You may be breathing in more tiny nanoparticles from your gas stove than from car exhaust

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In this Purdue-designed "tiny house" lab, Purdue researchers used instrumentation from GRIMM AEROSOL TECHNIK, a member of the DURAG GROUP, to more accurately study nanocluster aerosol particles emitted while cooking on a gas stove. Credit: Brandon Boor

A new Purdue University study has found that cooking on your gas stove

can emit more nano-sized particles into the air than vehicles that run on gas or diesel, possibly increasing your risk of developing asthma or other respiratory illnesses.

"Combustion remains a source of air pollution across the world, both indoors and outdoors. We found that cooking on your gas stove produces large amounts of small nanoparticles that get into your respiratory system and deposit efficiently," said Brandon Boor, an associate professor in Purdue's Lyles School of Civil Engineering, who led this research.

Based on these findings, the researchers would encourage turning on a kitchen exhaust fan while cooking on a gas stove.

The study, published in the journal PNAS Nexus, focused on tiny airborne nanoparticles that are only 1-3 nanometers in diameter, which is just the right size for reaching certain parts of the respiratory system and spreading to other organs.

Recent studies have found that children who live in homes with gas stoves are more likely to develop asthma. But not much is known about how particles smaller than 3 nanometers, called nanocluster aerosol, grow and spread indoors because they're very difficult to measure.

"These super tiny nanoparticles are so small that you're not able to see them. They're not like dust particles that you would see floating in the air," Boor said. "After observing such high concentrations of nanocluster aerosol during gas cooking, we can't ignore these nano-sized particles anymore."

Using state-of-the-art air quality instrumentation provided by the German company GRIMM AEROSOL TECHNIK, a member of the DURAG GROUP, Purdue researchers were able to measure these tiny

particles down to a single nanometer while cooking on a gas stove in a "tiny house" lab. They collaborated with Gerhard Steiner, a senior scientist and product manager for nano measurement at GRIMM AEROSOL.

Called the Purdue Zero Energy Design Guidance for Engineers (zEDGE) lab, the tiny house has all the features of a typical home but is equipped with sensors for closely monitoring the impact of everyday activities on a home's air quality.

With this testing environment and the instrument from GRIMM AEROSOL, a high-resolution particle size magnifier—scanning mobility particle sizer (PSMPS), the team collected extensive data on indoor nanocluster aerosol particles during realistic cooking experiments.

This magnitude of high-quality data allowed the researchers to compare their findings with known outdoor air pollution levels, which are more regulated and understood than indoor air pollution. They found that as many as 10 quadrillion nanocluster aerosol particles could be emitted per kilogram of cooking fuel—matching or exceeding those produced from vehicles with internal combustion engines.

This would mean that adults and children could be breathing in 10 to 100 times more nanocluster aerosol from cooking on a gas stove indoors than they would from car exhaust while standing on a busy street.

"You would not use a diesel engine exhaust pipe as an air supply to your kitchen," said Nusrat Jung, a Purdue assistant professor of civil engineering who designed the tiny house lab with her students and co-led this study.

Purdue civil engineering Ph.D. student Satya Patra made these findings by looking at data collected in the tiny house lab and modeling the

various ways that nanocluster aerosol could transform indoors and deposit into a person's respiratory system.

The models showed that nanocluster aerosol particles are very persistent in their journey from the gas stove to the rest of the house. Trillions of these particles were emitted within just 20 minutes of boiling water or making grilled cheese sandwiches or buttermilk pancakes on a gas stove.

Even though many particles rapidly diffused to other surfaces, the models indicated that approximately 10 billion to 1 trillion particles could deposit into an adult's head airways and tracheobronchial region of the lungs. These doses would be even higher for children—the smaller the human, the more concentrated the dose.

The nanocluster aerosol coming from the gas combustion also could easily mix with larger particles entering the air from butter, oil or whatever else is cooking on the gas stove, resulting in new particles with their own unique behaviors.

A gas stove's exhaust fan would likely redirect these nanoparticles away from your respiratory system, but that remains to be tested.

"Since most people don't turn on their exhaust fan while cooking, having kitchen hoods that activate automatically would be a logical solution," Boor said. "Moving forward, we need to think about how to reduce our exposure to all types of indoor air pollutants. Based on our new data, we'd advise that nanocluster aerosol be considered as a distinct air pollutant category."

More information: Brandon Boor et al, Dynamics of nanocluster aerosol in the indoor atmosphere during gas cooking, *PNAS Nexus* (2024). DOI: 10.1093/pnasnexus/pgae044.
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