Air Quality: Public Health Impacts and Local Actions

This briefing is to inform public health professionals of the public health impacts of air pollution, the sources of air pollution and measures available to reduce air pollution. It is to help inform discussions between local authority air quality and transport professionals and public health professionals on action to improve air quality. Air pollution is an indicator in the Public Health Outcomes Framework and has a significant public health impact in the UK, with an effect equivalent to 29,000 deaths a year.

Poor air quality is a significant public health issue. The burden of particulate air pollution in the UK in 2008 was estimated to be equivalent to nearly 29,000 deaths at typical ages and an associated loss of population life of 340,000 life years lost.[1] It has been estimated that removing all fine particulate air pollution would have a bigger impact on life expectancy in England and Wales than eliminating passive smoking or road traffic accidents[2]. The economic cost from the impacts of air pollution in the UK is estimated at £9-19 billion every year[3]. This is comparable to the economic cost of obesity (over £10 billion)[4].

The importance of the effect of air pollution on public health is reflected by the inclusion of an indicator of mortality associated with air pollution in the Public Health Outcomes Framework for England[5]. This will enable Directors of Public Health to appropriately prioritise action on air quality in their local area. The Public Health Outcomes Framework indicator reflects the *fraction of all-cause adult mortality attributable to long-term exposure to current levels of anthropogenic particulate air pollution*. The baseline data for the indicator have been calculated for each upper tier local authority in England based on modelled concentrations of fine particulate air pollution ($PM_{2.5}$) in 2010. Estimates of the percentage of mortality attributable to long term exposure to particulate air pollution in local authority areas range from around 4% in rural areas to over 8% in cities, where pollution levels are highest. These calculations of the mortality burden associated with particulate air pollution will be updated periodically.

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1 The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom. The Committee on the Medical Effects of Air Pollutants (COMEAP) (2010) http://www.comeap.org.uk/images/stories/Documents/Reports/comeap%20the%20mortality%20effects%20of%20long-term%20exposure%20to%20particulate%20air%20pollution%20in%20the%20uk%202010.pdf

2 Comparing estimated risks for air pollution with risks for other health effects, Miller and Hurley, IOM (2006) http://www.iom-world.org/pubs/IOM_TM0601.pdf

3/4 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69340/pb13378-air-pollution.pdf

5 http://www.phoutcomes.info/

The main pollutants of concern in the UK are particulate matter (PM), oxides of nitrogen, and ground level ozone. This briefing is concerned mainly with fine particulate matter ($PM_{2.5}$). This is the pollutant which has the biggest impact on public health and on which the PHOF indicator is based. Information on other pollutants is available from https://www.gov.uk/government/policies/protecting-and-enhancing-our-urban-and-natural-environment-to-improve-public-health-and-wellbeing/supporting-pages/international-european-and-national-standards-for-air-quality.

1. What is Particulate Matter? What is $PM_{2.5}$?

Particulate matter (PM) is a term used to describe the mixture of solid particles and liquid droplets in the air. It can be either human-made or naturally occurring. Some examples include dust, ash and sea-spray. Particulate matter (including soot) is emitted during the combustion of solid and liquid fuels, such as for power generation, domestic heating and in vehicle engines. Particulate matter varies in size (i.e. the diameter or width of the particle). $PM_{2.5}$ means the mass per cubic metre of air of particles with a size (diameter) generally less than 2.5 micrometres (μm). $PM_{2.5}$ is also known as fine particulate matter. (2.5 micrometres is one 400^{th} of a millimetre).

2. Health effects of PM

Inhalation of particulate pollution can have adverse health impacts, and there is understood to be no safe threshold below which no adverse effects would be anticipated[6]. The biggest impact of particulate air pollution on public health is understood to be from long-term exposure to $PM_{2.5}$, which increases the age-specific mortality risk, particularly from cardiovascular causes. Several plausible mechanisms for this effect on mortality have been proposed, although it is not yet clear which is the most important. Exposure to high levels of PM (e.g. during short-term pollution episodes) can also exacerbate lung and heart conditions, significantly affecting quality of life, and increase deaths and hospital admissions. Children, the elderly and those with pre-existing respiratory and cardiovascular disease, are known to be more susceptible to the health impacts from air pollution[7]. Potential mechanisms by which air pollution could cause its cardiovascular effects are described in the Committee on the Medical Effects of Air Pollution's (COMEAP) report *"Cardiovascular Disease and Air Pollution"* (2006).[8]

3. Sources of $PM_{2.5}$

Human-made sources of $PM_{2.5}$ are more important than natural sources, which make only a small contribution to the total concentration. Within UK towns and cities, emissions of $PM_{2.5}$ from road vehicles are an important source. Consequently, levels of $PM_{2.5}$, and population exposure, close to roadsides are often much higher than those in background locations. In some places, industrial emissions can also be important, as can the use of non-smokeless fuels for heating and other domestic sources of smoke such as bonfires. Under some meteorological conditions, air polluted with $PM_{2.5}$ from the continent may circulate over the UK – a condition known as the long range transportation of air pollution.

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[6] Air Quality Guidelines, Global Update 2005, World Health Organization (2006) http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/air-quality/publications/pre2009/air-quality-guidelines.-global-update-2005.-particulate-matter,-ozone,-nitrogen-dioxide-and-sulfur-dioxide

[7] http://www.who.int/phe/air_quality_q&a.pdf

[8] http://www.comeap.org.uk/images/stories/Documents/Reports/cvd%20report%202006.pdf

Long range transport, together with pollution from local sources, can result in short-term episodes of high pollution which might have an impact on the health on those sensitive to high pollution.

In addition to these direct (i.e. primary) emissions of particles, $PM_{2.5}$ can also be formed from the chemical reactions of gases such as sulphur dioxide (SO_2) and nitrogen oxides (NO_x: nitric oxide, NO plus nitrogen dioxide, NO_2); these are called secondary particles. Measures to reduce the emissions of these precursor gases are therefore often beneficial in reducing overall levels of $PM_{2.5}$.

Primary emissions of PM, the formation of secondary PM within the UK and long range transport of pollution from outside the UK all contribute to regional PM levels across the UK. Local primary emissions are also important in urban areas.

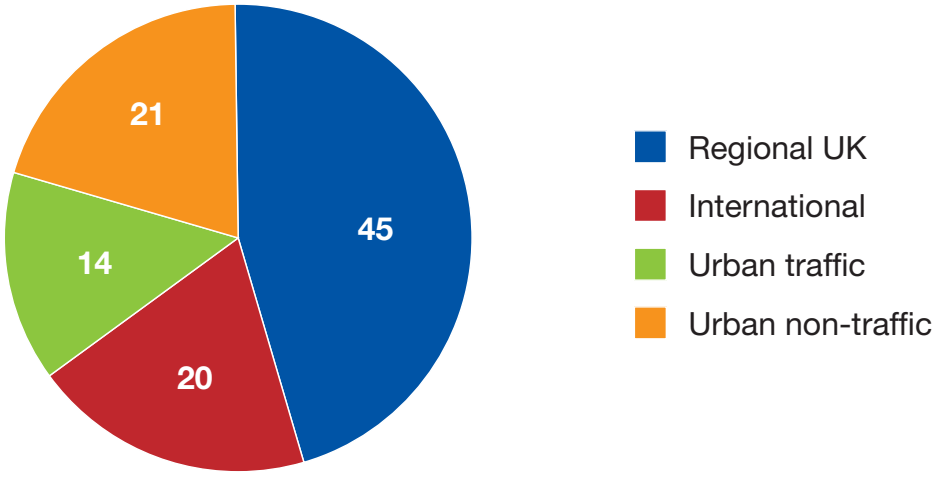

Figure 1. Percentage contributions to modelled annual mean ambient $PM_{2.5}$ concentrations at urban background[9] locations[10]. (Urban non-traffic emissions include: industrial, commercial and domestic emissions. "Regional UK" refers to national emissions in non-urban areas).

4. Legislative controls of air pollution

European legislation sets out a number of requirements to control outdoor levels of $PM_{2.5}$ and other air pollutants. The EU Directive on Ambient Air Quality includes legally binding Limit Values for some pollutants including PM_{10} (the mass per cubic metre of air of particles with a size (diameter) generally less than 10 micrometers) and nitrogen dioxide (NO_2). These pollutants also have adverse effects on health and are often associated with the same combustion sources as $PM_{2.5}$. There is also a requirement to notify the public when concentrations of ground-level ozone (O_3) are elevated.

[9] Urban background is an urban location distanced from sources and therefore broadly representative of citywide background conditions, for example, elevated locations, parks and urban residential areas.

[10] Data from: http://uk-air.defra.gov.uk/reports/cat09/1204301513_AQD2010mapsrep_master_v0.pdf

Member States are expected to ensure that the annual average concentration of $PM_{2.5}$ does not exceed 25 μg/m^3. The legislation also aims to reduce the levels of $PM_{2.5}$ to which the population is exposed: as no threshold for the effects of long-term exposure to particulate matter on mortality has been identified, continuing to reduce overall population exposure to $PM_{2.5}$ even below this target value will have important public health benefits. Each Member State should achieve an Exposure Concentration Obligation (ECO) of no more than 20 μg/m^3 averaged nationally across background sites in major urban centres over 3 years. In addition, Member States are required to achieve a reduction in population exposure to $PM_{2.5}$ over a period of 10 years between 2010 and 2020.

5. Distribution of air pollution

With the exception of ozone, levels of air pollutants are generally higher in urban than rural areas. For $PM_{2.5}$, there is a gradient in concentration across the country with higher levels found in the South East than other areas. Within cities, air quality (particularly in relation to concentrations of PM_{10} and NO_2) tends to be worse close to busy roads, where poorer communities often live.

Measures Available to Reduce Air Pollution

6. Role for Local Authorities

Local Authorities in the UK have a responsibility under Local Air Quality Management legislation to review air quality. Where levels exceed national objectives[11], measures should be put in place to reduce emissions, and be reported in the local Air Quality Action Plan. Most such Action Plans are designed to address difficulties in complying with national objectives for either NO_2 or PM_{10}. Typical measures to reduce emissions from local sources include traffic management, the encouragement of uptake of cleaner vehicles, and increased use of public transport along with more sustainable transport methods such as walking and cycling. Such measures will also reduce emissions of $PM_{2.5}$.

The use of smokeless fuels during industrial and domestic combustion is also important as are stringent industrial emission controls. The increased use of biomass as a fuel to meet renewable energy targets may give rise to increased particulate pollution if combustion plants are not well managed. Planning and development controls are also important for local authorities to reduce concentrations in local polluted hotspots.

[11] http://www.legislation.gov.uk/uksi/2000/928/contents/made

Local authorities can help to improve air quality in a number of ways, including:

- Encouraging schemes like ECOSTARS that recognise excellent levels of environmental and energy saving performance for the vehicles that operate within their area. http://www.care4air.org/eco_stars_scheme.html
- Introducing intelligent transport systems that maximise the efficiency of the highway network and also give real time information on traffic delays and journey times, car parking availability, and bus arrival times; together, these allow people to make better informed travel choices and also reduce traffic emissions. For example: http://www.bracknell-forest.gov.uk/application-form-local-sustainable-transport-fund-bid-appendix-b.pdf
- Incorporating air quality into planning considerations for new developments and refurbishments. For example: http://www.middevon.gov.uk/CHttpHandler.ashx?id=9424&p=0
- Promoting energy efficiency and sustainable transport to residents and businesses in the borough and putting in the necessary infrastructure to enable people to reduce the emissions they produce. For example: http://www.northumberland.gov.uk/default.aspx?page=8868

7. **Defra has produced guidance to assist local authorities** to develop air quality action plans which set out measures to reduce local emissions – see http://laqm.defra.gov.uk/ for further information.

8. **Role for Public Health Professionals**
   Public Health professionals are well placed to work with local communities and front line professionals to raise awareness of the health impact of poor air quality, support measures to reduce pollution and encourage lifestyle adaptations to reduce the risk to individuals and to their families, for example through advice on selecting walking routes away from the most polluted streets and information about air pollution messaging services such as AirText in London or AirAlert in the South East.

   Public Health professionals can also help to:

   - explain to their local population the impact of air pollution on health;
   - tailor messages to target those members of the public particularly susceptible to air pollution and to raise understanding that improving air quality would help to improve healthy life expectancy and reduce early death from cardio-respiratory diseases;
   - work with others to promote initiatives to facilitate active travel (for example Healthy Schools Programmes, school travel plans; cycle to work schemes etc; and
   - raise awareness of the need to improve air quality through linking to other public health issues such as obesity and through working with Health and Wellbeing Boards to include air quality in Joint Strategic Needs Assessments and Health and Wellbeing Strategies

9. There are many benefits from local action to control air pollution

Active travel, such as walking and cycling, has the health benefit of increased fitness and helps reduce obesity and cardio vascular disease. The black carbon (soot) component of fine particulate matter makes a significant contribution to climate change. In addition, the soiling effect of PM may create a public nuisance, degrade materials and affect property and amenity value. Indirectly, actions taken to reduce pollutant concentrations lead to improved quality of life and the enhancement of the natural environment.

10. Air Pollution forecasting

As an additional measure, providing early warning of elevated pollutant concentrations allows individuals that might be particularly vulnerable to the short-term effects of air pollution (e.g. asthmatics or those with pre-existing lung or heart conditions) to be alerted so that they can reduce strenuous activity outdoors. Such alerts can also help to anticipate increased demand for medical services. Public information services and pollution forecasts are provided throughout the UK see http://uk-air.defra.gov.uk/forecasting/ and for some local areas[12/13]. *Public Health professionals can also help local authorities in promoting actions to improve air quality by highlighting the health impact of poor air quality in their local areas, in order to further assist with the aim of changing behaviour.*

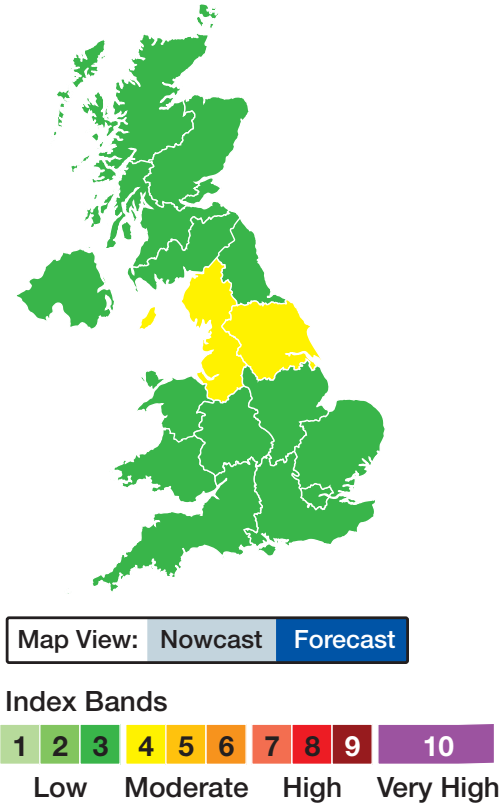

Figure 2.
Defra provides daily pollution forecasts for regions across the UK according to pollution index bands. Health advice for each pollution band is also given.

[12] http://www.airtext.info/
[13] http://www.airalert.info/