



Clearing the air: Assessing healthcare professionals' awareness of air pollution's health consequences

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ABSTRACT

Air pollution (AP) significantly jeopardises health, with the Royal College of Physicians accepting the adverse effects of AP are not being sufficiently communicated to patients by healthcare professionals (HCP). To explore HCPs' understanding and attitudes toward AP and its health impacts, we conducted a service evaluation survey in a group of hospital doctors.

A questionnaire comprising 20 questions about AP and its health associations was completed by 133 hospital doctors working at University Hospital Southampton NHS Foundation Trust, UK.

While 65% ($n = 86$) of respondents strongly agreed that AP is relevant to health, 79% ($n = 105$) felt insufficiently trained on AP and its health associations.

The survey shows that HCPs' knowledge of AP and its connection to poor health is a major barrier in discussions with patients. Further research is needed to understand whether these views are nationally shared among HCPs and to explore the most effective strategies for enhancing AP awareness.

Introduction

Air pollution (AP) poses a significant health risk, with 99% of the world's population residing in areas exceeding WHO guideline levels, resulting in an estimated 6.7 million premature deaths annually.¹ Disproportionately affecting those in low-resource settings, AP not only jeopardises health but also incurs economic cost, reducing productivity and escalating healthcare spending.¹ AP-related expenses are expected to cost the NHS £5.56 billion between 2017 and 2025.²

In the UK, a 2020 landmark inquest highlighted the severe health impacts of poor air quality (AQ). The death of 9-year-old Ella Adoo-Kissi-Debrah from asthma, which she had for only 30 months and, following 27 hospital admissions, was attributed to illegal levels of outdoor air pollution near her London home, just 30 m from a highly polluted road.³ Similarly, a 2022 coroner's report linked the death of 2-year-old Awaab Ishak to prolonged mould exposure caused by dampness in his home.⁴

Prompted by Ella Adoo-Kissi-Debrah's case, the Royal College of Physicians acknowledged insufficient communication of AP's adverse effects on health by healthcare professionals (HCP).⁵ Citing a report by the Royal College of Paediatrics and Child Health, they emphasised the need to educate HCPs and the public on AP's profound harms, highlighting HCPs' role in protecting vulnerable patients.^{6,7}

Despite ample evidence on the link between AP and health, there is limited understanding of HCPs' knowledge and attitudes towards AP. Previous research suggests that a knowledge gap on the long-term health effects of poor AQ and risk reduction strategies among HCPs may be a primary barrier to counselling patients.^{8,9} Implementation deficits in clinical settings, stemming from diffusion of responsibility or time constraints, may further impede effective health communication between HCPs and patients.⁸ To explore hospital doctors' knowledge of and attitudes toward AP and its health associations, a pilot survey was conducted at the University Hospital Southampton NHS Foundation Trust.

This article reflects the opinions of the author(s) and should not be taken to represent the policy of the Royal College of Physicians unless specifically stated.

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Methods

We designed a cross-sectional quantitative survey with 20 multiple-choice questions around hospital doctors' knowledge and attitudes towards AP and its health impacts. Questions were drafted by one author (LO) with direct input from others (TD). This draft was then reviewed, discussed, and revised in collaboration between four authors (TD, LO, JB and SH), two of whom have extensive experience in devising surveys and educational material. The survey covered participant demographics to discern varying attitudes across distinct age and professional cohorts, aiming to explore potential prospects for tailored interventions within diverse professional groups. Additionally, it assessed respondents' awareness of the Ella Adoo-Kissi-Debrah case to gauge their general understanding of environmental health issues, the intersection of climate change with health implications, and the importance of AP to different health systems. Guillain-Barré Syndrome (GBS) was included as a 'red herring' option to assess and minimise response bias by testing participant behaviour and quality of engagement with the questionnaire. GBS is the only condition on the list which, to the best of our knowledge, has no link to AP. Additional questions gathered insights on AP-related discussions with patients, communication training received, perceived communication barriers, and professional responsibilities (see *Table S1* for the questionnaire). The survey attempted to strike a balance between ascertaining key insights into the knowledge and attitudes of hospital doctors while maintaining brevity to accommodate the busy schedules of clinicians. To foster additional feedback and insights, a comment section was included at the end of the questionnaire, providing respondents with space for thoughts and suggestions to improve future survey iterations. This pilot survey captures only a subset of HCPs, with the aim of exploring similar themes among other staff groups in future.

The electronic survey, hosted by Google Forms (Google, Mountain View, California, USA), was distributed to all medically qualified staff at University Hospital Southampton NHS Foundation Trust (Southampton, UK), a large university teaching hospital, via email lists on 8 August 2021. Two reminder emails were sent 1 week and 2 weeks later, and the survey was closed on 8 September 2021. Out of 1,751 email recipients, 133 (7.6%) responded.

Survey data was analysed using Excel (Microsoft, Redmond, Washington, USA) and presented as raw numbers and percentages in text and tables. Because of the small sample size, no statistical analysis was undertaken.

Results

Out of 133 survey respondents, 61 (46%) identified as female and 72 (54%) as male. The majority were white ($n = 102$, 77%) and relatively evenly distributed across age groups. Most survey respondents were consultants ($n = 84$, 63%), as shown in *Table 1*.

Among the survey respondents, 83 (62%) were familiar with the Ella Adoo-Kissi-Debrah case, but only 19 (14%) reported in-depth knowledge (*Fig. 1*). Older hospital doctors (55–65 years) were more likely to be familiar with the case than their younger counterparts (18–34 years). While the majority ($n = 86$, 65%) strongly agreed that AP is directly relevant to general health, only 27 (20%) covering a range of specialties strongly agreed that it is directly relevant to their patient populations. Numbers of respondents, however, were too small to identify trends. As shown by *Fig. 2*, the most common health conditions thought to be affected by AP were respiratory diseases such as lung cancer ($n = 112$, 84%) and pneumonia ($n = 107$, 81%), and cardiovascular (CV) diseases, such as stroke ($n = 69$, 52%) and myocardial infarction ($n = 85$, 64%). A sizeable proportion of respondents erroneously considered GBS to be linked to AP ($n = 14$, 11%), suggesting a degree of response bias. This value was similar to response rate for other condition, which are linked to AP, such as schizophrenia, colorectal cancer, breast cancer and kidney disease. Notably, only 94 (71%) considered the healthcare industry a significant contributor to AP, contrasting with high attributions to the

Table 1
Demographic characteristics of survey respondents.

Variable ($n = 133$)	Frequency	Percentage (%)
Age (years)		
18–34	32	24.1
35–54	78	58.6
55+	22	16.6
Prefer not to say	1	0.7
Gender		
Female	61	45.9
Male	72	54.1
Prefer not to say	0	0
Ethnicity		
White	102	76.6
Asian	22	16.5
Arab	3	2.3
White and Black African	2	1.5
Any other ethnic background	3	2.3
I do not wish to disclose	1	0.8
Grade		
Consultants	84	63.2
Specialty registrars	20	15
Fellows	8	6
Core trainee	7	5.3
FY1, FY2	6	4.5
SAS	8	6
Specialty breakdown^a		
Internal medicine	30	22.6
Cardiology	7	5.3
Respiratory medicine	6	4.5
Intensive/critical care and anaesthesia	29	21.8
Haematology/oncology	12	9
Surgical specialties	11	8.3
Neurology	11	8.3
Paediatrics	7	5.3
Obstetrics and gynaecology	6	4.3
General practice	5	3.8
Geriatrics	5	3.8
Radiology	5	3.8
Others ^b	17	12.8

Abbreviations: FY, Foundation year; SAS, Specialty and specialist doctors.

^a Respondents could select more than one option.

^b Other specialties included pathology ($n = 4$), dermatology ($n = 3$), ophthalmology ($n = 3$), clinical genetics ($n = 2$), palliative medicine ($n = 2$), and occupational health ($n = 1$). Two respondents selected 'Prefer not to say'.

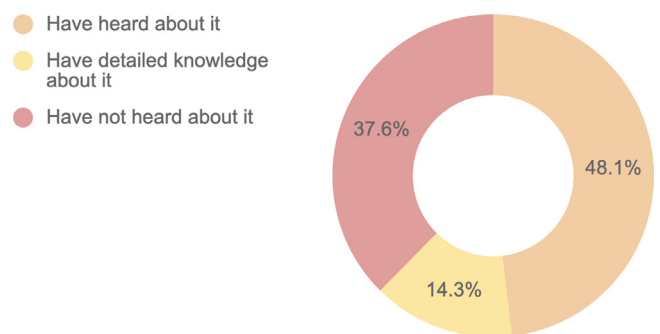


Fig. 1. Knowledge of the Ella Adoo-Kissi-Debrah case among survey respondents.

aviation ($n = 123$, 93%), shipping ($n = 119$, 90%), and electricity and gas production industry ($n = 128$, 96%). This is despite the contribution from healthcare in modern economies being similar to that of agricultural or aviation sectors.¹⁰ Most respondents either never ($n = 84$, 63%) or rarely ($n = 38$, 29%) discussed AP's health effects with patients, and when conversations occurred, both hospital doctors and patients were equally likely to initiate them.

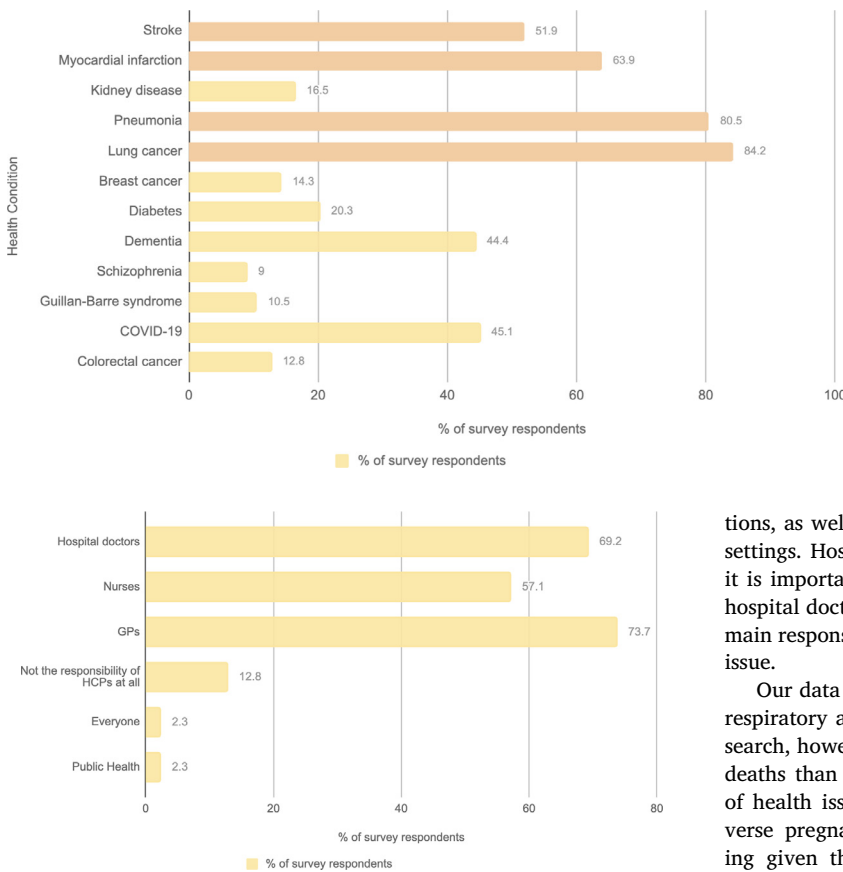


Fig. 3. Responsible roles regarding air pollution and health of the patients. Percentage of survey respondents who considered several professions responsible for engaging in discussions around the adverse health impacts of air pollution (multiple selections possible).

Surveyed hospital doctors (79%) felt inadequately trained on the evidence associating AP and health, with only 2 (2%) respondents feeling comfortable discussing it with patients. Among those comfortable ($n = 18$, 14%), the majority ($n = 13$, 72%) held senior clinical positions. Barriers to more discussions included lack of knowledge ($n = 95$, 71%), time constraints ($n = 34$, 26%) and perceived lack of relevance to medical practice ($n = 31$, 23%). Physicians believed initiating AP-related conversations was the responsibility of GPs ($n = 98$, 74%), hospital doctors ($n = 92$, 69%) and nurses ($n = 76$, 57%). Some hospital doctors ($n = 17$, 13%) disagreed that HCPs had a role in engaging in discussions about AP with their patients at all (Fig. 3). However, most agreed that HCPs should advocate for the importance of AP in the context of population health ($n = 109$, 82%).

Respondents highlighted their limited knowledge in general comments and recognised AP as a social determinant of health with ties to environmental and social justice. Many expressed the need for multifaceted approaches involving various public institutions to address AP-related health impacts.

Discussion

This survey of hospital doctors' knowledge and attitudes towards AP and its health impacts reveals that a majority of respondents are aware of the link between AQ and health and its relevance to the patients seen in their practice. And yet over three quarters rarely or never discuss AQ with their patients, highlighting a critical discordance identified in the Ella Adoo-Kissi-Debrah coroner's report. The challenge seems to stem from a lack of knowledge on specific individual impacts and ac-

Fig. 2. Air pollution and its health impacts. Percentage of survey respondents who considered air pollution to be a significant contributor to several health conditions (multiple selections possible). All conditions mentioned have a recognised contribution to aetiology, other than Guillain-Barre Syndrome which was included as a 'red herring'. The four most commonly selected options are highlighted in orange.

tions, as well as uncertainty about how to broach the topic in clinical settings. Hospital doctors appear to know 'what' AQ is, but not 'why' it is important to discuss with patients, nor 'how' to discuss it. Some hospital doctors also consider discussing AP with patients beyond their main responsibility, reflecting the social and political dimension of this issue.

Our data suggests that hospital doctors primarily associate AP with respiratory and, to a lesser degree, CV health conditions. Previous research, however, suggests that AP may contribute to twice as many CV deaths than respiratory deaths, and is implicated in a broader range of health issues, including cancers, mental health disorders, and adverse pregnancy outcomes.^{11,12} This knowledge gap is not surprising given the historical absence of focus on the impact of AP on health in medical education, and the lack of knowledge on the long-term effects of AP and the mechanisms by which it causes adverse health outcomes among HCPs.^{8,13} Although training interventions have shown promise in boosting HCPs' confidence in addressing specific health topics, integrating AP discussions into clinical practice with short consultation time remains challenging.^{14,15} Therefore, further research on how best to integrate AP conversations into consultations is required.

This pilot survey has significant limitations. Firstly, a small sample size and a low response rate of 7.6% may have introduced response bias, as reflected in the preponderance of consultant and specialty registrar respondents. This is particularly interesting given the interest of young people in climate change advocacy and suggests that our survey may not have successfully reached younger hospital doctors. The finding that 10% of survey respondents opted for the 'red herring' option GBS (similar to a number of conditions in which AP does play a role) further suggests that a notable proportion of respondents may not have been fully engaged or attentive to the survey questions. An alternative and not mutually exclusive message from this is that detailed knowledge of which conditions AP plays a significant role is limited. The small sample size of this survey further limited our ability to stratify responses by medical specialty. Understanding inter-specialty variations in the level of training on AP and its health impacts is required to understand where to focus resources and training. Secondly, the study's focus on hospital doctors within a singular institution limits generalisability. Clinicians working at other hospitals may have received different training on the health implications of AP and strategies for addressing them with patients, thus potentially yielding distinct responses. In addition, hospital doctors only make up about 13% of the NHS workforce and are outnumbered by more than two to one by nurses and midwives, who themselves deliver a large amount of healthcare advice. Thus, more work is required to understand the awareness of, and barriers to, air pollution education in other HCP groups. Lastly, the brevity of this survey only provides a snapshot of information. It does not inquire about respondents' training background or identifies resources they may find useful at different

stages of medical training, nor explores the accuracy of reported knowledge.

Further work is required to build on the findings of this pilot survey. A comprehensive national study, including a representative sample of hospitals and other healthcare institutions, including GP practices, would be required to enhance the generalisability of our findings and to understand how often HCPs in the wider NHS engage in discussions regarding AQ with patients. Particularly significant is the understanding of GPs' role, given their pivotal position in building and maintaining long term trusting relationships with patients, whilst having very limited consultation time.¹⁶ Additionally, including other clinical staff like nurses and allied HCPs will help provide a more nuanced perspective on how targeted interventions could be delivered at different levels of care. Importantly, delving deeper into the specifics of AP training currently received by HCPs and exploring potentially beneficial training initiatives is warranted to come up with targeted strategies. Lastly, we advocate for a focused examination of the barriers and facilitators surrounding conversations concerning AQ and its health implications with patients in future surveys. Beyond this, it is essential to understand what a whole system approach to protecting patients from the adverse health effects of poor AQ could look like. Organisations involved in AQ measurement and interventions should be closely linked to health services and local communities to understand local variations in AQ and foster interdisciplinary partnerships. These partnerships are essential for implementing proactive measures aimed at mitigating AP levels and safeguarding community well-being.

Numerous efforts to prioritise planetary health teaching within the medical curriculum are underway. These include the integration of General Medical Council (GMC)-recommended learning outcomes on sustainable healthcare and planetary health, the appointment of planetary health teaching fellows at medical schools, and the implementation of standardised assessments to evaluate medical schools' adherence to planetary health metrics.¹⁷⁻¹⁹ Other promising, practical initiatives aim at training climate-aware healthcare providers, such as incorporating environmentally focused history-taking exercises using simulated patients.²⁰ At the postgraduate level, there is a need for improved clinical and communication guidelines about AQ in patient consultations. In the UK, Joint Royal College of Physicians' Training Board (JRCPTB)²¹ oversees the curricula for postgraduate speciality training of physicians. However, the terms 'pollution' and 'air quality' receive just a single mention across all 34 specialty physician curricula (in the respiratory curriculum), totally 2,040 pages of higher specialist medical education. This is despite all but one of the curricula having been rewritten *after* the publication of the coroner's 'Prevention of Future Deaths' report, which detailed the requirement for HCPs to discuss the contribution of AP to patients' health.³ This is a missed opportunity that should be addressed in the future. As well as overarching structural changes, there is a need to understand how best to deliver impactful education on a more granular level. A recent study found that short, animated videos can significantly improve HCPs' understanding of the health impacts of AP and bolster their confidence in providing patient counselling.⁹ This may be a particularly effective and fast learning tool applicable across various training levels. In addition to national changes in the UK worth exploring, local initiatives may already be in place. Where these exist, they should be evaluated, and successful programs should be implemented elsewhere. In our hospital trust, partnerships have been established with local and national organisations to provide education for HCPs on AQ.^{22,23} Furthermore, participation in annual events on 'Clean Air Day', which may include activities like stalls at hospitals displaying local pollution statistics raising awareness to raise awareness among the general public, may be promising.²⁴

Conclusion

That AP is important to health is not contentious. However, despite the UK chief medical officer's 2022 report and the report by the coroner

in the Adoo-Kissi-Debrah case, this work suggests that AP is not discussed by most hospital doctors, and that the major impediment to more frequent and better discussions with patients is lack of education and training. This is perhaps not surprising given the absence of explicit references to 'air quality' and 'pollution' in the mandatory requirements for new medical graduates set forth by the GMC, and in the JRCPTB's higher specialty training curricula. If the coroner's demands are to be enacted, then the importance of AQ needs to be incorporated into all aspects of formal medical training, as well as into training for HCPs who are already qualified. This necessitates a concerted effort to expand upon these initial findings, explore their applicability across other groups of HCPs, and understand the best way to provide the education to HCPs that is required.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions

TD conceptualised the original idea. TD, SH, JB and LO contributed to conceptualising and refining of the pilot questionnaire. LO and TD conducted the pilot survey and collected the data. LH and DY analysed the collected data. LH, DY, CJ and TD created the first draft of the manuscript. All other co-authors reviewed and revised the manuscript draft. The final version was approved by all co-authors prior to publication.

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Data availability statement

All relevant data has been included in the article or the supplementary materials. Additional data are available upon request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.fhj.2024.100130](https://doi.org/10.1016/j.fhj.2024.100130).

References

1. WHO. *Ambient (outdoor) air pollution*. 2022 [cited 2023 Dec 11, 2023]; Available from: [https://www.who.int/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health).
2. Pimpin L, Retat L, Fecht D, et al. Estimating the costs of air pollution to the National Health Service and social care: an assessment and forecast up to 2035. *PLoS Med*. 2018;15(7):e1002602.
3. Philip Barlow, Assistant Coroner, Inner South London, *prevention of future deaths report relating to Ella Adoo Kissi-Debrah*. 2021: Courts and Tribunals Judiciary <https://www.judiciary.uk/wp-content/uploads/2021/04/Ella-Kissi-Debrah-2021-0113-1.pdf>.
4. Joanne Kearsley, Senior Coroner for the Coroner area of Manchester North, *prevention of future deaths report relating to Awaab Ishak*. 2022, Courts and Tribunals Judiciary <https://www.judiciary.uk/wp-content/uploads/2022/11/Awaab-Ishak-Prevention-of-future-deaths-report-2022-0365>. Published.pdf.
5. Royal College of Physicians. *Communicating the Adverse Effects of Air Pollution on health: Progress Report*; 2022 London.
6. Royal College of Paediatrics and Child Health, *Every breath we take: the lifelong impact of air pollution*. 2016.
7. Holgate ST. Every breath we take: the lifelong impact of air pollution' - a call for action. *Clin Med*. 2017;17(1):8-12.
8. Powell P, Brunekreef B, Grigg J. How do you explain the risk of air pollution to your patients? *Breathe*. 2016;12(3):201-203.
9. Doheny BM, Inglis JJ, Lunos S, et al. Short animated video increases knowledge and perceived comfort in clinical counseling on inequitable health impacts of air pollution among interprofessional health learners and clinicians. *BMC Med Educ*. 2023;23(1):858.
10. Pichler P-P, Jaccard IS, Weisz U, et al. International comparison of health care carbon footprints. *Environ Res Lett*. 2019;14(6):064004.

11. Lelieveld J, Klingmueller K, Pozzer A, et al. Cardiovascular disease burden from ambient air pollution in Europe reassessed using novel hazard ratio functions. *Eur Heart J*. 2019;40(20):1590–1596.
12. Sun Z, Zhu D. Exposure to outdoor air pollution and its human-related health outcomes: an evidence gap map. *BMJ Open*. 2019;9(12):e031312.
13. Bevan J, Blyth R, Russell B, et al. Planetary health and sustainability teaching in UK medical education: a review of medical school curricula. *Med Teach*. 2023;45(6):623–632.
14. Tavakoly Sany SB, Behzad F, Ferns G, et al. Communication skills training for physicians improves health literacy and medical outcomes among patients with hypertension: a randomized controlled trial. *BMC Health Serv Res*. 2020;20(1):60.
15. Howard S. Doctors have a role in tackling air pollution: here's how some are rising to the challenge. *BMJ*. 2023;380:409.
16. Elmore N, et al. Investigating the relationship between consultation length and patient experience: a cross-sectional study in primary care. *Br J Gen Pract*. 2016;66(653):e896–e903.
17. Bevan JH, Kumaran K, Walker IV, et al. Every medical school should have a planetary health teaching fellow. *BMJ*. 2023;382:2026.
18. Medical School Council. *Education for sustainable healthcare – a curriculum for the UK, MSC* <https://networks.sustainablehealthcare.org.uk/resources/education-sustainable-healthcare-curriculum-uk>.
19. Planetary Health Report Card Initiative. *Planetary health report card*. 2024 [cited 2024 Jan 29, 2024]; Available from: <https://phreportcard.org/>.
20. Ramkumar J, Rosencranz H, Herzog L. Asthma exacerbation triggered by wildfire: a standardized patient case to integrate climate change into medical curricula. *MedEd-PORTAL*. 2021;17:11063.
21. Joint Royal Colleges of Physicians Training Board. *The physician training pathway*. 2024 [cited 2024 Mar 25]; Available from: <https://www.thefederation.uk/training/specialties>.
22. The Environment Centre. *Cutting carbon across Southampton, Hampshire and Portsmouth*. 2024 [cited 2024 Mar 23]; Available from: <https://environmentcentre.com/>.
23. Global Action Plan. *Action for clean air*. 2024 [cited Mar 23 2024]; Available from: <https://www.actionforcleanair.org.uk/>.
24. NHS Mid Yorkshire Teaching. *Clean air day*. 2024 [cited 2024 Mar 23]; Available from: <https://www.midyorks.nhs.uk/clean-air-day/>.