Public Health England

Protecting and improving the nation's health

Particulate Matter

At a glance

- **PHOF 3.01**: public health indicator for fraction of adult mortality attributable to long-term exposure to human-made particulate air pollution (DH)
- **4.7%**: PHOF 3.01 indicator for fraction of adult mortality attributable to long-term exposure to human-made particulate matter air pollution (DH)
- **25,000**: estimated number of deaths every year attributable to fine particulate matter exposure ($PM_{2.5}$) in England (PHE)
- **health effects**: there is no evidence for a safe level of exposure to particulate matter (PM) - this suggests that even very low concentrations may have a detrimental effect on health

Particulate Matter (PM)

Particulate matter (PM) is a generic term used to describe a complex mixture of solid and liquid particles of varying size, shape and composition. Sources of PM can be natural or human-made. Some particles are emitted directly (primary PM); others are formed in the atmosphere through complex chemical reactions (secondary PM).

Particulate Matter
mass concentration of particles ($\mu g/m^3$)

Nanoparticles / ultrafine particles: smaller than 0.1 µm in diameter.
Fine particles $PM_{2.5}$: with a diameter of 2.5 µm or less
PM_{10}: with a diameter of 10 µm or less
Coarse particles $PM_{10-2.5}$: with a diameter 2.5 – 10 µm .
Dust: with a diameter of 75 µm or less

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Total PM emissions have decreased over recent decades, with the rate of decline being most pronounced during the 1990s. This has been achieved through a variety of mechanisms including industrial regulation and reduction in use of solid fuels. However, this decline has slowed in recent years and the composition of PM has changed.

The available evidence suggests fine particles ($PM_{2.5}$) to be of particular concern in relation to PM for public health.

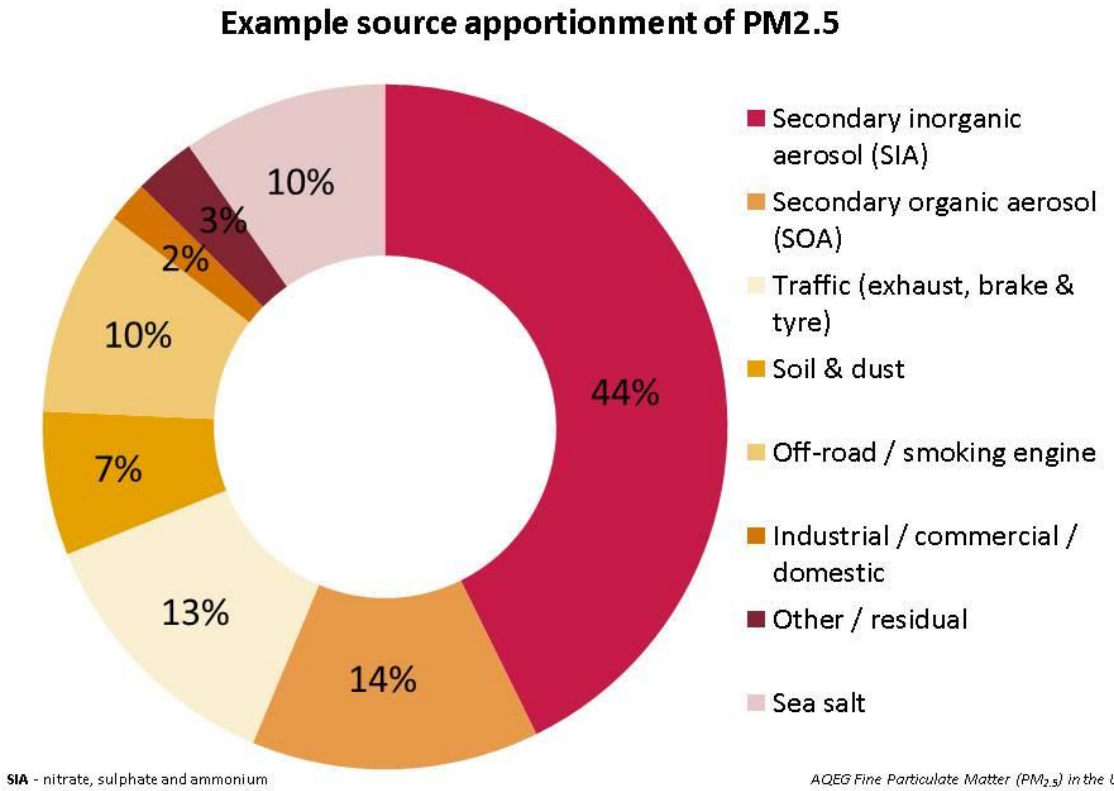
The air pollution health indicator in the Public Health Outcomes Framework (PHOF) estimates the fraction of adult mortality attributable to long-term exposure to $PM_{2.5}$ air pollution (in local authority areas) in England to range from less than 3% in the least polluted rural areas to over 7% in some London boroughs. The average for England is 4.7% (2015 data) - this equates to a population-wide effect roughly equivalent to 25,000 adult deaths.

Air pollution is considered to be a contributory factor rather than the sole cause of death in most cases.

Sources

The composition of PM varies depending upon source contribution and geographical location. The main source of PM is the combustion of fuels (vehicle, industry and domestic) and other human-made activities such as mining, quarrying, industrial processes and tyre and brake wear. Natural sources include wind-blown soil and dust, sea spray particles, volcanos and seismic events, and fires involving burning vegetation.

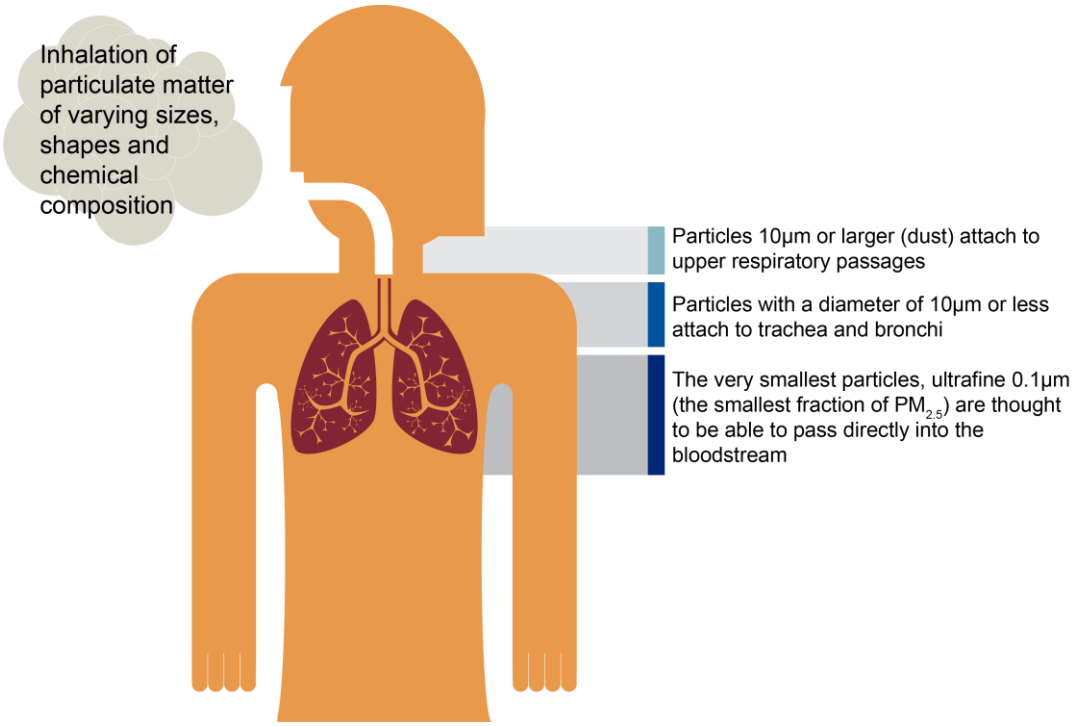
As well as emissions from local and regional sources, levels of PM are also influenced by emissions from mainland Europe and further afield. Among the common air pollutants fine particles stays in the air the longest and can therefore build up over days and be moved by winds over large areas.



Background $PM_{2.5}$ concentrations vary year on year as a result of variation in weather conditions. The variation in background $PM_{2.5}$ concentrations is one reason benchmarking annual PM concentrations may not give a true picture of the impact of interventions. However, this does not detract from the value of taking action and in fact supports the importance of measures that improve air quality across local authority boundaries. Local and national policy seek to influence the human-made component of these concentrations as there is less that can be done to reduce levels from natural sources.

Health effects

There is no evidence for a safe level of exposure to PM - this suggests that even very low concentrations may have a detrimental effect on health. The World Health Organization (WHO) 2005 guideline limits aim to achieve the lowest concentrations of PM possible, acknowledging the need to aim at achieving the lowest concentrations possible in the context of local constraints. This supports the need to take action to address PM, whatever the levels present.



The size of particles and the duration of exposure are key determinants of potential adverse effects on health. Particles with a diameter of 10 µm or less (PM_{10}) pose a risk to health as they are able to penetrate and lodge inside the lungs. There is some evidence that ultrafine PM of 0.1 µm or less can penetrate deeper into lung tissue, enter the bloodstream and therefore pose a greater risk.

Short term exposure to PM may result in irritation of the eyes and respiratory symptoms, such as irritation of the nose and throat, coughing, shortness of breath and chest tightness. Individuals with existing cardiovascular and respiratory conditions, children and older adults are particularly at risk of effects when air pollution levels are elevated. Hospital admissions and deaths from these causes are also increased.

Long term exposure to PM reduces life expectancy, probably by contributing to the development and progression of cardiovascular and respiratory diseases, as well as exacerbation of symptoms in those who already have these diseases. It increases the risk of lung cancer, and the International Agency for Research on Cancer (IARC) has classified particulate outdoor air pollution as carcinogenic to humans (IARC Group 1).

The evidence of the public health impact of PM exposure is consistent in showing adverse health effects at exposures that are currently experienced by urban populations. There is a close relationship between exposure to high PM concentrations and increased mortality or morbidity, both daily and over time. Cohort studies indicate that the relative risk associated with living in areas with elevated PM levels over the long term is of greater magnitude than that observed from studies of effects of daily variations in exposure.

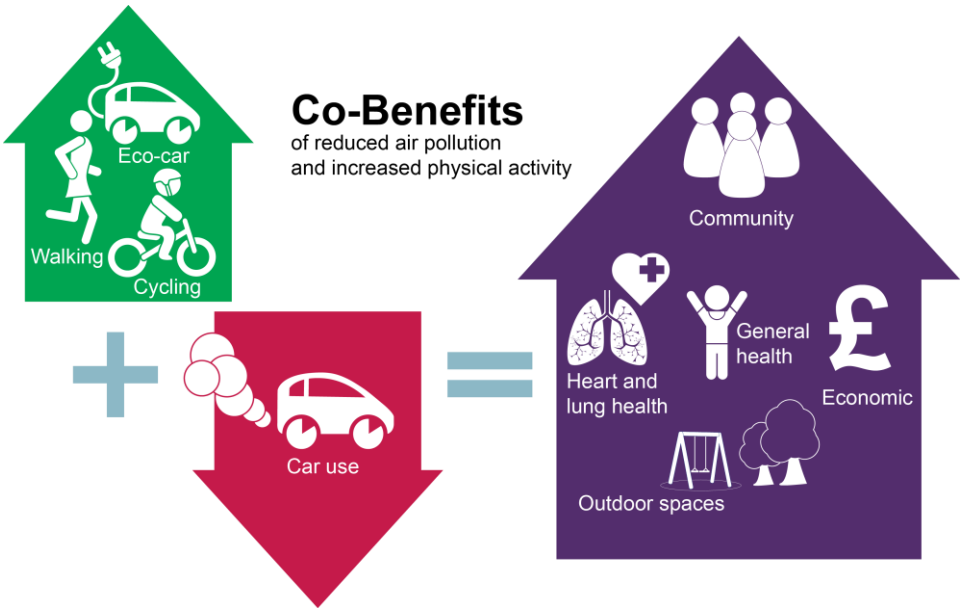
Taking action

The Action Toolbox in Annex A of the Defra Local Air Quality Management Technical Guidance (TG16) and the Action Matrix referred to in the London Local Air Quality Management (PG 16) provide information on action that can be taken to reduce air pollution and thereby improve the health of the public. The toolkit recognises that the suitability and effectiveness of different actions will vary by location and highlights activities that local authorities have taken, such as low emission strategies and promoting active travel.

The Defra Air quality: a briefing for directors of public health is intended to help local authorities and public health professionals to communicate to decision makers and the public on air pollution.

Co-benefits

Air pollution is not an issue in isolation. It is often a reflector of and contributor to wider environmental inequalities. A focus on measures that have co-benefits for air pollution along with other public health priorities such as increased physical activity, health inequalities, climate change mitigation and adaptation, and community cohesion and road safety would be appropriate. It is clear that actions to improve air quality will benefit other public health outcomes. PHE supports actions that improve air quality as a whole.



Attention to improving air quality over the wider area also acknowledges that the negative effects may occur at locations other than where the emissions occur.

Further information

Committee on the Medical Effects of Air Pollutants (COMEAP)

Defra UK-AIR Air Information Resource

Defra Air Pollution in UK

Defra Particulate Matter in the UK

Defra Air Quality Expert Group (AQEG) publications

Public Health Outcomes Framework

World Health Organization (WHO) Health effects of Particulate Matter

Royal College of Physicians (RCP) Every breath we take: the lifelong impact of air pollution

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