



Research Article

Women's Knowledge and Perceived Health Effects from Exposure to Indoor Air Pollution: Findings from a Population-based Cross-sectional Survey in Rural Bangladesh

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Abstract

Background: Indoor air pollution is a major environmental health problem affecting many developed and developing countries alike. Exposure to high levels of some pollutants, such as carbon monoxide, can even result in immediate death. This study explored the knowledge of women on indoor air pollution (IAP) and its perceived effects on women's health in rural Bangladesh. **Methods:** The study was conducted in 58 randomly selected villages of Jamalpur Sadar and Hatia sub-districts (29 each) in 2011. From each village, fifty households were selected randomly, totalling 2,900 households as sample. The study areas were chosen based on major fuels types used by households for cooking and geographical variation in different parts of Bangladesh. A pre-tested questionnaire was used for data collection. The analysis was performed using SPSS 16.0. The logistic regression analysis was conducted to find out the factors associated with the prevalence of health symptoms. **Results:** Over 98% of the stoves were found to be of traditional type including some improved cook stoves (ICS). Biomass and agricultural residues were the major sources of fuels used. Reportedly, women of the households suffered mainly from eye problems (89.5%), respiratory problems such as breathing problem (77.5%), dry cough (71%) and sweating at night (35%), due to greater exposure to IAP during cooking. The respondents were generally aware of indoor air pollution and its harmful effects, but attributed this more to fuel than to stove. As such, changing fuel was their solution to prevent IAP, not stove. Logistic regression analysis found the prevalence of health symptoms to be significantly associated with exposure to IAP, sex and age of the household members, type of stoves and smoking condition. **Conclusions:** IAP from use of traditional stove and organic fuels was found to be significantly associated with various health problems, especially among women. To address these health consequences of indoor air pollution, behaviour change communication activities to build awareness regarding its health risks and demand for ICS, is needed. This need to be supplemented by hands on training for women on how to cook traditional foods with ICS.

Keywords: Indoor air pollution; Improved cook stove; Respiratory illnesses

Abbreviations

IAP: Indoor Air Pollution; ICS: Improved Cookstoves; WHO: world Health Organization; OR: Odds Ratio; CO: Carbon monoxide; SPSS: Statistical Package for Social Science

Introduction

Indoor air pollution (IAP) resulting from the burning of traditional solid fuels such as fire wood and cow-dung is recognized as a serious global public health problem [1]. Recently, it has been estimated that over 3 billion people rely on solid fuels and other biomass for cooking and heating and most use traditional stoves that are very inefficient in

converting wood into heat while cooking food [2,3]. World Health Report identifies IAP as the single most environmental risk factor for female mortality, attributing 5% of all female deaths in the developing world to indoor air pollution such as smoke from cook stoves [4]. Epidemiological studies reported powerful associations between IAP exposure and acute respiratory tract infection (ARI) symptoms [5-8]. Despite these health hazards, half of the world's population and over 75% of South Asians continue to rely on dung, brush and wood as their primary source of energy for cooking and heating [4,6,8]. In general, the combustion products of wood are carbon dioxide, water vapour and carbon monoxide, particulate and polycyclic organic matters the last three of which are known to

be pollutants hazardous to human health [9].

Reasons underlying the use of traditional cook stoves include feeling comfortable, easily available fuel, cheaper to use, meeting seasonal demands etc. [9]. Traditional stoves generally have an unnecessarily large distance between the pot and the fuel bed which leads to heat loss, very low heat transfer to the cooking pot and inefficiency [10]. Some fuel-gas escapes without coming into contact with the cooking pot, further lowering conventional heat transfer. Apart from this low efficiency, traditional stoves emit smoke high in pollutant content, which affects users' health. The smoke exposure is particularly harmful for cooks (universally women) closest to the fire and others such as children who spend time in kitchen with mothers. Traditional stove dirties kitchen and soot blackens kitchen walls [11]. Due to incomplete combustion of biomass fuels in traditional cookstoves, appreciable quantities of irritants, toxins and carcinogens are released into the kitchen environment and these pose a major threat to the respiratory system of the users [9].

Biomass combustion with traditional cookstoves is an important contributor to climate change as well. Other than carbon dioxide, the leading contributor to rising global temperatures is black carbon ('soot'), accounting for 18% of the increase (with Carbon monoxide (CO) accounting for 40%) [12]. In Asia and Africa, traditional household cookstoves that burn solid biomass fuels produce the majority of black carbon [12]; household energy use in Africa alone will produce 6.7 billion tons of carbon by 2050 [13]. Climate change activities targeting black carbon emissions can have a much more rapid impact than those focusing on CO₂-CO₂ remains in the atmosphere for years, while black carbon lingers for only a few weeks [14].

Bangladesh scenario

While 37.9% of urban and 1% of rural households in Bangladesh use gas for cooking, 43.5% urban and 41.5% rural households use wood and 12.1% urban and 51.4% rural households use straw/leaves/cow-dung as fuels in their households [15,16]. With around 75% of the country's population living in rural areas, consumption of biomass fuels is therefore significant.

Recently, a study conducted on the promotion of ICS in rural Bangladesh have identified cooking practices both in rural and urban areas, the major types of fuels used in both dry and rainy seasons and types of cook stoves used [10]. In urban areas of Bangladesh where gas connections are available, people cook three times a day-once for each of the main meals (morning, noon and night) and spend upto 4 to 5 hours a day in cooking. In rural areas, amount of time spent for cooking varies by season. Women in Bangladesh are primarily the cooks and they spend up to 6-8 hours of their time in the kitchen to complete a variety of food-related tasks, such as preparing for cooking, gathering utensils, cleaning, washing, gathering fuels and cooking.

Stove type: The type of stove a household would use depends on the types of fuels that are available and preferred. It is most common to use biomass fuels in traditional cookstoves. A traditional cook stove typically consists of a

mud-built cylinder, built under or over ground, with three raised points on which cooking utensils rests. This results in three spaces in between these raised points, one of which is used as fuel feed and the other two as fuel-gas exits. Traditional stoves vary in size, design and other characteristics such as number of burners, whether it is fixed to the ground (as opposed to a portable variety), whether it is placed indoors or outdoors, etc. Traditional stoves used for preparing molasses (gur) or boiling paddy/rice are larger in size than regular stoves. We found that traditional stoves are used in 98% of all households. The majority of households (67%) use multiple stoves, but in almost all cases, both (or all) stoves are of the traditional variety. The use of multiple stoves is more common during the dry season when people can cook both indoors and outdoors.

There is a lack of information on awareness of IAP and its effects on health, especially in the rural areas. Hence, this study was undertaken to fill in the knowledge gaps and help in the informed design of an awareness campaign, besides appropriate intervention to mitigate the effects of IAP on the health of women and children in rural Bangladesh.

Methods

Study area and sampling

The study was conducted in 2011 in two sub-districts, Jamalpur sadar of Jamalpur and Hatia of Noakhali District situated in the northern plain land and southern coastland of the country respectively. This was done to reflect variation in major cooking stoves used and also geographical variations. Twenty-nine villages were randomly selected from each sub-district and fifty randomly selected households were surveyed in each village. Thus, a total of 2,900 households were visited and data collected using a pre-tested semi-structured questionnaire. Data were collected mainly from the women respondents who mainly took part in the cooking for their respective households. In her absence, a male guardian of the family was interviewed by the enumerators.

Data collection techniques and tools

Seventy-one field enumerators (social science graduates) were recruited and trained on data collection. They underwent a field test to check compliance with the survey procedures and questionnaire interview. Thirty teams of field enumerators (each team consisting of two enumerators) were deployed at a time successively in the two areas. To monitor the quality of work, five especially trained field enumerators (three for Hatia and two for Jamalpur sadar) were deployed while the rest six (three each for Hatia and Jamalpursadar) were given the task of supervision. There were two parts of each quantitative questionnaire, viz. male and female and the team of two field enumerators was assigned to interview them separately. The protocol passed through the institutional review process for ethical approval. Informed consent was obtained from the participants before interview and privacy of data collected was maintained anonymously. The field activities were closely supervised by the investigators through frequent visits, random and on-the-spot checking of the 20% of the filled-in

questionnaires and providing feedbacks and guidance as and when needed.

Data management and analysis

Filled-in questionnaires were edited and coded for computer entry under the close supervision of the researchers. The analysis was performed using SPSS 16.0. The logistic regression analysis was conducted to find out the factors associated with prevalence of health symptoms.

Results

Table 1 briefly summarizes the profile of the respondents. Most of them were 20–59 years old, married and almost half of them were literate. The main occupation of the male earning members of the households was agriculture followed by small trade, however, the females invariably were engaged exclusively in household chores.

Indicators	Jamalpur		Hatia		Total (n)
	Male (%)	Female (%)	Male (%)	Female (%)	
Age group					
Adolescent (10-19 years)	-	2.9	-	2.1	77
Adults (20-59 years)	83.4	92.7	81.2	93.9	5406
Older (60+)	16.6	4.4	18.8	4	674
Married	99.5	99.5	99.9	99.6	6134
Literate	45.5	48.1	59.5	54.1	3189
Occupation					
Agriculture	44.4	-	41	-	1315
Business	21.2	0.3	23.1	0.1	688
Day labor	19.1	0.1	18.4	0.3	583
Household work	-	98.4	-	97.5	3015
Others	15.3	1.5	17.5	2.1	560
Earning member	98.2	28	97.6	9.2	3586
Average family size	5.76 (±2.2)		7.34 (±2.9)		6.6
N	1,539	1,539	1,540	1,539	6,157

Table 1: Demographic profile of respondents.

Kitchen and stoves

To get an idea about the stoves and kitchens that are currently used in the survey areas, a number of issues were incorporated in the questionnaire viz. types of stoves in use, cost of obtaining such stoves, condition of the kitchens and its ventilation, etc. Among 2,900 surveyed households all had single cooking stove. Most of the stoves were placed inside an enclosed space near the main homestead (57.5%) or at some distance from the main homestead (34.8%). Very few were placed inside the main homestead (3.7%) or completely in open space (3.9%).

Knowledge on indoor air pollution

Less than 5% respondents opined that there was no IAP inside their house, however, 27.7% mentioned that significant amount of IAP was taking place in their households. About 67% of the respondents though the level of IAP to vary from less to moderate. Most of the other respondents recognized cooking as a source of IAP. Reportedly, 89.4% attributed this pollution due to fuel type, while 20.2% attributed this pollution due to stove design. Regardless of the attributable cause of pollution, 87.3% of the respondents realized that pollution was harmful to health.

Disease Name	Household member likely to suffer from a disease (as perceived by respondent)			
	Wife (% of households)	Husband (% of households)	Children (% of households)	Someone in General (% of households)
Eye problem	89.5	48.2	41.6	90.1
Breathing problem	77.5	49.1	36.9	79.1
Dry cough	71.3	46.2	34.6	72.6
Sweating at night	34.9	23.1	15.9	35.9
Cough with phlegm	32.2	24.0	15.9	33.1
Fever	31.2	24.9	16.4	31.9
Blood in sputum	18.4	13.8	8.9	19.5
* expressed as a percentage of people who thought air pollution harms health				
** n = 2.688				

Table 2: Health sufferings from particular diseases caused by IAP (Female respondents only).

Perceived health effects from IAP

Table 2 shows what the respondents thought about the likely suffering from a particular disease due to IAP. Most of the respondents identified women followed by husbands and children of the households to suffer from the listed diseases.

As to the question what measures they could take to prevent IAP, a variety of responses came up. Most popular response related to cooking was to change fuel type.

However, the number of households sharing such views differed considerably across the two study areas (85% households in Jamalpur sadar and 28% households in Hatia). Cooking outside and ensuring proper ventilation were among the next widely responded measures. Interestingly, using ICS was a solution to only about one-tenth of the respondents.

Association between selected variables and health effects of exposure to IAP

A logistic regression analysis was performed to explore the predictors of health effects due to IAP among the study

households (Table 3). This analysis was conducted for household members who reported to have had any of the following health sufferings: eye problem, breathing problem, dry cough and sweating at night. Analysis revealed that the prevalence of health effects due to exposure to IAP correlated with the study areas, sex and age of the household members, type of stoves and smoking condition (Table 3). Significantly higher association was observed for Hatia than Jamalpur Sadar sub-district because of placement of stoves close to the living room (71% vs. 44%) and also, placing stoves inside the house (5.3% vs. 2.1) which might have increased the prevalence of exposure to IAP (Table 3). Also, women showed significantly higher likelihood of having health effects of exposure to IAP (OR 1.1, CI 1.0-1.2) than men, especially, aged women. A strong association of health effects with exposure to IAP was found with traditional stove (OR 1.4, CI 1.1-1.9) and smoking behavior of household members (OR 1.1, 0.9-1.2).

Predicted variables	OR	95% CI	p-value
Study areas			
Hatia sub-district	1		
Jamalpur sub-district	0.705***	0.659-0.754	<0.001
Sex of respondents			
Male	1		
Female	1.072*	0.996-1.153	<0.063
Age of respondents	1.007***	1.005-1.009	<0.001
Stove types at household level			
Improved cook stove	1		
Traditional	1.381**	1.006-1.895	<0.046
Smoking condition			
No	1		
Yes	1.057	0.946-1.180	<0.328

Table 3: Odds ratio of selected variables predicting the health effects of exposure to IAP of the household members.

Discussion

Realizing the potentiality of improved cookstove in reducing indoor air pollution and ensuring healthy living environment, this study explored level of awareness on effects of IAP on health as perceived by the respondents in two rural areas of Bangladesh. Findings reveal that more than two-third of household members perceived a less or moderate amount of indoor air pollution taking place in the cooking area. Besides, most of the (80%) respondents recognized cooking with biomass fuel as a source of IAP.

The fact that IAP from cookstoves mainly affects women and children is reiterated from this study. It has been observed that the cookstoves are usually placed at some distances from the main living area, thereby reducing exposure to other members of the households. This result substantiates previous research findings reporting that a cook closest to smoke is highly exposed to IAP which is harmful for health [11].

Study found that eye problem, ARI symptoms such as breathing problem, dry cough and sweating at night were the most commonly perceived diseases caused by IAP, especially for women as they usually do the cooking and hence more

exposed to IAP. Previous study supports these findings where IAP exposure is typically greater for women and children as they are more exposed to smoke from the stove and suffers its consequences including mortality [1,4,10]. In addition, as noted in the World's Worst Polluted Report [15] that biomass fuels are typically burned in rudimentary stoves resulting in inefficient use of precious fuel and unnecessarily large amounts of air emissions [5]. The majority of research identified that although women are highly affected due to IAP but they were less included than male participants in the awareness raising or technology use and maintenance related training programs conducted by different stakeholders.

Conclusions

The respondents were generally well aware of indoor air pollution and its harmful effects on health but attributed this pollution more to fuel type than to stove type/design. Similarly, changing fuel was their solution to prevent IAP, not stove. Study identified that the prevalence of health effects due to exposure to IAP, could be predicted by age, sex, stove

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type and geographical location of the households. A community-based campaign to raise awareness on IAP as well as improving the use of improved cook stove through social marketing is urgently needed to address this problem.

Authors Contribution

Dr. Dey was responsible for development of concept, study design, management, analysis, interpretation of data and drafting the manuscript.

Ali was involved in questionnaire design, training enumerators, data collection, cleaning and analysis.

Arif was involved in questionnaire design, training enumerators, survey monitoring, data collection and analysis.

Dr. Ahmed was responsible for co-development of concept, advising on data analysis and assistance in drafting manuscript.

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