# LONDON WOOD BURNING PROJECT: HEALTH IMPACT EVALUATION

## Executive Summary

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# What is the London Wood Burning Project?

Wood burning is increasingly recognised as a major source of air pollution within London. To help combat this, Defra has funded the London Wood Burning Project (LWBP) to help raise awareness and understanding of the impact of burning wood and other solid fuels upon human health. The project is led by the London boroughs of Camden and Islington on behalf of 13 other participating London boroughs.

To raise awareness of the health impact of wood burning (and other solid fuels) the LWBP commissioned Ricardo Energy & Environment to undertake a Health Impact Evaluation that assessed and monetised these impacts across the Greater London region. The key findings from this study have been presented within this executive summary and are explained in greater detail in the main report "London Wood Burning Project: Health Impact Evaluation".

**What is the aim?**

The London Wood Burning Project (LWBP) aims to raise awareness and increase understanding of the impact of domestic solid fuel burning.

**Who is involved?**

The project, funded by Defra, is led by the London Borough of Camden and the London Borough of Islington on behalf of 13 other participating London boroughs.

**What action is being taken?**

The project will conduct research and implement and operate a communications campaign to inform the public.

**Where is the project located?**

There are 15 participating boroughs located across the Greater London region. The analysis was undertaken for these 15 boroughs, as well as for the Greater London region.

# What is air pollution?

Air pollution is the contamination of the environment caused by the release of pollutants into the air. These air pollutants are characterised by the World Health Organization (WHO) as chemical, physical or biological agents which impact the natural atmosphere.[1]

Air pollution can occur either outdoors (ambient air pollution) or indoors. The commonly used term 'air quality'[2] is used to refer to how polluted the air we breathe is and enables national and local governments to use this as a benchmark by which to set targets.

# What are the main pollutants?

There are a number of different types of pollutants emitted to air, each varying by source, location, and quantity released. Two of the most prevalent and most closely associated with harm to human health are **particulate matter (PM)** and **nitrogen dioxide ($NO_2$)**.

**What is PM?**

PM consists of a mixture of solids and liquid droplets which can be emitted through a range of sources.

PM can be found in different sizes – the smaller sizes, such as $PM_{2.5}$, are more harmful as they are more easily absorbed by human lungs.[3]

**What is $NO_2$?**

$NO_2$ or nitrogen dioxide is part of a wider group of gases called nitrogen oxides.

$NO_2$ is commonplace within London and when inhaled, $NO_2$ can lead to a range of health issues, in particular causing respiratory problems.[4]

1 Air Pollution, World Health Organisation, https://www.who.int/health-topics/air-pollution#tab=tab_1
2 Air Quality: Explaining air pollution at a glance, Defra, 2019, https://www.gov.uk/government/publications/air-quality-explaining-air-pollution/air-quality-explaining-air-pollution-at-a-glance
3 What is particulate matter and what are its effects on human health, European Environment Agency, https://www.eea.europa.eu/help/faq/what-is-particulate-matter-and
4 London Air, Imperial College London, https://www.londonair.org.uk/londonair/guide/WhatIsNO2.aspx

# Where does air pollution come from?

Air pollutants can be emitted from a range of activities, typically involving the combustion of fossil fuels.

**Common sources of air pollution within the UK include:**

**Domestic**
(For example cooking or heating)

**Transport**
(For example cars or heavy goods vehicles)

**Industrial and Commercial**
(For example power stations or restaurants)

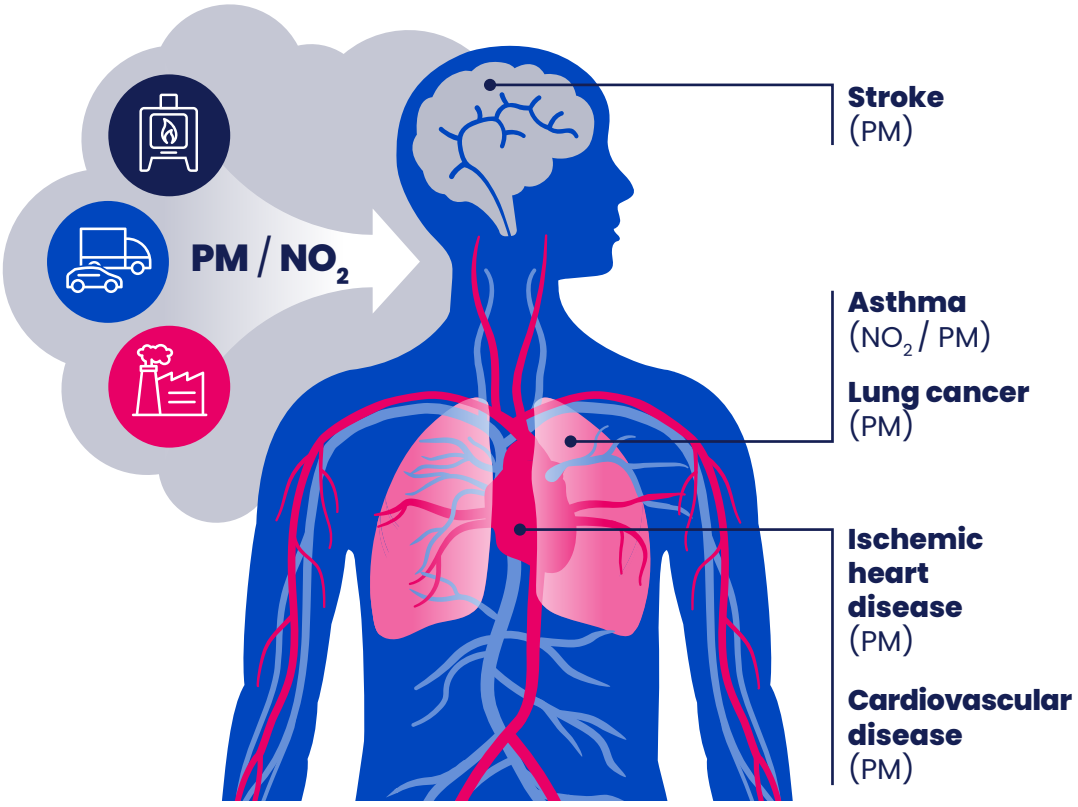
# How does air pollution affect our health?

Air pollution damages human health, and inhalation of PM and $NO_2$ has been associated with a range of different impacts, as summarised in the diagram below.

Fine particulate matter, $PM_{2.5}$ (particles smaller than 2.5 micrometres in diameter), can enter the bloodstream and penetrate internal organs, posing a risk of long-term health problems, as well as having more immediate impacts on some people, such as exacerbating respiratory problems or triggering asthma attacks.

$NO_2$ has been associated with higher levels of hospital admissions for various diagnoses, and causing increases in respiratory symptoms, asthma prevalence and incidence, cancer incidence and mortality.

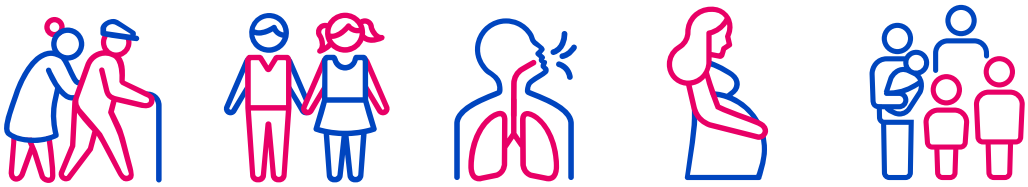
## Increased mortality rate




Note: The association between pollutants and health conditions displayed above has been based upon the impacts for which a robust and quantified relationship has been determined through the application of underlying evidence (discussed in the sections below). Qualitative associations have also been developed for a wider range of health impacts, for example conditions related to mental health.

Air pollutants are harmful to everyone; however, the extent of the impact can vary depending on a number of conditions. The image below illustrates a number of groups that are more at risk of experiencing health problems if they are exposed to high levels of air pollution.

## Groups Most at Risk



**Older people**

**Children**

**Individuals with existing cardiovascular disease or respiratory disease**

**Pregnant women** (impact on the foetus)

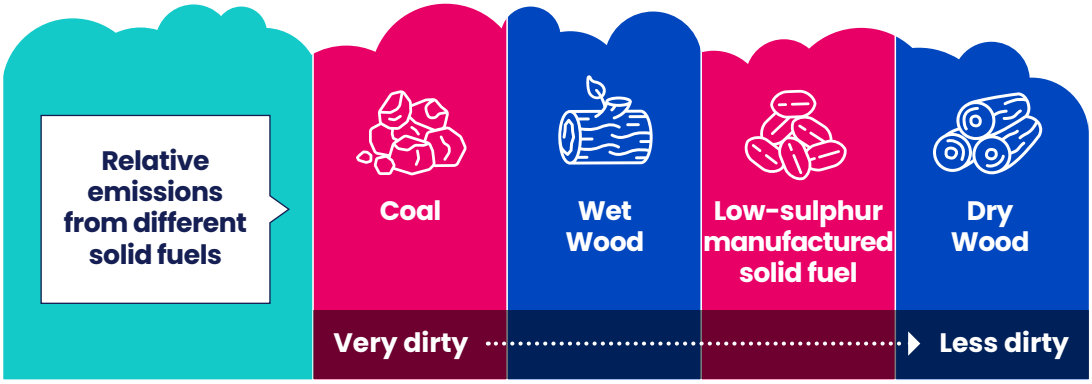
**Low-income communities**

# What is the link between domestic solid fuel use and pollution in London?

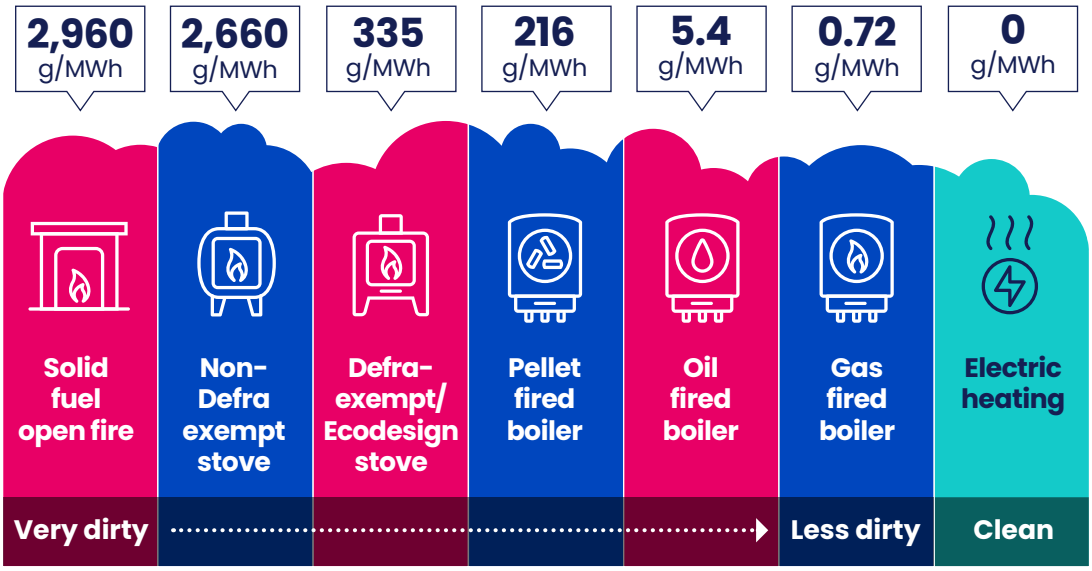
## The burning of solid fuels in homes for heating is a common practice in rural areas and it is also an important source of pollution in London as it has seen a resurgence in urban areas[5].

The increase in the use of solid fuels for heating in the home has also led to an increase in the emission of harmful air pollutants from this source, which will have detrimental impacts for human health. In the case of fine particulate matter ($PM_{2.5}$) emissions, there are choices that can be made when burning solid fuels that make a difference. Among other factors, these emissions are dependent on[6/7]:

**Type of solid fuel**



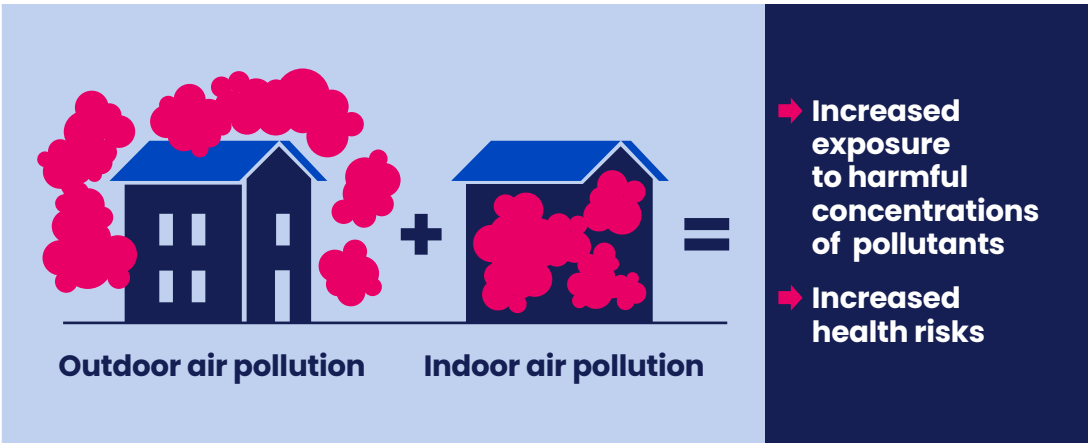

**Type of solid fuel burning appliance**




Note: Image provided by Defra

For many sources of pollution (such as road transportation), the key focus is on their contribution to 'outdoor' air pollution and the exposure of the population at large. However, for domestic solid fuel combustion, the exposure of households to the effects of 'indoor' air pollution also poses a critical health risk. This is compounded by the fact that the UK population spends on average 80-90% of its time indoors, the majority of which (60%) is spent in our own homes[8].

## Type of air pollution




5 Airborne particles from wood burning in UK cities, King's College London 2017. https://uk-air.defra.gov.uk/assets/documents/reports/cat05/1801301017_KCL_WoodBurningReport_2017_FINAL.pdf

6 Consultation on cleaner domestic burning of solid fuels and wood, Defra, ,2018. https://consult.defra.gov.uk/airquality/domestic-solid-fuel-regulations/

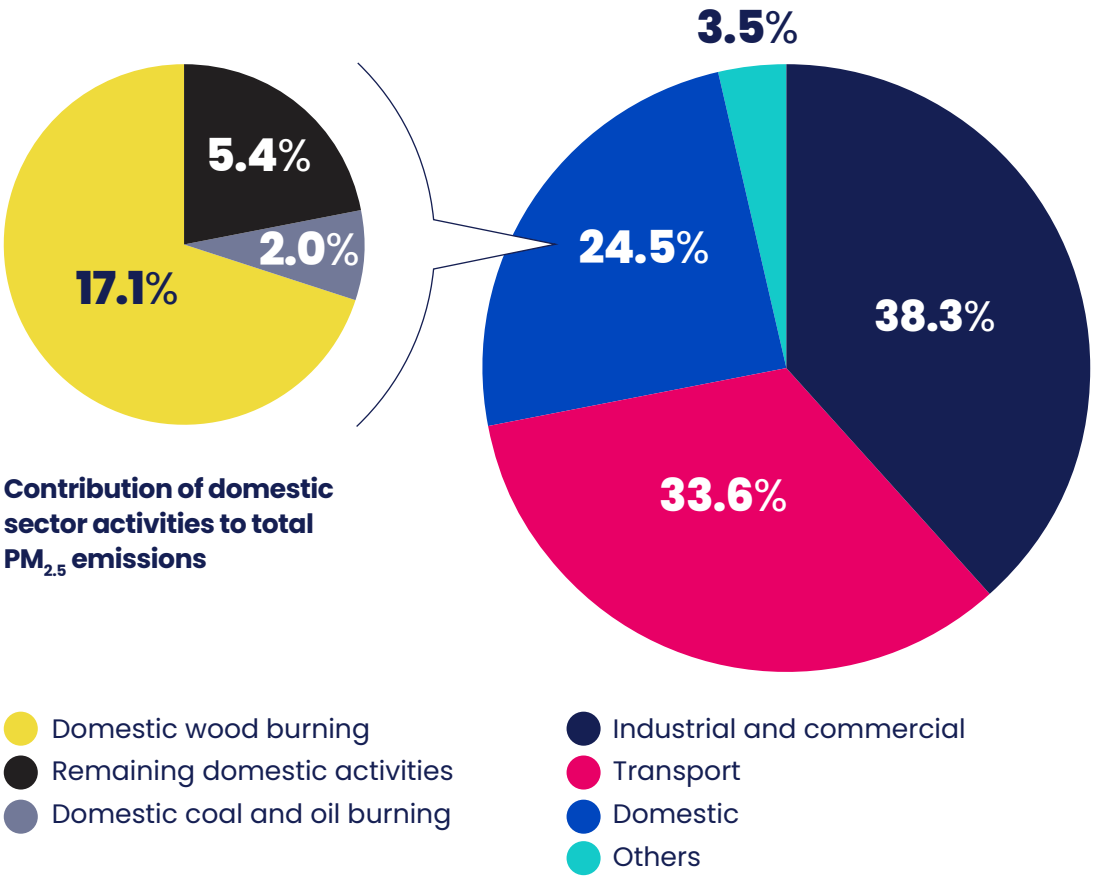
7 Smoke plumes are not to scale. Emission factors show emissions in the home – emissions during production of fuel or electricity are not included here. Emission factors taken from EMEP 2016 Guidebook (1A4 – small combustion tables). The following definitions were used: Solid fuel open fire: wood burner in an open fire; non-Defra approved stove: wood inn a conventional stove; Defra-approved/Ecodesign stove: wood in an advanced/ecolabel stove; Pellet fired boiler: wood in pellet stoves and boilers; Oil fired boiler: fuel oil in a medium (>50 kWth <1MWth) boiler; Gas fired boiler: natural gas in a small (<= kWth) boiler.

8 Indoor Air Quality Guidelines for selected Volatile Organic Compounds (VOCs) in the UK, Public Health England, 2019, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831319/VO__statement_Final_12092019_CS__1_.pdf

The chart below illustrates the breakdown of the contributions to $PM_{2.5}$ emissions from the key sectors included within the London Atmospheric Emissions Inventory (LAEI)[9]. As shown below, domestic emissions in London account for approximately a quarter of total $PM_{2.5}$ emissions. More specifically, wood burning is the largest source of domestic emissions, and accounts for approximately 17.1% of total $PM_{2.5}$ emissions in the Greater London region (69.8% of $PM_{2.5}$ emissions from the domestic sector). The burning of solid fuels in domestic settings is therefore a key contributor to $PM_{2.5}$ emissions in the Greater London region.[10]

Emissions of $NO_x$ (which includes $NO_2$) from the burning of solid fuels in the domestic sector contributes a smaller proportion of total $NO_x$ emissions in Greater London. However, due to the adverse health effects associated with $NO_x$ air pollution it remains important to consider these emissions.

**Sectoral contributions to total $PM_{2.5}$ emissions in the Greater London Region**




Source: based on 2019 LAEI data

9 The LAEI is an inventory containing modelled air pollutant emissions and concentrations across the Greater London Region https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory--laei--2019

10 London Atmospheric Emissions Inventory (LAEI), 2019, https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory--laei--2019

# What is the impact of domestic solid fuel use on health in London?

The findings presented below are based upon the LWBP commissioned 'Health Impact Evaluation' led by Ricardo Energy & Environment. The study was commissioned to explore the direct relationship between solid fuel burning and human health in the Greater London region (and more specifically within the 15 participating boroughs).

Health impacts were calculated following best practice guidance relating to the appraisal of effects. In particular, this followed the example set by Defra (and the use of air quality damage costs), and advice from the Committee on the Medical Effects of Air Pollutants (COMEAP)[11]. Through the application of these findings the impacts of exposure to harmful air pollutants on health, as a result of solid fuel burning, can be estimated.

**Estimates of the health impacts were made considering:**

| **Geographic area:** | **One activity within the domestic sector:** | **Two groups of fuels:** | **Two pollutants:** | **10 health impact pathways** |
|---|---|---|---|---|
| Greater London | Solid fuel burning | 'Coal and oil' and 'wood' | $PM_{2.5}$ and $NO_2$ | |

Note: It should be noted that, although oil is not a solid fuel and is outside the scope of the study, 'coal and oil' has been considered as the second fuel group due to the categorisation of the data obtained from the London Atmosphere Emissions Inventory.

The study shows that the health impacts on the inhabitants of Greater London from the burning of solid fuels in the residential sector are considerable, especially those generated by the finer particulates from wood burning. The health effects of $PM_{2.5}$ and $NO_2$ concentrations derived from the burning of solid fuels in the domestic sector include new cases of asthma in children, strokes, coronary heart disease, lung cancer and new hospital admissions for respiratory diseases every year.

11 Statement on the Evidence for the Effects of Nitrogen Dioxide on Health, COMEAP, 2015 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/411756/COMEAP_The_evidence_for_the_effects_of_nitrogen_dioxide.pdf
The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom, COMEAP, 2010, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/304641/COMEAP_mortality_effects_of_long_term_exposure.pdf

The results of the study found that the largest overall health impact was attributed to the $PM_{2.5}$ emitted as a consequence of wood burning. This was followed by impact upon human health as a result of $PM_{2.5}$ released from coal and oil, and then $NO_2$ from coal and oil. The emissions, and therefore health impact, as a result of $NO_2$ emitted through wood burning is negligible. These impacts are consistent across all health pathways within the scope of the study (displayed in the figures below).

The expected impact from $PM_{2.5}$ emissions on mortality (i.e. deaths, expressed in terms of lost life years) caused as a result of wood burning is up to 10 times larger than $PM_{2.5}$ from burning coal. However, it is important to note there are detrimental health impacts as a result of both wood burning and the burning of coal and oil. A key reason for the larger impact is the increased prevalence of wood burning compared to the burning of coal and oil across London.

The results presented in the figures below represent the annual human health impact across the Greater London region (encompassing solid fuel burning in the 32 boroughs and the City of London)[12] associated with one year of domestic solid fuel burning and the resulting emissions[13]. For example, as a result of $PM_{2.5}$ emitted from wood burning there are estimated to be 73 annual respiratory hospital admissions and 84 admissions linked to new cases of asthma in older children aged between 6 and 15.[14]

### $PM_{2.5}$ health impacts from wood burning

**3,035**
Chronic mortality - LYL

**73**
Respiratory hospital admission - # Hospital admissions

**84**
Asthma (Older Children) - # Hospital admissions

**48**
CHD - # New cases

**59**
Stroke - # New cases

**28**
Lung Cancer - # New cases

Scale: The image of one person represents 1,000 people.
The shaded pink area represents the number of people impacted.

12 The results included within the broader study include an assessment of the impacts of solid fuel burning within each of the 15 boroughs.

13 All results present impacts associated with one year of exposure. All health impacts then occur within that year, with the exception of life-years lost (LYL) which are calculated over a period of 100 years, to account for the assumed lag in effects between exposure in a given year, and the impacts associated with that exposure which occur in the first year and for many years after.

## $PM_{2.5}$ health impacts from the combustion of coal and oil

**395**
Chronic mortality - LYL

**9**
Respiratory hospital admission - # Hospital admissions

**11**
Asthma (Older Children) - # Hospital admissions

**6**
CHD - # New cases

**8**
Stroke - # New cases

**4**
Lung Cancer - # New cases

Scale: The image of one person represents 100 people.
The shaded pink area represents the number of people impacted.

## $NO_2$ health impacts from the combustion of coal and oil

**44**
Chronic mortality - LYL

**5**
Respiratory hospital admission - # Hospital admissions

**1**
Asthma (Older Children) - # Hospital admissions

**3**
Asthma (Small Children) - # Hospital admissions

Scale: The image of one person represents 10 people.
The shaded pink area represents the number of people impacted.

14 "Hospital admissions for asthma" differs from "respiratory hospital admissions", as according to the 'Air Quality Appraisal: Impact Pathways approach', asthma is one of the health impact pathways included in the morbidity effects associated with long-term (chronic) exposure, whereas respiratory hospital admissions is the health impact pathway selected to show the morbidity effects of short-term exposure. Both HIP show respiratory conditions, but they're presented separately to differentiate effects associated with long-term and short-term exposure. https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-impact-pathways-approach
The age boundaries of children (small/older) have been based upon boundaries used in a 2017 study on air pollutant exposure: Exposure to traffic-related air pollution and risk of development of childhood asthma: A systematic review and meta-analysis - ScienceDirect

The burning of wood in a proportion of London's households has a widespread effect that ultimately impacts on all Londoners, including those residing in households that do not burn wood:

**Life expectancy is reduced**

**Increased incidence of health conditions affecting wellbeing and quality of life**

**Vulnerable groups such as children are particularly affected**

## Health impacts each year

**+3,400**
Life-years lost

**–3 weeks**
Reduction in life expectancy at birth*

**284**
Equivalent deaths**

**+80**
Respiratory hospital admissions

**+60**
New cases of stroke

**+50**
New cases of coronary heart disease

**+30**
New cases of lung cancer

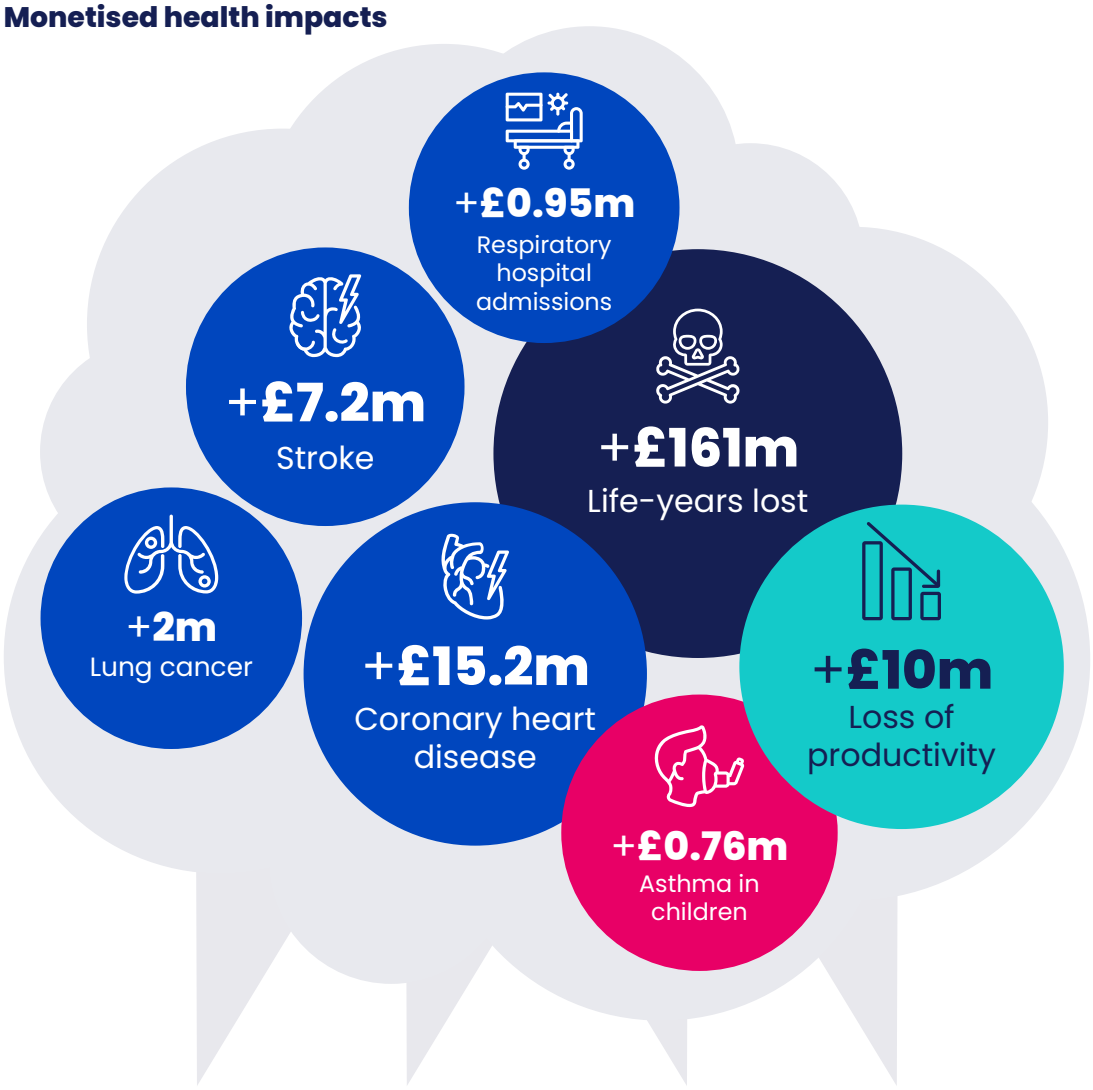
**+90**
New cases of asthma in children

Notes: * Reduction in life expectancy at birth for all persons (assuming individuals are exposed to air pollutant concentrations over their lifetime); **associated effect on mortality presented as equivalent deaths each year, at typical ages of death in 2019 in the UK.

The health impact of these pollutants can also be expressed in monetary terms since they have substantial economic consequences. These costs capture the combined value that people place on their own good health, economic productivity impacts and costs to NHS.

The loss of more than 3,400 years of life alone incurs a cost of more than £161 million per year. The monetised impact of all health effects expressed as new cases and new hospital admissions per year exceeds £26 million and, within that total, the effects of coronary heart disease account for more than £15 million. Finally, lost productivity also has a significant economic impact, in excess of £10 million. All these health impacts have a total cost of more than £197 million per year, which equates to a cost per inhabitant of approximately £24 per year.

**Monetised health impacts**




| Health costs | Economic costs | Total costs | Cost per London resident |
|---|---|---|---|
| +£187m per year | +£10m per year | +£197m per year | +£24 per year |

The study also considered whether the detrimental health impacts of solid fuel use could be higher for particular demographic and social groups in society. The relationship between air pollutant concentrations of $PM_{2.5}$ generated by domestic solid fuel burning, with information on the demographic characteristics of different areas of London – namely areas with higher or lower levels of deprivation, children, elderly, or Black and minority ethnic populations was also explored. Although the review found that some of the most deprived areas in London had the highest concentrations of $PM_{2.5}$ emitted by domestic use of these fuels, the results showed that these observations were at selected locations only and that there was not an overall statistically significant trend for any of the groups considered. As such, the exposure to particles produced by domestic solid fuel burning is widely felt across London regardless of the affluence of an area, citizen age or ethnicity.