

Coronavirus Lockdowns May Raise Exposure to Indoor Air Pollution

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This spring, as the COVID-19 pandemic led people to hunker down at home, outdoor air quality improved dramatically in many cities and countries. In the northeastern U.S., for instance, air pollution [dropped by 30 percent](#). But the lockdowns might be having the opposite effect indoors. In March [Airthings](#), an Oslo-based manufacturer of smart air-quality monitors, noticed conditions beginning to deteriorate in many customers' homes that it tracks. Between early March and early May, levels of carbon dioxide and volatile organic compounds (VOCs) increased by 15 to 30 percent in more than 1,000 homes across several European countries, the company says.

The data do not constitute a rigorous analysis. But they fit with a growing body of research, including several recently published papers and reports, showing that the indoor environment is a significant source of our exposure to air pollutants.

Although federal regulations in the U.S. have spurred dramatic improvements in outdoor air quality, indoor air remains largely unregulated. Many pollutants are now more concentrated inside of our buildings than outside of them. "People think the outdoor air in cities is not that great," says Yifang Zhu, an air pollution researcher at the University of California, Los Angeles. "But usually the indoor air is worse."

Spending more time in our home increases our exposure to chemicals emitted by building materials, furnishings, electronics and other consumer products. The pandemic also seems to be spurring many of us to cook and clean more. Those two activities are known to contaminate indoor air, says Delphine Farmer, an atmospheric chemist at Colorado State University.

In studies published this year, Farmer and Marina Vance, a mechanical and environmental engineer at the University of Colorado Boulder, carefully documented the pollutants produced by cooking and cleaning. The research is part of their House Observations of Microbial and Environmental Chemistry (HomeCHEM) project, [a series of controlled experiments](#) to learn more about the chemical processes that occur in homes. Certain kinds of cooking—such as roasting a pan of brussels sprouts in a gas oven—can generate 250 micrograms of fine particulate matter per cubic meter of air, an extraordinarily high level that matches what is sometimes observed in "the world's most polluted cities," [they reported](#).

Some of these particles are by-products of gas-stove combustion. Others come from the food itself: tiny droplets of oil are a common component of those found in the kitchen. Gas stoves emit far more particulate matter than electric ones. But electric stoves also produce the particles, especially during the first few minutes of operation, as they heat the thin layer of dust, food residue and other organic matter that covers their surface.

Fine particulate matter is a well-documented danger. "Particles that small penetrate deep into the respiratory system," Vance says. Studies of outdoor air suggest that exposure significantly ups the odds of a variety of heart and lung problems and an early death.

The health consequences of brief spikes in particulate matter from a few minutes or hours of cooking are not well understood, however. As Vance notes, outdoor concentrations in many polluted cities can be high for days or weeks—or longer. Still, recent studies of outdoor air quality suggest that there is no safe level of fine particulate matter and that even short-term exposures can reduce lung function and raise the risk of a heart attack.

The more we cook, the more particles we generate. In a new report, scientists at King's College London estimate that spending an extra hour a day cooking can increase our exposure to fine particulate matter by 19 percent. Research into consequences is just beginning, “so we can't say how clinically significant that increase of 19 percent actually is,” says Martin Williams, an air quality scientist and an author of the report.

Gas stoves also emit several potentially toxic gases, including carbon monoxide and nitrogen dioxide, a recognized lung irritant that can cause respiratory problems, especially in children. Cooking on a gas stove can lead to nitrogen dioxide levels that exceed federal standards for outdoor air. (There is no national standard for air inside buildings.) “Indoor pollution from gas stoves can reach levels that would be illegal outdoors,” experts concluded in [a literature review](#) report released earlier this month by the Rocky Mountain Institute, Mothers Out Front, Physicians for Social Responsibility and the Sierra Club.

Cleaning is another major source of indoor air pollutants; bleach is a particular hazard. When you mop a floor or swipe a countertop with bleach, “it's going to react with all of the surfaces inside your house,” Farmer says. Mixing bleach and water produces hypochlorous acid, which can react with the dirt and debris on your floor or counter. Or it can volatilize, wafting through the air and reacting with airborne compounds that are emitted by other cleaning agents, personal care materials or by-products of cooking. “That can do some really interesting chemistry and also create some well-known toxic compounds,” Farmer says.

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In [a HomeCHEM study published in January](#), Farmer and Vance reported that mopping with a bleach-and-water solution produced enough hypochlorous acid gas to potentially irritate the skin. Doing so also created enough nitrogen trichloride gas to possibly exacerbate asthma and other respiratory problems.

Our mere presence can change the chemistry of indoor air, too. [In a 2016 experiment](#), researchers at the University of California, Berkeley, found that 57 percent of the VOCs detected in a university classroom had been emitted by its occupants. The most abundant of these compounds were chemicals called cyclic volatile methylsiloxanes, which are commonly found in personal care products, especially antiperspirants. The scientists detected chemicals contained in our breath as well, including acetone and isoprene, plus compounds that are produced when ozone reacts with the oil on our skin. “We also saw even very small amounts of emissions from the microbes that live on your skin,” says atmospheric chemist Allen Goldstein, who was senior author of the study. Although the health effects of many of these human-

generated VOCs are not yet well-documented, data suggest that at least some of them may be worrisome.

Then, of course, there is the carbon dioxide we are constantly exhaling. Several papers suggest that moderate indoor increases of the gas can muddle our thinking. [A 2016 study](#) by Harvard University researchers found that as levels of indoor carbon dioxide rose from roughly 550 to 945 parts per million (ppm), cognitive function declined by 15 percent. That level of carbon dioxide is not uncommon inside buildings, especially in poorly ventilated, tightly sealed or densely occupied spaces. For example, investigations have found average levels of 982 ppm [in an apartment complex in Minnesota](#) and 1,200 ppm [in newly constructed apartments in Boston](#).

We can take some clear steps to improve the air quality in our home. When it comes to cooking, switching to electric appliances “is the cleanest option, if you can, but we recognize that not everyone is able to do that,” says Brady Seals, a senior associate at the Rocky Mountain Institute, who co-authored the recent literature review about gas stoves. Cooks can at least minimize the use of a gas stove by relying more on electric kettles, toaster ovens, microwaves or even portable, inexpensive induction cooktops, she says.

Ventilation is also critical. “You can think about the sniff test,” Farmer says. “If you burn a scented candle or cook aromatic food, do you still smell or see it? If so, you don’t have enough ventilation.” Opening a window can help. Range hoods can be very effective, but Vance cautions that their quality varies widely. “It’s important to know if [a range hood] will vent to the outside and if it has a proper flow rate,” she says. “A simpler investment might be a portable air cleaner with a good quality filter and appropriate flow rate for your room size.”

People who do have range hoods or kitchen fans should use them consistently—many people do not—and clean them from time to time, Seals says. Cooking on the back burners, which are typically closer to the exhaust vents, can be beneficial as well.

When cleaning, experts recommend avoiding bleach when possible and never mixing it with other cleaning products, which can produce dangerously high levels of chlorine gas. Farmer also suggests that people may want to avoid cleaning materials that contain peroxides, chlorates or perchlorates—all of which are oxidants that can react with a variety of common household chemicals to form toxic compounds.

No living environment is pollution-free. And while we should try to minimize our exposure to contaminants, we do not need to abandon our routines in a quest for pristine air. “I am not proposing that people stop cooking,” Vance says. “I love cooking, and I’ve only been cooking more during the pandemic.”

Read more about the coronavirus outbreak [from Scientific American here](#). And read coverage from our [international network of magazines here](#).