

What's polluting your indoor air? Exploring sources and determinants across Europe

In high-income countries, people spend most of their time indoors, where air quality is a growing concern and can have a big impact on health (1). However, indoor air pollution is often not studied enough, leading to gaps in safety rules and standards (2). Pollutants can come from outside, like car fumes, as well as from indoor activities such as cooking, smoking, cleaning, and even from furniture and building materials.

An important aspect of indoor air quality is identifying the sources of pollutants and the factors, or determinants, that influence their presence. Understanding these elements is crucial for developing effective solutions to improve air quality and create healthier indoor environments.

Therefore, within the K-HEALTHinAIR project a systematic review was conducted to explore the sources and determinants of indoor air pollutants across various environments. This systematic review considered research conducted in Europe from 2013 to 2023 to identify the main sources and determinants of indoor air pollution in settings such as schools, homes, lecture halls, hospitals, public transports, retirement homes, and canteens.

The findings from the review of indoor air quality across various settings reveal important variations in pollutant sources and determinants. Below, a summary of the results is presented for each scenario studied, highlighting key sources and factors that influence air quality in different environments.

Schools

Indoor air quality in schools is a critical concern, especially given the vulnerability of children to harmful pollutants. Studies show that factors such as the number of people in a classroom, the type of ventilation, and building maintenance significantly influence levels of pollutants like carbon dioxide (CO₂), volatile organic compounds (VOCs), and particulate matter (PM). Common sources of pollutants include outdoor air, cleaning products, furniture, and materials used in school activities like crafts and painting. Certain VOCs, such as formaldehyde, can come from furniture and wood-based materials, and poor ventilation can make the problem worse.

To improve indoor air quality in schools, it is essential to focus on effective ventilation, regular building maintenance, and the use of low-emission materials. Proper building design, including adequate insulation and room orientation, can also help control pollutant levels. Additionally, indoor factors, such as the number of people in a room, cleaning practices, and even the use of chalk, can contribute to the buildup of harmful particles. By following air quality guidelines and investing in ongoing research, schools can better protect the health and well-being of students and staff.

Homes

Regarding homes, indoor air pollutants are influenced by various sources and determinants. Occupancy, along with cooking, combustion, and fireplaces, are major sources of CO₂. VOCs, including formaldehyde, stem from sources like furniture, wood-based materials, textiles, cleaning products, smoking, and combustion, with outdoor sources also contributing. PM

originates from cooking, smoking, combustion, and outdoor emissions, with resuspension due to movement and cleaning also playing a role. Key determinants of indoor air quality include the number of occupants, ventilation type, room size, cleaning frequency and building characteristics, such as location and insulation. Seasonal variations and outdoor conditions can also impact indoor air quality.

Additionally, radon enters homes from the ground, with its concentration influenced by ventilation, insulation, floor level, foundation, and being higher in single-family homes than in apartments. Other pollutants like CO, ozone, and black carbon are influenced by smoking, cooking, cleaning, and outdoor sources and ventilation is key to managing these pollutants.

Lecture halls

Lecture halls, which are large spaces commonly found in universities, share similar indoor air quality challenges with schools and homes. Key sources of pollutants include smoking (formaldehyde), high occupancy (CO₂), and outdoor air, with radon from geogenic sources also being a concern. Ventilation plays a crucial role in controlling these pollutants, and inadequate ventilation can worsen indoor air quality.

Hospitals

Regarding hospitals, indoor air quality poses unique challenges for both patients, who are especially vulnerable due to their health conditions, and healthcare workers, who are exposed to pollutants daily. Common pollutants, such as CO₂, PM_{2.5}, and VOCs, are prevalent in these environments, with high occupancy being a key contributor. VOCs can originate from cleaning products, disinfectants, and pharmaceuticals, and their concentrations are influenced by factors like ventilation, room size, the number of occupants, and the amount of furniture. Efficient mechanical ventilation, along with strategies to reduce room clutter and limit the use of certain chemicals, can help lower VOCs levels. Additionally, radon is a concern, particularly in basement rooms, where higher concentrations are often found, highlighting the importance of floor level in exposure.

Retirement homes

In retirement homes, sources of PM_{2.5} and PM₁₀ include traffic, occupancy, human movement, soil, and cleaning products. The building's location, particularly near airports or the sea, also affects pollutant levels due to outdoor sources. Additionally, the number of occupants is a key factor influencing indoor air quality.

Public transports

Concerning public transport, studies in metro and tram identified occupancy as a key source of CO₂, with passenger numbers determining CO₂ levels. For PM, sources include occupancy, resuspension, and mechanical wear, with train frequency influencing PM concentrations.

Canteens

A study in a university canteen found that commercial cooking emissions are a significant source of air pollutants, particularly VOCs like benzene and formaldehyde. Ventilation and cooking device type (gas or electric stoves vs. grills) strongly influence indoor pollutant levels.

Conclusion

The systematic review conducted in the K-HEALTHinAIR project highlights the various sources and determinants that influence indoor air pollution across different environments in Europe, highlighting how daily activities, building design, ventilation, and outdoor pollution affect air quality.

In conclusion, recognizing these sources and determinants is essential for improving air quality and safeguarding health. Tackling indoor air pollution requires a comprehensive approach, including better ventilation, the use of low-emission materials, and regular building maintenance. By raising awareness and prioritizing these measures, we can create cleaner, healthier indoor environments for all.

References

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