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Innovating UK clean air policies
to prevent cognitive disorders

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Mitigating the Impact of Air Pollution on Brain Health and Dementia

POLICY AND PRACTICE BRIEF

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Emerging research suggests exposure to high levels of air pollution at critical points in the life course is detrimental to brain health, including cognitive decline and dementia. Social determinants such as socio-economic deprivation, environmental factors, and heightened health and social inequalities also play a significant role and make the problem more complicated. While policy and practice strategies have been proposed to address air pollution's impact on public health more generally, their benefits for brain health, including dementia, remain undeveloped [1, 2]. This policy brief suggests necessary advances across policy and practice to mitigate air pollution and its impact on brain health and dementia.

BRAIN
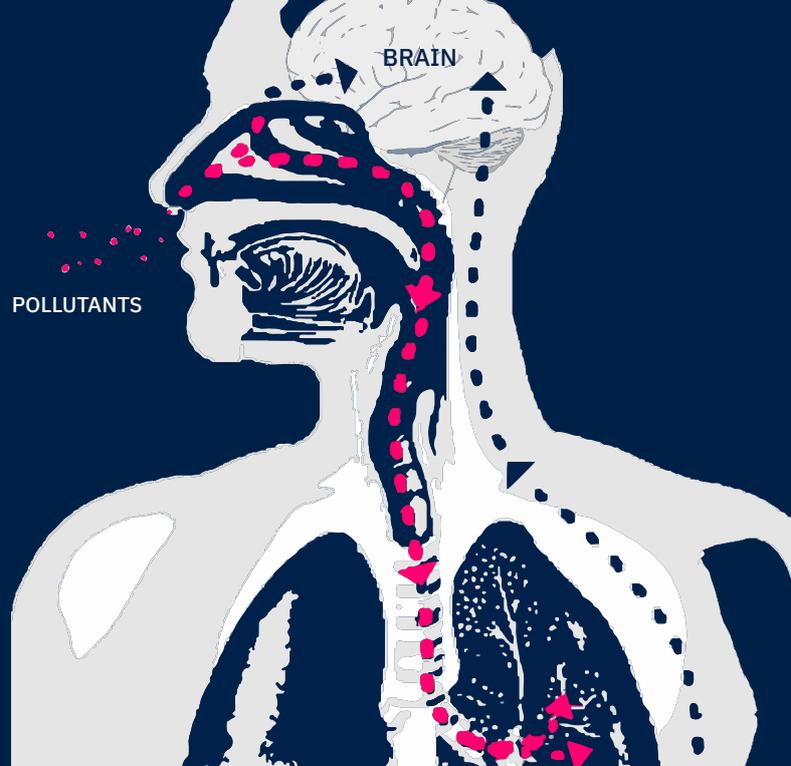
POLLUTANTS

Introduction

New research shows exposure to high levels of air pollutants, particularly in early life increases the risk of dementia syndrome and related disorders [e.g., 3, 4-7]. The WHO estimates that roughly 55 million people have dementia worldwide, at a global cost of roughly $1.3 trillion; and this figure is expected to rise to 139 million by 2050, with an estimated global cost of $2.8 trillion.[1] Given the global impact of air pollution on brain health and dementia, prevention through air quality improvement could lead to better-quality health outcomes, improve productivity and quality of life, and reduce health-related costs [e.g., 1, 2, 8].[2]

However, this public health challenge is very complex since social determinants of health play a major role in air pollution's impact on brain health and dementia [9, 10]. They do so through their complex intersection, which creates the larger, emergent systems in which people are born, live, work, and age [11, 12]. Public health experts call these "systems" impact the "effects of place" [13]. Examples include how the causal loop between poverty, living near an industrial air pollution source, and social inequalities across the life course impact cognitive decline and neurodegenerative disorders in older, urban populations [e.g., 3, 8, 14]. Or how air pollution exposure in early-life impacts adolescent global cognition, due to poor health behaviours, limited access to green space, living in congested housing with poor indoor air quality and walking to school on highly trafficked roads [15-19].

Such a complex issue requires an innovative systems approach to policy and practice [20, 21]. However, while strategies have been proposed to address the impact that air pollution has on public health more generally, their benefits for brain health and dementia are just beginning to be explored [1, 2]. This lack of policy development is an immediate public health concern, given the gravity of the links between places, air pollution, brain health, and dementia [2, 22].

Over the course of two years, we worked as a consortium of 20+ academics to develop the first policy agenda for mitigating air pollution's impact on brain health and dementia. We engaged with 11 stakeholder organisations, ran a participatory systems mapping workshop, and conducted an umbrella review of 38 articles and 6 policy papers for the last ten years of research.

Through thematic analysis, we identified two policy domains, including **Education and Awareness** and **Policy Evaluation**. Around these two domains, we arrived at **8 priority areas** that need to take place to co-produce a policy agenda for addressing the impact of places on air quality and brain health across the life course.[3] We characterise these suggestions in the following.

Suggested advances

1 Education and Awareness

Making this unrecognised public health issue a known concern

There is growing mindfulness that air quality may impact brain health [e.g., 23]. However, the details of this link, including the role of social determinants, are less clear. According to our study, not only funding organisations are oblivious to this issue, but also air pollution and public health experts are unaware. Hence, we recommend the need for researchers in the field to get the message out through various academic outlets.[4]

Moreover, if the links between air quality and brain health are significant, including early-life cognitive development and later-life dementia, and if the places where people live and work matter, then these linkages need to be made known to public and third-sector organisations, including dementia and Alzheimer's societies, healthcare organisations, school boards, healthcare practitioners, and government programmes and international organisations focused on mitigating air pollution or improving brain health outcomes. The call for awareness workshops as well as national and international public awareness campaigns are also needed.

Developing educational products

Most of the stakeholder organisations asked that educational outputs be a policy priority area. This ranged from lesson plans on healthy air and happy brains for primary and secondary schools [link] to newsletters and blog posts for those living with or caring for someone with dementia. They emphasised that education needs to focus on local framings, collective responsibility, and action. Education also needs to provide people with positive messages and actionable items. It should also connect with people's emotions, to help them overcome disengagement or a sense of powerlessness.

Another actionable item is co-producing educational products, as when communities work together, it usually leads to collective corrective actions [24].

Attaching air pollution and brain health to existing strategies and campaigns

According to our investigations, the public and third-sector stakeholder organisations saw the direct benefits of either (a) adding air pollution to their existing campaigns for brain health and dementia or (b) adding brain health

to their current strategies around air quality improvement, climate change, or sustainable development goals. They wanted help making use of current evidence to bolster their campaigns and to demonstrate co-benefits, be it around dementia awareness and brain health or a clean air programme or initiative.

We endorse this idea, seeing it as a key priority. Hence, current evidence can be added to stakeholder organisations' newsletters and social media, and to their outreach to healthcare practitioners and those living with or caring for someone with a brain health disorder.

This action is an immediate win; because from a policy perspective, these existing campaigns are tried-and-tested and have often established a level of credibility, trustworthiness, and authority with the public, government, civil service, third-sector, and private-sector organisations. Thus, it takes less time and investment to add current evidence to existing air quality or brain health strategies and campaigns.

This action also gives the field of air quality and brain health time to further develop policy recommendations and strategies, as well as work with stakeholders on policy development and evaluation.

Providing publicly available monitoring, screening, and assessment tools

Another key priority area is determining what publicly available data and tools are needed to decide where, when, and how interventions can make the most impact. This priority area is more than raising awareness or education. It is about monitoring, screening, and assessment.

An identified need of stakeholders is for ambient and indoor air pollution datasets and models to be translated into usable, publicly accessible resources for people, healthcare providers, governments, and third-sector and private-sector organisations. Such tools would include a fusion of monitoring data and modelling to provide near-real time air quality exposure information. These datasets could be accessible through online dashboards or other public outputs, including television and print media. Developing such tools would also help governments, public institutions, and healthcare organisations with the identification, assessment and monitoring

of cohorts, communities, and places most at risk for brain health [1]. These data, in turn, could be used to create historical and regularly updated air quality and brain health profiles for countries, regions, cities, communities, schools and even particular streets, available for public consumption.

A second actionable item would be developing screening and assessment tools for individual exposure, particularly during early life and at critical points in the life course where air pollution is most impactful on brain health. This would also include personal and mobile monitors for indoor and outdoor exposure [e.g., 25, 26, 27].[5]

The third actionable item is developing tools for assessing health behaviours, pre-existing conditions, or comorbid health conditions that prevent, slow down, or exacerbate the impact of air pollution on brain health.[6] These tools could be also used to potentially slow the progression of cognitive disorders, cognitive decline, and even dementia, post-diagnosis [e.g., 6, 7, 28].

2 Policy Evaluation

Conducting complex systems evaluation

The air quality and brain health of different populations are directly linked to the complex socioecological systems in which they live. These systems also emerge out of the nexus of wider social determinants and their intersection with exposure profiles and public health across the life course. In addition, the causal pathways by which places impact air quality and brain health create an intricate web of causal connections, including nonlinear feedback loops and unintended consequences. Therefore, any policy evaluation needs to make such 'complexities of place' a priority.

Adopting a complex systems perspective does not necessarily require whole-systems evaluations, which may be unfeasible; neither does it mean that evaluations have to be complex. Instead, it requires the realisation that even the simplest policy or practice strategies take place in complex systems, making outcomes often difficult to predict, guide, manage or control. This realisation is particularly important when making small or large-scale changes to social determinants such as poverty, transportation, health inequalities, and urban planning [29].

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4 One example is the July 2022 report Air pollution: Cognitive Decline and Dementia, released by the UK Committee on the Effects of Air Pollution (COMEAP). https://www.gov.uk/government/publications/air-pollution-cognitive-decline-and-dementia

5 Although we acknowledge issues involved in the validity and reliability of this technology
6 Although the ethical and legal implications of such public health screening strategies and data collection would need to be addressed.

Therefore, we recommend that policy evaluation for air quality and brain implement a complex systems approach, consistent with wider trends in public policy evaluation [e.g., 12, 20, 29-32]. We recommend drawing from the highly developed literature on complexity in evaluation to adopt best practices; augmenting conventional evaluation methods with the latest developments in participatory systems mapping, agent-based modelling, and case-based modelling [e.g., 33, 34, 35]; mapping barriers and incentives to change and counterfactuals [36]; and embracing a co-production approach to evaluation.

Engaging in co-production and participatory research

The identified needs of stakeholders and people living with or caring for someone with brain health issues can be kept at the forefront of research and policy. For example, we found that, for those living with dementia, a key concern is how air pollution may accelerate the progression of their disease; in contrast, parents and school systems were concerned with cognitive development, school performance, and early-life screening; in turn, local planning boards were focused on the benefits of green urban planning and public transportation; and civil servants were concerned with sustainable development goals and the health burden and economic costs of dementia and other brain conditions over the next two decades.

Being responsive and sensitive to these varied interests is challenging. In each instance, it is critical to calibrate the process of co-production within the operating context of each stakeholder organisation, as each situation requires different types of engagement [see 37, 38, 39]. The best way to provide the evidence necessary is to work with stakeholders to understand and incorporate nuances from the beginning of the research process.

We also recommend that regional, national, and international differences in resources, politics, and culture as well as local capacity be taken into consideration. The populations most negatively impacted by air pollution are often those struggling with the greatest levels of inequality, vulnerability, and political economy, particularly in poor urban environments. We, therefore, emphasise the importance of *local-level co-production and engagement.*

Evaluating current air quality policies for brain health benefits

We advocate engagement with current policies for air pollution and public health in general, to evaluate them for their brain health benefits [e.g., 40, 41, 42]. We recommend evaluating this existing repository straightaway, which would allow policymakers to fast-track guidelines and resources for planning and prevention across the life course, and at multiple levels. We also recommend exploring wider policy needs beyond just emissions reduction, such as improving public health inequalities, creating dementia-friendly communities, upgrading school zones, improving public transportation, addressing housing congestion, and enhancing climate change reductions, as well as linking air pollution and brain health to legally binding net zero targets, which would provide a unique policy opportunity to deliver ambitious and transformative place-based changes.

COMPLEX SYSTEM
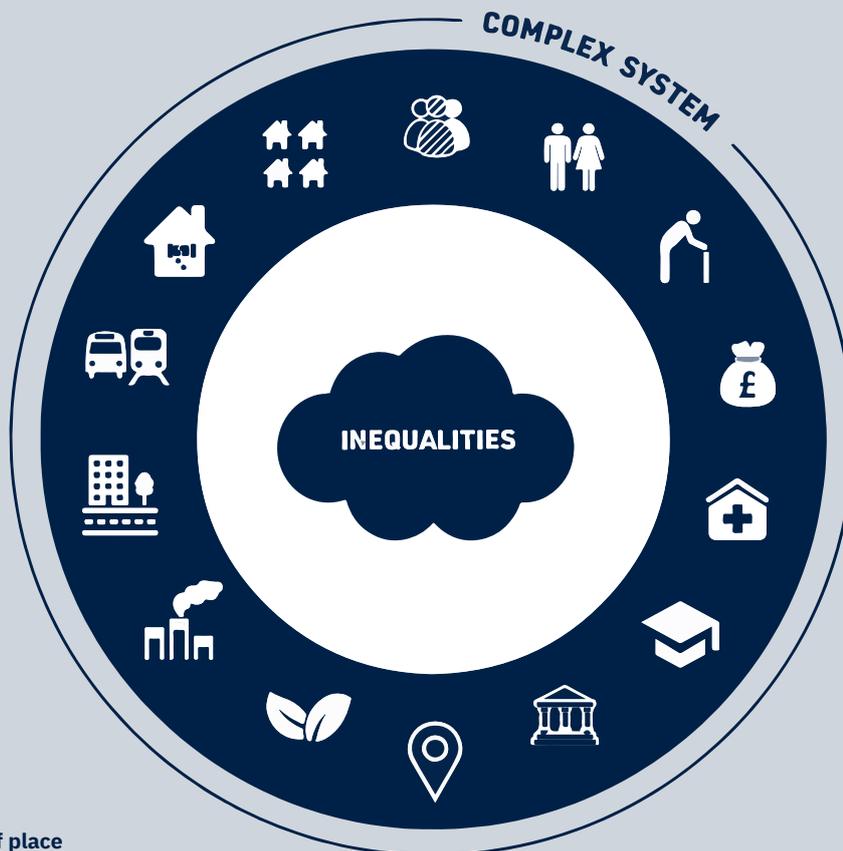
INEQUALITIES

The importance of place
Understanding the social
determinants of air pollution and
related health inequalities

Conclusion

There is no one way to move forward with our proposed policy agenda and our suggested priority areas differ in terms of their urgency, feasibility, and impact, as well as the parties primarily responsible for their enactment, depending upon which stakeholders, policymakers, or funding organisations within and across different countries are considering them.

Nevertheless, amongst all suggestions, *raising awareness* and *attaching air pollution and brain health to existing campaigns and strategies* of *public and third-sector organisations* are proximately attainable and can have a significant and immediate impact.

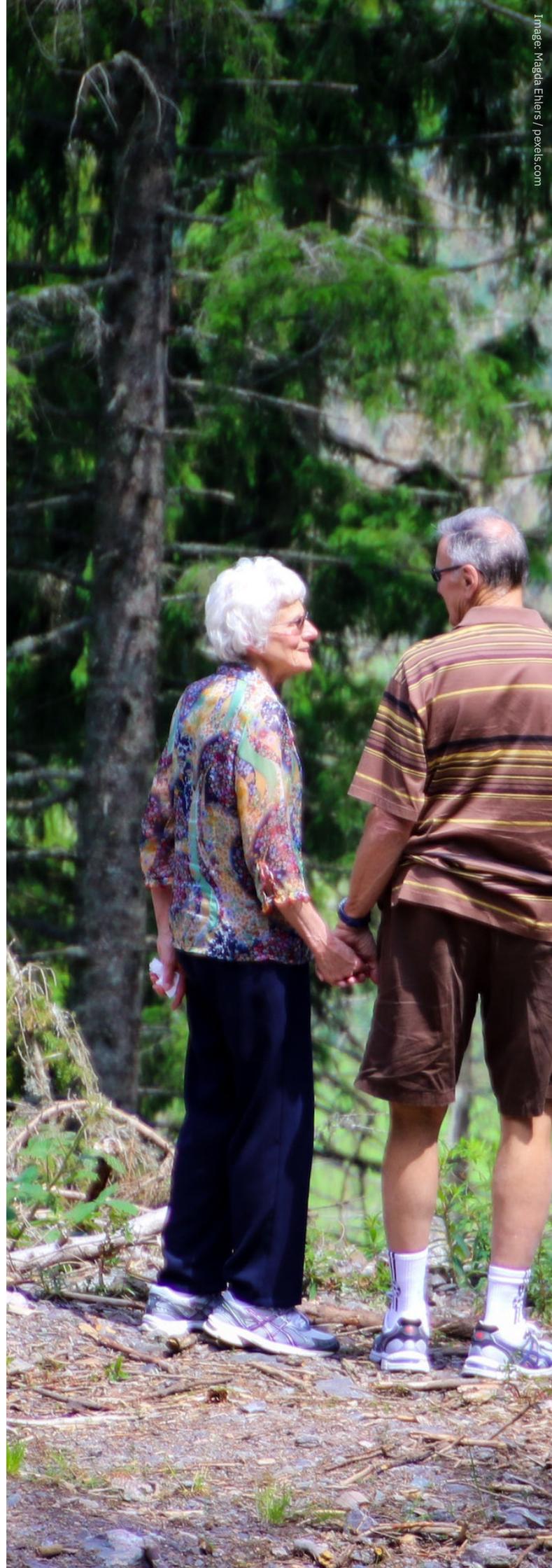## We would also like to emphasise two considerations:

First, any policy agenda needs to be matched by scientific evidence and appropriate guidelines, including bespoke strategies to optimise impact and mitigate unintended consequences. Advances in policy, therefore, be they regionally, nationally, or internationally, need to be matched by *advances in research, evaluation, and education.*

Second, we should emphasise the need for *funding organisations* to support these advances, in particular the high-risk/high-payoff science that is needed to address the complex details of this public health issue. One of the most striking results of our study is the extent to which funding agencies were not only unaware of the impact that air pollution has on brain health, but also how resistant they were to acknowledge the emerging research in this area. It has created a policy gridlock where more funded research outputs are required to inform the major interdisciplinary grant funding applications which are critical to achieving major priorities in this area.

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InSPIRE is a UK policy and research consortium devoted to mitigating the impact that air pollution and the exposome have on brain health (including cognitive function, mental health and dementia).

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