

Full Length Research Paper

Evaluation of socio-economic impact of arsenic contamination in Bangladesh

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Groundwater arsenic contamination in Bangladesh is reported to be the biggest arsenic disaster in the world in terms of the affected population. Arsenic contamination in groundwater is recognized as the major threats to drinking water and is being the key environmental health problem of 21st century. In Bangladesh Arsenic was first detected in Chapai Nawabgonj, in 1993; since then higher levels of arsenic (exceeding the WHO standard of 0.01 mg/L and Bangladesh standard of 0.05 mg/L) have been identified in various regions of the country. Seventy five million people are at risk and 24 million are potentially exposed to arsenic contamination. From various research works conducted at government and non-government levels and examination of the patients affected with Arsenic pollution, it has been clear that the groundwater of Bangladesh is being contaminated with Arsenic since long period of time. The main consideration of our work is to asses the socio-economic impact on arsenic victims particularly earning male family member, young male, married female, and young female going to be married. The relationship between Arsenicosis and social, educational status was also determined in order to understand the financial influence of arsenic.

Key words: Arsenic, socio-economic status, arsenicosis, groundwater.

INTRODUCTION

After the first indication of the arsenic problem, lots of arsenic-related health problems were diagnosed in West Bengal as well as in Bangladesh. Since then, large-scale water quality investigations have detected dangerous levels of arsenic in the groundwater is 9 out of the 18 districts in West Bengal, and in 59 of the 64 districts in Bangladesh (SOES and DCH, 2000). Thousands of deaths have already been linked to long-term ingestion of contaminated water supplies. Thousands more cases of arsenic dermatosis have been diagnosed, and it is clear that millions of people are currently ingesting dangerous amounts of arsenic.

Extensive arsenic contamination of groundwater has become a major disquiet where the water supplies predominantly rural water supply, is profoundly reliant on groundwater extracted from shallow aquifers and common trace of arsenic in drinking-water identified as a significant health risk (McNeill and Edwards, 1997; Pontius et al.,

1994) and public health is severely endanger for its high toxicity and its ability to induce skin cancer after long term ingestion (Driehaus et al., 1998) leading to an inevitable socio-economic collapse of the poor rural society where more than seventy percent people under poverty limit. Recent studies indicate that arsenic in drinking water is a matter of great concern and is considered more dangerous than it was in the past because of the collapse of socio-economic backbone of the poor society especially in the developing countries. Arsenic has been acknowledged as a poison. Even at low concentration, it can produce devastating human health effects. The toxic character of arsenic species mainly depends upon their chemical form. The most toxic form is arsine gas, followed by inorganic trivalent compounds, organic trivalent compounds, inorganic pentavalent compounds, organic pentavalent compounds and elemental arsenic. Arsenic taken by mammals is subject to either direct excretion, direct accumulation in some parts of the body like hair, nails, and skin tissue, or to biotransformation in form of methylation. Methylation is considered as the most important pathway of biotransformation. Plants

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absorb arsenic fairly easily, so that high-ranking concentrations may be present in food.

Arsenic is generally known as a poison. Arsenic is present in more than 200 mineral species, the most common of which is arsenopyrite. It has been estimated that about one-third of the atmospheric flux of arsenic is of natural origin. Volcanic action is the most important natural source of arsenic, followed by low-temperature volatilization. Inorganic arsenic of geological origin is found in groundwater (elevated levels of arsenic are found more frequently in ground water than in surface water). Used as drinking-water in several parts of the world, for example Bangladesh. Elemental arsenic is produced by reduction of arsenic trioxide (As_2O_3) with charcoal. As_2O_3 is produced as a by-product of metal smelting operations. It has been estimated that 70% of the world arsenic production is used in timber treatment as copper chrome arsenate (CCA), 22% in agricultural chemicals, and the remainder in glass, pharmaceuticals and non-ferrous alloys.

MATERIALS AND METHODS

Originally this investigation was designed to assess the socio-economic condition of arsenic affected poor people of Bangladesh. For this reason three different arsenic affected areas were selected and the ground water sample were collected and tested for determining the arsenic concentration using fields' kits, standard methods, Spectrophotometer, UV Spectrophotometer, AAS etc. The direct effects of arsenic among people who are taking arsenic contaminated water are examined and their visible symptoms are identified. Different types of questionnaire survey were conducted to estimate the socio-economic crash of arsenic contamination on the poor rural society where more than seventy percent people under poverty limit in the study area. Socio-economic impact on arsenic victim specially male bread winner, young male, married female and young female going to be married as well as arsenic affected family and their interactions with non-arsenic victim of the society was investigated. Also relevant information and pertinent data were collected from other sources and analyzed subsequently to assess the severity of arsenic contamination. For this study three most arsenic affected areas of Bangladesh Samta of Jessore, Courtpara of Kushtia and Rajarampur of Chapainawabgang are selected.

RESULT AND DISCUSSION

After detecting the arsenic in groundwater in Bangladesh arsenic has been recognized as a serious threat for the human health as well as the social and economic structure in Bangladesh. The rural people especially women and children are suffering most as their body structure is more sensitive of the poisonous arsenic. Recent studies in Bangladesh indicate that the groundwater is severely contaminated with arsenic above the maximum permissible limit of drinking water. In 1996, altogether 400 measurements were conducted in Bangladesh. Arsenic concentrations in about half of the measurements were above the maximum permissible

level of 0.05 mg/L in Bangladesh.

Data on arsenic contamination in tube-well water gathered so far suggest that the presence of arsenic in groundwater is highly scattered in nature. At many places, tube-wells at relatively close proximity showed very different levels of arsenic concentrations. This makes it difficult to define the affected areas and to estimate the population at risk. So far arsenic contamination of groundwater has been detected in 41 out of 61 administrative districts and an estimated 35 million people in Bangladesh are at risk of arsenic toxicity (Khan et al., 1998). According to the survey findings of Dhaka Community Hospital (DCH-1997), 60 million people of 41 districts are at risk of arsenic contamination as water of tube-wells of 41 districts showed arsenic concentration above 0.05 mg/L (permissible limit of arsenic in drinking water for Bangladesh). Survey conducted by SOES (School Of Environmental Science) and DCH (Dhaka Community Hospital) shows that 100 million people of 54 districts of area 125,133 sq. km. is at risk of arsenic hazard where groundwater of 73.39% of tube wells contain arsenic above 0.01 mg/L; and 9.3 million people of 47 districts of area 112,407 sq. km. is at a risk of arsenic poisoning where groundwater of 53.47% of tube wells contain above 0.05 mg/L. (SOES and DCH, 2000). Shallow tube wells (the most important drinking water source) are also affected by arsenic and a recent estimate shows, 27% of shallow hand-tube wells have arsenic concentration exceeding 0.05 mg/L; and more than 75% of shallow tube wells are contaminated with arsenic in acute arsenic problem areas. Out of 64 administrative districts of Bangladesh, arsenic contamination has so far been reported in 61 districts. Arsenic problem alone has reduced the national safe water supply coverage by about 15 to 25%. The experts from Bangladesh Council for Scientific and Industrial Research (BCSIR-1999) have been found the highest level of arsenic contamination, 14 mg/L of shallow tube-well water in Pabna9. The recent statistics on arsenic contamination indicate that 59 out of 64 districts of Bangladesh have been affected by arsenic contamination 3. Approximately, arsenic has contaminated the ground water in 85% of the total area of Bangladesh and about 75 million people are at risk 10. It has been estimated that at least 1.2 million people are exposed to arsenic poisoning. As the people are getting arsenic also from food chain such as rice, fish and vegetables, the problem is growing more severe.

Chandpur, Comilla, Laksmipur and Noakhali of chittagong division, Faridpur, Gopalganj, Munshiganj, Madaripur, narayangang, Shariatpur and Sherpur of Dhaka division, Jessore, Kushtia, Meherpur and Satkhira of Khulna division are the most arsenic contaminated areas of Bangladesh (Figure 1). There is huge inconsistency in the concentration ranges of arsenic found within an area. In certain areas the concentration ranges show normal distribution pattern, whereas in other

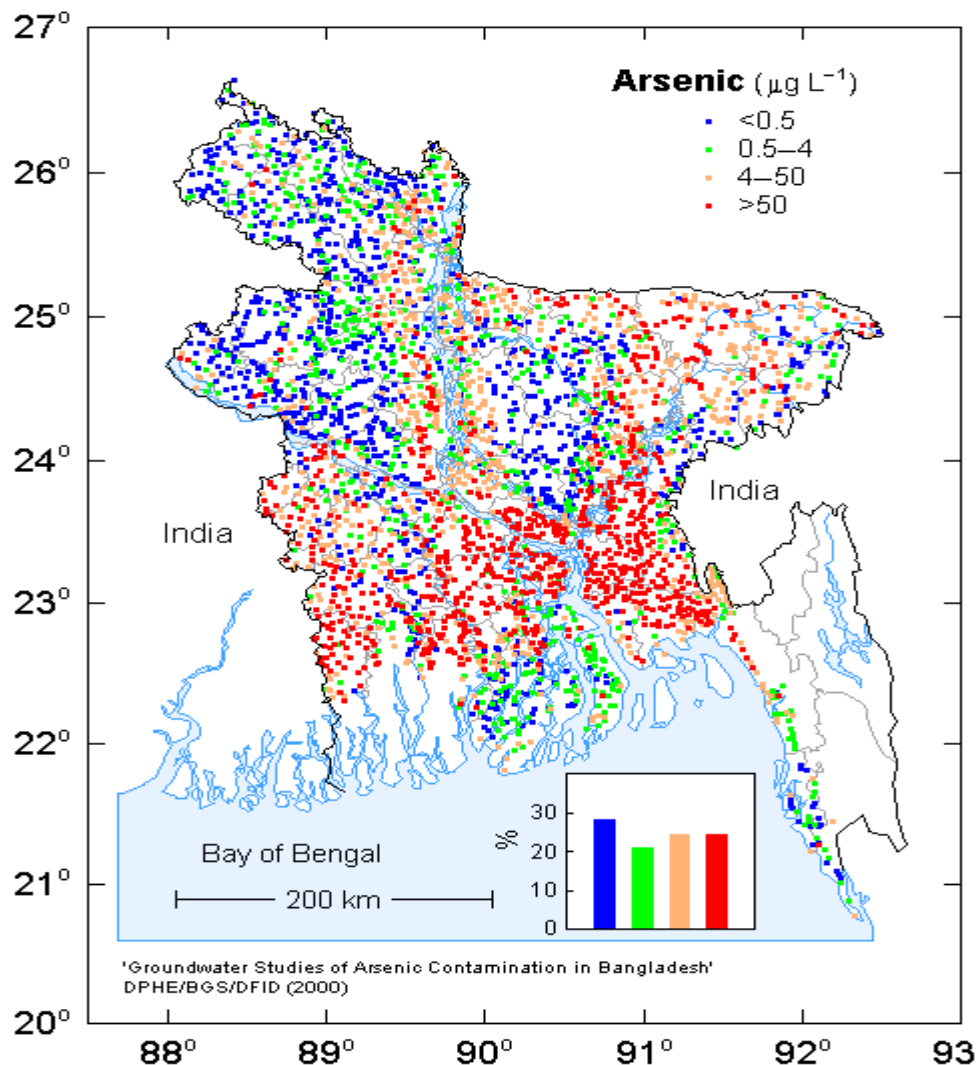


Figure 1. Arsenic contaminated areas in Bangladesh (Source; BGS and DPHE, 2001).

areas bimodal or polymodal distribution patterns are shown. There are variations in concentration ranges even in villages have been reported by British Geological Survey-2000. Lakshmipur sadar of Lakshmipur District is one of the most arsenic affected Thanas of Bangladesh. British Geological Survey-2000 tested about 230 tube wells water of Mandari union of Lakshmipur sadar and 90% tubewells are reported as above 0.5 mg/L of arsenic. Sonargaon is a severely contaminated upazilla under Narayanganj District where all the wells have been tested by BRAC under a UNICEF/DPHE programme. The union wise distribution of arsenic contaminated wells show that in eight unions most of the wells are contaminated (up to 89%). The recent investigation shows that the groundwater of capital Dhaka is still safe. Water samples from 177 places were analyzed in the joint survey of DCH and SOES. But high levels of Arsenic in 161 were less than WHO recommended value 0.01 mg/L. It means that the water is

safe for drinking. Arsenic concentration in the rest 16 samples also did not exceed the maximum permissible level, which is 0.05 mg/L. However, none can say how long the capital's groundwater will remain safe. High concentration of Arsenic was found in groundwater in the areas adjacent to the capital. In this respect, Narsingdi and Narayanganj can be mentioned. These two are among the 15 districts affected by Arsenic severely.

It has been observed in Bangladesh that access to tube well drinking water is partially determined by social status. High-income families have priority in accessing tube wells that are known to pump arsenic free water (WHO, 2000). And they are able to get medical treatment. In the present study, the poor were the highly infected with arsenicosis. The Figure 2 indicates that there are significant relationships between economic status and the arsenicosis. In Samta of Jessore where more than 68% people are affected who are living below the poverty line, while in Courtpara of Kushtia this amount

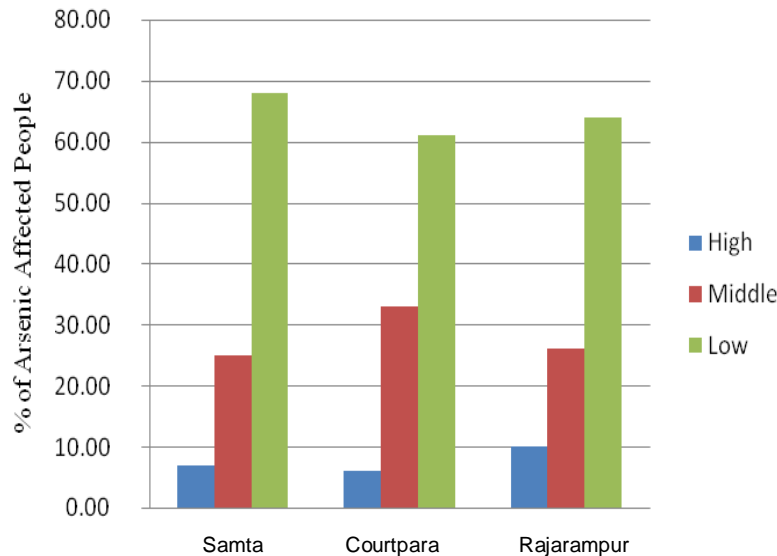


Figure 2. Relationship between economic status and arsenicosis.

is 61% and in Rajarampur of Chapainawabgang, 64% poor people are affected.

There is significant difference of arsenicosis with the status of education. In the present study; illiterates are highly infected (72, 59 and 59% respectively for Samta, Courtpara and Rajarampur) with arsenicosis. People of education level secondary, primary are also infected in small percentages. However, no highly educated people (education level more than 12 classes) were found to be infected with arsenicosis in Samta of Jessore District where in Courtpara of Kushtia and Rajarampur of Chapainawabgang District are 5 and 7% respectively (Figure 2). There was significant difference of occupation and the Arsenicosis found in the study area. In the present study; agricultural workers were severely infected (68, 48 and 52% respectively for Samta, Courtpara and Rajarampur) with arsenicosis. Where labors are 25, 30 and 26% are affected in Samta, Courtpara and Rajarampur respectively (Figure 3).

A questionnaire survey was conducted to feature the knowledge of Arsenic and its impacts among the people. Study shows that the majority of the respondents (82%) knew about the arsenic contamination of drinking water. Most people (83%) in the study villages learned about the hazard through well testing campaign and research activities. Others (15%) learnt from mass media such as radio, television, and government and NGO sponsored publicities. Seventy eight percent of sampled respondents in the village had knowledge about water purification and various arsenic mitigation procedures and options.

Actually, the high prevalence of arsenicosis among the business man and the job holder might be due to their financial status and ability of getting Arsenic treated water. The numbers of farmers seem to be considerably

higher due to the usual contact of arsenic infected water. Absence of arsenicosis in the students might be due to their awareness and less exposures duration. The higher occurrence of Arsenicosis in the illiterate people might be due to lack of awareness of arsenic health impacts among the literate and conduction of mitigation options, such as, arsenic filter, switch to nearby wells, arsenic free deep tube wells. The higher prevalence of the arsenicosis in poor might be explained on the basis of the fact that the poor have low balanced diet and environmental factors, particularly diet, different methylating capacity among individuals and population.

A public health catastrophe

The most common manifested disease so far is skin lesions. Over the next decade, skin and internal cancers are likely to become the principal human health concern arising from arsenic. A large number of patients with visible or measurable health impacts are anticipated - although such precise estimates for Bangladesh have not even been developed as yet. It takes several years of drinking arsenic-contaminated water to develop visible symptoms - although they may appear earlier in some patients. There are many case reports of death of humans due to ingestion of high doses of arsenic. In nearly all cases, the most immediate effects are vomiting, diarrhea, and gastrointestinal hemorrhage, and death may ensue from fluid loss and circulatory collapse (Levin-Scherz et al., 1987; Saady et al., 1989; Uede and Furukawa, 2003). In other cases, death may be delayed and resulted from the multiple tissue injuries produced by arsenic (Campbell and Alvarez, 1989).

A child's exposure may differ from an adult's exposure

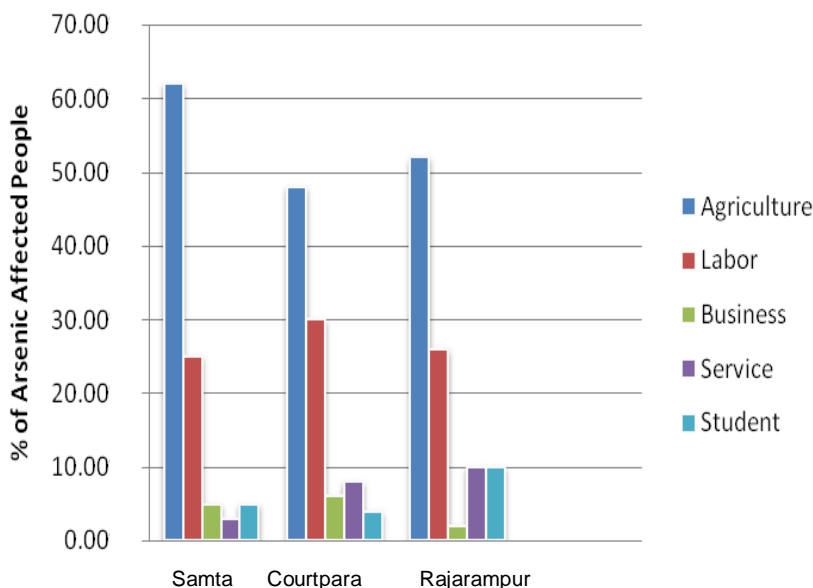


Figure 3. Relationship between Occupation and arsenicosis.

in many ways. Children drink more fluids, eat more food, breathe more air per kilogram of body weight, and have a larger skin surface in proportion to their body volume. A child's diet often differs from that of adults. The developing human's source of nutrition changes with age: from placental nourishment to breast milk or formula to the diet of older children who eat more of certain types of foods than adults. A child's behavior and lifestyle also influence exposure. Children crawl on the floor, put things in their mouths, sometimes eat inappropriate things (such as dirt or paint chips), and spend more time outdoors. Children also are closer to the ground, and they do not use the judgment of adults to avoid hazards (NRC, 1993). Inorganic arsenic has been recognized as a human poison since ancient times, and large oral doses (above 60,000 ppb in water which is 10,000 times higher than 80% of U.S. drinking water arsenic levels) cause death. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans which may influence irritation of stomach and intestines, symptoms such as stomachache, nausea, vomiting, and diarrhoea, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a "pins and needles" sensation in your hands and feet.

Arsenic exposure also interferes the action of enzymes, essential cations and transcriptional events in cells throughout the body and causing non-cancer effects e.g. Anemia, myelofibrosis, rash, allergy/asthma, autoimmune, neurologic. The most common long term effect of inorganic arsenic is pattern of skin changes. These include patches of darkened skin and the appearance of small "corns" or "warts" on the palms, soles, and torso, and are often associated with changes

in the blood vessels of the skin. In the field investigation, it is seen that thousands of poor rural people of Bangladesh living under poverty limit are severely attacked by both type of arsenicosis due to the long term exposure of arsenic contaminated water. The majority of arsenic patients in Bangladesh are unable to take proper treatment suffered by severe financial crisis and leads to the death day by day. New arsenic affected patients are recognized daily in every corner of the country. As a result, the social scenario takes an ugly phase as these huge populations are not able to be treated and the economical structures are being lowered day by day. The investigation identified a number of common arsenical manifestation and arsenic lesions such as different type of melanosis e.g., diffused melanosis, spotted melanosis, lucomelanosis, mucus membrane melanosis, different type of keratosis e.g., diffused keratosis, spotted keratosis, shyper keratosis, gangrene, squamous cell carcinoma and hyper pigmentation in palms and soles and non-cirrhotic portal fibrosis among the population affected by arsenic in Bangladesh.

In a later stage the patches might develop into cancer and foot will probably have to be amputated (Battacharaya et al., 1997; Quadiruzzaman, 1996; Pontius et al., 1994). Skin cancer, internal cancers of bladder, kidney, liver and lungs, neurological effects, hypertension, cardiovascular disease and diabetes mellitus, pulmonary disease and peripheral vascular disease are included to long-term health effects of exposure to arsenic (WHO, 2000). Characteristics skin lesions of arsenic toxicity indicates high exposure of arsenic which are distinctive in contrast to other clinical manifestations of arsenic intoxication including weakness, conjunctivas congestion, edema, portal

Table 1. Nature of the treatment of arsenic patients.

Area	No. of arsenic treatment patients by				% of arsenic treatment patients		
	Self	Government	NGOs and Donar	Total	Self	Government	NGOs and Donar
Samta, Jessore	0	4	24	28	0.00	14.00	86.00
Rajarampur, Chapainawabgang.	4	6	2	12	33.33	50.00	16.67
Courtpara, Kushtia	1	7	2	10	10.00	70.00	20.00

hypertension, bronchitis and hepatomegaly (Tondel et al., 1999; Mazumdar et al., 1992). According to Tondel et al. (1999), in four villages of Faridpur, Narayangang, Nawabgang and Jessore District, arsenic concentration in ground water ranged from 0.01 to 2.04 mg /L and the prevalence rate of arsenic lesions was 30.1 and 26.5% for males and female, respectively. Melanosis (93.5%) and keratosis (68.3%) are the most common presentations among the affected people. Patients of Leucomelanosis (39.1%) and hyper-keratosis (37.6%) have been found in many cases. Few cases of skin cancer (0.8%) have also been identified among the patients seriously affected by the arsenicals (arsenite and arsenate).

Societal problems and social instability

The study mainly conducted to feature the societal and the economical impact of arsenic contamination in ground aquifer in Bangladesh. Report shows that a significant number of people are affected by arsenic and arsenic related problem. The arsenic contamination problem has triggered a number of social and societal problems that could not have been foreseen and are still not fully recognized or understood. According to the report the arsenic affected people are not only suffering the health related problem but also being the burden of his/her family as well as the society and country. The arsenic problem is wrongly recognized as a contagious or hereditary or Allah's curse because of lack of knowledge about the arsenicosis and vast majority of the population lives in rural areas and is not well-educated. The Arsenic victims are separated from social participation and social works. Problem of arsenicosis is hampering the socialization of a child due to the fear of becoming a victim of arsenicosis is working as a barrier towards the proper psychological and physical development of a child. Many time it has been seen that the arsenic affected children are not allowed to play with the normal children and avoided in the schools by their classmates which forces them on a deep mental depression. Children of arsenicosis patients are not allowed to attend social and religious functions as well as are denied to take water from neighbor's tube well. Arsenic is producing social stigmatization and discrimination. The victims are not allowed to offer their worship in mosque or in

temples. Arsenic patients are often identified as patient of leprosy and remain ostracized (Mandal et al., 1998). They are discarded not only by society but also by their family members, in many cases husbands left wives or remarried and wives left their husbands temporarily for fear of being attacked by arsenicosis. These families are not allowed to take bath in any of the village ponds; even people avoid making new relationship with arsenic victim's families. These evidences create the social instability among the arsenic affected areas. The social life of the people are confused to get a valuable solution of arsenic contamination and to get arsenic free water for drinking and their household purposes. Still now arsenic victims are not getting proper treatment and the total amount of arsenicosis patients are not identified. Due to the financial inability and ignorance, self treatment is not possible. Table 1 shows that in Rajarampur of Chapainawabgang and Courtpara of Kushtia arsenicosis treatment by NGOs and donor is very poor varying from 16.67 to 20% only where public motivation, involvement and activities of NGOs and donors are found very seldom; also self treatment of arsenicosis in Chapainawabgang is more than 3 times than Kushtia due to the better economic condition and financial status while self treatment in Samta of Jessore is almost nil due to very poor economic and financial condition. Pre-existing philosophy and superstitions about the diseases triggered by arsenic exposure further worsen the situation. This is despite the concerted efforts made by many players to educate the general public and raise the level of awareness. Given the magnitude of the problem and the level of education amongst the villagers, this is a particularly challenging undertaking. There is also a certain social stigma associated with people affected by arsenicosis, with the disease wrongly attributed to sins in the current or past lifetimes generating social conflict and destroying social harmony and network relationships.

The arsenic gradually diminishes the working ability of the people. The blackening of skin and hardening of palms and soles progressively turns to the nodules and pronounced depending to the exposure of arsenic contaminated ground water. Cancer of the skin along with cancer of some internal organs - liver, kidney, and bladder loses the workability and reduce the strength of move. The families where the earning members are affected by arsenicosis hazards are leading a financially instable life. A person is not interested to make a marital

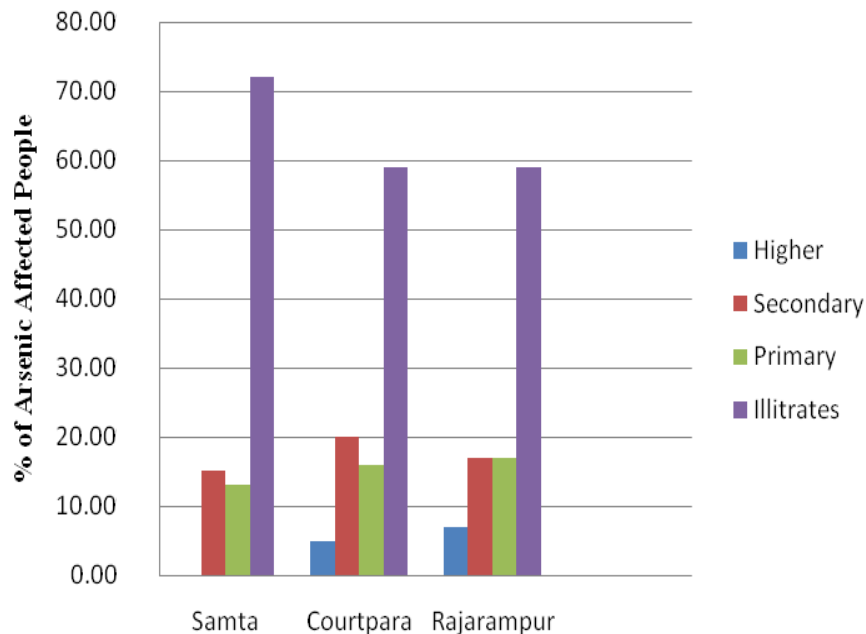


Figure 4. Educational status of the respondent.

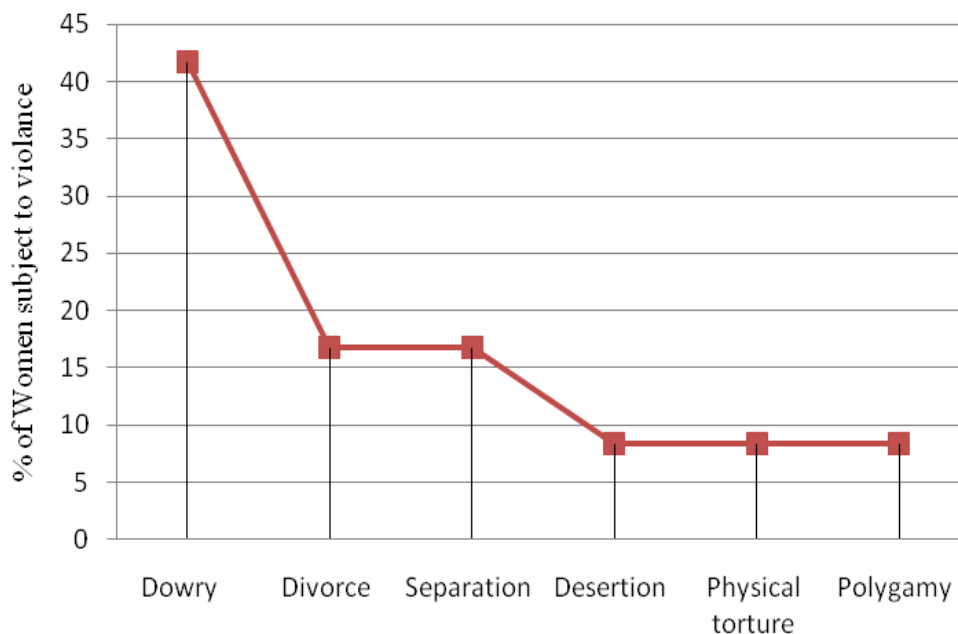
relationship with those who suffering by arsenic. So the arsenic affected unmarried people have become the lumber for their parents. Arsenic victims are not able to find spouse; many times young woman and men are advised to remain unmarried. Arsenic victims are divorced by their partners; many couples live separately from their spouse, even many women are either getting divorced or becoming abandoned by their husbands.

Many arsenic patients in the remote villages are passing miserable days condition due to superstitions, prejudices of the illiterate people. Someone thinks that it is the effect of devil or evil spirits or impure air and keeps themselves and their family members away from arsenic patients. In Samta of Jessore where more than 70% people are illiterate (Figure 4), tendency of superstition is the highest in the level of 80% (Figure 5) while in Courtpara of Kushtia where about 65% public are literate (Figure 4), only 30% arsenic patient remain untreated due to superstition and 70% due to financial crisis, on the other hand in Samta, Jessore 80% patients were remained untreated due to superstition (Table 2).

Impact on women

Women play the most important role in every family and they are directly related with arsenic as they cook food, wash clothes, and they always search for finding a drop of clean and arsenic free water to feed the family members including their husbands and children. It is an additional responsibility for them and sometimes they walk up to few kilometers to get an arsenic free tube well. It crates great conflicts between the religious ideology

and the family responsibility as they are to be out of their home. And in some society they are often misunderstood and their sacrifice is castigated. To cope with the crises of arsenicosis woman often play the key role not only through carrying arsenic free drinking water but also through providing nutritious food to the victims, drawing upon their savings, selling their very own assets and drawing upon network relationship (Sarkar, 1999). A woman can play a vital role in order to make her children to understand about arsenic and its effects on health and how to avoid it in his/her daily life. So that women should be well-educated and trained. Women are most sensitive of arsenicosis as their body structure is not so strong comparing with the men, by the disease itself and by becoming excommunicated or outcast. They are more at risk then their male counterparts. Furthermore, once members of a household contract arsenicosis, a significant amount of attention is paid to the detriment of the breadwinners, or the men, sometimes to the detriment of the women. This can mean, for example, that most of the treatment costs will be spent on improving the health of the men. Arsenicosis like melanosis, spotted melalanosis, keratosis, ulcer Keratosis etc. change the complexions of victims and make them physically weak, these women's marital tie becomes weaker (Sarker, 2001). The social structure of Bangladesh is still now dominated by men and in making relations the arsenic victim's women are being avoided to select them as their spouse. A study conducted by Sarkcr (2001) showed that women with arsenicosis were subject to domestic violence such as dowry (41.7%), divorce (16.7%), separation (16.7%), desertion (8.3%), physical torture (8.3%) and polygamy (8.3%) (Figure 5).



Source: Sarkar-2001

Figure 5. Rate of women facing different domestic violence due to arsenicosis.

Table 2. Reasons behind arsenic patients untreated in study areas.

Area	Arsenic patients untreated due to			% of patients untreated	
	Superstition	Financial crisis	Total	Superstition	Financial crisis
Courtpara, Kushtia	3	7	10	30	70
Rajarampur, Chapainawabgang.	6	6	12	50	50
Samta, Jessore	8	2	10	80	20

Arsenicosis, a burden of poor

Poverty is the dominating factor in terms of arsenicosis remedies actions associated because the government assistance is not enough to provide treatment facilities for the victims. The poor arsenic affected people are not capable to get arsenic free water and its relevant facilities. Due to the financial instability they are incapable to buy arsenic free bottled water and nutritious food against arsenic toxicity. It is evident from the study that most of the people affected by arsenicosis are enormously poor and living below the poverty line. Where people fight for the bread, how they can get bottled water? From the study it has been seen that the economic status dominantly play an important role as most of the arsenic victims are of middle and low status. The poor were highly infected with arsenicosis. It is also evident that a poor person is affected by arsenic accompanied with his other family members (wives, boys and daughters) indicating that their incapability of getting

arsenic free water and their social instability is the key factor in order to survive with arsenic.

Spending huge money for the treatment of arsenicosis increases the economic burden of poor as the have to pay out extra money for that purposes. However, the poor victims are incapable of hard working, which results the financial instability. Recent studies show that a large scale poisoning of the population is bound to have a negative effect on the economy of the nation. Since the arsenic poisoning problem in Bangladesh has a potential of affecting the economy on a large scale. The arsenic problem can affect the already crushed educational status of these countries. This will, in turn affect a negative way the economy of these countries. When a breadwinner gets sick, many times they are forced to abandon their job and hence they fail to contribute the financial support for his/her family, the children of the household often have to take his place. They can start working in the fields, or could be involved in selling goods or foods at the market place. Hence they will not be able

to attend school anymore.

Conclusions

The arsenic problem leaves a huge burden for the society as well as for the country itself. Due to taking arsenic contaminated water the social structures are being fallout such as breaking marital relationship, social instability, losing workability and superstition. Due to lack of proper knowledge about arsenic the majority of villagers think that it is Allah's (God) curse and much time it has been seen that the arsenic affected people are not allowed to take part in any social program. As a result of Arsenicosis and its visible symptoms, they are shunned in community, and not allowed to sit with other normal people (at the village tea-stall, at play ground, at Mosque to offer prayer). Because of their low economic status they could not get any medical treatment and gradually lead to death. In case of making marital relationship, people become unwilling to have an arsenic affected person as their companion. The families in which "bread earners" are infected by arsenicosis face a unavoidable social hazards.

In order to face the problems of arsenic contamination and its effects among the villages, a systematic and proper planned step can solve this threat. The main challenge is to provide the millions of people at risk with arsenic free, bacteriologically as well as chemically safe and aesthetically acceptable alternative source of drinking water. The factors remain in these challenges are:

- (1) Identification of arsenic affected tube wells in the known affected areas to aware the people to avoid it.
- (2) Identification of arsenic free tube wells in the known affected areas.
- (3) Identification of arsenicosis patients.
- (4) Treatment of the patients with arsenicosis.
- (5) Treatment of arsenic contaminated water where no other safe source exists.
- (6) Identification of arsenic free aquifers extent of the potential alternative sources, namely, surface water and rain water.
- (7) Habit, culture and custom of the people.
- (8) Economic condition of the people, and their willingness and ability to pay for the service.
- (9) Community motivation to face the challenge collectively.
- (10) Technologies.
- (11) Cost.
- (12) Monitoring.
- (13) Research and development.
- (14) Institutional support.
- (15) Regular monitoring of all tube-well including irrigation wells.
- (16) Giving preference to surface water over groundwater as water (safe) source.

- (17) Capacity at community level for proper installation, operation and management of mitigation options.
- (18) Arsenic removal technology shall not be marketed without proper testing and validation from Bangladesh Scientific and Industrial Research Institute and submit the report to panel of experts for verification.
- (19) Assess Impact of groundwater withdrawal on deep aquifer.
- (20) Guideline to protect arsenic safe aquifer.
- (21) Training of all health workers for identifies and manages "Arsenicosis" according to developed protocol.
- (22) Arsenic in ground water used for irrigation may also affect agriculture and food chain.
- (23) Safe and arsenic free drinking water must be available for the affected people.

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