# INDOOR AIR QUALITY: SHOULD WE BE WORRIED?

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## CONTEXT

**We spend around 85-90% of our time indoors in developed countries such as the UK, including in our homes, at work and commuting between the two. However, with the exception of occupational settings, regulation around air pollution exposure focuses almost entirely on outdoor air pollution. If we want to understand our overall exposure to air pollution, and then design scientifically rigorous mitigation strategies, we need to consider exposures to both indoor and outdoor air pollution.**

## INDOOR AIR POLLUTION

Indoor air pollution can derive from numerous sources and materials. Some of the air pollution we are exposed to indoors comes from outdoors, for instance through open windows and doors. If a building is located on a busy road, traffic emissions could be a major source of indoor air pollutants. Indoor sources include activities such as cooking, cleaning, fuel burning on open fires or inefficient/poorly maintained stoves, DIY activities, smoking and the use of personal care products and air fresheners. There are also sources of pollution from furnishings and building materials, as well as bio-effluents (e.g. carbon dioxide and numerous other chemicals) from people. Finally, there can be chemical and physical interactions between air pollutants and/or internal building surfaces, which can produce even more air pollutants indoors.

The indoor air quality in a building will therefore depend on its location, how it is ventilated (naturally or mechanically) and the activities inside it. Unlike for outdoor air quality, the indoor air quality can differ significantly along a street from building-to-building, even in identical houses. Human behaviour plays a large part in the composition of indoor air pollution, making it challenging to generalise between buildings.

## UNEXPECTED CONSEQUENCES

The discussion so far has shown that indoor air quality is influenced by a wide range of potential sources, the emissions from which are then modified by physical, chemical and behavioural factors. It is vital that both indoor and outdoor sources of air pollution are considered when trying to understand the overall exposure and consequent health effects of an individual. Otherwise, by trying to avoid one source of pollution, you may inadvertently expose an individual to higher (and potentially more harmful) concentrations of a different pollutant. For instance, shutting the windows of a house to avoid traffic exhaust from cars outside, may lead to higher exposure to cigarette smoke generated by a smoker indoors. In addition, cleaning and cooking indoors can lead to the production of particulate matter, and the use of fragranced products can produce formaldehyde, both of which are associated with adverse health effects.

Our current drive to increase energy efficiency in buildings as

we move towards our net zero aspirations could also have unanticipated consequences if not considered carefully. Energy efficiency in buildings is often achieved through increased insulation, which generally leads to more airtight buildings. However, more airtight buildings mean that species emitted indoors take longer to be diluted and removed. If these species have impacts on health, we may just be replacing one problem with another.

## RELEVANCE FOR POLICY MAKERS

There are several issues for policy makers to consider when it comes to indoor air pollution. It would be very difficult to regulate indoor air quality in homes, although there is some general advice that can be shared as summarised at the end of this article. Public buildings would be an easier place to start and a recent European project (INDAIRPOLLNET: Indoor Air Pollution Network) involving 200 scientists led by the University of York, suggested how we might start to put regulations in place using a fairly simple approach[1].

In the meantime, we need to better regulate the products we take into and use in our homes. These include cleaning products, scented candles, and building and furnishing materials, all of which emit chemicals when used[2]. Products need to be tested in realistic indoor environments, rather than the carefully controlled laboratory environments they are tested in at the moment. Such testing environments should encompass the temperature and humidity fluctuations, and mixtures of indoor air pollutants typically found in houses. Clearer labelling would also help consumers to choose lower emission products and materials, maybe using a traffic light system such as that adopted for the sugar and salt content of food. On a related note, our recent research has shown that some products marketed as 'green' or 'natural', often contain more volatile organic compounds and at higher concentrations than regular products[3]. There is an implicit assumption that such products are better for health and/or environment. Such labels are confusing for the consumer and need to be more carefully defined.

There also needs to be regulation around air cleaning devices. These devices often claim to remove bio-pathogens (such as covid) and/or air pollutants such as particulate matter. Whilst some of them are effective, others are less so and some use chemical reactions internally that can cause harmful products to be emitted upon use. As these devices are largely unregulated at the moment, it is important to understand the full impacts of any instrument used in a building, particularly in a school or a healthcare setting. The UK Government's SAGE Environmental Modelling Group recently published a comprehensive report on these air cleaning devices, and particularly their use during the covid pandemic[4].

INGENIOUS

## TRANSFORMING INDOOR AIR QUALITY KNOWLEDGE THROUGH UK SCIENCE

At the University of York, we are currently leading 2 projects to better understand the science behind indoor air quality, with the aim of informing policy in this area. The first is called INGENIOUS (Understanding the sources, transformations and fates of indoor air pollutants) and aims to better understand air pollution in our homes[5]. We are focusing on the city of Bradford, which has a multi-ethnic population, high levels of deprivation and some of the highest childhood illness rates in the UK. The Born in Bradford study[6] is involved in this project, which is a long-term health research study involving 30,000 Bradfordians. We are making indoor air pollutant measurements in 300 Bradford homes, whilst tracking resident behaviour through diaries, which should allow us to better understand links between indoor air pollution, behaviour and health.

The second project aims to build a new indoor air quality testing facility called INTERIORS (An Interdisciplinary Facility for Indoor Air Quality and Health Research) on the University of York campus. The facility will comprise two houses with an integrated air pollutant sampling laboratory. One of the houses will be standard build, whilst the other will be built to Passivhaus standard, and thus can be thought of as a proxy for our net zero housing of the future. INTERIORS will be used to quantify the emission rates of speciated pollutants from key indoor products (e.g. cleaning products, air-fresheners, building materials), understand how these emissions and resulting concentrations are affected by ventilation characteristics (standard versus Passivhaus), house design, furnishings, chemical transformations and occupant behaviour, and how emissions from indoor materials vary over time and in realistic environments. Concurrent outdoor measurements of air pollutants will also be made, allowing investigation of the exchange of pollutants between indoors and outdoors.

## WHAT CAN WE DO IN THE MEANTIME?

There are several ways to lower exposure to indoor air pollutants in any setting.

- Avoid excessive personal care or cleaning product use and always follow manufacturers instructions
- Always use cream products instead of spray products: the latter form aerosols, which are much easier to breathe in.
- Use a cooker hood (that ventilates outdoors) while cooking and regularly clean the filter. If you don't have a cooker hood, open the window while cooking and for 10 minutes afterwards.

- Use the back rings on a hob, as cooker hoods work more efficiently over the back rings.
- Switch from a gas hob to an electric or induction hob if possible.
- Ventilate regularly with outdoor air if it is relatively clean: if you live near a road, use a window on the other side of the building, or open windows outside of rush hour.

Finally, there is a clear need for a holistic approach to considering how to provide the best possible indoor air quality, through combining the expertise and experiences of building designers, managers, and users. It also requires a more joined up approach across Government, given the cross-cutting nature of the topic and to avoid some of the unintended consequences highlighted above.

**References**


1. INDAIRPOLLNET website. https://indairpollnet.york.ac.uk/policy-launch accessed February 27th, 2024
2. Weschler, C.J. and N. Carslaw, Indoor Chemistry. Environmental Science & Technology 2018 52 (5), 2419-2428, DOI: 10.1021/acs.est.7b06387
3. Harding-Smith, E., D.R. Shaw, M. Shaw, T.J. Dillon and N. Carslaw (2024). Does green mean clean? Volatile organic emissions from regular versus green cleaning products. Environ. Sci.: Processes Impacts, 2024,26, 436-450.
4. SAGE Environmental Modelling Group (2020) Potential application of air cleaning devices and personal decontamination to manage transmission of COVID-19, 4 November 2020 https://www.gov.uk/government/publications/emg-potential-application-of-air-cleaning-devices-and-personal-decontamination-to-manage-transmission-of-covid-19-4-november-2020 accessed February 27th, 2024
5. INGENUIOUS website. https://ingenious.york.ac.uk/home accessed February 27th, 2024
6. Born in Bradford website. https://borninbradford.nhs.uk/ accessed February 27th, 2024


**Other resources that provide more information:**

The RCPCH and Royal College of Physicians Report 'The inside story: Health effects of indoor air quality on children and young people (2022). https://www.rcpch.ac.uk/resources/inside-story-health-effects-indoor-air-quality-children-young-people

CMO report on air pollution from 2022: https://assets.publishing.service.gov.uk/media/639aeb81e90e0721889bbf2f/chief-medical-officers-annual-report-air-pollution-dec-2022.pdf ■