

Air pollution: one of the greatest health challenges of our time

May van Schalkwyk and Emer O'Connell outline the neglected impacts of air pollution, and the key steps needed to tackle it.

The scale of the problem

Pollution is one of the most important public health challenges of the 21st century and, despite marked progress in policy and technology over the past decades, it continues to threaten the health and prosperity of populations across the globe.¹ Pollution is responsible for three times more deaths than the combination of those due to AIDS, Tuberculosis and Malaria and 15 times more than is caused by wars and others forms of violence.¹ While many populations experience exposure to harmful levels of pollution, the health burden falls disproportionately on the poor and vulnerable. Pollution-related disease is most prevalent among minorities and the marginalised in all countries,¹ exacerbating inequities and injustices.

Air pollution (ambient/outdoor and household) is a major contributor to this concerning picture, with 3 million and 4.3 million deaths annually being attributable to ambient and household air pollution, respectively.² In the European region (as classified by the World Health Organisation), exposure to particulate air pollution is estimated to reduce the life expectancy of every individual by an average of nearly 1 year, primarily due to the increased risk of cardiovascular and respiratory diseases and lung cancer.³ In the UK, the impact of exposure to particulate air pollution in 2008 was estimated to be equivalent to almost 29,000 deaths at typical ages and an associated loss of population life of 340,000 life years lost.⁴ To put these figure into context, household exposure to second-hand smoke has been estimated to account for 10,700 deaths in the UK.⁵

Unless aggressive interventions are implemented, the number of deaths attributed to ambient air pollution globally are predicted to increase by over 50% by 2050.⁶ The drivers of air pollution are complex and policy solutions are not straightforward. However, the dividends from policy solutions that are designed to maximise other health benefits whilst reducing the direct burden from air pollution provide an important opportunity.

What is air pollution and what are the health effects?

The term 'air pollution' is used to refer to substances in the air that have harmful effects on human health, welfare, plant and animal life. Although there are numerous air pollutants that have been associated with significant excess morbidity and mortality, oxides of nitrogen (NO_x), ozone, carbon monoxide and sulphur dioxide for example, it is the effects of particulate matter 2.5 (PM_{2.5}) that has the strongest epidemiological link with health outcomes. It is the air pollutant that is most commonly adopted as a proxy indicator of air pollution exposure⁴ and has been shown to be associated with a wide range of diseases in many human organ systems.^{7,8} PM, a complex mixture of solid and liquid particulates of organic and inorganic substances, is categorised depending on particle size. For example, PM₁₀ is used to refer to particles of diameter less than 10 micrometers (µm). The health impacts of air pollutants are dependent on the size of the particle. PM₁₀, shown to penetrate and lodge deep within the lungs, is strongly associated with short term increase in death rates and exacerbation of some common medical conditions, such as asthma. Elevated concentrations of ambient PM_{2.5} are even more harmful to health as long term exposure to these smaller particles increases the risk of premature mortality from cardiovascular and pulmonary diseases.⁹

The evidence for these associations is strong with numerous large-scale studies reporting statistically significant impacts on health consistently, regardless of context. The evidence also indicates that there is no safe level of exposure for human health.^{4,10} The International Agency for Research on Cancer has categorised airborne PM and ambient air pollution as proven human carcinogens.^{11,12,13}

There is increasing concern about the health impacts associated with exposure to nitrogen dioxide (NO₂). In 2015, the UK Department of Health's Committee on the Medical Effects of Air Pollutants concluded that the strength of the evidence on the health impacts of NO₂ has increased significantly over recent years and, based on the findings, can be considered a cause of certain health effects.¹⁴ This is a particular concern given the very high ambient concentrations of NO₂ in many urban areas due to high traffic volumes.

Who are exposed and what are the sources?

Air pollution affects all regions of the world and it is estimated that 92% of the world's population lives in places where air pollution levels exceed WHO safety limits.² There are however, marked geographical differences in exposure to air pollution. People who live in Africa, Asia or the Middle East are exposed to much higher levels of air pollutants in comparison to those who live in other parts of the world.¹⁵ Motorised vehicles (from petrol and diesel exhaust emissions, brake and tyre wear), industries and households emit complex mixtures of air pollutants, all contributing to the levels of ambient air pollution. Most PM comes from fuel combustion, both from mobile sources such as vehicles and from stationary sources such as power plants, industry, households or biomass burning.¹⁶

Approximately 3 billion people still depend upon solid fuels (i.e. wood, crop wastes, charcoal, coal and dung) in open fires and leaky stoves to cook and heat their homes. The majority of these people are deprived and living in low- and middle-income countries. These practices produce high levels of household air pollution that contains a suite of pollutants known to be harmful to health, including small soot particles that can penetrate deep into the lungs. Poor ventilation can lead to indoor smoke levels reaching 100 times higher than is acceptable for fine particles. Women and young children are at high risk of exposure as they spend most time near the domestic hearth.¹⁷

A call for action

Action is needed to prevent the huge burden of premature death and ill health attributable to air pollution annually. Addressing the detrimental effects of air pollution poses a unique opportunity for improving health and prosperity worldwide. By adopting initiatives that focus on broader health issues and equity, multiple benefits – such as reducing levels of physical inactivity, obesity and non-communicable disease, social isolation, and climate change mitigation - can be realised also.

The drivers of air pollution are multiple and complex so multi-faceted cross-sectoral initiatives are needed. We must realign the way we design and function in our cities and the way we use resources. Importantly, collaborative working across multiple

Feature Articles

sectors, and improvement in the application of evidence to improve urban design and transport are pivotal in addressing the inter-related health issues such as air pollution, climate change and non-communicable diseases. The evidence demonstrates that land use and transport policies and practices contribute substantially to such health threats.¹⁸⁻²⁰ For example, the approach to city planning with the greatest potential to produce the largest health benefits is one where walking, cycling and public transport are supported by a safe infrastructure and given prioritisation over private motorised forms of transport.¹⁸⁻²⁰

Led by WHO, the Climate and Clean Air Coalition, and the Government of Norway, BreatheLife is a global campaign that advocates for action that prioritises: (1) knowledge sharing between cities; (2) upscaling monitoring; (3) supporting solutions; and (4) educating people and provide examples of city-wide solutions and actions that can be taken by individuals, leaders and the healthcare community.²¹

May CI van Schalkwyk is a Public Health Registrar at Imperial College, London. Emer O'Connell is a Public Health Registrar currently on sabbatical.

References

[web links correct as of 29/11/17]

1. Landrigan PJ, Fuller R, Acosta NJR, et al (2017). The Lancet Commission on pollution and health. *Lancet*. October.
2. WHO (2017). Ambient and household air pollution and health. http://www.who.int/phe/health_topics/outdoorair/databases/en/
3. WHO Regional Office for Europe (2017). Air Quality: Data and Statistics. October. <http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/data-and-statistics>
4. Dept of Health (2010). The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom. Committee on the Medical Effects of air pollution. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/304641/COMEAP_mortality_effects_of_long_term_exposure.pdf
5. Jamrozik K (2005). Estimate of deaths attributable to passive smoking among UK adults: database analysis. *British Medical Journal*, vol.330(7495), p.812.
6. Lelieveld J, Evans JS, Fnais M, Giannadaki D, Pozzer A (2015). The contribution of outdoor air pollution sources to premature mortality on a global scale. *Nature*, vol.525(7569), pp.367-371.
7. Cohen AJ, Brauer M, Burnett R, et al (2017). Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *Lancet*, vol.389(10082), pp.1907-1918.
8. Thurston GD, Kipen H, Annesi-Maesano I, et al (2017). A joint ERS/ATS policy statement: what constitutes an adverse health effect of air pollution? An analytical framework. *European Respiratory Journal*, vol.49(1), p.1600419.
9. Brook RD, Rajagopalan S, Pope CA, et al (2010). Particulate Matter Air Pollution and Cardiovascular Disease: An Update to the Scientific Statement From the American Heart Association. *Circulation*, vol.121(21), pp.2331-2378.
10. WHO Regional Office for Europe (2013). Review of Evidence on Health Aspects of Air Pollution – REVIHAAP Project. http://www.euro.who.int/__data/assets/pdf_file/0004/193108/REVIHAAP-Final-technical-report-final-version.pdf?ua=1
11. Loomis D, Grosse Y, Lauby-Secretan B, et al (2013). The carcinogenicity of outdoor air pollution. *The Lancet Oncology*, vol.14(13), pp.1262-1263.
12. Burnett RT, Pope CAI, Ezzati M, et al (2014). An Integrated Risk Function for Estimating the Global Burden of Disease Attributable to Ambient Fine Particulate Matter Exposure. *Environmental Health Perspectives*, vol.122(4), pp.397-403.
13. Hamra GB, Guha N, Cohen A, et al (2014). Outdoor Particulate Matter Exposure and Lung Cancer: A Systematic Review and Meta-Analysis. *Environmental Health Perspectives*, vol.122(9), pp.906-911.
14. UK Government (2015). Nitrogen dioxide: health effects of exposure. <https://www.gov.uk/government/publications/nitrogen-dioxide-health-effects-of-exposure>
15. WHO (2016). Ambient air pollution: A global assessment of exposure and burden of disease. <http://apps.who.int/iris/bitstream/10665/250141/1/9789241511353-eng.pdf?ua=1>
16. WHO (2016). Ambient air pollution. http://www.who.int/gho/phe/outdoor_air_pollution/en/
17. WHO (2016). WHO Household air pollution and health. <http://www.who.int/mediacentre/factsheets/fs292/en/>
18. Sallis JF, Bull F, Burdett R, et al (2016). Use of science to guide city planning policy and practice: how to achieve healthy and sustainable future cities. *Lancet*, vol.388(10062), pp.2936-2947.
19. Stevenson M, Thompson J, de Sá TH, et al (2016). Land use, transport, and population health: estimating the health benefits of compact cities. *Lancet*, vol.388(10062), pp.2925-2935
20. Giles-Corti B, Vernez-Moudon A, Reis R, et al (2016). City planning and population health: a global challenge. *Lancet*, vol.388(10062), pp.2912-2924.
21. BreatheLife. <http://breathelife2030.org/>

Doctors Against Diesel

Doctors Against Diesel is a new evidence-based campaign run by the public health charity Medact, and supported by numerous doctors, nurses and health professionals. Our mission is to reduce the impacts of air pollution on children's health.

We recognise that there are multiple sources of outdoor air pollution. However, in urban areas the single biggest source is road transport. Children in particular are vulnerable to the effects of air pollution from traffic. Hence, it is of particular concern that a recent Greenpeace UK investigation revealed that more than 2,000 schools and other similar establishments are within 150m of roads emitting illegal levels of nitrogen dioxide (NO₂).

Our campaign specifically focuses on diesel because it is the biggest source of air pollution in cities, and a source of two of the most dangerous air pollutants for health: NO₂ and particulate matter (PM₁₀ and PM_{2.5}).

Diesel cars produce more of these pollutants than petrol cars. Indeed, diesel cars produce over 40% of the NO₂ coming from roads in cities.

Following the Volkswagen 'Dieselgate' scandal in 2015 and other similar scandals, it has become apparent that many car companies have been knowingly fixing emissions tests designed to reduce emissions from diesel, and hence breaking air pollution standards.

Despite some moves to alter testing regulations and 'fix' some of the cars, two-thirds of the newest, high 'Euro 6' standard diesel cars still do not meet emissions standards in real world conditions.

Doctors Against Diesel is working for a world where:

- No child's health is adversely affected by air pollution
- Highly polluting diesel vehicles are phased out from UK towns and cities

- Policies support the choice to walk, cycle or take public transport as healthy and safe alternatives to driving

For more information or to support the campaign, see <https://doctorsagainstdiesel.uk/> or phone Carla Stephan on 0207 324 4739.