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Background

The UK Environmental Audit Committee aims to determine the adequacy of measures in 2023 to promote indoor and outdoor air quality. Poor air quality damages people's health and the natural environment and has been described as the largest environmental risk to the public's health. There have been calls for better coordination between national and local actors on efforts to improve air quality and especially as this pollution is unevenly distributed across the UK – clearly an environmental justice issue. Poor air quality is also a major driver of biodiversity decline in the UK and other parts of the world [14].

The coroner's report on the death of Awaab Ishak, who was found to have died from a severe respiratory condition caused by prolonged exposure to mould in his home, highlighted the significant impacts of poor indoor air quality [14]. Similarly, the coroner's report on the tragic death of nine year-old Ella Roberta Adoo Kissi-Debrah resulted in Ella becoming the first person in the world to have air pollution listed as a cause of death on her death certificate. Until dying from an asthma attack in 2013 Ella had lived near London's South Circular road and been exposed to levels of air pollution that exceeded the legal limits and the WHO standards [2].

The UK has legal air quality limits for major pollutants at a national and local level, including ammonia, fine particulate matter (PM_{2.5}), nitrogen oxides (NO_x), non-methane volatile organic compounds and sulphur dioxide. PM_{2.5} is potentially the most harmful to human health due to its small size allowing it to travel deep into the alveoli of the lungs. In 2023 the Government set new targets for fine PM_{2.5} to be met by 2040. However, these targets are less ambitious than the latest public health guidance from the World Health Organisation (WHO) which has revised targets that are half of the UK ones and with aims to be achieved in a shorter time frame [14].

This paper is an opinion piece that addresses aspects of ten questions raised by the committee:

1. What evidence exists of the extent of air pollution directly or indirectly impacting health of individuals or communities in England?

There is a growing substantial body of evidence that air pollution globally has serious impacts on health and wellbeing affecting most major organs within the human body including lungs, heart, brain and also bones and bladder [11,13,16]. The range of illnesses based on epidemiological studies and correlational research analysis include allergies and autoimmune diseases, osteoporosis, cancers including childhood leukemia, a spectrum of cardiovascular problems, reduced cognitive function, diabetes, reduced visual capacity, skin irritations, respiratory problems, liver and renal diseases, and several acute gastrointestinal illnesses. It appears that all parts of the body are potentially at risk from toxic, reactive and acidic gases that can dissolve into the blood and micro particles that can also pass through the alveoli walls in the lungs [11]. Poursafa *et al* (2022) provide one pathway through DNA metabolic processed that could explain how some of these diseases arise, yet further work is recommended [9].

The air pollution does not only affect humans [5,10]. Many of the plants and animals harmed provide vital roles in a range of ecosystem services [7]. The harm done to birds and many animals also has a negative impact on the wellbeing of people as many consciously value being part of nature and thrive when able to interact with the natural environment. Several psychological studies have shown the benefits of spending quality time in pristine countryside, but where people are struggling to breathe easily it is hardly the rewarding or enriching experience that they should have a right to, desire and need. Most communities in the UK may not suffer the very visual poor quality air seen in some large cities in Asia for example. However, that does not mean that high levels of pollution are present at certain time and certain locations. Therefore, it is essential to continue full monitoring, extending the number of studies that seek to determine both the extent and mechanisms that cause health problems. Furthermore, there needs to be much greater awareness raising of the effects and education of the general public as to how they can protect themselves. There is good news relevant to this. That with the right legislation improvement is possible. Leonard (2020), for example, claims that ozone reduction laws developed and enforced during the past four decades in the US may have protected the lives of one and half billion birds [8].

2. Are the current national targets for outdoor air pollution ambitious and wide-ranging enough to provide adequate protection for public health and the environment in:

a) rural

In addition to air pollution from transport, certain forms of electrical power generation, quarrying, construction and some industrial sources rural locations can potentially be exposed to ammonia from agricultural animal waste. This reacts with NO_x and sulphur dioxide, which contributes to ozone formation. Generally ammonia levels have fallen in the last four decades but the decline has not been entirely consistent in recent years and has even shown some signs of an upturn [4]. In March 2021 the ozone level in rural Rochester Stoke in Kent exceeded the population information threshold of $180 \mu\text{g m}^{-3}$. This was the only recorded level above the threshold, but that does not mean that the air quality was acceptable in areas where monitoring was not taking place. The Automatic Urban and Rural Network (AURN) is the UK's largest automatic monitoring network, making up a significant proportion of the UK's statutory monitoring evidence¹. However, according to the DEFRA website there are only 171 current monitoring sites, many of which are in urban locations. This is hardly a comprehensive representation of rural Britain.

b) urban areas

According to the UK Parliament POSTnote 691 although particulate matter and nitrogen dioxide levels in urban areas are on average decreasing there is a slight increase in street level ozone [2]. In some locations the levels of some serious pollutants are above the WHO guidelines. Even taking new targets of the revised UK National Air Pollution Programme that were set earlier in 2023 these are still double the revised WHO guidelines [14]. And these levels are just for people, we have very limited data on what is tolerable to other organisms in the environment. As the Royal College of Physicians (2016) report emphasises: every breath we take affects our health from conception to old age [13]. So if we, and other organisms, are being exposed to

¹ AURN includes automatic air quality monitoring stations measuring NO_x , sulphur dioxide, ozone, carbon monoxide and PM_{10} , and $\text{PM}_{2.5}$. These sites provide high resolution hourly information which is communicated rapidly to the public, using a wide range of electronic, media and web platforms. Data from the AURN are also available on Defra's online UK Air Information Resource, UK-AIR at <https://uk-air.defra.gov.uk/>.

elevated levels of toxins it seems very likely that current targets not going to provide adequate protection for public health in some urban areas.

3. What are the long-term health impacts of indoor air pollution?

There have been, according to Fuller, Friedman, Mudway and Mills (2023), at least 50 000 research articles published relating air pollution to health, and well over half of those are within the last ten years. The more recent research has found lifelong impacts, leading to increased burden of disease with unknown economic and societal costs [6]. Fuller *et al* give a clear summary of triangulated epidemiological and correlational studies illustrate how air pollution may impact throughout foetal, childhood and adolescent development and beyond into adulthood and old age. There are differences between indoor and outdoor air pollution, but pollution outdoors will drift indoors when windows and doors are open. Conversely, if houses are not well ventilated then indoor air pollutant levels can build up as has happened some toxins can build up to unhealthy levels and in the case of radon in certain regions or carbon monoxide from poorly maintained gas burners.

4. What steps can the Government take to improve indoor air quality?

The most significant measure to improve indoor air quality is awareness raising. This should be focusing on educating the general public of the causes, the extent of the negative effects on health, and ways to reduce indoor air pollution. This will include advertising or public announcements similar to road safety campaigns, but should be extended from traditional media to reach people through social media platforms. To support the public monitor their own levels of indoor air quality, low cost sensors should be freely available for loan in the same way as books have available from libraries for well over 100 years. This would form a massive data base for more fully comprehensive monitoring. In public buildings such as council premises, workplaces, and offices, hospitals, schools, libraries, museums, places of worship, sports centres etc., etc. air quality certification² could be a compulsory requirement. To offset the cost

² AirRated is a company based in London that provides different tier certificates on Indoor Air Quality

of this it could be linked to insurance such as public liability that would be an added incentive for responsible parties to do their utmost to ensure a healthy working environment. Naturally, indoor air is influenced by external conditions, so there would be a need to assess this in relative terms for insurance purposes. There could also be tax incentives for employers fitting air quality improvement systems or encouraging cycle / walk to work schemes. Short haul flights should be banned within the UK if alternative transport could reach the target destination within an acceptable time frame. For instance, if train travel can reach Plymouth from London in under four hours is there really a *need* for air travel over that distance? By the time travelers have gone to the airport, queued for check in waited for preflight checks and other necessary stages for travel it is questionable whether there is any significant difference in time between public transport and air travel over such distances for the average passenger.

5. What are the differential impacts, geographically, and across socioeconomic groups, of poor outdoor and indoor air quality?

Obviously people next to major sources of pollution from traffic, heavy industry and certain agricultural sources will be more at risk than people living in comfortable suburbs with low volumes of traffic and little industry in the vicinity. The cost of housing in these later areas is premium over other very urban districts, and affordable council or association housing facilities tend to be in the former areas. Added to this the cheaper housing is often located much closer to roads with little possible protection due to a dilution effect over the distance of green spaces like flourishing parks and gardens, or filtering by hedgerows or trees.

Regarding domestic air pollution for example, are people fully aware of potential risks from seemingly innocuous activities such as using certain air fresheners, scented candles, vaping, barbeques or even from regularly inhaling certain cooking vapours such as those that may come from deep fat fryers in poorly ventilated situations. As fuel prices rise some people will be less likely to open windows and ventilate rooms properly in cold months. Others may be tempted to use damp wood and other unsuitable combustibles in wood burners that have been given approval only when tested under very controlled conditions using idealised dry fuel stock

[3]. It will be the less advantaged households who, if they do have access to a fireplace or solid fuel stove, will be more likely to opt for cheaper alternatives.

There is much evidence from surveys and researchers of how unaware the general public are regarding the domestic sources as risks to their health[3]. In rural northern and central Thailand for example a small survey of approximately 570 adults in three different rural locations in 2020 found that less than 10% of people were aware that air pollution was linked to some neurological disorders, the majority were unaware that ozone was unsafe to breathe or that it was potentially damaging to crops [15]. One encouraging outcome following this survey was that over half of the respondents requested further information and a follow up study in 2022 showed a significant increase in the knowledge and understanding of the sources and effects of air pollution. Further research is needed to assess *long term* behavioural change. The same needs to be done in the UK; although the sources and types of air pollutants and associated health risks will be different there is likely to be similar degrees of ignorance and spectrum of related negative long term health issues.

6. Are measures to address poor air quality appropriately targeted?

Different sources of air pollution contribute different toxins, different volumes or concentrations and at different peak times to the overall blend that the population is exposed to. For this reason, there is a need for local authorities to have more control and power to enforce regulations. These authorities also must be held accountable if measures are not met. One of the major sources of pollution is from congested traffic and there needs to be much greater incentives for people to shift from their love affair with the car to sharing public mass transport systems. In London the levels of passenger traffic on the tube has not returned to pre-pandemic levels in part due to rising travel costs. The point is that much more needs to be done to develop usable and affordable mass transport systems that help to reduce road traffic. The congestion charge in London may be a slight deterrent for some low income people, but there are many middle and high income people who still prefer the comfort of using their own vehicle. But, it is this high volume of traffic that is one of the main sources of toxic gases. So more needs to be done at source, rather than spent on mopping up the problem. This would

obviously have value added benefits of working towards reduced greenhouse gas emissions as well. The shift towards electric vehicles may appear to help, but there will be huge volumes of air pollution linked to the manufacture of the vehicles and their batteries, the extraction of the materials needed to build them and during the use of non-renewables in generation of electricity to maintain their functioning. So, with all those externalities accounted for it is unclear to the overall extent they improve air quality.

7. What are the differential impacts, geographically, and across socioeconomic groups, of poor outdoor and indoor air quality?

There needs to be studies carried out that looks for correlations between school locations, levels of air pollution, proximity to sources of pollution, socioeconomic status of the students' families and the cognitive abilities of the students themselves along with other health measures such as asthma rates. Students in the most at risk locations should be more closely monitored for a wider range of possible health issues and be given full training and resources to protect themselves from further harm.

8. Are measures to address poor air quality appropriately targeted?

There is a need to address ultimate rather than proximate causes regarding outdoor air pollution just like when treating a disease. Otherwise there will be a continual need for ongoing "medication" and there is a risk that other "symptoms" will arise and unforeseen damage will be incurred in other parts of the system. To this end air quality targets and indicators for monitoring air quality across the country need to be explicitly linked to net zero targets, the public health agenda, and related goals of improving biodiversity within the UK.

9. How well is the Government spreading awareness of the impacts of poor air quality and promoting action being taken to tackle the issue?

To achieve significant and embed behavioural change in the general public a determined campaign to raise awareness of the causes and the extent of the effects of poor air quality needs to be established. The goal to reduce road traffic accidents and fatalities³ has been

achieved in a variety of ways: speed kills, drink driving, seatbelt advertising campaigns, legislation, monitoring and enforcement, technological improvements in vehicles, and as public awareness has been raised several ultimate behavioural causes have become taboo behaviours. For example letting a child not wear a seat belt would not have been considered as neglect in most people's minds forty years ago, but nowadays many people would remonstrate parents who failed to do this. It is this level of joined up approaches that need to be planned for regarding air pollution that kills, reduces life expectancy and negatively impacts the quality of life of many, many more people than are involved in road traffic accidents or, in the long run, more people than were lost in the Covid pandemic.

10. How well is the Government coordinating measures between national and local actors to improve air quality, both outdoors and indoors?

The BBC recently reported the lack of capacity in the national grid that is causing significant delays in the development of many community and sustainable energy projects that would significantly assist in both reducing air pollution and contribute towards net zero targets [12]. There are similar concerns within the motor industry that the lack of battery manufacturing capacity in the UK will cause problems for the viability of making electric vehicles. These wider issues must be addressed.

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