Arsenicosis in Bangladesh: prevalence and sociodemographic correlates

Abdullahel Hadi

Correspondence
Abdullahel Hadi
Research and Evaluation Division
BRAC Centre
75 Mohakhali
Dhaka 1212
Bangladesh

Fax: 880-2-8823542
e-mail: shirsha@bangla.net

Arsenicosis in Bangladesh: prevalence and sociodemographic correlates

Summary

Arsenic contamination in drinking water has created concern for its potential health effects but our understanding of the risk factors of arsenicosis remains limited. This study assesses the prevalence of and socio-demographic differentials in arsenic-associated skin lesions in a rural community in Bangladesh. Data were collected from a village where BRAC had both health surveillance system and community-based arsenic mitigation project since 1999. A total of 1,654 residents in the study village were examined to detect arsenic-associated lesions on their skin in May 2000. The socio-demographic information was extracted from the surveillance system database covering the village. Finding reveals that nearly 2.9% of the study population had clinical manifestations of arsenic poisoning. The prevalence of arsenicosis was associated with age, sex, education and the economic status of the household. Multivariate analysis identified age and economic status as significant predictors of arsenicosis controlling for education and gender. The study concludes that arsenic contamination in drinking water became a major public health problem in the affected communities although the burden of disease was spread unevenly and fell most heavily on certain groups. A detailed understanding of the distribution of arsenicosis is needed in designing an effective mitigation project.

Keywords Arsenic, prevalence, clinical manifestation, correlates, age, household wealth

Introduction

The discovery of hazardous level of arsenic in drinking water in Bangladesh has created concern for its potential health effects among the population in the affected communities (Bearak 1998; Schmetzer 1999; Ahmad *et al.* 1999). A recent study discloses that more than 35 million people in the country are at the risk of arsenic poisoning (Smith *et al.* 2000). Among those, it is estimated that nearly 21 million people were exposed to arsenic concentrations above the Bangladeshi standard of 0.05 mg/l (BRAC 2000). The arsenic has probably been present in the ground water for thousands of years. It is widely believed that the contamination occurred only recently because the groundwater has been extensively used for drinking and irrigation water in the rural areas during the late 1960s (British Geological Survey 1998).

The arsenic poisoning is manifested primarily in skin lesions on the palms of the hands and soles of the feet that create such health problems as melanosis, leukomelanosis, hyperkeratosis, cardiovascular disease, hepatomegaly, neuropathy and cancer (BRAC 2000). The process may take between five and fifteen years to reveal clinical manifestations of arsenicosis (British Geological Survey 1998; Guha Mazumder *et al.* 1998). Chronic exposure can cause adverse health effects including skin and lung cancer (Hopenhayn-Rich *et al.* 1998; Smith *et al.* 1992). Studies conducted elsewhere report that arsenic affects many organs and systems in the body such as skin (Tondel *et al.* 1999), heart vessels (Abernathy *et al.* 1999), respiratory organs (Guha Mazumder *et al.* 2000), and kidneys (Kurttio *et al.* 1999) that may lead to the development of lung, kidney and bladder cancer (Hopenhayn-Rich *et al.* 1998; Bates *et al.* 1995; Cuzick *et al.* 1992; Hindmarsh 2000).

The problem of arsenicosis in Bangladesh has been intensively discussed. Nevertheless, our understanding of the risk factors of arsenicosis remains inadequate although conducting community-based epidemiological studies on arsenicosis has not been difficult. Early studies indicated that the prevalence of arsenicosis varied widely from 1.2% to as high as 29% (Guha Mazumder *et al.* 1998; Tondel *et al.* 1999) although information on the variation in risks by age, sex and socio-economic condition were scarce. In this study, we estimated the prevalence of arsenicosis and examined its association with socio-demographic co-variates in a rural community. It is expected that the findings of this study would help determine the target population for prevention and treatment in public-health programmes.

Materials and methods

The study was conducted in the Jafarnagar village in southwest Bangladesh where BRAC had its demographic and health surveillance system as well as a community-based arsenic mitigation project since 1999. Jafarnagar was one of the several communities where all people were drinking arsenic contaminated tubewell water for years. Agriculture was the major economic activity in the community that required extensive use of shallow wells for irrigation. The people were generally poor and living in the area for generations. In-migration to the community was insignificant.

The longitudinal health surveillance system maintained a database where population profile was updated every month. A computerised census of the study community showed a total of 1679 population living in 367 households during the study period. All residents of the community were targeted for this study. A total of 1654 persons were examined to detect arsenicosis while the remainder were not available in the households or did not co-operate. Data for this study were collected during May 2000.

There was no universally accepted definition of arsenicosis (WHO 2000). In this study, the arsenicosis was assessed by the standard protocol of observing signs of clinical manifestations and discussing the symptoms (Ahmad *et al.* 1999; BRAC 2000; Khan *et al.* 1997). Using this protocol, potential arsenicosis patients were identified by the community health workers of BRAC as part of their routine surveillance. Each of the potential patients was then re-examined by a group of trained physicians to confirm the presence of arsenicosis. A clinical assessment schedule was maintained for each patient to record the diagnosis and treatment.

The sociodemographic information including age, sex, years of schooling and household assets were extracted from the surveillance database. The arsenicosis disease profile was then matched with the socio-demographic database where non-patients were also identified. The economic status scores for each person were estimated on the value of selected assets owned by the household. Age and economic status were classified into three groups in bi-variate analysis. Years of schooling were grouped into illiterate and educated. Chi-squared tests were used to measure the associations between socio-demographic variables and the prevalence of arsenicosis. Odds ratios for prevalence and 95% CI, and P values for a two-sided test were calculated by logistic regression.

Table 1 here

Results

The community health workers examined a total of 1654 persons in the community and the response rate was 98.5%. The mean age of the study population was nearly 27.6 ± 19.2, the median, 23 years, 40.6% were young (≤ 19 years) and about 48.6% were males (Table 1). Less than a half (48.3%) of the population were literate while the mean years of schooling was 2.7 only. According to the economic status-based categorisation, about 28% were classified as poor while only 22.3% as rich. The remaining 49.6% were considered members of the middle class.

Table 2 here

Nearly 2.9% of the study population were found to have arsenic lesions on their skin although the prevalence of arsenicosis was found as high as 10% in other areas in Bangladesh (Ahmad *et al.* 1999). Age seemed to be an important risk factor of arsenic poisoning. Table 2 shows that the prevalence was only 1.63% in the young (≤19 years) compared to 3.99% in the middle (20–39 years) and 3.46% among the old (40± years) population. Odds ratios suggest that the prevalence rose to nearly 2.5 times from the young to the mid-aged ($P<0.01$) and then reduced marginally in the old-aged population. Men (3.23%) were more likely to be exposed to arsenic poisoning than women (2.59%) although the gender variation in prevalence was not statistically significant. The odds ratios also suggest that women were less likely than men to be affected as found in other studies (Ahmad *et al.* 1999; Guha Mazumder *et al.* 1998). The prevalence of arsenicosis indicates a negative association with the economic status of the population. While only 2.43% of the rich and 2.44% of the middle class were exposed to arsenic poisoning, the prevalence of arsenic-associated skin lesions was about 4.09% among the poor. Education had no clear link with arsenicosis as the prevalence seemed to be slightly lower among the illiterate than educated persons although the difference was not statistically significant.

Table 3 here

The role of selected risk factors in explaining the prevalence of arsenicosis is examined using logit regression analysis (Table 3). Model I indicates that the increase of economic status would reduce the prevalence of arsenic lesions to 78% ($P< 0.01$) controlling for the years of schooling. When sex variable was added to the regression equation in model II, the effect of economic status on the prevalence remained same ($P<0.05$) indicating that gender and schooling had no significant influence on the prevalence of arsenicosis. The effects of both the economic status and age on the prevalence –

controlling for education and gender – are estimated in model III. The role of economic status on the prevalence seemed to sustain with slightly lower influence of education and gender on the prevalence. As found in the bivariate relationship, age had negative and statistically significant association with the prevalence of arsenicosis when the economic status, education and gender variation were controlled. Overall, the results suggest that the risk of a person to be affected by arsenicosis was high if the person was poor, middle-aged and men.

Discussion

This study is the first attempt to examine the socio-demographic risk factors of arsenicosis which might have programmatic significance in identifying arsenic patients at the community level. Although nearly 3% of the community population have clinical manifestations of arsenicosis, the prevalence varies across different sociodemographic categories such as age, sex, education and economic status. Middle age, male and poor were associated with higher prevalence of arsenicosis. It is still unknown why middle aged men were significantly more likely to be affected than their wives and children who drank water from the same source and showed no visible signs of poisoning. One explanation has been that arsenic toxicity may take several years to develop signs and symptoms which usually begins with hyperpigmentation of skin and mucous membrane (BRAC 2000). Studies indicated that a minimum time gap of first exposure and initial manifestation of arsenicosis was 5 to 10 years (Guha Mazumder *et al.* 1998). The incubation period may differ by the amount of arsenic ingested, and their nutritional and other immunity levels (BRAC 2000). The higher prevalence among the old than the young people was due to the longer duration of exposure among the old than young people. This assumption, however, raised the question of why the oldest persons were relatively less exposed to arsenic than the mid-aged persons. This remains one of the most important enigmas in the epidemiology of arsenicosis. It is still unknown whether the human body reduces its capacity to regenerate new cells and, thus, looses its capacity to accept arsenic in the body in the oldest ages. The question of gender variation in the prevalence of arsenicosis has also remained unresolved. One explanation has been that men were more exposed to arsenic poisoning than women because men, most of whom were in the labour force and involved in physical activities, generally consumed more fluid than women (Ahmad *et al.* 1999; BRAC 2000; WHO 2000). In the study community, the primary choice of the fluid was arsenic contaminated tubewell water.

The most robust finding of this study is the negative association between the economic status and the prevalence of arsenicosis (WHO 2000). Several plausible mechanisms could link low economic

status with the high prevalence of arsenicosis. Poor people, who earn their living by selling physical labour, were more likely to drink more fluid than the rich. In most cases, the obvious source of that fluid was tubewell water. Also, the rich people were more likely to consume more nutritious food than the poor (Guha Mazumder *et al.* 1998; WHO 2000; Vahter & Marafante 1987; Tani 1999). Thus, the immunity levels among the rich were much better than the poor.

There is a dominant view that the international public health tends to avoid the health problems of the poor communities. Non-existence of research on the sociodemographic aspects of arsenic poisoning has reinforced this accusation. The magnitude of arsenic problem in Bangladesh demands a series of systematic studies on various dimensions of this problem. Our research has only indicated the potential health effects of arsenic poisoning in a poor rural community. The estimated prevalence clearly indicates that arsenicosis has already become a serious public health problem in the affected communities. The study concludes that the socio-demographic distribution of arsenicosis, as found in this research, may be useful in identifying the high-risk groups from among the arsenic affected communities. More studies are needed in designing an effective arsenic mitigation project in Bangladesh.

Acknowledgements

This research was supported by the *Action Research into Community-Based Mitigation* Project of the UNICEF, Dhaka, Bangladesh. The author wishes to thank the respondents who were kind enough to provide information for this research.

Contributor: Abdullahel Hadi conceptualised, designed, analysed the data and prepared the draft.
Conflict of interest: None.

References

Abernathy CO, Liu YP, Longfellow D et al. (1999) Arsenic: health effects, mechanisms of actions, and research issues. *Environmental Health Perspectives* **107**, 593-597.

Ahmad SA, Sayed MH, Hadi SK et al. (1999) Arsenicosis in a village in Bangladesh. *International Journal of Environmental Health Research* **9**, 187-95.

Bates MN, Smith AH, Cantor KP (1995) Case-control study of bladder cancer and arsenic in drinking water. *American Journal of Epidemiology* **141**, 523-530.

Bearak B (1998) New Bangladesh disaster: Wells that pump poison. Death by Arsenic. A special report. *New York Times*. November 10: A10.

BRAC (2000) *Combating a Deadly Menace: Early Experiences with a Community-based Arsenic Mitigation Project in Bangladesh*. Research Monograph Series No. 16. Dhaka: BRAC.

British Geological Survey. (1998) *Groundwater studies for arsenic in Bangladesh*. British Geological Survey. London: Mott Macdonald Ltd.

Cuzick J, Sasieni P, Evans S (1992) Ingested arsenic, keratoses, and bladder cancer. *American Journal of Epidemiology* **136**. 417-421.

Guha Mazumder DN, Haque R, Ghose N et al. (1998) Arsenic levels in drinking water and the prevalence of skin lesions in West Bengal, India. *International Journal of Epidemiology* **27**, 871-877.

Guha Mazumder DN, Haque R, Ghose N et al. (2000) Arsenic in drinking water and the prevalence of respiratory effects in West Bengal, India. *International Journal of Epidemiology* **29**, 1047-1052.

Hindmarsh JT (2000) Arsenic, its clinical and environmental significance. *Journal of Trace Elements in Experimental Medicine* **13**, 165-172.

Hopenhayn-Rich C, Biggs ML, Smith AH (1998) Lung and kidney cancer mortality associated with arsenic in drinking water in Cordoba, Argentina. *International Journal of Epidemiology* **27**, 561-569.

Khan, AW, Ahmad SA Sayed MH et al. (1997) Arsenic contamination in ground water and its effects on human health with particular reference to Bangladesh. *Journal of Preventive & Social Medicine (JOPSOM)* **16**: 65-73.

Kurttio P, Pukkala E, Kahelin H, Auvinen A & Pekkanen J (1999) Arsenic concentrations in well water and risk of bladder and kidney cancer in Finland. *Environmental Health Perspectives* **107**, 705-710.

Schmetzer U (1999) Drinking deadly in Bangladesh. *Chicago Tribune*. February 7.

Smith AH, Lingas EO & Rahman M (2000) Contamination of drinking-water by arsenic in Bangladesh: a public health emergency. *Bulletin of the World Health Organization* **78**, 1093-1103.

Smith AH, Hopenhayn-Rich C, Bates MN et al. (1992) Cancer risks from arsenic in drinking water. *Environmental Health Perspectives* **97**, 259-267.

Tani M (1999) Ethnographic studies for mitigating arsenic poisoning in Sampta village. In: Research Group for Applied Geology, eds. *Arsenic contamination of groundwater in Bangladesh*. Interim report of the Sampta village. Asia Arsenic Network. Department of Occupational & Environmental Health, National Institute of Preventive and Social Medicine. Bangladesh.

Tondel M, Rahman M, Magnuson A, Chowdhury IA, Faruquee MH & Ahmad SA (1999) The relationship of arsenic levels in drinking water and the prevalence rate of skin lesions in Bangladesh. *Environmental Health Perspectives* **107**, 727-729.

Vahter M & Marafante E (1987) Effects of low dietary intake of methionine, choline or proteins on the biotransformation of arsenite in the rabbit. *Toxicology Letters* **37**, 41-46.

WHO (2000) *Towards as Assessment of the Socioeconomic Impact of Arsenic Poisoning in Bangladesh*. Geneva: World Health Organization. WHO/SDE/WSH/00.4.

Table 1 Sociodemographic characteristics of the study population

Characteristics	Number	%
Age (in years)		
≤19	673	40.6
20–39	577	34.9
40+	404	24.5
Sex		
Male	804	48.6
Female	850	51.4
Education		
Illiterate	856	51.7
Educated	798	48.3
Economic status		
Poor	464	28.1
Middle	820	49.6
Rich	370	22.3
Total	1654	

Table 2 Prevalence of arsenic-associated skin lesions by socio-demographic risk factors of the population, Bangladesh, 2000

Risk factor	Arsenicosis			
	No.	Infected	%	OR
All	1654	48	2.90	
Age (in years)				
≤19	673	11	1.63	1.00
20–39	577	23	3.99	2.49***
40+	404	14	3.46	2.16**
Sex				
Male	804	26	3.23	1.00
Female	850	22	2.59	0.79
Economic status				
Poor	464	19	4.09	1.00
Middle	820	20	2.44	0.59*
Rich	370	9	2.43	0.57
Education				
Illiterate	856	21	2.45	1.00
Educated	798	27	3.38	1.39

* $P < 0.10$; ** $P < 0.05$ *** $P < 0.01$.

Table 3 Risk factors in multivariate logistic regression analysis of the prevalence of arsenicosis

	Model I		Model II		Model III	
Predictor	OR	CI	OR	CI	OR	CI
Economic status score	0.78**	0.63-0.97	0.78**	0.63-0.97	0.79**	0.64–0.98
Years of schooling	1.06	0.98-1.16	1.06	0.97-1.16	1.03	0.95–1.13
Sex (rc=male)			0.81	0.45-1.44	0.79	0.44–1.42
Age (in years)						
≤19					1.00	
20–39					2.41**	1.14–5.11
40+					2.15*	0.96–4.79

* $P < 0.10$; ** $P < 0.05$.