

Cooking with Gas Can Harm Children:

Cooking with gas stoves is associated with increased risk of childhood respiratory illnesses, including asthma

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Key Points

Question Does cooking with a gas stove harm children's health?

Findings In a systematic review of the literature, we found that cooking with natural gas increases nitrogen dioxide, degrades indoor air quality, and increases the risk of respiratory illnesses in children, including asthma. Over 30% of households in United States cook with gas stoves, and in Massachusetts, many health workers and others do not know about this health risk.

Meaning A public health education campaign is needed that informs medical professionals, parents, caregivers, and public health officials that cooking with gas can harm children because of increased respiratory illnesses, including asthma.

Abstract

Importance Children spend about 90% of their time indoors. Indoor air quality, even in industrial cities, has been shown to be worse than outdoor air quality.

Objective To review published literature of the health impacts on children of cooking with a gas stove.

Methods We searched PubMed for articles including U.S. populations using the search terms, "Gas Stoves" with a human-only filter. The search found 247 articles. We excluded articles for the following reasons: the main topic was burns; case studies of individual deaths; the study was done outside the United States.; the study group was infants or adults. We found ten studies meeting these criteria, including two meta-analyses. Following our review, we searched for studies about the biological plausibility of nitrogen dioxide increasing the risk of respiratory illnesses in children, the health impacts of outdoor nitrogen dioxide, and interventions to reduce the harms of cooking with a gas stove. We informally asked healthcare workers and others in Massachusetts if they knew about the negative health impacts of cooking with a gas stove.

Results The ten articles documented an association between cooking with a gas stove and increased indoor nitrogen dioxide levels, and that nitrogen dioxide and cooking with gas were both associated with increased risk of respiratory illnesses, including asthma and more severe asthma. Most people we asked in Massachusetts, did not know about the risks of cooking with a gas stove.

Conclusions and Recommendations Cooking with gas can harm children by increasing their risk of respiratory illnesses, including asthma. In the United States, this risk is substantial, because at least a third of United States households cook with gas stoves. Reports show that air quality indoors, which is not regulated, can be worse than outdoor air. For children who are indoors about 90% of the time, cooking with a gas stove is a largely unrecognized risk. We recommend a public health education campaign for health workers, parents, caregivers, and public health workers that cooking with a gas stove can harm children.

Introduction

We review the evidence of the associations between:

- Cooking with a gas stove and nitrogen dioxide levels in the home;
- Nitrogen dioxide levels in the home and respiratory illnesses, including asthma, among children living in the home;
- Cooking with a gas stove and respiratory illnesses, including asthma among children living in the home.

Cooking with “natural gas” (hereafter “gas”) increases nitrogen dioxide (NO₂) levels in the home. Nitrogen dioxide causes airway inflammation and has been shown to increase asthma severity outside the home. Multiple studies show outdoor nitrogen dioxide increases asthma severity and may cause the initial development of asthma. Nitrogen dioxide levels inside the home and cooking with gas are both directly associated with higher risk of respiratory illnesses, including asthma, and increased asthma severity. There is a dose-response relationship: Greater exposure to gas fumes (as measured by time cooking, stove pilot lights, and not using stove exhaust fans) increases the risk of respiratory illnesses. Despite strong evidence that cooking with gas in our homes can cause respiratory illnesses, public and professional awareness of this risk appears quite limited. Clinicians and public health practitioners can alert patients and community members to the risk and suggest alternatives to cooking with gas.

Nitrogen Dioxide and Childhood Respiratory Illnesses

Poor indoor air quality is associated with increased risk of respiratory illness, including asthma and increased asthma severity.^{1,2}

Cooking with gas releases fumes into the kitchen and the rest of the house. Both unburned and burned gas release toxic chemicals into indoor air. These chemicals include lead, chromium, benzene, hexane, formaldehyde, particulate matter less than 2.5 microns (PM_{2.5}), and NO₂, all of which are harmful to human health.³ This paper focuses on nitrogen dioxide and cooking with gas. Nitrogen dioxide levels are significantly higher in homes with gas stoves than homes with electric stoves.^{4,5} Nitrogen dioxide levels are higher in homes where residents spend more time cooking,⁶ have gas cook stoves with pilot lights,⁷ or don’t use exhaust fans to push gas fumes outdoors.⁸

A meta-analysis of 11 pediatric studies found that a long-term increase of 15 parts per billion of NO₂ (about the increase in NO₂ levels between cooking with gas versus electric) increased the likelihood of respiratory illnesses such as asthma by 20%.⁹ A year-long prospective study of NO₂ exposure in urban and suburban children with active asthma in Massachusetts and Connecticut found a dose-response relationship between the amount of NO₂ exposure and asthma severity.¹⁰

The association between NO₂ levels and respiratory illnesses is supported by experimental data from animals¹¹ and laboratory NO₂ exposures of healthy adults and adults with asthma^{12,13} showing NO₂ is a biologically plausible cause or promoter of asthma. Nitrogen dioxide induces airway inflammation in humans¹⁴ and airway hyper-responsiveness in mice,¹⁵ two characteristic features of asthma. A study of children with asthma who were fourteen years or younger measured individual NO₂ exposure and found

significant positive associations between higher levels of individual NO₂ exposure and asthma symptoms.¹⁶ Higher outdoor NO₂ levels are also associated with increased risk of respiratory symptoms and asthma severity. Guarnieri and Balmes found that greater exposure to outdoor NO₂ is associated with greater risk and exacerbations of asthma.¹⁷

The Environmental Protection Agency (EPA) summarizes the deleterious health effects of NO₂: “. . . over short periods [nitrogen dioxide] can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions, and visits to emergency rooms. Longer exposures to elevated concentrations of NO₂ may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma, as well as children and the elderly are generally at greater risk for the health effects of NO₂.”¹⁸

These risks pose serious concern because indoor air quality is often times worse than outdoor air. According to the EPA, a growing body of scientific evidence indicates that, even in large cities, indoor air in homes can be more polluted than the outdoor air.¹⁹

Cooking with Gas and Childhood Respiratory Illnesses

Cooking with gas is associated with increased risks of current and lifetime asthma. The 41 study meta-analysis looked at the effects of indoor NO₂ and cooking with gas on asthma and wheeze in children. The analysis showed that children living in a home with a gas cooking stove have a 42% increased risk of current asthma (95% confidence interval [CI] 1.23, 1.64), and a 24% increased lifetime risk of asthma (CI 1.04, 1.47). The study also looked at indoor NO₂ levels and found higher levels

increased the risk of current wheeze in children by 15% (CI 1.06, 1.25).²⁰

Two nationally representative studies show higher prevalence of respiratory illnesses in children who lived in households with gas cooking stoves without using an exhaust fan vented outside the home. A cross-sectional study of US children participating in National Health and Nutrition Examination Survey III (NHANESIII) found that, in homes where parents reported using exhaust fans with a gas stove, the likelihood of an asthma diagnosis was lower than those who didn't report using exhaust fans with a gas stove (adjusted odds ratio [aOR] = 0.64, 95% CI 0.43, 0.97).²¹ Wheezing and chronic bronchitis were also lower in homes using exhaust fans with gas cooking stoves.²¹ Another cross-sectional study, using NHANESIII data, found children under five were 76% more likely to have pneumonia if they lived in homes with gas cooking stoves where exhaust fans were not used compared to homes with gas stoves where exhaust fans were used (aOR = 1.76, CI 1.04, 2.98). In families who both cooked and heated with their gas cooking stoves, the adjusted odds ratio for pneumonia was three times higher than for those who lived in homes with vented gas stoves (aOR=3.06 CI 1.29, 3.30). The study showed a dose-response relationship: children exposed to the most indoor gas fumes (from a combination of cooking and using the gas stove to heat the home) have the highest likelihood of pneumonia.²²

Cooking with gas is associated with increased occurrence of respiratory illnesses and worse asthma in children, especially in homes not using an exhaust fan. Exposure to gas stoves is substantial: about one-third of households in the United States cook with gas stoves.²³ Interventions that lower NO₂ concentrations or

remove gas cooking stoves may reduce the occurrence of and severity of these illnesses, and in turn, reduce healthcare costs. A simulation study of building design interventions to improve indoor air quality and reduce pediatric asthma showed that some of the highest reductions in healthcare costs were from fixing exhaust fans and replacing gas stoves with electric ones.²⁴ The health impact and health care cost savings could be substantial as asthma is one of the most common chronic childhood diseases across all socioeconomic classes and is the most frequent cause of hospitalization among children in the US.²⁵ In Massachusetts, the estimated cost of environmentally attributable asthma is between \$10 and \$50 million per year and estimated hospital costs are between \$735,000 and \$2.5 million annually.²⁶

Public Health Information

A 2007 Expert Panel Report to the National Heart Lung and Blood Institute recommended that health care providers counsel patients with asthma to avoid the use of unvented gas stoves.²⁷ The Centers for Disease Control and Prevention²⁸ and the Massachusetts Department of Public Health²⁹ websites identify gas stoves as a trigger for asthma. However, informal questioning by the authors finds that many parents, Boards of Health, public health staff, teachers, and others know little or nothing about the risky association between gas stoves and respiratory illnesses.

Health care providers could ask families whose children suffer respiratory illnesses what kind of stove is used for cooking. They can encourage families who cook with gas stoves to consistently use properly installed exhaust

fans to blow gas fumes outdoors, and, instead of cooking with gas stoves, to cook with electric appliances like microwaves, hotpots, electric kettles, a hot plate, or an induction burner.

The best solution appears to be replacing gas stoves with electric stoves, which can be expensive. A three-arm randomized trial evaluating interventions aimed at reducing indoor NO₂ concentrations in homes with gas cooking stoves found that replacing gas stoves with electric resulted in a 42% decrease in median NO₂ concentrations, while homes that received a new exhaust fan hood over a gas stove did not have a statistically significant decrease in median NO₂ concentration. It's possible NO₂ concentrations did not decrease because people did not use the new fans³⁰ or that the fans were used and did not expel enough of the NO₂ produced by the gas cooking stove. A study of commonly used United States stove ventilation hoods found that hoods captured less than 30% of the pollutants coming from front stove burners.³¹

While more research is needed on interventions to protect children from gas stoves, there is clear evidence that cooking with gas can harm children. We believe that information that cooking with gas is associated with increased respiratory illnesses and increased asthma severity should be widely disseminated. Parents, public health staff, building inspectors, teachers and many others should know about this association so that they can make informed decisions about protecting children from respiratory illnesses and asthma.

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