NATIONAL FAMILY HEALTH SURVEY

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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 Smoke Increases the Risk of Acute Respiratory Infection in Children

Acute respiratory infections—primarily pneumonia—are a major cause of illness among children throughout the world. In developing countries, an estimated 4.1 million children under age five die from acute respiratory infections (ARI) every year (WHO 1995). In India, as in many other countries, ARI is the leading cause of childhood death (Murray and Lopez 1996).

There is some evidence that smoke from wood, animal dung, or other forms of biomass increases the risk of ARI, but there has been very little research on this subject. India's 1992–93 National Family Health Survey (NFHS) provides information on the incidence of ARI in young children and on major sources of household cooking fuel. Such information offers a valuable opportunity to assess the role of cooking smoke in the incidence of this deadly childhood disease.

The NFHS found that 1 in every 15 children under age three had suffered from ARI—defined as a cough accompanied by short, rapid breathing—during the two weeks before the survey (IIPS 1995). At the same time, about three-quarters of households in the survey reported using wood or animal dung as their main source of energy for cooking. The analysis reported in this issue of the *NFHS Bulletin* shows that children under age three living in households that use wood or animal dung as their primary cooking fuel have an almost one-third higher risk of ARI than do children living in households that use cleaner fuels, even after controlling for a number of other variables.

ARI and cooking fuel

The analysis is based on data for the 33,875 children covered by the NFHS who were under age three at the time of the survey. Two questions were used to identify ARI cases—whether the child had been ill with a cough at any time in the past two weeks and whether the child, when ill with a cough, breathed with short, rapid breaths.

The NFHS collected data on a nine-fold classification of primary cooking fuel, including wood, dung cakes, coal/coke/lignite, charcoal, kerosene, electricity, liquefied petroleum gas, biogas, and a residual category of other fuels. The survey did not include a separate category for crop residues, which are an important source of cooking fuel in India. Evidently crop residues were mostly reported as wood because the

Vinod Mishra and Robert D. Retherford

Vinod Mishra is a visiting fellow and Robert D. Retherford is a senior fellow at the East-West Center's Program on Population.

residual category of "other fuels" is small, accounting for only 2% of households.

In India, women often cook under poorly ventilated conditions using pits or open U-shaped stoves, called *chulhas*. These stoves burn biomass inefficiently and release high volumes of noxious air pollutants indoors. Biomass smoke contains various irritants, cilia toxic fractions, and mucous coagulating agents, including respirable particulates, carbon monoxide, nitrogen oxides, formaldehyde, and polyaromatic hydrocarbons. Extended exposure to high levels of these air pollutants can impair the clearing ability of the lungs and render them more susceptible to infection. The negative health effects of these pollutants are particularly severe for young children who tend to stay indoors and are often carried on their mothers' backs or laps while their mothers are cooking.

Coal, coke, and lignite produce similar levels of pollutants as biomass fuels, but they are usually burned on portable stoves that are often started in open areas and only brought indoors once the fuels are burning cleanly. Most of the smoke is released outdoors within the first few minutes after the fire is ignited. Wood, animal dung, and crop residues, on the other hand, are usually burned on indoor stoves that cannot be lifted or transported. Moreover, fires from biomass fuels require more or less continual feeding, resulting in extended exposure to noxious indoor pollutants.

For this analysis, the various cooking fuels were grouped into two categories—biomass fuels (wood or dung) and cleaner fuels (coal/coke/lignite, charcoal, kerosene, electricity, liquefied petroleum gas, or biogas). The small category of "other fuels" was excluded.

Other variables

If there is a relationship between a household's choice of cooking fuel and another variable that increases the risk of ARI, then any apparent effect of cooking smoke might actually be due to the other variable. To assess the effect of exposure to cooking smoke on the risk of ARI more accurately, statistical controls are introduced that adjust for the effects of such variables by holding them constant.

Household and individual characteristics covered by the NFHS that might affect the risk of ARI include:

- Availability of a separate kitchen
- Number of rooms in the house (treated as a continuous variable)
- House type: *kachcha* (made from mud, thatch, or other low-quality materials) or *pucca* (made entirely from high-quality materials)/semi-*pucca* (made from both low- and high-quality materials)
- Residence (urban or rural)
- Sex of child
- Mother's education (illiterate, literate but less than high school, or high school and above)
- Caste/tribe (scheduled caste/scheduled tribe or other)
- Religion (Hindu, Muslim, or other)
- Region: north and northeast (Jammu region of Jammu and Kashmir, Himachal Pradesh, Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura), central and eastern (Delhi, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal, and Orissa), west (Maharashtra, Goa, Gujarat, Rajasthan, Haryana, and Punjab), or south (Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu)

The first three variables relate to housing quality. They are included because the likelihood of using biomass fuels decreases as housing quality improves. Urban/rural residence is included because urban residents are less likely than rural residents to use biomass fuels. Sex of child is included because exposure to cooking smoke may be different for boys than for girls. Mother's education is included because more-educated mothers tend to live in higher-income households that are less likely to use biomass fuels. Religion and caste/tribe are included because they are cultural variables that are correlated with a wide range of behaviors, including possibly the type of cooking fuel used. Region is included because households in some regions may be more likely than households in other regions to use biomass fuels. Housing quality and mother's education also help control for economic status, which, in turn, helps to control for nutritional level and access to medical services.

Effects of cooking fuel

Figure 1 shows the effects of cooking fuel on the incidence of ARI, measured as the number of ARI cases per 1,000 children under age three during the two-week period before the survey. The unadjusted and adjusted ARI rates shown in the figure are predicted values derived by logistic regression and multiple classification analysis. In the calculation of adjusted ARI rates, the control variables are held constant by setting them at their mean values for the children under consideration.

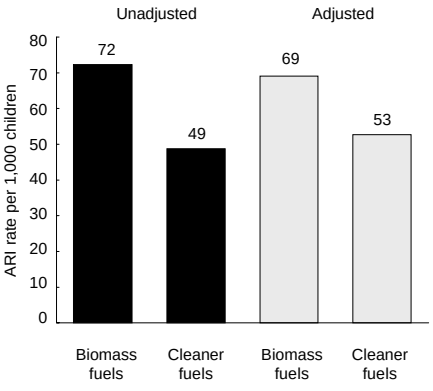

Figure 1. Acute respiratory infection (ARI) rates among children under age three by type of cooking fuel: National Family Health Survey, 1992–93

The unadjusted ARI rate is substantially higher for children living in households that use biomass fuels than for children living in households that use cleaner cooking fuels. Adjusting for the control variables reduces this difference, but not by much. The adjusted ARI rate is still almost one-third higher for children living in households that use biomass fuels.

Effects of other variables

The adjusted effects of the other variables considered in this analysis are summarized in Table 1, along with the adjusted effects of cooking smoke. For any given predictor variable, the set of control variables consists of all the remaining predictor variables listed in the table.

Table 1 shows that children living in *kachcha* houses have a substantially higher ARI rate than children living in *pucca* or semi-*pucca* houses. A surprising finding is that girls have a substantially lower ARI rate than boys. Children whose mothers are literate but did not complete high school have a substantially higher ARI rate than children whose mothers completed high school or children whose mothers are illiterate. This last finding is unexpected. A possible explanation is that illiterate mothers may be less likely than more-educated mothers to report incidents of ARI.

The ARI rate is much higher in the north and northeast than in other regions, perhaps because of the colder climate. None of the other predictor variables—except fuel type itself—has a statistically significant effect when other potentially confounding variables are controlled.

The effects of cooking smoke on ARI rates were also examined separately by age of the child (results not shown). With the other variables controlled, there was no significant difference between the effects of cooking smoke on ARI in infants (less than age one) and in toddlers (age one and two).

Why do girls have a lower ARI rate than boys?

The finding that girls have a substantially lower ARI rate than boys is surprising given the strong preference for sons that prevails in large parts of India. A possible explanation is that mothers may be less likely to report incidence of ARI in girls than in boys. This would be consistent with previously published findings from the NFHS that boys with ARI are more likely than girls to be taken to a health facility for medical treatment (IIPS 1995). Both these results suggest that ARI is taken more seriously when it is a boy who is ill.

If mothers who use wood or dung for cooking fuel are less likely to report ARI than mothers who use cleaner fuels, then the effect of cooking smoke on the incidence of ARI is likely to be underestimated. If, at the same time, ARI is more likely to be reported for boys than for girls, then this underestimation will be less for boys. As a result, the effect of cooking smoke on the incidence of ARI will appear to be larger for boys than for girls. To test this hypothesis, the data were analyzed separately for boys and girls, with sex of child deleted from the set of control variables. Results are shown in Figure 2. Not only is the incidence of ARI higher for boys than for girls, but the effect of biomass fuels on the ARI rate is considerably larger for boys than for girls, as hypothesized.

Differential underreporting of ARI by sex may not be the only factor responsible for a higher ARI rate and a larger effect of cooking smoke for boys than for girls. Another reason may be that mothers in India are more likely to carry young boys than girls with them or keep them in the kitchen area while they are cooking. As a

Table 1. Effects of biomass fuels and other selected variables on acute respiratory infection (ARI) rates among children under age three during the two weeks before the National Family Health Survey, 1992–93

Variable	Adjusted ARI rate per 1,000 children
Cooking fuel type	
Biomass fuels	69*
Cleaner fuels[a]	53
Separate kitchen	
Available	66
Not available[a]	66
Number of rooms in house	
Two rooms	67
Four rooms	64
House type	
Kachcha[a]	72
Pucca or semi-*pucca*	59*
Residence	
Urban	63
Rural[a]	67
Sex of child	
Boy[a]	72
Girl	59*
Education level of mother	
Illiterate[a]	61
Literate but less than high school	79*
High school and above	64
Caste/tribe	
Scheduled caste/ scheduled tribe	63
Other[a]	66
Religion	
Hindu	66
Muslim[a]	68
Other	55
Region	
North and northeast	106*
Central and eastern	67
West	57
South[a]	65
Number of unweighted cases	32,892

[a]Reference category

*Underlying coefficient is statistically significant at the 5% level or better. Significance levels take into account clustering in the sample design.

Note: Calculations are based on the weighted sample.

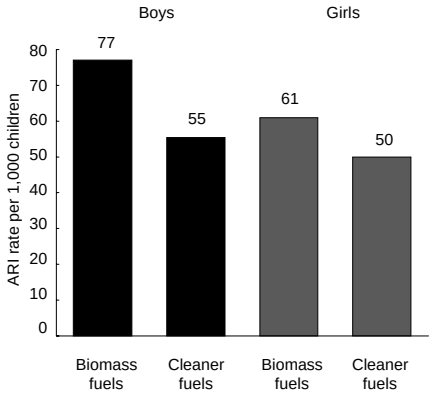

Figure 2. Acute respiratory infection (ARI) rates among children under age three by type of cooking fuel and sex of child (adjusted for effects of control variables): National Family Health Survey, 1992–93

result, boys would have greater exposure to cooking smoke than girls, which could result in both a higher level of ARI and a larger effect of cooking smoke.

Results and policy implications

For several reasons, the true effects of cooking smoke on ARI rates are probably greater than estimated here. First, women who use biomass fuels may be more likely than other women to underreport ARI in their children. Second, although the NFHS only collected information on the primary cooking fuel, households in India typically use a combination of fuels. To the extent that households use a mixture of biomass fuels and cleaner fuels, the estimated effects of biomass fuels are likely to be reduced.

Third, young children who died from ARI during the two weeks before the survey are not included in responses to the survey questions on ARI and are thus not covered in this analysis. If childhood mortality from ARI is higher in households that use biomass fuels than in household that use cleaner fuels, then leaving out all cases of ARI that resulted in death will contribute to an underestimation of the effects of biomass fuels on ARI rates. Finally, the estimated effects of biomass fuels would have been larger if the comparison had been restricted to households using biomass fuels and households using a very clean fuel, such as electricity.

The results reported here suggest that a great deal of childhood sickness and death from ARI could be prevented by reducing indoor air pollution from biomass fuels used for cooking. An obvious policy implication is that the Indian government should educate the public about the adverse effects of cooking smoke on child health and should do what it can to encourage a shift from biomass fuels to cleaner cooking fuels.

Such a shift will probably occur slowly, however, because cleaner fuels are more expensive than biomass fuels, and many Indian households cannot afford to purchase them. Cleaner fuels are also simply not available in many areas. Given these constraints, the government should strengthen its efforts to make improved biomass-burning stoves more widely available—stoves that use fuel more efficiently and produce less smoke than traditional models. These efforts should give high priority to local needs and emphasize community participation.

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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.

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

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@axcess.net.in

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