Out of the frying pan and into the fire: The gas stove toxicity debate

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Jeremy MacMahon, Chelsea Unkel and Pamela J. Lein from the University of California, Davis, unpack household air pollution, focusing on the gas stove toxicity debate

Recent comments by the U.S. Consumer Product Safety Commission about regulating gas stoves have triggered significant public debate in the United States (U.S.) about the harmful effects of gas stoves on human health. So, what is the science surrounding this issue?

Gas cooking is a predominant source of household air pollution

It is now scientific consensus that household air pollution can increase the risk for numerous noncommunicable diseases, including stroke, ischemic heart disease, chronic obstructive pulmonary disease (COPD) and lung cancer. The World Health Organization (WHO) estimates that in 2019, household air pollution accounted for the loss of 86 million healthy life years, and that annually, 3.2 million deaths can be attributed to air pollutants in the home environment. A significant source of household air pollution, second only to cigarette smoking, is cooking.

Health impacts of cooking

The adverse health impacts of cooking were initially identified in dwellings where open fires or inefficient stoves fueled by kerosene, biomass (wood, crop waste or animal dung) or coal were used to cook foods. Incomplete combustion of these cooking fuels generates toxic gases and small particulates (referred to as particulate matter or PM) that penetrate deeply into the lungs and can enter the bloodstream. Poor ventilation can effectively increase these pollutants to exceed 100 times the level considered to be safe.

These early studies, which were conducted predominantly in low- and middle-income countries, prompted scientists to investigate whether cooking fuels used in high-income countries similarly contribute to household air pollution. Subsequent studies found that gas stoves, which burn natural gas, generate many of the same pollutants released during the burning of kerosene, biomass and coal, including nitrogen dioxide (NO_2), formaldehyde and polycyclic hydrocarbons (PAHs). Gas stoves also generate hazardous air pollution via the leaking of unburned natural gas, which contains benzene, a known carcinogen.

Of most concern for human health is NO_2. Recent studies of apartments in New York City and Washington, D.C. found cooking on gas stoves increased NO_2 in kitchen air to 200-400 parts per billion (ppb), more than double the level identified as safe by the U.S.

Environmental Protection Agency (USEPA) for one hour of exposure. A 1992 meta-analysis conducted by scientists at the USEPA and Duke University found that exposure to NO_2 at levels comparable to those generated by cooking on a gas stove increased the odds of children developing a respiratory illness by 20%. Similar findings have been reported in numerous subsequent studies from the U.S., Canada, Europe and Asia, including a recent 2022 peer-reviewed study that concluded 12.7% of childhood asthma cases in the U.S. could be attributed to gas stove use. The health risks of NO_2 are not limited to children: adults chronically exposed to NO_2 from gas stoves also have a significantly increased risk for chronic lung disease and mortality.

Gas cooking also creates fine particles with a diameter of 2.5 microns or less (PM2.5), and ultrafine particles (UFPM) with a diameter of 0.1 microns or less. PM2.5 and UFPM are known irritants that not only cause or exacerbate respiratory problems, but also are linked to increased risk of cardiovascular disease, immune dysfunction, and neurological disorders. Interestingly, electric cooking can also generate significant PM2.5 and UFPM, as demonstrated in a recent study commissioned by the Air Resources Board (ARB) of the California Environmental Protection Agency. In this study, researchers measured PM generated by different cooking activities on gas and electric stoves in northern California homes. They found that steaming or boiling foods produced significantly less PM than frying and other methods used to cook oils or fats at high temperatures. Frying foods on electric stoves actually produced higher PM levels than on a gas stove. But, by far, the highest PM levels were produced during the self-cleaning cycle of gas and electric ovens. Notably, several of these cooking activities produced levels of particles in the kitchen and other rooms of the house that exceeded the ARB's indoor air quality guideline levels and ambient air quality standards.

Gas stoves contribute to climate change

Gas stoves also contribute to climate change by releasing two prevalent greenhouse gases into the air: carbon dioxide, which is generated by the combustion of natural gas, and methane, which is present in unburned natural gas that leaks from gas stoves. These gases accumulate in the atmosphere, trapping heat and contributing to climate change. A 2022 study by Eric Lebel at Stanford University estimated that methane leaks from gas stoves which is not directly harmful to human health, could have as much impact on the climate as half a million cars.

Mitigating cooking hazards

So, how can we mitigate the hazards associated with cooking? The most effective strategy for decreasing household air pollution is to replace gas stoves with electric induction stoves. However, this is not always viable, particularly for economically disadvantaged individuals or those who rent with limited options to change appliances. In these cases, increasing kitchen ventilation is the most effective approach for reducing personal risk from gas stoves. The optimal method is to use an exhaust hood that vents to the outside and to run it at the highest flow rate, starting before cooking and continuing for 15 minutes after cooking. While it is well documented that using hoods under these

conditions significantly reduces levels of air pollutants generated during cooking, on average, home cooks use ventilation only 24-40% of the time while cooking. If a hood is not an option, opening windows and/or exterior doors to improve airflow through the kitchen can significantly reduce indoor air pollution. Other approaches include:

1. Ensure gas stoves are cleaned and adjusted annually to reduce carbon monoxide leaks.
2. Improve hood efficiency by cooking on back burners.
3. Avoid overheating food, spilling food on burners, and clean spills and spatter before subsequent use.
4. Use a microwave oven, air fryer, Instant Pot, electric kettle or hot water heater instead of a gas or electric stove.
5. Clean stoves manually rather the using the self-cleaning cycles.

The view of our homes as sanctuaries against the hazards of the outside world needs to be adjusted to mitigate the health risks associated with an indoor activity over which we have significant personal control: how we prepare our food.

Please Note: This is a Commercial Profile

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UC Davis Department of Molecular Biosciences

The Department of Molecular Biosciences serves as the academic home for all nutritional, physiological chemistry, and pharmacologic and toxicologic programs of the School of Veterinary Medicine at UC Davis. The goal of the Department of Molecular Biosciences is to study fundamental biological processes and their perturbations by mutations, nutrition, drugs and xenobiotics and the application [...]