

# NATIONAL FAMILY HEALTH SURVEY BULLETIN

INTERNATIONAL INSTITUTE  
FOR POPULATION SCIENCES  
MUMBAI

EAST-WEST CENTER  
RESEARCH PROGRAM  
POPULATION AND HEALTH  
HONOLULU

Number 13

February 1999

ISSN 1083-8678

*The NFHS BULLETIN summarizes findings from the 1992–93 National Family Health Survey. The NFHS collected information from nearly 90,000 Indian women on a range of demographic and health topics. The survey was conducted under the auspices of the Indian Ministry of Health and Family Welfare to provide national and state-level estimates of fertility, infant and child mortality, family planning practice, maternal and child health, and the utilization of services available to mothers and children.*

*The International Institute for Population Sciences (IIPS), Mumbai, conducted the NFHS in cooperation with various consulting organizations and 18 population research centres throughout India and with the East-West Center in Honolulu, Hawaii, and Macro International in Calverton, Maryland. The U.S. Agency for International Development provided funding for the NFHS and for this publication.*

## Cooking with Biomass Fuels Increases the Risk of Tuberculosis

It is estimated that more than half of India's adult population is infected with the tuberculosis bacterium, *Mycobacterium tuberculosis*. The growth of drug-resistant strains, combined with the rapid spread of HIV/AIDS, has contributed to a serious resurgence of tuberculosis in recent years. About 500,000 people die of tuberculosis in India every year.

There is mounting evidence that outdoor air pollution can cause serious health problems, but indoor air pollution poses greater health risks in developing countries such as India where many households use biomass fuels for cooking and heating. Fuels such as wood, animal dung, crop residues, and grasses produce large quantities of smoke that contains many noxious components. These include respirable suspended particulates, carbon monoxide, nitrogen oxides, formaldehyde, and polyaromatic hydrocarbons such as benzo[*a*]pyrene.

Cooking smoke has been shown to increase the risk of acute respiratory infection and various types of lung disease, but there has been little research on the possible contribution of cooking smoke to the risk of tuberculosis. Data from India's National Family Health Survey (NFHS), conducted in 1992–93, provide a valuable opportunity to address this question. The NFHS collected information from a nationally representative sample of 88,562 households that included 260,162 adults age 20 and above. Household heads answered questions on the primary type of cooking fuel used in their households and on the prevalence of active tuberculosis among household members.

The results reported in this issue of the *NFHS Bulletin* show that adults in households that cook with biomass fuels—defined in the survey as wood and dung—suffer a significantly higher risk of tuberculosis than adults in households that cook with cleaner fuels. An estimated 51% of the active tuberculosis cases reported in the NFHS can be attributed to exposure to cooking smoke from biomass fuels. The effect on tuberculosis risk of cooking with biomass fuels remains strong even after controlling for several potentially confounding demographic and socioeconomic variables.

### How cooking smoke might increase tuberculosis risk

Tuberculosis is a contagious, airborne disease that is transmitted by coughing, sneezing, or even talking. Once a person is infected, any condition that weakens the immune

**Vinod K. Mishra, Robert D. Retherford, and Kirk R. Smith**

*Vinod K. Mishra is a Fellow, and Robert D. Retherford is a Senior Fellow in Population and Health at the East-West Center. Kirk R. Smith is a Professor of Environmental Health Sciences at the University of California at Berkeley and holds a joint appointment as a Senior Fellow at the East-West Center.*

system can trigger the development of active tuberculosis.

According to the NFHS, about three-quarters of Indian households rely primarily on biomass fuels for cooking. Cooking is often done under poorly ventilated conditions using inefficient stoves that produce a great deal of smoke. Such stoves are often no more than a pit, a *chulha* (u-shaped construction made of mud), or three pieces of brick. To a considerable extent, life revolves around the cooking area, and women, in particular, spend much of their time exposed to cooking smoke.

Although research is not available that links cooking smoke directly with tuberculosis risk, there is some evidence that tobacco smoke, which is also biomass smoke, is a risk factor for tuberculosis. Passive cigarette smoke has been linked to increased risk of tuberculosis in children, and cigarette smoking has been shown to render tuberculosis treatment less effective.

Cooking smoke has been shown to compromise important pulmonary immune defense mechanisms in laboratory animals. Benzo[*a*]pyrene, a known carcinogen, is found in large quantities in cooking smoke from biomass fuels. There is evidence that exposure to benzo[*a*]pyrene, and to other polycyclic aromatic hydrocarbons also found in biomass smoke, can depress immune system responses in both animals and humans.

Cooking smoke might increase the risk of tuberculosis by reducing resistance to the initial infection, by promoting the development of active tuberculosis in people who are already infected, or both. Cooking smoke also tends to increase coughing, which could contribute to the spread of infection.

## What the NFHS measured

The NFHS asked several questions on the current health status of household mem-

bers, including the prevalence of active tuberculosis. The household head or another knowledgeable adult in the household reported on the status of each household member. No effort was made to test for tuberculosis clinically. This analysis focuses on adult household members—age 20 and above—because prevalence of active tuberculosis in India is much higher in adults than in children or adolescents.

Exposure to cooking smoke is measured indirectly by the primary type of cooking fuel used in the household. The NFHS classifies cooking fuel into nine types—wood, dung, charcoal, coal/coke/lignite, kerosene, electricity, liquefied petroleum gas, biogas, and a residual category of other fuels. The survey does not include a separate category for crop residues, although these are an important source of cooking fuel in India. Most households that use crop residues as their primary cooking fuel appear to be classified as using wood because very few households (2%) fall in the residual category of ‘other fuels’.

In the analysis, the various cooking fuels are grouped into two categories—biomass fuels (wood or dung) and cleaner fuels (charcoal, coal/coke/lignite, kerosene, electricity, petroleum gas, or biogas). The small category of ‘other fuels’ is excluded. Coal/coke/lignite can be highly polluting when first ignited, but they are classified as cleaner fuels in this analysis. In India these fuels are normally used in portable stoves that are ignited outdoors and are only brought indoors after the fire is burning more cleanly. Biomass fuels, by contrast, are normally used indoors in stationary stoves that require regular feeding, resulting in the continuous release of smoke.

Because several demographic and socioeconomic factors may also affect the prevalence of tuberculosis, the independent effect of cooking fuel is estimated using logistic regression and multiple clas-

sification analysis, controlling for the effects of 10 other, potentially confounding, variables. These are: age, sex, education, household head’s religion, household head’s membership in a scheduled caste or tribe,<sup>1</sup> urban/rural residence, geographic region, house type (indicating quality of construction of roof, walls, and floor), crowding (measured by number of persons per room in the household), and availability of a separate kitchen in the house. In the calculation of adjusted prevalence rates, the control variables are held constant by setting them to their mean values in the underlying logistic regression.

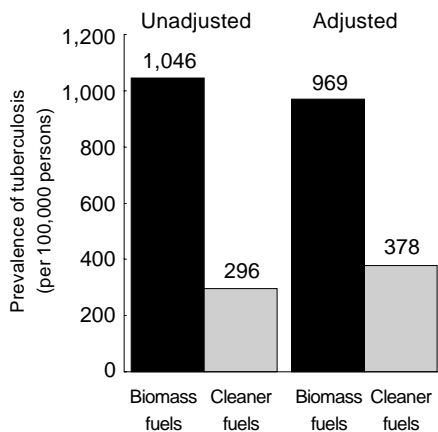
This analysis does not control for the effect of tobacco because the NFHS did not ask about smoking. Smoking would probably not affect the results presented here, however, because it is unlikely to be correlated with the type of cooking fuel used. This is especially true for women since in India very few women smoke.

## Effects of cooking smoke

This analysis shows that a household’s use of a biomass cooking fuel has a strong effect on the prevalence of active tuberculosis among adult household members (Figure 1). The effect remains large and highly statistically significant even after adjusting for the effects of the 10 demographic and socioeconomic variables.

When measured without controls, active tuberculosis is 3.6 times as prevalent among adults in households that use biomass fuels (1,046 per 100,000) as among adults in households that use cleaner cooking fuels (296 per 100,000). Adjusting for the 10 control variables reduces

1. Scheduled castes (SC) and scheduled tribes (ST) are those castes and tribes identified by the Government of India as socially and economically disadvantaged and in need of protection from social injustice and exploitation.



**Figure 1. Unadjusted and adjusted prevalence of active tuberculosis in adult household members, by primary type of cooking fuel used in the household**

this difference somewhat, but the independent effect of cooking fuel remains strong. After adjusting for the other variables, active tuberculosis is 2.6 times as prevalent among adults in households that use biomass fuels (969 per 100,000) as among adults in households that use cleaner fuels (378 per 100,000). Both the unadjusted and the adjusted effects are highly statistically significant ( $p < .0001$ ).

**The effect is greater for women.** Because women do virtually all the cooking in India, they are much more exposed than men to cooking smoke. Thus, if exposure to cooking smoke is an important factor affecting the risk of active tuberculosis, then the type of cooking fuel used in a household would be expected to have a stronger effect on tuberculosis risk among women than among men.

Findings from the NFHS show that this is the case (Figure 2). Tuberculosis prevalence rates are much higher for both men and women in households that use biomass fuels than for men and women in households that use cleaner fuels, even after controlling for the 10 potentially confounding variables. The prevalence rate is 2.4 times higher for men and 2.7

times higher for women, indicating that the effect of cooking fuel is larger for women than for men, as expected. This effect is highly statistically significant ( $p < .0001$ ) for both sexes.

**The effect is greater in rural areas.** The adjusted effect of biomass fuels on tuberculosis prevalence is large and highly statistically significant ( $p < .0001$ ) in both rural and urban areas (Figure 3). The effect is somewhat larger in rural areas than in urban areas, however, perhaps mainly because medical services to treat tuberculosis are less widely available in rural areas.

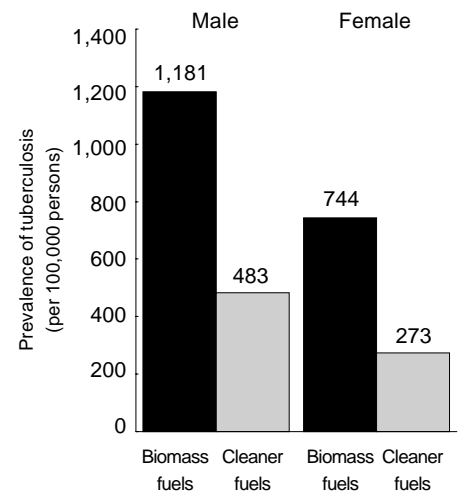
### How much tuberculosis can we attribute to cooking smoke?

It is useful to consider what proportion of the tuberculosis prevalence indicated in the NFHS may be due to smoke from biomass fuels. A ‘population attributable prevalence proportion’ can be defined as:

$$\frac{\text{Prevalence in total population} - \text{Prevalence in unexposed group}}{\text{Prevalence in total population}}$$

This measure can be interpreted as the proportionate reduction in tuberculosis prevalence that would occur if everyone were to use cleaner cooking fuels. It indicates (after controlling for the 10 potentially confounding variables) that 51% of the prevalence of active tuberculosis among persons age 20 years and older in India is attributable to cooking smoke from biomass fuels.

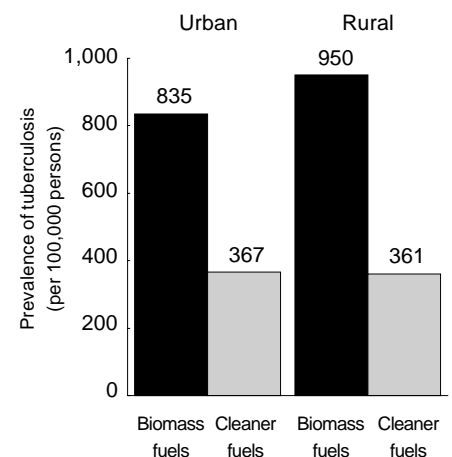
A much higher proportion of active tuberculosis can be linked to cooking smoke in rural areas (59%) than in urban areas (23%). This difference stems from two factors. First, the effect of biomass fuel use on tuberculosis prevalence is stronger in rural areas, and, second, bio-



**Figure 2. Adjusted prevalence of active tuberculosis in adult household members, by primary type of cooking fuel used in the household and by sex**

mass fuels are much more widely used in rural areas.

The link between exposure to cooking smoke and risk of tuberculosis may be even stronger than this analysis suggests. For one thing, households in India typically use a combination of cooking fuels, but the NFHS only provides information on the primary cooking fuel used. To the



**Figure 3. Adjusted prevalence of active tuberculosis in adult household members, by primary type of cooking fuel used in the household and by residence**

extent that households actually use a mix of fuels, the difference in tuberculosis prevalence due to fuel type will be greater than estimated here.

The NFHS does not provide information on the history of fuel use in households, although such information is important because the effects of cooking smoke are likely to be cumulative over time. To the extent that households have shifted from biomass fuels to cleaner fuels, the difference in tuberculosis prevalence due to fuel type will again be underestimated. The estimated effect of fuel type would also be greater if the comparison were between biomass fuels and a very clean fuel such as electricity.

Finally, cases of active tuberculosis may be underreported in the NFHS because of the stigma attached to the disease. In some cases too, the survey informant might not realize that a household member has tuberculosis. Members of households that use biomass fuels tend to be poorer and less educated than members of households that use cleaner fuels, and thus they may be more likely to underreport tuberculosis cases. Underreporting may also be greater for women because of their low status relative to men. This differential in underreporting, to the extent that

it occurs, would result in an underestimation of the effect of cooking smoke on the prevalence of active tuberculosis.

### Policy implications

These findings suggest that tuberculosis prevalence could be reduced substantially in India—and probably in many other developing countries—by lowering exposure to cooking smoke from biomass fuels. Perhaps the most obvious long-run policy implication is that the Indian government should promote a shift from biomass fuels to cleaner cooking fuels. Such a policy would undoubtedly bring many other significant health benefits.

In the short run, however, such a shift may not be feasible. A large proportion of Indian households cannot afford to buy cleaner cooking fuels. Moreover, given current infrastructure and fuel availability, neither the Indian government nor the private sector can make cleaner fuels available to all households.

A more feasible policy in the short run would be for the government and nongovernmental organizations (NGOs) in India to strengthen programs that promote improved cookstoves. Improved cookstoves, equipped with flues or hoods, use biomass fuels more efficiently than traditional

stoves, thus producing less smoke and requiring less fuel. Local needs and community participation should be given high priority in such efforts in order to gain community acceptance.

In addition, the government and NGOs need to increase their efforts to educate the public about the adverse health effects of cooking smoke. The government should also continue to strengthen its tuberculosis prevention and treatment programmes.

Further research, in India and in other developing countries, could elucidate the relationship between cooking smoke and tuberculosis more precisely. For one thing, the use of different types of fuel is not an ideal measure of exposure to cooking smoke. In addition, reports of tuberculosis by household heads or other informants are not as accurate as clinical tests. To validate the results presented here, studies are needed that are based on better measures of these critical variables.

### Further reading

Mishra, Vinod K., Robert D. Retherford, and Kirk R. Smith. 1999. Biomass cooking fuels and prevalence of tuberculosis in India. *International Journal of Infectious Diseases* 3(2).

The **International Institute for Population Sciences** was established at Mumbai in 1956 as the regional institute for training and research in population studies for the Asia and Pacific region of the United Nations. Now also a deemed university, it is an autonomous institution sponsored jointly by the Government of India, the United Nations Population Fund, and the Sir Dorabji Tata Trust.

The U.S. Congress established the **East-West Center** in 1960 to foster mutual understanding and cooperation among the governments and peoples of the Asia-Pacific region, includ-

ing the United States. Principal funding for the Center comes from the U.S. Government, with additional support provided by private agencies, individuals, and corporations and more than 20 Asian and Pacific governments.

The *NFHS Bulletin* Editorial Committee consists of Fred Arnold, B. M. Ramesh, Robert D. Retherford, T. K. Roy, and Sidney B. Westley.

Copies of the *NFHS Bulletin* may be reproduced for educational purposes.

*Correspondence addresses:*

**International Institute for Population Sciences (IIPS)**

Govandi Station Road, Deonar  
Mumbai - 400 088, India  
Fax: 91-22-556-3257  
E-mail: iips.nfhs@access.net.in

**East-West Center**

Research Program/Population and Health  
1601 East-West Road  
Honolulu, HI 96848-1601, U.S.A.  
Fax: 1-808-944-7490  
E-mail: poppubs@ewc.hawaii.edu