A CHINA ENVIRONMENTAL HEALTH PROJECT RESEARCH BRIEF

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Environmental Health and Indoor Air Pollution in China

By H. Dean Hosgood, III

Since humans typically spend 90 percent of their time indoors, the indoor environment is an important determinant of health. Indoor air pollution attributed to fuel combustion products from heating and cooking is a major public health challenge in rural China. While most of rural China utilizes coal as their domestic fuel source, some also use biomass. The use of these fuels in homes with poor or no ventilation is worrisome because this smoke has been associated with a variety of negative health outcomes, the most notable being lung cancer.

In 2006, the World Health Organization's International Agency for Research on Cancer assessed the potential carcinogenicity of household use of solid fuels. This comprehensive review conducted by the world's experts concluded that indoor emissions from household combustion of coal are carcinogenic to humans, while biomass combustion emissions are probably carcinogenic to humans. [1]

Coal and Biomass Usage

According to the United Nations, half of the world's population, or 3 billion people, use coal or biomass for heating and cooking—most of them live in developing countries such as China and India. [2] More than 75 percent of all households, and almost all rural households, in China utilize solid fuel for their main source of heating and cooking. While biomass use has remained relatively constant, rural home use of coal has tripled over the past 20 years in China. [3]

Disease burden

Conservatively, the annual global health burden of indoor air pollution from solid fuel use is estimated to be 1.6 million deaths and over 38.5 million disability-adjusted life years. [4] This equates to 3 percent of the total global disease burden. In 2000, it was estimated that indoor air pollution caused 425,000 deaths in China and it was the fourth leading cause of mortality (it is the fifth leading cause of disease burden for developing countries throughout Asia). [4] Overall, indoor air pollution accounts for 20 percent of all deaths in China. [5]

Associated Diseases

Coal and biomass smoke have been associated with a variety of health outcomes, the most notable being lung cancer. [6-8] Other health outcomes include chronic bronchitis, chronic obstructive pulmonary disease, tuberculosis, cataracts, childhood mortality, childhood asthma, upper aero-digestive tract carcinomas (including mouth, pharyngeal, and laryngeal),

decreased birth weight, nasal polyposis, respiratory problems and decreased lung function. [9-19].

Exposures

The associations observed between indoor air pollution and adverse health outcomes are not surprising since solid fuel combustion products are known to contain carcinogens. In-home smoky coal combustion increases levels of sulfur dioxide, carbon monoxide, fluorine, and known carcinogens such as polycyclic aromatic hydrocarbons (PAHs), benzene, arsenic, and formaldehyde. [20;21] The corresponding concentrations of benzo(*a*)pyrene, an indicator of PAHs, from indoor exposures to coal smoke due to cooking and heating can be comparable in some instances to coke oven occupational exposure levels. [22] Evidence suggests that risk of lung cancer attributed to coal exposure may be driven by PAHs. [23;24]

Interventions

Methods to prevent harmful exposure to domestic fuel combustion have focused on behavioral changes (i.e. food preparation practices and smoke avoidance), technological interventions (i.e. stove improvement, ventilation improvement, and cleaner fuel use), and various combinations of the two. [25;26] In general, technological interventions have been the most successful at reducing in-home exposures.

Stove improvements have been shown to reduce the negative short-term health effects associated with fuel combustion exposures, such as acute respiratory infections [27] and headaches, [28] by reducing indoor air pollution levels. [29;30] It is estimated that stove improvements can reduce 23 percent of all mortality in rural China. [31] The only study to have evaluated the long-term benefits of combustion exposure reduction is the retrospective cohort evaluating the health impact of residents in Xuan Wei, Yunnan China who converted from firepits to stoves with chimneys. [32]

The population in Xuan Wei, poses a unique opportunity to assess in-home coal smoke exposures because it has the highest prevalence of lung cancer in China and more than 95 percent of residents use coal for heating and cooking. [6;32;33] In Xuan Wei, nearly all women and a few men cook, while most men and nearly no women smoke tobacco. [32] Further, 90 percent of Xuan Wei's residents are farmers and have minimal industrial and automotive air pollution exposures. [6] The primary source of indoor air pollution in Xuan Wei is smoke from domestic fuel combustion for heating and cooking with most residents burning smoky coal (bituminous coal) and some using smokeless coal (anthracite coal) and wood. Subjects who underwent stove improvement were part of the China National Improve Stove Program, which installed 129 million new stoves in rural homes between 1982 and 1992. Evaluation of the Xuan Wei population is the first intervention study to show a decrease in lung cancer. A significant reduction in lung cancer incidence, about 40 percent, was associated with improvement from firepits to stoves with chimneys in both men and women using smoky coal. [32]

The Xuan Wei study has helped to inform policymakers of the beneficial impact of cleaner household stoves, other major research initiatives include:

• The Chinese CDC's Institute of Environmental Health and Related Product Safety has been working with the Partnership for Indoor Air Pollution and the World Bank on conducting studies across Shaanxi, Guizhou, Gansu, and Inner Mongolia assessing the severity of indoor air pollution and creating community education initiatives in parallel with clean stove distribution.
• The U.S. Geological Survey has conducted studies into how naturally occurring arsenic and fluorine in coal and soil in southwest China have been producing particularly harmful indoor air pollution.
• Dr. Kirk R. Smith, in collaboration with the Shell Foundation's Household Energy and Health Program, is currently evaluating programs that have been implemented in China to promote improved household stoves.

Call for Action

Overall, the health benefits from stove interventions vary and more research is needed to substantiate their expansion to residents throughout developing countries, which receive about 80 percent of the global exposure to indoor airborne particulate matter. [34] The Chinese government has made great strides at reducing the health impact attributed to in-home domestic fuel usage by initiating the China National Improve Stove Program and setting an indoor air pollution standard in 2003. However, indoor air pollution is currently not part of China's official national health agenda and there is no evidence that the indoor air pollution standard is being enforced. [35] Further, even after the extensive stove improvement programs, most coal stoves still lack flues for ventilation which may not be considered an improvement. [36] Finally, research and interventions need to be implemented to better determine a cost-effective manner of reducing indoor air pollution and increasing both the short- and long-term health benefits.

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