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Research Note

**ARSENIC CONTAMINATION AND HUMAN HEALTH: A
SOCIOECONOMIC STUDY IN SOME SELECTED AREAS OF
BANGLADESH***

**W. M. H. Jaim
Mahabub Hossain**

Abstract

Arsenic contamination of groundwater is a case of mass poisoning in Bangladesh. In order to examine the nature and extent of the problem, household survey was conducted in both arsenic contaminated and non-contaminated areas. The selected arsenic 'hot spots' were Faridpur and Lakshimpur while the arsenic free area was Gazipur. One village from each of the three locations was purposively selected and the number of households considered as samples was 250. The analysis showed that severity of arsenic related diseases was more acute in the poor village of Lakshimpur area (where about 50% of the household members were suffering from arsenic related skin diseases) compared to Faridpur while in Gazipur there was no case of any patient suffering from arsenic related diseases. Further, the impact of arsenic problem was found to be extended from immediate health effect to extensive social and economic hardship especially for the poor. On the other hand, access to health care facilities as well as access to safe drinking water and even access to information about arsenic mitigation programs were seriously lacking particularly in Lakshimpur. Special attention from the Government, private and NGOs is needed to meet the urgent need of supplying arsenic free water to save lives of the millions of people living in the arsenic contaminated areas of Bangladesh.

I. INTRODUCTION

Arsenic contamination of groundwater is a severe problem in Bangladesh. Contamination of groundwater by arsenic has also been reported from many countries including Argentina, Australia, Chile, China, Hungary, Mexico, Peru, Thailand, Vietnam and USA (Smedley and Kinniburgh, 2002; WHO, 2004). But the magnitude of the problem has been assessed as most severe for Bangladesh (BGS, 2000). In some parts of Bangladesh, the arsenic level in the groundwater has been assessed at over 100 times higher than the norm of 0.01 mg/l- set by the World Health Organization (WHO) and the U.S. Environmental Protection Agency (USEPA). According to a study conducted by the British Geological Survey (BGS) 46% of the samples had arsenic levels above 0.01 mg/L and 27% were above 0.05 mg/L (BGS, 2000). It is estimated that about 35 million of people are exposed to arsenic concentrations above 0.05 mg/L (Bangladesh standard for drinking water).

*The authors are respectively Professor, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh; Executive Director, BRAC, BRAC Centre, 75 Mohakhali, Dhaka-1212, Bangladesh

It is now generally agreed that the arsenic contamination of groundwater in Bangladesh is of geological origin. There is a distinct pattern of arsenic contamination with the greatest concentration in the south and south-east of the country and the lowest concentration in the north-west, with occasional arsenic 'hot spots' in the northern and north-eastern parts of the country. Consumption of arsenic contaminated water and foods in the arsenic affected areas of Bangladesh is a significant risk to public health. Up to 1999, more than 10,000 patients of arsenic poisoning have been identified in the country (Hussain, 2001).

Adverse impact of arsenic contamination of groundwater has been categorized as primary and secondary by Khuda (2001). The primary impact is on the health of individuals who are exposed to arsenic poisoning through drinking groundwater laced with arsenic. After several years of low level arsenic exposure, various skin lesions appear. These are manifested by hyperpigmentation (dark spots), hypopigmentation (white spots) and keratoses of the hands and feet. After a dozen or so years, skin cancers are expected. Twenty or thirty years after exposure to 0.05 mg/L of arsenic, internal cancers (lung, kidney, liver and bladder) appear among 10% of all exposed. Next to drinking water, food is another source of arsenic entry into body. The secondary impact is an outcome of the primary impact and is reflected in the socioeconomic consequences like inability to do productive works, social exclusion, problems of getting married, etc.

With the above background, a study was undertaken to see the impact of arsenic in drinking water on human health in the arsenic contaminated areas compared to arsenic free area. Villagers' perceptions about arsenic contamination in water and its impact as well as measures taken to get arsenic free water have also been assessed.

II. METHODOLOGY

In selecting the study areas, areas with arsenic contamination and without arsenic contamination of drinking water have been considered. Accordingly, three sites, namely Faridpur, Lakshmipur and Gazipur were selected. Both Faridpur and Lakshmipur areas are characterized by high level of arsenic contamination in drinking water lifted by Hand Tubewells (HTW) or by Shallow Tubewells (STW) while in Gazipur there is no report of arsenic contamination in water. Consulting local officials as well as local people, one village was selected to represent each of the three sites. The selected village in Faridpur was Bilvora under Manikdoho Union of Bhanga Upazila while the selected village in Lakshmipur was Chandipur under Chandipur Union of Ramgonj Upazila. In the case of Gazipur, the selected village was Sripur which was located in Sripur Union under Sripur Upazila.

For field survey, Cluster Sampling Method (CSM) was adopted in selecting households from each of the villages. It may be mentioned that in the case of CSM all households located in a cluster are considered as samples. In this study, the sample consisted of 100 households for each Faridpur and Gazipur and 50 households for Lakshmipur. Total number of households in the selected villages of Faridpur, Gazipur and Lakshmipur were 250, 500 and 2000 respectively. The smaller sample size in Lakshmipur was due to non-cooperation of the household heads in sharing information on the impact of arsenic poisoning as they felt shy of

disclosing the information to the outsiders that someone in their families are affected by arsenic. The field survey was conducted during October, 2005 to March, 2006.

III. RESULTS AND DISCUSSION

In this section, socio-economic characteristics of the selected household members and their health status in general have been described in both arsenic contaminated (Faridpur and Lakshimpur) and non-contaminated area (Gazipur). However, particular emphasis has been given to arsenic affected areas where people are suffering from various diseases for drinking arsenic contaminated water. In this respect, villagers' perceptions about arsenic contamination in water, its effects on human health, socio-economic impact on arsenic affected males and females, measures taken for treatment of arsenic related diseases as well as arsenic mitigation programs have been discussed.

3.1 Socio-economic characteristics of the selected households

Annual per household income in the selected village of Lakshimpur was Tk. 39,240 compared to Tk. 51,686 in Faridpur and Tk. 49,212 in Gazipur (Table 1). However, high standard deviation of the average income in all locations indicated that household income varied widely among the households. It was observed that the majority households in all locations had *Katcha* house with a single room, as such type of households were 86% in Lakshimpur, 63% in Faridpur and 55% in Gazipur. It appears from annual household income and house type, the villagers of Lakshimpur were economically poorer compared to those of Faridpur and Gazipur. Again, the economic condition of the villagers of Faridpur and Gazipur was found to be close.

Agriculture was found to be the main source of income of the households in all the locations. In Faridpur and Lakshimpur, selling labour (both in farm and non-farm) was also important; however, in Gazipur, business was found to be the second most important source of income (Table 1).

Average family size of the households in the selected villages was 5. About one-third of the household members (aged 5 years and above) in all the locations were found to be illiterate. The highest percentage of the literacy was found with the Primary Level of education. In Faridpur, about half of the household members (49.5%) had Primary education, the corresponding percentages for lakshimpur and Gazipur were 29.5 and 26.7 respectively. It was found that majority of the household members had either Primary or Secondary levels of education and the household members with SSC and above were considerably low in all the locations.

Table 1. Socio-economic characteristics of household members in the selected study areas

Socio-economic characteristics	Faridpur	Lakshimpur	Gazipur
House type (in %):			
Pucca	1	-	1
Semi-pucca	8	12	27
Katcha with many rooms	28	2	15
Katcha with single room	63	86	55
Total	100	100	100
Annual household income (Tk)	51,686 (38,915)	39,240 (28,005)	49,212 (29,774)
Main source of income (in %):			
Agriculture	29	38	36
Business	10	14	22
Service	11	12	10
Day labour	22	28	15
Others	28	8	17
Total	100	100	100
Average family size:	5	5	5
Education of the family members (in %):			
Illiterate	30.6	28.6	29.7
Primary	45.4	32.9	29.5
Secondary	17.1	27.7	23.8
SSC & HSC passed	4.8	8.7	14.7
Graduation & Masters	2.1	2.1	2.2
Total	100.0	100.0	100.0

Figures in the parentheses indicate Standard Deviation.

3.2 Human health status in arsenic contaminated and non-contaminated areas

About 20% of the family members in Faridpur and 34% in Lakshimpur had health problems. In the arsenic non-contaminated area of Gazipur also about 30% of the family members had health problems. However, the nature of health problems varied widely in arsenic contaminated and non-contaminated areas.

In the arsenic contaminated area of Faridpur, skin diseases constituted about 21% (Table 2). The situation is more serious in Lakshimpur where the incidence of skin diseases was as high as 49%. On the contrary, in Gazipur the incidence of skin diseases was less than 2% and in most of the cases these were like allergy, skin rash, etc. which are not related to arsenic. Besides skin diseases and some other diseases as shown in the Table, family members in both arsenic contaminated and non-contaminated areas suffered from lot of other health problems which has been grouped as 'Others' in the Table 2. The health problems under 'others' group are headache, chest pain, blood pressure, stone in liver, rheumatic pain, tuberculosis, paralysis, uterus problem, eye problem, ear problem, etc.

However, the most troubling health problem as reported by 46% of the household heads in Lakshimpur was arsenic related skin diseases and this figure in Faridpur was 28%, while in

Gazipur gastric, liver function problems, etc. were the most troubling health problem as reported by 40% of the household heads (Table 3). Other troubling health problems dealt by the families which are not related to arsenic (i.e. heart diseases, blood pressure, asthma, diabetics, etc.) were also mentioned by the household heads both in arsenic contaminated and non-contaminated areas.

Table 2 Type of current health problems of the family members

Health problems	Faridpur		Lakshimpur		Gazipur	
	No.	%	No.	%	No.	%
Fever	1	1.1	3	3.4	4	3.0
Flue / cough	-	-	2	2.3	10	7.5
Dysentery	2	2.1	-	-	-	-
Asthma	2	2.1	2	2.3	-	-
Ulcer	3	3.2	1	1.1	4	3.0
Heart disease	2	2.1	-	-	-	-
Kidney disease	1	1.1	-	-	-	-
Skin diseases	20	21.3	43	48.9	2	1.5
Others	63	67.0	37	42.0	112	84.2
Total	94	100.0	88	100.0	132	100.0

Table 3 Most troubling health problems in the family

Health problem	Arsenic Contaminated Areas				Arsenic Non-contaminated Area	
	Faridpur (n = 100)		Lakshimpur (n = 50)		Gazipur (n = 100)	
	No.	%	No.	%	No.	%
Arsenic related skin diseases	17	28	18	46	-	-
Skin rash / Allergy / Itches	2	3	6	15	3	5
Sore	1	2	1	3	1	2
Gastric / liver function problem / indigestion	19	29	2	6	26	40
Heart disease	4	7	4	11	7	11
Blood pressure / Stroke / Paralysis	5	8	2	6	8	12
Asthma	2	3	1	3	6	9
Diabetics	2	3	-	-	2	3
Pain in waist	3	5	2	5	4	6
Eye problem	1	2	2	5	-	-
Weakness / Headache	4	7	-	-	4	7
Gout pain	2	3	1	3	2	3
Others	1	1	-	-	2	3
All	63	100	39	100	65	100

Long-term exposure to arsenic via drinking-water causes cancer of the skin, lungs, urinary bladder, and kidney, as well as other skin changes such as pigmentation changes and thickness (Hyperkeratosis). Considering all family members, 4.8% of the family members in the selected village of Faridpur were suffering from arsenic related disease; in the case of Lakshimpur, this percentage was 12.8. In the selected village of Gazipur, as expected there was no case of patient suffering from arsenic related diseases.

Distribution of arsenic affected patients by sex showed that in Faridpur area the male members were more affected than the females. In this case, the percentage of male patients was 73 while the rest 27% were females. On the other hand, in Lakshimpur the distribution of male and female patients was about 50:50 (Table 4).

Table – 4 Distribution of arsenic affected patients by sex

Sex	Faridpur		Lakshimpur	
	No. of patients	% of total	No. of patients	% of total
Male	16	73	16	48
Female	6	27	17	52
All	22	100	33	100

Again, distribution of arsenic affected patients by age showed that there was no case of children below 5 years of age who had diseases related to arsenic. This may be because of the fact that the symptoms of arsenic on health can be seen after long-term exposure to arsenic via drinking-water. Except children (Aged up to 5 years), family members of all age groups were found to be affected by arsenic related diseases. However, most of the arsenic affected patients were found in the age group of 31-40. In this age group in Faridpur, the percentage of the arsenic affected patients was 45 while in Lakshimpur it was about 36% (Table – 5). It was also found that those who were suffering from arsenic related diseases; 90% of them in Faridpur and about 76% in Lakshimpur were in the age group of 21 – 60 years which implies that family members of the most active age group were relatively more affected by arsenic contamination. However, explanations for degree of variation of arsenic affected persons by age and sex need further investigation which was beyond the scope of this study.

Table 5 Distribution of arsenic affected patients by age

Age of the Patients (Years)	Faridpur		Lakshimpur	
	No. of patients	% of total	No. of patients	% of total
6-10	-	-	2	6.1
11-20	1	4.5	3	9.1
21-30	3	13.5	6	18.2
31-40	10	45.0	12	36.4
41-60	7	31.5	7	21.2
61-80	1	4.5	3	9.1
All	22	100.0	33	100.0

In Faridpur, 54.6% of the family members had been suffering from arsenic related illness for about 2 years (Table- 6) and in the case of Lakshimpur, 40% of the family members had

been suffering from arsenic related illness for about 5 years. Therefore, it was found that between the two locations of arsenic hot spots, number of arsenic affected patients as well as duration of suffering from arsenic related illness were more in Lakshimpur compared to Faridpur. It was also reported that about 32% of the arsenic affected persons in Faridpur and about 13% in Lakshimpur were unable to work.

Table 6 Length of arsenic related illness (in years)

Length of illness (in year)	Faridpur		Lakshimpur	
	Number of persons	% of total	Number of persons	% of total
Up to 1.0	1	4.5	2	6.7
1.1 - 2.0	12	54.6	6	20.0
2.1 - 3.0	3	13.5	2	6.7
3.1 - 4.0	1	4.5	-	-
4.1 - 5.0	2	9.0	12	40.0
5.1 - 10.0	3	13.5	4	13.3
10.1 & above	-	-	4	13.4
Total	22	100.0	30	100.0

3.3 Sources of drinking water in arsenic contaminated and non-contaminated areas

Primary source of water for drinking in the arsenic hot spot of Faridpur was mostly (72% of the households) Deep Tubewell (DTW), the water of which was arsenic free (Table 7) and 27% of the households used HTW for drinking water, often contaminated with arsenic. Again in the case of Lakshimpur, 64% of the households used HTW for drinking water and only 34% of the households drink water from DTW. On the contrary, in the arsenic free area of Gazipur, the primary source of water for drinking was HTW. In Faridpur, arsenic was found in 32% HTWs while it was about 63% in Lakshimpur showing that drinking water in Lakshimpur was more contaminated with arsenic. Water of HTW in Gazipur was found arsenic free.

Table 7 Primary source of water for drinking

Sources of drinking water	Faridpur		Lakshimpur		Gazipur	
	No.	%	No.	%	No.	%
HTW	27	27	32	64	100	100
STW	1	1	-	-	-	-
DTW	72	72	17	34	-	-
Dug well	-	-	1	2	-	-
All	100	100	50	100	100	100

3.4 Villagers' perception about arsenic and its impact on health

In response to a question of what arsenic is; almost all (98% of the household heads) in Lakshimpur and 76% of the household heads in Faridpur said that arsenic is one kind of water borne dangerous disease. Again, in response to a question whether people get sick from arsenic, almost everyone said yes. They were also asked about how arsenic contamination /

poisoning occurs. In Faridpur, 92% of the respondents mentioned that arsenic contamination occurs through water and the same answer was given by 100% respondents of Lakshimpur.

In response to a question whether any one affected by arsenic is known, 95% of household heads in Faridpur and 94% in Lakshimpur said yes. They were again asked what happened to the arsenic affected person. In Faridpur, it was reported that 36% had black spot on their body, and 32% palm was black and spurious. Variety of other diseases / problems like development of lump (13% cases), weak feeling (7% cases), rush in the body (4% cases), pain in hands and feet (3% cases), etc. including kidney and liver problems were also reported (Table – 8). In the case of Lakshimpur, among various diseases of the arsenic affected persons, black spot on the body has been reported by the majority of the respondents (60% cases) followed by black and spurious palm (13% cases), weak feeling (11% cases) and rush in the body (6% cases).

In Faridpur, health care providers mostly suggested to drink arsenic free water, as reported by 63% of the household heads. They also suggested to consult with expert of arsenic problem (33% respondents) followed by taking medicine regularly (14% respondents). In the case of Lakshimpur, health care providers mostly suggested to consult with expert of arsenic problem (63% respondents) and drinking arsenic free water (37% respondents). In Faridpur, about 64% of the sick persons listened to the advice of health care providers while the corresponding percentage for Lakshimpur was 39%. It was reported that two family members in the selected households of Faridpur and one family member in the selected households of Lakshimpur died due to arsenic poisoning.

Table 8 Responses about what happened to arsenic affected persons?

Responses about what happened to arsenic affected person?	Faridpur		Lakshimpur	
	No.	%	No.	%
Black spot on body	34	36	28	60
Palm was black and spurious	30	32	6	13
Lump developed in body	12	13	2	4
Pain in hands and feet	3	3	-	-
Hardened skin	-	-	2	4
Rush in body	4	4	3	6
Infection in body	2	2	-	-
Felt weak	7	7	5	11
Kidney problem	1	1	-	-
Liver damaged	1	1	-	-
Hair dropped	-	-	1	2
All	94	100	47	100

3.5 Secondary impact of arsenic on family members

Arsenic affected persons suffered from various social/economic problems, as reported by 82% of the respondents in Faridpur and 100% respondents in Lakshimpur. However, the nature of social/economic problems was somewhat different for males and females. In the

case of male members, this was mainly economic problems while in the case of females, this was mostly social problem.

For male members, 46% of the respondents in Faridpur and 98% respondents in Lakshimpur mentioned that inability to do productive works was the main problem (Table 9). On the other hand, this was not considered as so serious problem for arsenic affected females, rather problem of getting married was the main problem for females as reported by 78% of the respondents both in Faridpur and Lakshimpur (Table 9). Social exclusion of the arsenic affected both males and females was also reported as a problem.

Table 9 Secondary impact of arsenic affected male and female members

Type of problem	Male members				Female members			
	Faridpur		Lakshimpur		Faridpur		Lakshimpur	
	No.	%	No.	%	No.	%	No.	%
Inability to do productive works	35	46	49	98	2	3	10	20
Social exclusion	10	13	-	-	7	9	1	2
Problems of getting married	-	-	1	2	59	78	39	78
Others	31	41	-	-	8	10	-	-
All	76	100	50	100	76	100	50	100

3.6 Villagers' perception about arsenic mitigation programs

It was found that 23% of the household heads in the selected village of Faridpur and only 6% of the household heads in Lakshimpur knew about the arsenic mitigation program. In Faridpur, 71% of them knew about the arsenic mitigation program through UNICEF and some of them also came to know about the program through NGOs, particularly BRAC (14 %) and also through TV (10%) and neighbours (5%).

Among various programs for arsenic mitigation, harvesting rain water for drinking was found to be most important, as reported by 70% of the respondents in Faridpur (Table - 10). In Lakshimpur, only 3 household heads said that they knew about the program and reported that they knew it through a seminar held in their village in 1998.

Table 10 Nature of the arsenic mitigation programs

Nature of the program	Faridpur		Lakshimpur	
	No.	%	No.	%
Harvesting rain water for drinking	14	70	-	-
Advise to drink arsenic free water	3	15	-	-
Supplies medicine	2	10	-	-
Creates awareness among the people	1	5	3	100
All	20	100	3	100

About 55% of the household heads in Faridpur reported that program to get arsenic free water was available to them. However, in Lakshimpur there was no program or source of

information available for getting arsenic free water. In Faridpur, the sources of information about the program of getting arsenic free water were mostly Union Parishad Office / Members (45%) as well as neighbours (43%) followed by NGOs / UNICEF (12%). The program was in the form of advice which was mostly to drink water from DTW (95% of the responses). Drinking rain water was also advised (5% responses). To get arsenic free water, 73% of the household heads in Faridpur and 82% in Lakshimpur (82%) gave preference to installation of DTW for the villagers.

V. CONCLUSIONS

Because of the delayed health effects, poor reporting, and low levels of awareness the extent of health problems caused by arsenic in drinking water is unclear and not well documented. Field surveys in arsenic affected areas of Faridpur and Lakshimpur also experienced the problem of getting information from the household head. This was because of the fact that socially they feel shy to disclose the information about any family member suffering from diseases related to arsenic contamination. Particularly, for females they think that it will create marriage problem for the younger girls in the family.

Between the two selected arsenic areas surveyed, the problem of arsenic in drinking water was more severe in the relatively poor village of Lakshimpur compared to Faridpur. Again access to arsenic free drinking water (through installation of DTWs) as well as access to information about arsenic mitigation programs were found to be less in the selected village of Lakshimpur compared to Faridpur.

In the Faridpur area, although a number of DTWs have been installed to supply arsenic free water, initially most of the villagers collected arsenic free water from DTW, but later on, the villagers residing far from the DTW location became reluctant to travel long distance to collect arsenic free water. Installation of more DTWs as well as awareness building of the villagers about arsenic mitigation programs are urgently needed in the arsenic contaminated areas.

Many international and domestic organizations are attempting to organize a combined and concerted effort to address this problem. However, only a few proven sustainable options are available to provide safe drinking-water in Bangladesh. These include: obtaining low-arsenic groundwater through accessing safe shallow groundwater or deeper aquifers (greater than 200 m); rain water harvesting; pond-sand-filtration; household chemical treatment; piped water supply from safe or treated sources and use of 'Sono Filter'. However, effectiveness and acceptance of these technologies by the rural masses in the arsenic contaminated areas of Bangladesh are questionable.

REFERENCES

- BGS/DPHE (2000): Arsenic Contamination of Groundwater in Bangladesh. British Geological Survey, Technical Report WC/00/19.
- Hussain, A. Z. M. I. (2001): Report on Emergency Program for Mitigation of Arsenic Contamination of Groundwater in Bangladesh. A UNDP supported program, Ministry of Health and Family Welfare. Government of Bangladesh, Dhaka.

- Khuda, Z. R. M. M. (2001): Environmental Degradation – Challenges of the 21st Century. Environmental Society and Research Unit, Dhaka, Bangladesh.
- Smedley, P. L. and D. G. Kinniburgh (2002): A Review of the Source, Behaviour and Distribution of Arsenic in Natural Waters. *App. Geochem.* 17:517-568.
- WHO (2004): Arsenic in Drinking Water, World Health Organization. [http://www.who.int/water_sanitation_health/dwq/arsenic3/en/]