Why is indoor exposure to fine particulate matter a concern?

We spend nearly all of our time indoors. Airborne fine particulate matter (PM) can infiltrate our organs and is associated with health issues including respiratory, cardiovascular, and neurological system problems and adverse birth outcomes.

What is particulate matter?

Particulate matter (PM) is a mixture of solid particles and liquid droplets. Airborne PM is a complex and ever-changing combination of chemicals, dust, and biologic materials that can adversely affect health.

What is fine particulate matter (PM2.5)?

Fine particulate matter has a diameter of 2.5 microns (<0.0001 inch) or smaller, thus the notation PM2.5. It's small enough to penetrate deep into the respiratory system when inhaled. The smallest fraction of these particulates are ultrafine particles (UFP) with diameters less than 0.1 micron, which can cross the blood-brain barrier. PM2.5 is of special concern because of its ability to infiltrate deep into the body.

What are the health effects of fine PM exposure?

There is ample evidence that exposure to fine PM indoors causes adverse health effects. Most of the knowledge we have on the health effects of fine PM is from studies of outdoor exposures. These studies apply to indoor spaces because of the encroachment of outdoor pollution into indoor spaces and because a significant fraction of outdoor $PM_{2.5}$ is inhaled indoors.

Respiratory effects: Indoor $PM_{2.5}$ exposure has been linked to exacerbating asthma and to chronic obstructive pulmonary disease, or COPD, as well as causing respiratory problems in those who are not asthmatic or do not have lung disease.

Cardiovascular effects: Elevated outdoor $PM_{2.5}$ levels are associated with adverse cardiovascular health outcomes. Currently, the effects of $PM_{2.5}$ of indoor origin on cardiovascular health are inconclusive.

Cancer: Substantial evidence supports a causal link between outdoor PM exposure and lung cancer incidence and mortality. The link between cancer and indoor PM exposure results from studies of biomass burning in low- and middle-income countries and is primarily focused on lung cancer. Indoor wood-burning stove/fireplaces have been associated with a higher risk of breast cancer in women with a family history of breast cancer.

Neurological effects: Living in areas with higher levels of particle components was associated with increased risk of psychiatric hospitalization and neurodegeneration risks, such as dementia and cognitive decline.

Reproductive and early childhood effects: Links have been found between $PM_{2.5}$ exposure and preterm birth and decreased birth rate,

particularly with exposure to wildfire smoke. There have been multiple reports associating prenatal and early childhood exposures to fine PM with adverse neurological outcomes in children; primarily behavioral effects and school performance.

How is outdoor PM transported indoors?

Outdoor PM can enter a building through doors and windows, via ventilation systems, and through small cracks and spaces. Once there, it mixes with indoor air and is transported throughout a structure. Even walking from one room to another affects the movement and distribution of PM throughout a space. In multiunit residences like apartments and condos, particles can be transported from neighboring units. A classic example of this is secondhand smoke transmission among units.

Where does $PM_{2.5}$ originate?

PM, $PM_{2.5}$ and UFP originate from a number of sources that may vary widely depending on where you are. Particulate matter found in buildings can come from outdoor pollution sources like vehicle and industrial emissions, wildfire smoke, and dust from construction sites that are transported into buildings. It also comes from indoor sources like cooking, wood burning stoves and smoking substances like tobacco. While typically being a shorter-term factor, cooking can cause large increases in both $PM_{2.5}$ and UFP levels, especially when stoves are not properly vented outside. Other indoor PM sources include candles, incense, office equipment, spray products, and aerosolized water sources. And building occupants themselves emit respiratory particles that can contain bacteria and viruses.

Which groups are most affected by fine PM exposure?

Studies point to the potential for large disparities in fine particulate matter exposure and related health outcomes among populations. Susceptible populations including the elderly, young children, and those with pre-existing conditions are at particular risk; and communities that are located closer to pollution sources and are more likely to be exposed to outdoor fine particulate matter. These disparities can lead to excessive health burdens on some populations, often economically disadvantaged and marginalized communities.

How do I protect myself from the effects of $PM_{2.5}$ exposure?

Practical mitigation of indoor exposure to fine PM is possible today. It involves a combination of controlling sources, improving ventilation where outdoor levels are low, employing filtration-based air cleaning, and where necessary using personal protective equipment. Proper ventilation and filtration of both indoor and outdoor areas can decrease the presence of fine PM. Filtration systems like HVAC systems, range hood fans that are vented outdoors, and standalone air cleaners can all decrease exposure. The use of personal protective equipment like masks has been linked to protection from PM; however, studies specifically examining $PM_{2.5}$ are limited.

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