help coordinate efforts across sectors and participate in regional and international commitments to decrease air pollution.<sup>16</sup>

### **Indoor air-specific recommendations**

- Investigate effective interventions and implementation methods for sustainable and financially viable changes to reduce indoor air pollution.<sup>4</sup>
- Encourage the substitution of solid fuels in the home by cleaner and more efficient fuels and technology.<sup>17</sup>
- Encourage the use of improved stoves to lower pollution levels in poor rural communities where access to alternative fuels is limited and biomass remains the most practical fuel.<sup>17</sup>
- Improve ventilation in homes, schools and the working environment.<sup>17</sup>
- Change user behaviour (e.g. drying wood before use).<sup>17</sup>
- Prevent and remediate problems related to dampness and mould in housing to decrease the risk of exposure to hazardous microbes.<sup>9</sup>
- Eliminate or reduce tobacco smoking indoors.<sup>3</sup> Prohibit smoking in public buildings.
- Promote risk reduction strategies for indoor radon exposure.<sup>10</sup>

### **Outdoor air-specific recommendations**

- Encourage technological innovation to decrease emissions from stationary sources and conventional vehicles, and investigate alternative fuels.<sup>11,18</sup>
- Implement control mechanisms (e.g. emission inspections).<sup>11,18</sup>
- Integrate environmental and health considerations in urban planning, including locating offices and commercial space in areas convenient for pedestrians and bicyclists in order to reduce the need for motorized transport, preventing traffic congestion, creating green areas, separating pedestrians and bicyclists from road traffic and locating non-residential functions around urban highways.<sup>11</sup>
- Focus on transportation systems that provide an alternative to cars and diesel buses, including rail, electric or alternative fuel-powered buses and cycling or walking networks.<sup>11,18</sup>
- Promote the use of clean, renewable energy sources, such as solar and wind-powered energy, and encourage the movement away from dirtier fuels, such as coal.<sup>11,18</sup>
- Monitor air quality.<sup>3</sup>
- Inform the public of effective pollution reduction activities and associated health benefits.<sup>3</sup>

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