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Female perceptions of health hazards associated with indoor air pollution in Bangladesh

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This paper will identify health hazards associated with indoor air pollution (IAP) in Bangladesh. Research into IAP in Bangladesh has been neglected for many decades. This neglect may reflect aspect of the marginalization of women in Bangladeshi society, especially as cooking is considered a social responsibility of women. The main purpose of the paper is to examine the extent to which female domestic cook experience health threats related with cooking environment and to understand their perceptions of the link between IAP exposure and poor health outcomes. One hundred female domestic cook in Rajshahi City, Bangladesh, were interviewed by using a semi-structured questionnaire interview method, educational level, oven and fuel types are used as proxy determinants of class, based on educational level, respondents were categorized into three classes, illiterate, graduate and above and in-between (from level one to level 12). It was found that the higher the educational level the respondents had, the more they were likely to be aware of health effects associated with IAP. The author draws a conclusion that respondents with minimum levels of education, using wood fired mud-ovens, are more likely to be exposed to IAP and, as a consequence, have greater health risks than other women. Finally, it is recommended that fuel efficiency intervention, such as, a pipe line gas supply, is urgently needed to reduce cook-related work loads and, ultimately, improve the health of women, particularly poorer women in Rajshahi city.

Key words: Health hazards, indoor air pollution, women, Bangladesh.

INTRODUCTION

Smoke in the home, the fourth greatest cause of death and diseases in the world's poorest countries, kills more people than malaria does and almost as many as unsafe water and sanitation. It kills 1.6 million people annually, nearly a million of them are children. Most of the rest are women. (Smith et al., 2005)

Indoor air pollution is a greater public health hazard in the developing countries than malaria or lack of access to clean water and sanitation, resulting in a fatality every 20 seconds (Smith et al., 2005). Nonetheless, wood fires remain an important resource in food preparation. To fuel wood fires, people in developing countries generally use both bio-mass fuels (organic matter convertible into heat, directly by burning or indirectly by bio-gasification) such as animal dung, crop residues, wood and fossil fuels (a hydrocarbon deposit derived from living matter of a previous geologic time and used for fuel) such as electricity, gas, kerosene. About 2.4 billion people rely on traditional biomass, mainly for cooking and heating. The international energy agency (IEA, 1998) estimated that

biomass accounted for approximately 14% of final energy consumption (Ahsan and Afrin, 2007). Moreover, as mentioned by Bruce et al. (2002), approximately half of the world's households cook daily with unprocessed solid fuels, that is, bio-fuels.

However, biomass fuel users usually cook indoors, using open fires or poorly functioning stoves with inadequate ventilation facilities. The smoke generating from biomass fuels contains a large number of pollutants that include carbon monoxide, carcinogens such as benzo[a]pyrene and benze, formaldehyde, nitrogen dioxide, small particles and sulphur dioxide (this mainly from coal) (Bruce et al., 2000). These pollutants are dangerous for the cook and her associates and render indoor environment unlivable. Several studies conducted on households in Asia, Africa and the Americas reported that indoor air pollution level in homes is much higher than the limit set by the Department of Environment (DOE in Bangladesh), national standard, the U.S Environmental Protection Agency (EPA), and World

Health Organisation (WHO) (Ahsan and Afrin, 2007; Smith et al., 2000, WHO, 2000). For instance, Bruce et al. (2000) noted that indoor concentrations of particles usually exceed guideline levels by a large margin: average PM10 level in 24 h should be in the range 300 - 3000 $\mu\text{g}/\text{m}^3$, but 30000 $\mu\text{g}/\text{m}^3$ or more was reported during cooking periods.

Recently, numerous studies have reported that indoor air pollution has adverse health effects on women and children¹. They argue that exposure increases the risk of Acute Lower Respiratory Infections (ALRI) in children, Chronic Obstructive Pulmonary Disease (COPD) in adults and lung cancer, where coal is used extensively. In addition, evidence has now emerged showing a link of IAP with a number of other conditions, including asthma, cancer of the upper airway, cataracts, low birth weight, otitis media, perinatal mortality (stillbirth and deaths in the first week of life), and tuberculosis (WHO, 2000). However, a plethora of studies in both developed and developing countries have found the link between IAP and certain diseases.

For instance, the association of IAP with acute (lower) respiratory infection², asthma (Kenya et al., 1995; Smith et al., 2000; Xu et al., 1996a), COPD³, lung cancer (Mumford, 1987; Smith, 1993; Duflo et al., 2007; WHO, 2000), low baby weight (Dona and Harding, 2005, WHO, 2000) and tuberculosis (Gupta and Mathur, 1997; Bruce et al., 2002, WHO, 2000) was found.

Furthermore, many documents such as estimates of the global burden of disease, the 1992 world development report and the WHO report that indoor air pollution is one of the four most critical global environmental problems and might be responsible for nearly 4% of the global burden of disease (Smith, 2000, WHO, 2000). In addition to these figures, global estimates revealed that approximately 2.5 million deaths result from indoor exposures to particulate matter in rural and urban areas in developing countries occur each year. This mortality figure represents 4 - 5% of the 50 - 60 million global deaths that occur annually (Bruce et al., 2002).

As women are primary cooks and caregivers for children in nearly all cultures, they with their children are prone to receive the greatest exposure to the smoke from solid fuel combustion. This exposure ultimately leads to

higher risks for women and children (Dasgupta et al., 2004a; Smith et al., 2005; WHO, 2000). As reported in observational research conducted in developing countries, young children in households using solid biomass fuels are 2 - 3 times more likely to suffer acute lower infections than children in households that use alternate fuels. Similarly, women exposed to biomass fires for 15 years or more are 2 - 4 times more likely to develop COPD compared with other women (Larson and Rosen, 2002).

In Bangladesh, Ahsan and Afrin (2007), Dasgupta et al. (2004a), Ms Tobassum (2007), and Pitt et al. (2006) identified and found a linkage between indoor smoke exposure and possible negative health effects on women and children. Yet, studies have not explored whether women in Bangladesh had any understanding of health risks associated with indoor air pollution. It is highly likely that millions of people are unaware of the threats in their homes, just as millions of smokers were unaware of the hazards of tobacco until the 1960s (Donna and Harding, 2005). Accordingly, the present paper will examine the extent to which female domestic cooks experienced health problems which has been linked with indoor cooking environments and to understand their knowledge about the relationship of IAP to various diseases.

DATA AND METHODS

The study undertaken was using a survey method (face to face interview). The main reasons for following this method were that it allowed for the collection of data within a limited time framework, was relatively cost-effective and that it provided a minimal imposition on respondents' time compared with other methods. Primary data were collected by using the semi-structured questionnaire interviews. A research team consisting of one principal investigator and four research assistants was formed. The principal investigator and four students (two males and females) from the Department of Sociology of Rajshahi University were recruited as research assistants. Initially a draft questionnaire was developed on issues such as socio-economic background of the respondents and the perception about the health hazards of IAP. The questionnaire used in this study had three parts. The first part asked some general questions, such as age, occupation, household size, income and marital status.

The following section of the questionnaire incorporated questions on health issues, such as what types of health problems the respondents faced within the last year before the interview was done and how these problems were treated. In the last section of the questionnaire, questions examined the effects of IAP on health, with questions such as: 'Do you think that the following symptoms of diseases appear due to smoke exposure?' 'How can we overcome this problem?' Several discussions were held among the researchers who found certain anomalies regarding ordering the questions and then felt the necessity of adding few more questions with changes and adjustments in the questionnaire. With some addition and correction, the questionnaire was finalized for pre-testing. Both open and close-ended questions were incorporated in the questionnaire.

The pre-test was conducted among four respondents in order to test the effectiveness of suitability of the research instrument and to discover possible weaknesses, inadequacies, ambiguities and problems so that they could be corrected before actual data

¹ (Ahsan and Afrin, 2007, Bruce et al, 2002, Tobassum , 2007, Dasgupta et al,2004a, 2004b, Donna and Harding,2005, Duflo and Hanna,2007, Smith et al, 2000,2005)

² (Armstrong & Campbell,1991, Bruce et al.,2000, Campbell et al., 1989, Cerquero et al., 1990, Collings et al., 1990, de Francisco et al., 1993, Depmsey et al., 1996, Dona and Harding, 2005, Ezzati and Kammen, 2001a, 2001b in Duflo et al.,2007, Johnson & Aderle, 1992, Lopez-Bravo et al., 1997, Morris et al., 1990, Mtango et al.,1992, Pandey et al., 1989, Robin et al., 1996 in Bruce et al.,2002, Shah et al., 1994, sixteen studies in LDCs- Kossove, 1982, Smith,2000, 2002, Victora et al., 1994, Wesley & Loening., 1996, WHO,2000)

³ (Bruce et al.,2000, Colombia/Dennis et al.,1996, Dona and Harding., 2005, eight studies in six countries-Bolivia/Albalak et al.,1999, India/Gupta and Mathur,1997, Malik,1985, Mexico/Perez-Padilla et al.,1996, Nepal/Pandey, 1984b, Pandey et al.,1998, and Saudi Arabia/Dossing et al. in Smith et al., 2000, WHO, 2000)

Table 1. Socio-economic characteristics of the respondents.

Socio-economic characteristics	n	%
Age (in year)		
<30	26	26
30 - 39	43	43
40 - 49	22	22
50 - 59	6	6
>60	3	3
Total	100	100
Level of education		
No education	26	26
Up to S.S.C ⁴	43	43
H.S.C ⁵	12	12
Graduate and above	19	19
Total	100	100
Monthly family income (in taka)		
<2000	22	22
2000 - 3999	27	27
4000 - 5999	12	12
6000 - 7999	5	5
8000 - 9999	10	10
10000 - 11999	6	6
12000 - 13999	-	-
14000 - 15999	3	3
16000 - 17999	1	1
18000 - 19999	11	11
>20000	3	3
Total	100	100
Types of ovens (multiple answers)		
Kerosene stove	16	
Hitter	5	
Gas oven	25	
Mud-oven	61	
Others	5	
Total		
Sources of fuels (multiple answers)		
Wood	49	
Cow dung	10	
Kerosene	17	
Gas	24	
Electricity	5	
Others	14	
Total		
Time spent daily in the kitchen		
2	21	21
3 - 4	26	26
5+	53	53
Total	100	100

(Source: field-work).

collection started. It was also done in order to test the need of adding new questions, so that clear information on certain issues could be addressed in the questionnaire. After the pre-testing, necessary correction and modifications were made in the questionnaire.

Field investigation began in early December and ended in late December 2007. Rajshahi city is the biggest city in the northern division. Total area of Rajshahi city is 96.72 km². Total number of population in this city is 720,514 (male-396,283 and female 324,231). The city is divided into 30 wards. Among 30 wards, 4 wards were selected purposively based on different social backgrounds such as educational, households, and income levels. After selecting four wards, 100 female cooks were interviewed. It is worthwhile to mention here that they all gave responses voluntarily. The underlying reason for doing this was to examine variation among female cooks from diverse socio-economic backgrounds in terms of the perception of the health hazards of IAP. Frequency distribution tables with percentage and figure are provided to describe responses. All kinds of data processing activities were done manually.

FINDINGS

Data on socio-economic characteristics of the respondents illustrated in Table 1 reveal that approximately 75% were aged between 30 and more than 60 years. Of these, a large number (43%) belonged to the 30 - 39 year age group. The sample was not homogeneous in terms of level of education and monthly family income. Only 26% have no education, whereas 43% of the respondents were educated up to secondary school certificate level. Only 27% of the respondents had monthly income from 2000 to 3999 Taka (around USD 28-59), while 22% had less than 2000 Taka. The sample was also heterogeneous in terms of use of oven, sources of fuels, and length of time they usually spend daily in the kitchen. A significant number of the women (61) questioned use mud-oven (the surroundings of the oven are covered by mud/clay) followed by gas oven (25). Moreover, a half of the respondents use wood as a source of fuel and 24 use gas. Furthermore, more than half of the women (53%) daily spend more than 5 h in the kitchen.

Table 2 shows how level of education that the respondents have appeared to affect people choices (types of ovens, sources of fuels and length of period spent daily in the kitchen). It was found that approximately 34% (21 out of 61) mud-oven users are illiterate. Moreover, all gas-oven users have certain level of education. It was also found, the most of the respondents using wood as fuel source have less than level 12 educations while around half of the gas users have graduation degrees. Only 8% (four among 49) wood users and 45% (11 out of 24) gas users have graduate level education. It is worthwhile to mention here that only 5% of the respondents used electricity as a cooking fuel. Moreover, as shown in the table, 20 respondents with no education spend more than 5 h daily in the kitchen compared with eight with graduation.

Table 3 demonstrates the respondents' opinion about the symptoms of cooking related physical problems. Only

⁴ Secondary School Certificate (level 10)⁵ Higher Secondary Certificate (level 12)

Table 2. Variation in use of oven, fuel sources and length of period spent daily in the kitchen according to the levels of education of the respondents.

Levels of education	Illiterate	In-between	Graduate	Total
Types of ovens				
Kerosene stove	4	9	3	16
Hitter		1	4	5
Gas oven		14	11	25
Mud-oven	21	35	5	61
Others		4	1	5
Sources of fuels				
Wood	15	30	4	49
Cow dung	6	4		10
Kerosene	5	9	3	17
Gas		13	11	24
Electricity		1	4	5
Others	2	10	2	14
Length of time (in hour)				
2	2	16	3	21
3 - 4	4	14	8	26
5+	20	25	8	53

(Source: field work)

Table 3. Distribution of physical troubles the respondents faced within the last year.

Facing troubles	Total		Illiterate		In-between		Graduate	
	Yes	No	Yes	No	Yes	No	Yes	No
Chest pain	61	39	21	5	36	19	4	15
Breathing problem	34	66	11	15	20	35	3	16
Coughing	27	73	10	16	12	43	5	14
Allergy	69	31	18	8	37	18	14	5
Coughing(morning)	23	77	7	18	10	45	6	13
Coughing (winter)	16	84	5	21	8	47	3	16

(Source: field work).

23 and 16% of the respondents experienced coughing in morning and winter respectively. More than half of the respondents reported that they experience chest pains (61%) and allergies (69%). Out of the respondents with chest pain and allergy, most have less than level 12 educations.

Table 4 demonstrates the awareness of the respondents about the linkage between IAP and exposure to various diseases. Most of the respondents mentioned that pulmonary (49%), Asthma (48%), eye problem (71%), low weight baby (37%), burning (84%), eye irritation (86%), cardiac problem (45%) could be the result of IAP. Most of the respondents acknowledging the link between IAP and various diseases are literates. In contrast, no linkage of acute Respiratory Infection (ARI/48%), TB (41%) and digestion problem (42%) with

IAP was found. Most of the respondents mentioned that they do not know about the relationship of lung cancer with IAP when they were asked about their personal opinion.

DISCUSSION

Biomass fuel use generates high indoor air pollution

Per capital energy consumption, an indicator of the physical quality of life, is very low in Bangladesh. 30% use electricity, while only 4% use natural gas for cooking. More than 90% of the households depend on unsustainable supply of biomass fuels for cooking (Akhter, 2002; Ahsan and Afrin, 2007). It has been found

Table 4. Distribution of awareness about diseases related with cooking.

Disease awareness	Illiterate			In between			Graduate		
	Yes	No	Do not know	Yes	No	Do not know	Yes	No	Do not Know
ARI	6	8	12	24	18	13	2	12	5
Pulmonary	8	7	11	27	14	14	14	2	3
T.B	3	11	12	17	22	16	9	8	2
Asthma	8	6	12	25	19	11	15	1	3
Lung cancer	3	5	18	17	17	21	9	4	6
Eye problem	16	4	6	40	9	6	15	3	1
Low weight baby	11	5	10	23	17	15	3	6	10
Burning	21	3	2	49	4	2	14	5	
Eye irritation	24		2	43	11	1	19		
Digestion problem	14	6	6	24	25	6	3	11	5
Cardiac	8	6	12	30	14	11	7	6	6

(Source: field work)

that 61 and 25% of the female participants used mud-oven and gas oven for cooking purpose respectively. These findings contradict with national statistics which reports that 98.6% urban households use open-fire oven (NIPORT, 2009: 17). However, the data on fuel sources this study found do support the national data. For instance, the former shows that most of the mud-oven users use wood and cow dung as fuel sources where as the latter reports that the majority of urban households in Bangladesh use wood (44.3%), followed by LPG/natural gas/biogas (37.49%), agricultural crop/straw/shrubs/grass (13.2%), animal dung (3.6%) and other (1%) as fuel sources (NIPORT, 2009:17).

One of the reasons for using woods and cow dung is that they are locally available and/or are cheaper compared with other fuels. Women from poor families collect fuels at the expense of their opportunity costs. Furthermore, cylinder gas, very costly compared with pipe-line gas supply in Bangladesh, is available in Rajshahi city. This high cost restricts poor households from using environmentally friendly fuels. According to the energy ladder, animal dung is on the lowest rung of the ladder progressing to crop residues, wood, charcoal, kerosene, gas, and finally electricity. People generally move up the ladder when their socio-economic condition seems to improve (Bruce et al., 2002; Duflo et al., 2007; Smith et al., 2005; WHO, 2000). In addition, Dasgupta et al. (2004b) describes the nature of the fuels in terms of dryness. According to Dasgupta et al. (2004b), among biomass fuels, dung seems to be the dirtiest fuel (291 $\mu\text{g}/\text{m}^3$), followed by firewood (263), sawdust (237), straw (197), jute (190) and twigs and branches (173). As most of the households use unprocessed fuels in mud-oven, these fuels are not burnt completely and ultimately emit a large amount of toxic air pollutants (Ahsan and Afrin, 2007; Dasgupta et al., 2004b; WHO, 2000). For instance, Smith (2000 in Duflo et al., 2007) reported that mean 24 h PM10 concentration in solid fuel using households in

India sometimes exceeds $2000\mu\text{g}/\text{m}^3$ and Dasgupta et al. (2004 in Duflo et al., 2007) found an average of $600\mu\text{g}/\text{m}^3$ in Bangladesh, far outside the EPA accepted guidelines of $50\mu\text{g}/\text{m}^3$. Moreover, Bruce et al. (2000) cited that indoor concentrations of particles usually exceed guideline level by a large margin: 24 h mean PM10 levels are typically in the range 300 - $3000\mu\text{g}/\text{m}^3$ and may reach $30000\mu\text{g}/\text{m}^3$ or more during periods of cooking.

IAP and exposure to health hazards

IAP from both biomass and fossil fuels seems to affect the health of people, particularly women and children, who usually spend their major time daily in the kitchen. The fact that IAP causes many health problems is well known in the development literature. As mentioned earlier, many health problems such as tuberculosis, eye irritation and contact, low birth weight, lung cancer could arise from the result of exposure to IAP. The present study also reveals the same scenario. For instance, it has been found that 23% of the respondents have coughing in morning while only 16% have coughing in winter. More than half of the respondents with experienced pain and allergy were also found. In addition, the respondents identified IAP as one of the possible causes of these disease symptoms. Moreover, Pitt et al. (2006) and Duflo et al. (2007) show that Bangladeshi women and children are likely to exhibit greater symptoms of respiratory illness as women and their children have more attachment to the kitchen.

Women, particularly poor women are more vulnerable

Women are responsible for the preparation of domestic foods in every culture and spend a large portion of their

daily life in the kitchen and Bangladeshi women are not the exception. As a result, women are more likely to be affected by the smoke generated from the use of unprocessed fuels in indoor environment than their male counterparts. For example, several researchers (Tobassum, 2007; Dasgupta et al., 2004a; Smith et al., 2000, 2005) came to the conclusion that females more than 15 years old were affected by asthma, blindness, COPD, lung cancer, and tuberculosis from IAP. However, all females in Bangladesh are not affected in the same manner. It is well known fact that poor women are always affected more than others by any kind of man-created catastrophes. It has been found that around half of the respondents had less than 4,000 Taka (USD around 60) monthly household incomes. The figure indicates that they live either below or at the US two-dollar poverty line. Moreover, this finding does not support another study which noted that the urban poverty rate in Bangladesh was 36.6% in 2000 (Begum and Salimullah, 2004). Furthermore, as reported in this study, about a quarter of the respondents do not have any level of education which is similar to national data (NIPORT, 2009). And most of the women studied used mud-oven with wood and cow dung. All these variables, cited above, indicate the social condition of the respondents. It appears that most of respondents in this study are poor. And the study found the link between health problems resulting from exposing to IAP and poverty. For instance, it has been found that most of the respondents with physical troubles have undergraduate level of education and use mud-oven with wood and cow dung. Moreover, as of Mishra et al. (1999b in Smith et al., 2000), indeed women in households using biomass fuels were found to be 2.7 times more likely to have tuberculosis than women in households using cleaner fuels, even after correction for a range of socio-economic factors. Furthermore, Dasgupta et al. (2004a) indicated the same scenario: that the poorest, least-educated households have twice the pollution level in compared with high-income households with highly-educated adults. In addition, as found in the study, poor women are less aware about the health effects of IAP. More than half of the illiterate respondents do not have knowledge on the connection.

Conclusion

Like other developing countries, women's health issues in Bangladesh have for long been neglected, though their contribution in cooking and domestic care is immense. Both biomass and fossil fuels, used for cooking, generate smoke that pollutes the indoor environment. The polluted air inside the kitchen might cause many health problems for women who spend a large part of their day devoted to food preparation duties. It has been found in the study that the higher educational level and ability to use refined fuels was associated with respondents having less identifiable health problems and greater awareness about

the health impacts of IAP. It could thus be concluded that female domestic cook with minimum levels of or no education and using mud-oven are more likely than other women to have health risks associated with exposure to IAP. Moreover, this study asserts that no clear-cut relationship between IAP and health hazards can be drawn without scientific investigation. No access to education and environment friendly fuels, such as electricity or gas, could be the result of poverty. It thus recommends that the Bangladesh government should try to supply pipe line gas with subsidies for the poor in Rajshahi city to reduce the IAP related health threats.

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