

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. More than 30% of United States households cook with gas. In Massachusetts, many health workers and others do not know that cooking with gas is associated with increased risk of asthma.

Meaning A public education campaign is needed to inform parents, health care providers, caregivers, and public health staff that cooking with gas can harm children.

Abstract

Importance Children spend more than 80% 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 group was entirely outside the United States.; the study group was infants or adults. After applying these exclusions, we found ten studies, including two meta-analyses. Following our review, we searched for studies of 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 health 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. Because at least a third of United States households cook with gas stoves, this risk is substantial. Reports show that indoor air pollution can be worse than outdoor air pollution. For children who are indoors more than 80% of the time, cooking with a gas stove is a largely unrecognized risk. We recommend a public education campaign to inform parents, health care providers, public health staff, and caregivers that cooking with a gas stove can harm children.

Introduction

According to the United States Environmental Protection Agency (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.¹ This is particularly worrisome because children spend more than 80% of their time indoors.² One source of indoor air pollutants is cooking with gas stove. Burning “natural” gas (hereafter “gas”) releases nitrogen dioxide (NO₂), particulate matter, formaldehyde, and other pollutants. To better understand the risks for children of cooking with gas, we conducted a systematic review of the published literature.

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 population was entirely outside the United States; the study group was infants or adults. After applying these exclusions, we found ten studies, including two meta-analyses. Following our review, we searched for studies of the biological plausibility of nitrogen dioxide increasing the risk of respiratory illnesses in children, the health impacts of outdoor NO₂, 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 increase in asthma among kids in a home with a gas cooking stove.

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 a Gas Stove and Nitrogen Dioxide Levels in the Home

Cooking with gas increases NO₂ levels in the home. Nitrogen dioxide levels are significantly higher in homes with gas stoves than homes with electric stoves.^{3,4} Nitrogen dioxide levels are higher in homes where residents spend more time cooking, have gas cook stoves with pilot lights, using the gas cooking stove to heat the home, and don’t use exhaust fans to push gas fumes outdoors^{5,6,7,8}

Nitrogen Dioxide and Childhood Respiratory Illnesses

Poor indoor air quality is associated with increased risk of respiratory illness, including asthma, and increased asthma severity.^{9,10} 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.¹¹

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.¹² This paper focuses on NO₂ and cooking with gas. The relative contributions to childhood respiratory illnesses of NO₂ and the co-pollutants listed above are not known. However, NO₂ is an established marker for indoor air pollution resulting from burning gas.

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.”¹³

A meta-analysis of 11 pediatric studies found that a long-term increase of 15 parts per billion (ppb) of NO₂ increased the likelihood of respiratory illnesses such as asthma by 20%.¹⁴ Cooking with a gas stove releases around 15 parts per billion more NO₂ than cooking with an electric stove. 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.¹⁵ Another study of children 14 and younger with asthma measured individual NO₂ exposure using NO₂ detection patches worn by participants and found significant associations between higher levels of individual NO₂ exposure and asthma

symptoms.¹⁶ Similar associations of outdoor NO₂ and asthma are well documented.¹⁷ Nitrogen dioxide is a biologically plausible cause or promoter of asthma. The direct association between NO₂ levels and respiratory illnesses is supported by data from animal studies¹⁸ and NO₂ exposures of healthy adults and adults with asthma.^{19,20} Nitrogen dioxide induces airway inflammation in humans²¹ and airway hyper-responsiveness in mice,²² two characteristic features of asthma.

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 found that higher levels of indoor NO₂ were associated with a 15% (CI 1.06, 1.25) increased risk of current wheeze in children.²³

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 with a gas stove where parents reported using exhaust fans, 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, CI 0.43, 0.97).²¹ Wheezing and chronic bronchitis were also lower in

homes using exhaust fans with gas cooking stoves.²⁴ 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 that both cooked and heated the home with gas cooking stoves, the adjusted odds ratio for pneumonia was three times higher than for those who lived in homes with gas stoves where an exhaust fan was used (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.²⁵

Exposure to gas stoves is substantial: about one-third of households in the United States cook with gas stoves.²⁶ Interventions that lower NO₂ concentrations or remove gas cooking stoves may reduce the occurrence of and severity of these illnesses and reduce healthcare costs. A simulation study of building designs to reduce indoor air pollution and reduce pediatric asthma showed that some of the highest reductions in healthcare costs were from repairing exhaust fans and replacing gas stoves with electric ones.²⁷ 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.²⁸ In Massachusetts, the estimated cost of environmentally attributable asthma is between \$10 and \$50 million per year.²⁹

Implications for Public Health Practice

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.³⁰ The Centers for Disease Control and Prevention³¹ and the Massachusetts Department of Public Health³² 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 association between gas stoves and childhood respiratory illnesses.

Health care providers should ask families whose children have respiratory illnesses what kind of stove is used for cooking.

They can encourage families who cook with gas stoves to:

1. Use electric appliances instead of cooking with the gas stove. Possible appliances include; microwaves, toaster ovens, rice cookers, crock-pots, or portable single, electric induction burners.
2. When cooking with a gas stove:
 - use the back burners
 - turn on the fan above the stove
 - and/or open a window.The fan above the stove works better at cleaning the air when it pushes the stove fumes outdoors.
3. When the gas stove needs to be replaced, consider replacing it with an electric or electric induction stove.

The best solution appears to be replacing gas stoves with electric (or electric induction) stoves, which can be expensive. A randomized study evaluating interventions to reduce indoor NO₂ concentrations in homes with gas cooking stoves found that replacing gas with electric stoves 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. Cooking, like other behaviors, may be difficult to modify. It's possible NO₂ concentrations did not decrease because people did not use the new over-stove exhaust fans.³³ One survey found that less than 35% of people regularly use cooking stove exhaust fans when they were available.³⁴ Alternatively, fans were used and did not expel enough of the NO₂ produced by the gas cooking stove. A study of commonly-used stove ventilation hoods in the United States found that hoods captured less than 30% of the pollutants coming from front stove burners.³⁵

Awareness

Many people in Massachusetts do not know about the association between cooking with a gas stove and childhood asthma. Informal conversations with health department staff, health workers, families, and others found that few were aware that cooking with gas was associated with higher risk of asthma or more severe asthma.

Recommendations

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.

Health care providers treating children with asthma should ask if the family cooks with a gas stove.

Parents, public health staff, teachers, and many others should know about this association so that they can make informed decisions about protecting children from preventable respiratory illnesses and asthma.

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