Indoor Air Quality

IMPORTANCE OF INDOOR AIR QUALITY

"Indoor air quality" refers to the quality of the air in a home, school, office, or other building environment. The potential impact of indoor air quality on human health nationally can be noteworthy for several reasons:

- Americans, on average, spend approximately 90 percent of their time indoors, where the concentrations of some pollutants are often 2 to 5 times higher than typical outdoor concentrations.

- People who are often most susceptible to the adverse effects of pollution (e.g., the very young, older adults, people with cardiovascular or respiratory disease) tend to spend even more time indoors.

- Indoor concentrations of some pollutants have increased in recent decades due to such factors as energy-efficient building construction (when it lacks sufficient mechanical ventilation to ensure adequate air exchange) and increased use of synthetic building materials, furnishings, personal care products, pesticides, and household cleaners.

POLLUTANTS AND SOURCES

Typical pollutants of concern include:

- Combustion byproducts such as carbon monoxide, particulate matter, and environmental tobacco smoke.
- Substances of natural origin such as radon, pet dander, and mold.
- Biological agents such as molds.
- Pesticides, lead, and asbestos.
- Ozone (from some air cleaners).
- Various volatile organic compounds from a variety of products and materials.

Most pollutants affecting indoor air quality come from sources inside buildings, although some originate outdoors.

- **Indoor sources** (sources within buildings themselves).

  Combustion sources in indoor settings, including tobacco, wood and coal heating and cooking appliances, and fireplaces, can release harmful combustion byproducts such as carbon monoxide and particulate matter directly into the indoor environment.

Cleaning supplies, paints, insecticides, and other commonly used products introduce many different chemicals, including volatile organic compounds, directly into the indoor air.

Building materials are also potential sources, whether through degrading materials (e.g., asbestos fibers released from building insulation) or from new materials (e.g., chemical off-gassing from pressed wood products). Other substances in indoor air are of natural origin, such as radon, mold, and pet dander.

- **Outdoor sources**: Outdoor air pollutants can enter buildings through open doors, open windows, ventilation systems, and cracks in structures. Some pollutants come indoors through building foundations. For instance, radon forms in the ground as naturally occurring uranium in rocks and soils decays. The radon can then enter buildings through cracks or gaps in structures.

  Harmful smoke from chimneys can re-enter homes to pollute the air in the home and neighborhood. In areas with contaminated ground water or soils, volatile chemicals can enter buildings through the same process.

  Volatile chemicals in water supplies can also enter indoor air when building occupants use the water (e.g., during showering, cooking).

  Finally, when people enter buildings, they can inadvertently bring in soils and dusts on their shoes and clothing from the outdoors, along with pollutants that adhere to those particles.

OTHER FACTORS AFFECTING INDOOR AIR QUALITY

In addition, several other factors affect indoor air quality, including the air exchange rate, outdoor climate, weather conditions, and occupant behavior.

The air exchange rate with the outdoors is an important factor in determining indoor air pollutant concentrations. The air exchange rate is affected by the design, construction, and operating parameters of buildings and is ultimately a function of infiltration (air that flows into structures through openings, joints, and cracks in walls, floors, and ceilings and around windows and doors), natural ventilation (air that flows through opened windows and doors), and mechanical ventilation (air that is forced indoors or vented outdoors by ventilation devices, such as fans or air handling systems).

Outdoor climate and weather conditions combined with occupant behavior can also affect indoor air quality. Weather conditions influence whether building occupants keep windows open or closed and whether they operate air conditioners, humidifiers, or heaters, all of which can affect indoor air quality. Certain climatic Indoor Air Quality conditions can increase the potential for indoor moisture and mold growth if not controlled by adequate ventilation or air conditioning.

EFFECTS ON HUMAN HEALTH

Health effects associated with indoor air pollutants include:

- Irritation of the eyes, nose, and throat.
- Headaches, dizziness, and fatigue.
- Respiratory diseases, heart disease, and cancer.

The link between some common indoor air pollutants (e.g., radon, particle pollution, carbon monoxide, Legionella bacterium) and health effects is very well established.

- Radon is a known human carcinogen and is the second leading cause of lung cancer.
- Carbon monoxide is toxic, and short-term exposure to elevated carbon monoxide levels in indoor settings can be lethal.
- Episodes of Legionnaires' disease, a form of pneumonia caused by exposure to the Legionella bacterium, have been associated with buildings with poorly maintained air conditioning or heating systems.
- Numerous indoor air pollutants—dust mites, mold, pet dander, environmental tobacco smoke, cockroach allergens, particulate matter, and others—are "asthma triggers," meaning that some asthmatics might experience asthma attacks following exposure.

While adverse health effects have been attributed to some specific pollutants, the scientific understanding of some indoor air quality issues continues to evolve.

One example is "sick building syndrome," which occurs when building occupants experience similar symptoms after entering a particular building, with symptoms diminishing or disappearing after they leave the building. These symptoms are increasingly being attributed to a variety of building indoor air attributes.

Researchers also have been investigating the relationship between indoor air quality and important issues not traditionally thought of as related to health, such as student performance in the classroom and productivity in occupational settings.

Another research area that is evolving is "green building" design, construction, operation, and maintenance that achieves energy efficiency and enhances indoor air quality.

ROE INDICATORS

Though much is known about the broad range of indoor air quality issues and associated health effects, currently only two national indicators of indoor air quality are available based on long-term and quality data: Radon and Serum Cotinine (a measure of exposure to tobacco smoke).

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For various reasons, ROE indicators could not be developed for other indoor air quality issues. For example, there is no nationwide monitoring network that routinely measures air quality inside a statistically valid sample of homes, schools, and office buildings. This does not mean that nothing is known about the broad range of indoor air quality issues and associated health effects. Rather, information and data on these issues can be gathered from government publications and the scientific literature. These data are not presented as ROE indicators since they are not representative on a national scale or do not reflect an issue over a sufficiently long time period.