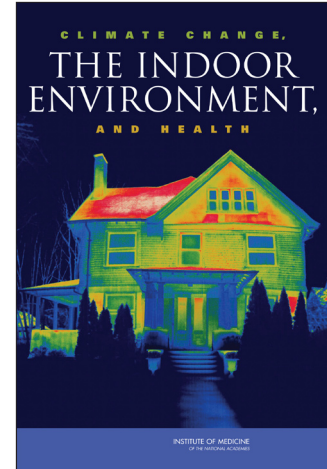


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Climate Change, the Indoor Environment, and Health



Amid the considerable research on how climate change may affect public health, one subject has received relatively little attention—the impact of climate change on indoor environments and thereby on the health of people who live, work, study, or play in them. No government or private body has lead responsibility for investigating this question, and the lack of leadership is hindering action on identifying potential hazards, formulating solutions, and setting research and policy priorities.

Against this backdrop, the U.S. Environmental Protection Agency (EPA) asked the Institute of Medicine to convene an expert committee to summarize the current state of scientific understanding of the effects of climate change on indoor air and public health and to offer priorities for action.

Health Problems Here—and May Worsen

The committee's report, *Climate Change, the Indoor Environment, and Health*, points to extensive research on how climate change affects the outdoor environment, how the outdoor environment affects indoor environments under different climate conditions, and how indoor environments affect occupant health, among other related topics. But facing a dearth of research specifically directed at how these factors interact, the committee analyzed and synthesized information from the various independent lines of research.

The committee concludes that climate change influences indoor environmental quality, warranting attention and action. The committee based its conclusion on three key findings:

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1. Poor indoor environmental quality is creating health problems today and impairs the ability of occupants to work and learn. By one estimate, poor indoor conditions cost the nation's economy tens of billions of dollars a year in exacerbation of illnesses and allergic symptoms and in lost productivity.
2. Climate change may worsen existing indoor environmental problems and introduce new problems.
3. There are opportunities to improve public health while mitigating or adapting to alterations in indoor environmental quality induced by climate change.

Problematic Exposures Identified

To help in targeting research, the committee identified five major types of climate-induced indoor environmental problems.

Indoor air quality. Indoor environments can be contaminated by chemical, organic, and particulate pollutants that migrate from outdoors or that result from gas stoves and other indoor emission sources, such as building materials, radon, and environmental tobacco smoke. Climate change can affect these factors in various ways. For example, changes in the outdoor concentrations of a pollutant due to alterations in atmospheric chemistry or atmospheric circulation will affect indoor concentrations. Measures to reduce energy use in buildings, such as lowering ventilation rates may cause higher exposures to pollutants emitted from indoor sources. The expected increased use of air conditioning, if accompanied by reduced ventilation, could increase the concentrations of pollutants emitted from indoor sources. Additionally, power outages—caused by heat waves or other extreme weather events—could lead to the use of portable electricity generators that burn fossil fuels and emit poisonous carbon monoxide.

Dampness, moisture, and flooding. Extreme weather conditions associated with climate change may lead to more frequent breakdowns in

building envelopes—the physical barrier between outdoor and indoor spaces—followed by infiltration of water into indoor spaces. Dampness and water intrusion create conditions that encourage the growth of fungi and bacteria and may cause building materials to decay or corrode, leading in turn to chemical emissions. Poorly designed or maintained heating, ventilation, and air-conditioning systems may introduce moisture and create condensation on indoor surfaces. Humid conditions can, however, be improved by well-designed and properly operating systems. Mold-growth prevention and remediation activities also may introduce fungicides and other agents into the indoor environment.

Infectious agents and pests. Weather fluctuations and climate variability influence the incidence of many infectious diseases. Climate change may affect the evolution and emergence of infectious diseases, for example, by affecting the geographic range of disease vectors. The ecologic niches for pests will change in response to climate change, leading to changed patterns of exposure and, possibly, increased use of pesticides in some locations.

Thermal stress. Extreme heat and cold have several well-documented adverse health effects. High relative humidity exacerbates these effects in hot conditions. An increased frequency of extreme weather events may result in more frequent power outages that expose persons to potentially dangerous conditions indoors. The elderly, those in poor health, the poor, and those who live in cities are more vulnerable to both exposure to temperature extremes and the effects of exposure. Those populations experience excessive temperatures almost exclusively in indoor environments.

Building ventilation, weatherization, and energy use. Leaky buildings are common and cause energy loss, moisture problems, and migration of contaminants. Poor ventilation is associated with occupant health problems or lower productivity. Climate change may make ventilation problems more common or more severe by prompting the implementation of energy-

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efficiency (weatherization) measures that limit the exchange of indoor air with outdoor air. The introduction of new materials and weatherization techniques also may lead to unexpected exposures and health risks.

Priority Issues for Action and Recommendations

In formulating recommendations for ways to reduce the health effects caused by climate-induced indoor environmental conditions, the committee adopted a public health approach founded on three guiding principles. The overall effort, it said, should

- prioritize consideration of health effects into research, policy, programs, and regulatory agendas that address climate change and buildings;
- make prevention of adverse exposures a primary goal in designing and implementing strategies to address health effects; and
- include collection of data to be used in making better-informed decisions in the future.

The committee made a number of specific recommendations for actions to be taken by the EPA, in cooperation with other government agencies and with private-sector organizations where appropriate. These actions include:

- Initiating or expanding programs to identify populations at risk for health problems resulting from alterations in indoor environ-

mental quality induced by climate change and implementing measures to prevent or lessen the problems.

- Developing or refining protocols and testing standards for evaluating emissions from materials, furnishings, and appliances used in buildings and promoting their use by standards-setting organizations and in the marketplace.
- Facilitating research to identify circumstances in which climate change mitigation and adaptation measures may cause or exacerbate adverse exposures.
- Facilitating the revision and adoption of building codes that are regionally appropriate with respect to climate-change projections and that promote the health and productivity of occupants.
- Developing model standards for ventilation in residential buildings and fostering updated standards for commercial buildings and schools, based on health-related criteria and aimed at providing a healthful environment under all design and operation conditions.
- Implementing a public health surveillance system that expands current ongoing surveys to gather information on how outdoor conditions, building characteristics, and indoor environmental conditions are affecting occupant health.



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- Educating the public on issues of climate change, the indoor environment, and health.
- Evaluating actions taken in response to climate change-induced alterations in the indoor environment to determine whether they are enhancing occupant health and productivity in a cost-effective manner.
- Spearheading an effort across the federal government to make indoor environment and health issues an integral consideration in climate change research and action plans and, more broadly, coordinating work on the indoor environment and health.

Conclusion

The committee's observations and recommendations are based on scientific evidence that clearly shows that adverse indoor environmental quality is harming people's health. Altered climatic conditions will not necessarily introduce new risks for building occupants but may make existing indoor environmental problems more widespread and more severe and thus increase the urgency with which prevention and interventions must be pursued. Buildings that were designed to operate under the "old" climatic conditions may not function well under the "new." Considering the consequences of climate change adaptation and mitigation actions before they play out and thereby avoiding problems that can be anticipated will yield benefits in health and in avoiding costs of medical care, remediation, and lost productivity. 🌱

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