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Twenty Years of Arsenic Contamination and Arsenicosis Patients in a Village of Bangladesh

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Abstract **Background:** Arsenic contamination in groundwater of Bangladesh was first detected in 1993 and still a major public health problem in the country. In 1997, Samta was identified as a severely arsenic contaminated village and many villagers were found to suffering from arsenicosis. **Methods:** A series of surveys were carried out in Samta village in the years 1997, 2002, 2008 and 2017 to assess the situation of arsenic contamination and the status of arsenicosis in the village. The water sources and the entire population of the village were included in the study. **Results:** In 1997 about 87% of the shallow tubewells in Samta village were arsenic-contaminated and 10.1% villagers had arsenicosis. Twenty years later in 2017, about 90% shallow tubewells were arsenic contaminated, 39 deep tubewells and a pond sand filter were installed in the village and 2.3% of the villagers had arsenicosis. On an average 43.8% arsenicosis patients had recovered from the illness and condition of 21.2% patients had deteriorated or remained unchanged. During the 20-year period 37(6.1%) arsenicosis patients and 185(1.6%) non-arsenicosis villagers had died. The main cause of death among arsenicosis patients was cancer (40.5%) and among non-arsenicosis villagers the cause was geriatric problem (11.8%). The mean age at death was 57.6 years and 61.2 years respectively. **Conclusion:** In twenty years, measures were undertaken to make available arsenic-safe water options and people were motivated to stop the use of arsenic-contaminated water and to increase the intake of protein and vitamin AEC rich food. Recovery had occurred in a substantial proportion of patients.

Keywords: *arsenic, arsenicosis, arsenic toxicity, contamination, groundwater, water, tubewell, Bangladesh*

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1. Introduction

Shallow tubewells (STWs) were the main source of drinking water for 97% population in rural Bangladesh. With the identification of arsenic contamination in groundwater in 1993 and arsenicosis patients in 1994, a large proportion of the population found themselves to be without access to safe drinking water. Estimations showed that about 50 million people in Bangladesh were at risk of arsenic exposure through drinking arsenic-contaminated water [1,2,3,4]. STWs of almost all the districts of Bangladesh, except for those in the hilly and terrace upland areas, were reported as arsenic contaminated. The STWs tapping water from less than 150 meters below ground level were found to contain arsenic at levels higher than 50 ppb. British Geological Survey (BGS) survey found that 27% of the STWs water had arsenic over 50 ppb and estimated that 1.5 million to 2.5 million STWs in the country sunk between the range of 10 to 50 meters could be arsenic contaminated. The southeast part of Bangladesh was severely affected by arsenic contamination, with over 90% of tubewells being yielding arsenic much higher than the Bangladesh standard (50 ppb) for arsenic in drinking water [4,5,6,7].

In 2002, a blanket survey was conducted in 270 Upazilas out of 430 Upazilas, covered 57,482 villages and found that 29.1% (1.44 million) of the examined STWs (about 5 million) were arsenic-contaminated. Fifteen percent of the surveyed villages were identified as a hot spot as more than 80% of the STWs in these villages were arsenic contaminated [3,7,8]. Bangladesh Demographic and Health Survey (BDHS) in 2004 on examination of water samples from 10,465 households, found that 9.5% samples contained arsenic >50 ppb. A household water survey in 2009 for arsenic in drinking water, water samples collected from 13,301 households from the entire country, showed that 15.9% had arsenic content at levels >50 ppb [8,9]. To provide arsenic safe water in the arsenic contaminated areas, government agencies and many NGOs had installed varieties of arsenic safe water options such as deep tubewells (DTW), modified dug wells, arsenic removal plants and pond sand filter (PSF)

on a priority basis. But none of these options was universally accepted because of various technical and social reasons, and people were found to using the arsenic contaminated water sources [8,10,11].

In Bangladesh arsenicosis, the clinical condition arising out of chronic low dose arsenic exposure was first officially recognized with the detection of 8 cases in 1994 and by 1997, 1625 cases were detected in different districts. In the 2002 blanket survey about 38,500 arsenicosis cases were reported. Directorate General of Health Services (DGHS) using WHO arsenicosis case diagnosis and management protocol, trained the health workers in screening for suspected arsenicosis cases based on classical dermatological skin manifestations. The suspected cases were examined by trained physicians and finally by 2012 about 66,000 clinically confirmed arsenicosis cases were identified [1,2,6,12,13]. These patients were managed by cessation of exposure, increased intake of protein and vitamins AEC rich food, application of keratolytic ointment (if applicable), and vitamins AEC supplementation [1,6,12].

Multi-organ pathologies and various NCDs including cancers have been reported in populations having chronic arsenic exposure through drinking contaminated water. Cancers may occur on multiple sites, especially lungs, skin, bladder, liver and prostate [14,15]. In Bangladesh, the association of occurrence of cancers and NCDs with chronic exposure to arsenic had been evident in many studies [1,6]. However, in Bangladesh, most of the arsenicosis patients were found in the mild and moderate stages of the disease [1,2,6].

In 1997, a survey in the Samta village of Jashore district found it to be a severe arsenic-contaminated village. The entire village surveyed to find out the extent of arsenic contamination in the tubewells and the prevalence of arsenicosis. Of the 284 tubewells in the village, 87% (247) were arsenic-contaminated. Among the total 3606 villagers, 363 (10.1%) had developed arsenicosis. Most of the arsenicosis patients were in the mild and moderate stage, only 6.6% (24) were in the severe or complicated stage of arsenicosis [16]. Government and an NGO - Asia Arsenic Network (AAN) undertook several measures to provide arsenic safe water and management of arsenicosis patients. By twenty years many arsenicosis patients recovered, some deteriorated, some developed cancer and some died, and some new arsenicosis cases evolved. This study was under taken to find out the current status of arsenicosis patients and the state of arsenic exposed villagers, and the status of arsenic contamination as well.

2. Methods

A series of surveys were carried out in Samta village of Sharsa upazilla, Jashore in the years 1997, 2002, 2008 and 2017 to assess the situation of arsenic contamination and the status of arsenicosis in Samta village. The surveys were carried out by the Department of Occupational and Environmental Health and AAN. All water sources and the entire population of the village were included in the study. Examination of the water samples and sources and the population was undertaken in the surveys. Face-to-face interview of the respondents was also carried out to collect information relating to their health and about water sources in their household possession. All the households in the village were included in the study, and the senior household members were taken as the respondent. Water samples from all tubewells were examined for arsenic concentration, and the household members were examined for arsenicosis. For identification of arsenicosis, the WHO arsenicosis case diagnosis and management protocol was followed [1,13]. Pretested-questionnaire and checklist were used for the collection of data through interview and observations. To collect data for any death among households in twenty years, available documents and reports regarding the death were checked to ascertain the cause of death. In doubtful cases, in-depth interview regarding the death of the household member was also performed. AAN provided information relating to arsenic contamination, safe water options and arsenicosis patients. Senior household members were interviewed as respondents of the study and were assured that information provided by them would not be disclosed and would be used in a manner so that it could not be traced back to individual respondent. The respondents were encouraged to provide correct information, as far as they knew. They were also informed that their participation was voluntary, and they had the autonomy to withdraw from the study.

3. Results

The population of Samta village in 1997 was 3603 distributed in 682 households; Over the years, the population and the number of households had increased. The initial survey (1997) revealed that shallow tubewells (STW) water was the main source (95.5%) of water in the village and for cooking water, pond/river was a source. While in 2008, deep tubewell (DTW) became a large source (67.1%) of water and the use of STW decreased to 26.5% and in 2017, DTW use further increased to 79.7% and STW decreased to 19.3%. In 1997, the village had a single DTW and 284 STWs, of the STWs most (86.9%) were arsenic-contaminated. Both STWs and DTWs had increased in number in 2017 but most (89.9%) of the STWs and 10.3% DTWs were arsenic-contaminated. (Table 1) In the years 1997, 2002 and 2017, the maximum arsenic in STW water was found to be 1371, 850 and 1678 ppb respectively. While the mean arsenic concentration in the water of STWs was 240±206, 212±180 and 219±183 ppb respectively. A few STWs were found safe (arsenic up to 50ppb) which were 13.1%, 16.1% and 10.2% in the years 1997, 2002 and 2017 respectively. Of the total 39 DTWs, 5.2% was found arsenic-contaminated. (Table 2)

The mean depth of STWs was found to be 121.6±27.29 feet in 2017 and 118.3± 28.101 feet in the year 2002. Further, it was found that in 2017 and in 2002 majority of the STWs were in the depth of 100-149 feet and the mean arsenic concentration was found highest in this depth which was 227.93±188.70 ppb and 221.83±180.415 ppb respectively. On the other hand, the mean depth of the DTWs was found 666.90± 81.09 feet in 2017 and 719.20±138.67 feet in 2002 and a higher proportion (61.5%) DTWs were in the depth 600-699 feet in 2017

and in 2002, 60.0% were in the depth of 600-799 feet. (Table 3)

In Samta village, the prevalence of arsenicosis was 10.1%, 5.9% and 2.3% in the years 1997, 2008 and 2017 respectively. Males accounted for a higher number of arsenicosis than females. In 1997, 73.3% of the patients were aged 10 to 39 years, in the year 2008 almost 79% were in the age group of 20 to 59 years; finally, in the year 2017, three-fourths (75.8%) were in between 30 to 59 years of age. Table 4 shows the prognosis of the arsenic patients of Samta, from 1997 to 2008, in 11 years the prevalence of arsenicosis declined from 10.1% to 5.9% and in 9 years (2008 to 2017) declined from 5.9% to 2.3%. Over the period of 11 years (1997 to 2008), 35.5% of the arsenicosis patients recovered from the illness while over the subsequent 9 years period (2008 to 2017), 52.1% of the remaining patients recovered. New arsenicosis patients accounted for 9.9%, and 3.1% of the total arsenicosis patients in the years 2008 and 2017, respectively. (Table 4)

Table 5 reveals that from 1997 to 2017 (20 years), 222 deaths had occurred in Samta village. Of the total deaths 37(16.7%) were arsenicosis patient and 185(83.3%) deaths were among the population without signs of arsenicosis. Maximum death (12.4%) occurred among the arsenicosis patients in 9 years (between 2008 to 2017). Per year death among arsenicosis patients was 1.7 and 9.4 among non-arsenicosis population. Among both arsenicosis and non-arsenicosis deaths, there was a male predominance. The mean age at death of arsenicosis patients was found lower (57.6±9.6 years) than that of non-arsenicosis deaths (61.2±17.4 years) but statistically not significant. Chi-square test revealed that more deaths had occurred among arsenicosis patients than expected in the age groups 41 to 50 years and among those who were over 70 years of age. While in case of non-arsenicosis, deaths were higher in the older age groups (over 70 years). Table 6 shows that during the period 1997 and 2017, 24 cancer deaths occurred of which 15(62.5%) were arsenicosis patients and 9(37.5%) were non-arsenicosis. Lung cancer (21.6%), liver cancer (10.8%) and skin cancer (8.1%) accounted for 40.5% of the cancer deaths among arsenicosis patients. While blood cancer, lung cancer and breast cancer were the common cancers deaths among non-arsenicosis individuals. Other important causes of deaths in arsenicosis patients included gangrene, cirrhosis, tuberculosis and hypertension. (Table 6)

The in-depth interview of the selected households revealed the reasons for continuing the use of STWs. A majority (55%) of them mentioned that DTWs were away from their house. One-third of them believed that the STWs were arsenic-contaminated but not much harmful or did not create any health problem. Other reasons mentioned by them that habituated with using STW water; DTWs did not belong to them, no one in the house to carry DTW or from other safe water sources, and DTWs water was arsenic-contaminated.

Table 1. Distribution of Population and Households by Water Sources and Arsenic Contamination

Population & Water sources		Years of Survey			
		1997	2002	2008	2017
Total	Population	3603	3826	4080	4472
	Household	682	809	875	997
	STWs	284	316	437	691
	DTWs	01	09	17	39
Water sources used by Household*	STWs	651 (85.5%)	345 (42.8%)	232 (26.5%)	192 (19.3%)
	DTWs	36 (5.3%)	395 (48.9%)	587 (67.1%)	795 (79.7%)
	PSF (1)	0 (0.0%)	72 (8.9%)	66 (7.6%)	53 (5.3%)
	Pond/River†	233 (34.3%)	326 (40.3%)	322 (36.8%)	301 (30.2%)
Arsenic Contamination	STW	247 (86.9%)	265 (83.9%)	376 (86.0)	621 (89.9%)
	DTW	0 (0.0%)	1 (14.3%)	2 (11.8%)	4 (10.3%)

* Multiple response, †Additional water source for cooking.

Table 2. Arsenic concentration in tube well water examined in 1997, 2002 and 2017

Arsenic in Water (ppb)	Shallow Tube wells			Deep Tube wells	
	1997	2002	2017	2002	2017
	n (%)	n (%)	n (%)	n (%)	n (%)
Upto 10	11 (3.9)	20 (6.3)	33 (4.8)	5 (50.0)	9 (23.1)
20-50	26 (9.2)	31 (9.8)	37 (5.4)	4 (40.0)	26 (66.7)
>50-100	55 (19.4)	117 (37.0)	304 (44.0)	1 (10.0)	04 (5.2)
>100 - <300	86 (30.2)	77 (24.3)	153 (22.1)	-	-
>300 - <500	60 (21.1)	61(19.3)	148 (21.4)	-	-
≥500	46 (16.2)	10 (3.2)	16 (2.3)	-	-
Total	284 (100)	316 (100)	691 (100)	10 (100)	39 (100)
Mean±SD Maximum	240 ± 206 1371	212±180 850	219±183 1678	30 ±29 100	27±15 63

Table 3. Depth of tube wells and arsenic concentration in water in years 2002 and 2017

Tube well type	Tube wells Depth (feet)	2002		2017	
		n (%)	Mean As in Water (ppb)	n (%)	Mean As in Water (ppb)
Shallow tube well	50-99	57 (18.0)	193.45±188.209	83 (12.0)	208.61±180.44
	100-149	229 (72.5)	221.83±180.415	523 (75.7)	227.93±188.70
	150-199	21 (6.7)	166.00±174.97	68 (9.6)	181.73±145.83
	200 & above	09 (2.8)	188.88±131.761	17 (2.5)	184.35±141.36
	Total	316 (100)	212.24±179.89	691 (100)	219.99±183.24
	Mean depth	118.3±28.101		121.6± 27.29	
Deep tube well	500-599	2 (20.0)	17.50 ±10.606	4 (10.3)	23.50 ±9.256
	600-699	3 (30.0)	46.7 ±35.11	24 (61.5)	26. 26± 14.973
	700 -799	3 (30.0)	33.33± 14.43	8 (20.5)	32.75± 19.381
	800 & above	2 (20.0)	10.00 ±.000	4 (7.7)	24.10± 12.124
	Total	10 (100)	29.50 ±23.50	39 (100)	27.12± 15.122
	Mean depth	719.20±138.67		666.90± 81.09	

Table 4. Distribution of the arsenicosis patients by age, sex and prognosis

Arsenicosis and Prognosis		**Year**			**Average (%)**
		1997 n (%)	2008 n (%)	2017 n (%)	
Total Patients	Prevalence	363 (10.1)	242 (5.9)	98 (2.3)	6.1
Sex	Male	191 (52.6)	142 (58.7)	58 (59.8)	57.0
	Female	172 (47.4)	100 (41.3)	39 (40.3)	43.0
Age	<10	28 (7.7)	4 (1.7)	0 (0.0)	3.1
	10-19	80 (22.0)	28 (11.6)	2 (2.1)	11.9
	20-29	103 (28.4)	57 (23.6)	9 (9.2)	20.4
	30-39	83 (22.9)	63 (26.0)	14 (14.3)	20.9
	40-49	32 (8.8)	46 (19.0)	37 (37.8)	21.8
	50-59	21 (5.8)	25 (10.3)	23 (23.7)	13.2
	60-69	11 (3.0)	13 (5.4)	9 (9.3)	5.9
	70 +	05 (1.4)	6 (2.5)	4 (4.1)	2.7
Prognosis	Recovered	0	129 (35.5)	126 (52.1)	43.8
	Improved	0	115 (31.7)	61 (25.5)	28.4
	Unchanged/Deteriorate	0	103 (28.4)	34 (14.0)	21.2
	New patients	0	24 (9.9)	03 (3.1)	6.4

Table 5. Arsenicosis and non-arsenicosis deaths in Samta village

Death of Villager by duration, sex and age		**Arsenicosis n=37 (16.7%)**	**Non-Arsenicosis n=185 (83.3%)**	**Total n=222 (100%)**
1997 to 2017	20 years	37 (6.1%)*	185 (1.6%)†	222 (1.8%)‡
	Per year	1.7	9.4	11.1
1997 to 2002	5 years	4 (1.2%)*	51 (1.4%)†	55 (1.5%)‡
	Per year	0.8	10.2	11.0
2002 to 2008	6 years	12 (4.8%)*	57 (1.5%)†	69 (1.7%)‡
	Per year	2.0	9.5	11.5
2008 to 2017	9 years	21 (12.4%)*	77 (1.9%)†	98 (2.3%)‡
	Per year	2.3	8.5	10.9
Sex	Male	25 (67.6%)	122 (65.9%)	147 (66.2%)
	Female	12 (32.4%)	63 (34.1%)	75 (33.8%)
	Significance Test	χ^2=0.036; p=.849		
Age	up to 40	2 (5.4%)	26 (14.1%)	29 (13.1%)
	41-50	6 (16.2%)	25 (13.5%)	31 (14.0%)
	51-60	16 (43.2%)	41 (22.2%)	57 (25.7%)
	61-70	11 (29.7%)	49 (26.4%)	60 (27.0%)
	>70	2 (5.4%)	44 (23.2%)	46 (20.3%)
	Mean ± SD	57.6 ±9.551	61.23 ±17.359	60.64±16.355
	Significance Test	χ^2=12.473; p=**.014**		
		t=1.207; p=.229		

* percentage of mid-year arsenicosis patients
† percentage of mid year non-arsenicosis villagers
‡ percentage of mid year exposed population.

Table 6. Cause of deaths in Samta village during the period 1997-2017

Cause of Death	Non-arsenicosis n (%)	Arsenicosis n (%)	Total
Accident	12 (6.5)	0 (0.0)	12 (5.0)
Asthma	9 (4.9)	1 (2.7)	10 (4.5)
COPD	8 (4.3)	2 (5.4)	10 (4.5)
Cancer	9 (4.9)	15 (40.5)	24 (10.8)
Cirrhosis	4 (2.2)	2 (5.4)	6 (2.7)
Diabetes	11 (5.9)	1 (2.7)	12 (5.4)
Diarrhea	8 (4.3)	0 (0.0)	8 (3.6)
Fever	7 (3.2)	1 (2.7)	8 (3.6)
Gangrene	4 (2.2)	3 (8.1)	7 (3.2)
Geriatric problem	22 (11.8)	1 (2.7)	23 (10.3)
Gynecological	5 (2.7)	0 (0.0)	5 (2.3)
Heart disease	13 (7.0)	1 (2.7)	14 (6.4)
Hepatitis	3 (1.6)	1 (2.7)	4 (1.8)
Hypertension	8 (4.3)	2 (5.4)	10 (4.5)
Kidney failure	11 (5.9)	2 (5.4)	13 (5.9)
Labor problem	3 (1.6)	0 (0.0)	3 (1.4)
Neurological	10 (5.4)	0 (0.0)	10 (4.5)
Pneumonia	14 (7.6)	2 (5.4)	16 (7.3)
Stroke	14 (7.6)	1 (2.7)	15 (6.8)
Tuberculosis	5 (2.7)	2 (8.1)	7 (3.2)
Unknown	5 (2.7)	0 (0.0)	5 (2.3)
Total	185 (83.3)	37 (16.7)	222 (100)

4. Discussion

Despite various measures undertaken by the government and the NGOs, arsenic contamination in tubewell water remains as a major public health challenge in Bangladesh even after 25 years of its identification. Challenges in coping with this problem includes lack of appropriate, acceptable and affordable arsenic safe water options; and absence of specific treatment and proper management for the arsenicosis patients [6,8]. In 1997, almost all the villagers in Samta used STW water and only 13% of the STWs were safe in-terms of arsenic contamination (up to 50 ppb) and one-tenth of the villagers were suffering from arsenicosis. Most of the arsenicosis patients in Samta were found to be having the mild and moderate stage of the disease and some of them had severe disease or complications like cancer, pre-cancer (Bowen's disease), gangrene, non-pitting edema and hepatopathy [16,17]. For the management of arsenicosis, the villagers were motivated to use water as much as possible from the prevailing arsenic safe sources and were also advised to take protein and vitamin-rich food and vitamins AEC medicinal supplements. However, in the following years to reduce arsenic exposure of the villagers, several DTWs and a PSF were installed to provide safe water both for drinking and for cooking purpose [6,17,18].

In 20 years, a majority of the identified arsenicosis patients were found to have recovered (43.8%) and improved (28.4%) from the illness; and the condition of over one-fifth (21.2%) remained unchanged or had deteriorated. Recovery or improvement was found to have occurred among those who had followed the advice and instructions properly. It has been reported that recovery and improvement was more likely patients with mild or moderate arsenicosis if they consumed arsenic safe water and took antioxidants regularly; however, recovery in patients with severe disease or complications was time taking or even difficult [2,18,19,20,21,22,23]. Though the antioxidants were found to be useful, the mechanism was not clear. It is possible that the antioxidants (vitamin E and C) could play a role in reducing cellular oxidative stress produced by arsenic [24,25,26,27]. Vitamin A (Retinol) has the antikeratinizing effect and used as chemoprevention against some cancer particularly skin cancer [27,28]. However, in the early years there were not enough safe water options (DTWs), so many villagers continued to take arsenic contaminated STWs water. As a result, the condition of a substantial number of arsenicosis patients remained unchanged or had deteriorated (103), and some villagers (24) developed arsenicosis newly.

After 2008, the government and AAN took special measures for arsenicosis patients. Upazila health complex enlisted the arsenicosis patients and supplied them with medicinal vitamin AEC regularly. The health complex provided a follow-up card, which included information of the patients' manifestations and management provided. The patients were re-examined every three months, and their prognosis was recorded. AAN specially arranged for the management of arsenicosis patients with complications, particularly of those who developed cancer. AAN mobilized community involvement and community participation in installing DTWs to ensure easy availability of arsenic safe water [6,12].

Despite all measures taken in twenty years, 34(14.0%) arsenicosis patients were found in unchanged or deteriorated conditions, and 37(6.1%) died. Individuals consuming arsenic-contaminated water, even if not having a manifestation of arsenicosis, are likely to have various health effects including cancers [13,14,15]. The co-morbidities or complications leading to death as found in this study have been previously reported as the cause of death relating to arsenic exposure [29,30,31]. The main cause of death among arsenicosis patients in Samta was cancer, which contributed 40.5% of the total deaths of the arsenicosis patients and the common sites of cancers were the lung, liver and skin. On the other hand, among the non-arsenicosis deaths, the most common cause was the geriatric problem (11.8%) and cancer contributed only 5% of the total non-arsenicosis deaths. This study has also revealed that the proportion of death and per year average death of the arsenicosis patients was increased with the increased years of sufferings from arsenicosis. Studies [31,32,33] reported that increased risk of mortality was related to exposure to arsenic contaminated water, and the risk was manifold higher if the exposed had co-morbidities. It was found that the non-arsenicosis villagers having arsenic exposure and those patients who had recovered from arsenicosis lived longer compared to those with arsenicosis and many (one-fourth) of them died after 70 years. Thus, it is possible following cessation of arsenic exposure through consuming arsenic contaminated water.

Studies [34,35,36] have revealed that in arsenic-contaminated area if the household food contained high protein and vitamins there was no or fewer arsenicosis

patients compared to those of the household having less protein and vitamins in their daily food. It was also reported that arsenicosis was more prevalent in households which consumed fewer protein intake in-terms of eating no egg or infrequent egg consumption. Poor nutrition, particularly less intake of protein resulting in decreased potentiality of methylation, consequently hampering the arsenic detoxification capacity and thus resulting in increased the toxicity [27,37,38].

Till seventies surface water was mainly used for drinking and cooking. It took years to motivate people to switch from the traditional water sources to STWs as a source of drinking water. Unfortunately, when over 97% of the population was relying on these STWs for safe drinking water, many of them were found to be arsenic-contaminated in mid 90s. National Policy for Arsenic Mitigation identified a range of arsenic safe water options for adoption in the country, but none of these sources is unique in-terms of technological acceptability, affordability, and sustainability. As an option, DTW was a choice of many organizations but it was expensive for an individual family, not workable in all the areas and some DTWs are reported to have arsenic contamination [6,9,11,39]. The current study revealed that on an average the DTW in the depth of 600-800 feet contain a higher concentration of arsenic in water, and some DTW had arsenic exceeding the Bangladesh standard. There was a report that the tubewells of <320 feet (100 meters) depth were relatively safe in-terms of arsenic contamination [9]. But in the current study, the STWs in the depth between 50-200 feet was found unsafe. Therefore, to get arsenic safe water the tubewells should be installed beyond the depth as reported in this study, and test boring should be done to determine arsenic content before installation. In the national policy it was also recommended for testing the quality of water before installation of any water source, and in each area multiple water sources should be made available [39].

In Samta, after the detection of arsenic contamination in STW water, the use of STWs decreased, and many villagers switched to DTWs. However, till 2017 one-fifth of the villagers (19.3%) were found to use STWs even though many DTWs were installed. The reasons for continuing the use of STWs as mentioned by the villagers were, DTWs were away from their house, arsenic did not create any health problem, did not know how much the contamination, DTWs not belonged to them and DTWs water also arsenic-contaminated.

5. Conclusion

Samta was a highly arsenic-contaminated village, and many people were suffering from arsenicosis. Initiatives of the government and NGO, in twenty years majority of the arsenicosis patients had recovered. The recovered patients followed the instructions of exposure cessation and consumption of extra-protein and antioxidant supplementation. Majority of arsenicosis patient deaths were from complications like cancer. Thus, to prevent the development of arsenicosis or to avoid any effect of arsenic exposure, the arsenic exposed population must have access to a sustainable and suitable arsenic-safe water option. In addition, increasing consumption of easily available protein and vitamin-rich food could help to reduce toxic effects of arsenic.

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Conflict of Interest

Authors declare that they have no conflict of interest.

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