

Arsenical Disease Burden and Psychosocial, Behavioral & Economic Issues Associated with Chronic Arsenic Exposure: A Study in Malda District, West Bengal

Kunal Kanti Majumdar¹, Alope Kumar Ghosh², Prमित Kumar Majumder³, Shyamsree Mukherjee⁴, Debendra Nath Guha Mazumder⁵

¹Professor, Department of Community Medicine, KPC Medical College and Hospital, Jadavpur, Kolkata,

²Research Associate, DNGM Research Foundation, Kolkata- 700 053, India,

³Project Coordinator, ⁴Research Associate, ⁵Director, DNGM Research Foundation, 37/C Block B New Alipore, Kolkata - 700 053.

Corresponding Author: Debendra Nath Guha Mazumder

ABSTRACT

Background: Arsenic pollution in groundwater had been causing great environmental health hazard in West Bengal, India. A study on disease burden, and psychosocial, behavioral and & economic issues related to chronic arsenic exposure were done in Malda, an arsenic affected district of West Bengal.

Methodology: An epidemiological study was carried out in all arsenic affected blocks of Malda. Information on psychosocial, behavioral & economic issues were assessed amongst surveyed population.

Results: Prevalence of arsenicosis was found to be 8.3% amongst 5355 number of people surveyed. Majority (62%) patients who were aware of their illness, felt embarrassed, many having anxiety, tension and depression. Most (93.6%) patients felt that their status had been changed within the community. Small number (3%) of patients volunteered marital problem. Not many (18.9%) patients consulted doctors for their treatment. Majority of patients had disability leading to change of occupation or loss of jobs. Small number (8.7%) participants considered arsenicosis as a communicable disease. Social exclusion was reported among small (1.4%) number of participants.

Conclusion: Significant number of arsenicosis cases was detected in the district of Malda, A wide range of psycho-social, behavioral and economic consequences were observed associated with chronic arsenic toxicity in the society.

Key Words: Arsenic, disease burden, mental health; socio-economic problems behavioral issues, West Bengal

INTRODUCTION

Arsenic pollution in groundwater, used for drinking purposes, has been envisaged as a problem of global concern. Arsenic contamination in drinking water has been reported from many countries like Taiwan, China, Argentina, Chile, Mexico, Cambodia, Thailand, Myanmar, Nepal,

USA, ⁽¹⁾ but the severity of this contamination in India and Bangladesh is unprecedented. In India, significant arsenic contamination in groundwater was detected in the year 1983 in West Bengal, when some villagers were diagnosed to be suffering from arsenicosis due to drinking of arsenic contaminated water. Today, in West

Bengal, the arsenic contamination in ground water has been detected in 8 districts of the state. ⁽¹⁾ Of these, the major affected districts are Malda, Murshidabad, Nadia, and North and South 24 Parganas. It is suspected that 6 million people are exposed to arsenic contaminated ground water (>50µg/L). In India, occurrences of arsenic in ground water have also been reported from Bihar, Jharkhand, Chhattisgarh, Uttar Pradesh and Assam. ⁽¹⁾ Predominant manifestation of chronic arsenic toxicity is skin lesions characterized by pigmentation and keratosis. However it produces protean systemic manifestation over and above skin lesions, important ones being chronic lung disease like chronic bronchitis, chronic obstructive pulmonary disease and bronchiectasis, liver disease like non cirrhotic portal fibrosis and other diseases like polyneuropathy, peripheral vascular disease, hypertension and ischaemic heart disease, diabetes mellitus, non-pitting edema of feet/ hands, weakness and anemia. ⁽²⁻⁴⁾ Further the incidence of arsenic related cancer was reported to be 5.1% among 4865 cases of arsenicosis examined during the period of 1983 to 2000 in West Bengal. ⁽⁵⁾ Remedy of chronic arsenic toxicity, known still today, is to take arsenic free water. ^(4,6)

In the past several epidemiological studies have been carried out in many arsenic affected districts of West Bengal, ^(2,7-12) but no such study has so far been done in the district of Malda. Current report is based on an epidemiological study carried out for determining the prevalence of arsenicosis patients in Malda and estimation of the arsenicosis disease burden.

Apart from the health effects, chronic arsenic toxicity also causes a wide range of social problems and economic loss. But there is a distinct dearth of necessary knowledge-base on the economic and social consequences of arsenicosis. The further objective of this paper is to ascertain the key findings of psychosocial, behavioral & economic issues associated with chronic arsenic exposure in the district of Malda, West Bengal.

MATERIALS AND METHODS

An epidemiological study was carried out in all the 7 arsenic affected blocks of Malda district of West Bengal for determination of prevalence of arsenicosis cases and assess the psychosocial, behavioral & economic issues related to arsenicosis in the exposed population. These 7 blocks were selected purposely as these are the arsenic affected blocks of Malda District of West Bengal according to report of Public Health Engineering Department (PHED,) Govt. of West Bengal as cited by West Bengal Pollution Control Board. ⁽¹³⁾ Twenty six Gram Panchayats (GPs) were selected within these arsenic affected blocks, based on the information of presence of arsenic contaminated public tube wells, present in these habitations. [Habitation arsenic data for West Bengal PHED ⁽¹⁴⁾]. Forty two villages were selected purposefully within these 26 GPs because of presence of arsenic contaminated public tube wells in these villages. Based on feasibility, eighty one habitations were selected randomly from these 42 villages and a total of 2013 households were selected by random sampling from these habitations for carrying out the epidemiological study. All members of the household were examined. A total of 5355 number of participants were studied. A pro forma was prepared with questionnaires collecting information about the clinical manifestation of the participants with arsenicosis if any, socio-economic condition, sanitation status, source of water used for cooking and drinking purpose. All of the participants were examined by expert doctor for detection of skin lesions characteristic of arsenicosis. Severity of skin lesions were determined according to the scoring system described earlier. ⁽¹¹⁾ Water Samples were collected from different sources including home tube wells during the house to house survey and sent for testing of arsenic content at the Reference Laboratory of PHED at Malda.

Psychosocial, Behavioral & Economic issues

All the participants were asked questions in a prepared format of questionnaire which gathered information related to psychosocial, behavioral & economic issues and efficacy of drinking safe water on arsenical symptoms, and recorded by the field investigators for analysis. Not all participants responded to all the questions asked, related to different issues, but data were collected based on the responses obtained from them who volunteered to reply to the query. The report was based on voluntary response recorded from varying number of participants on different issues.

Initially, knowledge and perception among the arsenicosis patients were recorded. Participants who were diagnosed to have arsenical skin disease and responded to the query were asked whether they were aware of their arsenical illness. The feeling of the people who were aware was also recorded. The arsenicosis cases were then asked whether their status within the family and within the community had been changed by knowing that they were suffering from arsenicosis. Further, arsenicosis cases were asked whether they were facing any marital problem because of their arsenic relate skin lesion and if so, nature of such problem was also noted. Whether the arsenicosis cases were facing any disability in carrying out their schedule work and whether this affected their occupation were also asked. Whether the patients were attending physicians for their treatment were noted and reasons for those who were not seeking any medical advice were also recorded.

Knowledge and perception among the total surveyed people were also ascertained. Perception regarding efficacy of treatment for arsenicosis patients was also noted. Whether arsenicosis was a communicable disease and whether arsenic exposed people were apprehensive about the disease were enquired to the studied population. To ascertain any occasion of

social exclusion people were asked about their feeling in regard to cases of arsenicosis. Further knowledge about arsenic contamination status of home tube wells of the participants was determined. Effects of drinking arsenic safe water on arsenical symptoms were also recorded.

Analysis of Data

The association of arsenicosis status with each factor of Age, Sex, Education, type of dwelling, annual income, occupation, Sanitation status has been measured with Chi-Square test.

Multiple responses from the participants expressing the feelings of awareness of their illness can lead to overestimation of the categories leading to spurious inflated correlation so statistical test were not done in those cases. Paired sample t test has been used with 95% confidence interval for finding reasons for inability to work.

Institutional review committee of DNGM Research Foundation approved the protocol for the study. Informed consent was obtained from each participant before carrying on the interview, clinical examination and collection of water samples from drinking water sources for arsenic testing.

RESULTS

A total of 446 (8.3%) cases of arsenicosis (subjects with skin lesion) were detected out of 5355 participants examined during house to house visit in 2013 households in the arsenic affected Blocks of Malda. Pigmentation was found to be present in 440 subjects and keratosis in 209 subjects. Pigmentation was mild in 294 (66.8%) cases, moderate in 120 (27.27%) cases while severe in 26(5.9%) cases. Further keratosis was found to be mild in 148(70.81%) moderate in 52 (24.88%) cases and severe in 9 (4.3%) cases.

Arsenic concentration in drinking water

A total of 1665 water samples, used by the participants for drinking purpose from various sources, were collected for arsenic estimation. Out of these 1638 (98%)

water samples were collected from home tube wells and the remaining 27 samples from other sources (Govt. tube wells, dug wells and river well). Arsenic contamination was found to be more than 50 µg/L in 60.48% samples of water tested from home tube wells. Maximum concentration of arsenic in drinking water of home tube well was found to be 0.99 mg /L.

Psychosocial, Behavioral & Economic issues

Majority of the head of the families studied were males (>90%) and they

belonged to the age group of 30 -60 years. Significantly small number of families lived in *Kutch* houses (20%). However, most (80%) of head of families were either illiterate or had education up to primary level. Further significant numbers of them (48%) were daily laborers and belonged to BPL category (56%-65%). Sanitary Latrine was absent in household of 27-33% of participants. The association of arsenicosis status with each factor of Age, Sex, Education, type of dwelling, annual income, occupation, Sanitation status has been measured with Chi-Square test. [Table 1]

Table 1.Characteristics of head of the family (HOF) [with and without arsenicosis patients] in the total (2013) households studied in the district of Malda

Characteristics	(Cases)Patients Family Total(n=340)		(Controls)Non Patients Family (n=1673)		P
	n	%	n	%	
Age in years					
18-<30	12	3.5	95	5.7	.984
30-<60	202	59.4	1194	71.4	.983
>60	126	37.1	381	22.8	.982
NA	0	0	3	.2	
Sex					
Male	308	90.6	1527	91.3	.205
Female	32	9.4	146	8.7	.0
Type of dwelling					
Pucca	127	37.4	748	44.7	.000
Kutch	70	20.6	344	20.6	.000
Kutch-Pucca	141	41.5	581	34.7	.000
NA	2	.6	0	.0	
Education of family head					
Illiterate	137	40.3	602	36.0	.996
Primary	132	38.8	582	34.8	.996
Secondary	40	11.8	200	12.0	.996
Higher than Secondary	21	6.2	183	10.9	.996
School deserter	9	2.6	106	6.3	.996
Occupation					
No earning	46	13.5	104	6.2	.977
Farmer	44	12.9	230	13.7	.979
Daily labour	164	48.2	813	48.6	.978
Service	7	2.1	95	5.7	.979
Petty business	42	12.4	296	17.7	.979
Others	36	10.6	130	7.8	.978
Annual income of family head					
BPL	221	65.0	944	56.4	.066
<=50000	72	21.2	397	23.7	.100
>=50001-100000	38	11.2	238	14.2	.120
>=100001-200000	8	2.4	61	3.6	.161
>=200001-500000	0	0.00	14	.8	.970
>500000	0	0	0	0	.066
NA	1	.3	19	1.1	
Sanitation status					
Present	221	65.0	1192	71.2	.091
Absent	112	32.9	456	27.3	.280
NA	7	2.1	25	1.5	.984

A total of 136 (38.1%) participants were not aware out of 357 arsenicosis cases who responded to the query whether they were aware of their arsenical illness. All the

remaining 221 participants felt embarrassed due their illness and expressed various feelings. Forty seven patients felt badly, 68 patients felt depressed, 59 patients felt pain

and uneasiness, 77 felt tired and 76 felt anxiety and tension. [Table 2]

Only 3 (1.6%) patients out of 187 arsenicosis cases, who responded, felt that their status had been changed within the family. However, 175 (93.6%) patients felt that their status had been changed within the community.

When enquired about any marital problem, 6 (3.1%) out of 192 arsenicosis cases, who responded, said that they had encountered marital problem due to arsenicosis. In one case the prospective partner thought that his partner was unsuitable, while in 5 cases they confided weakness during physical relation.

Regarding disability, majority (239, 92%) of 269 arsenicosis cases who responded, complained that their ability to work was affected due to the arsenical illness. These patients narrated various reasons; often multiple by a single patient, like can't work as earlier, felt lethargic, weak to work. Out

of these 171(71.5%) patients had to change their previous occupation. Termination of job occurred in 161(67%) cases. Here paired sample T test has been used with 95% confidence interval. Here none is significant, so null hypothesis is being accepted, and conclude that no significant difference exists. [Table 3]

Table 2. Distribution of Arsenicosis cases according to their feelings about skin lesions

(Multiple response from single participant)		
Feelings of people who are aware of their illness	No	%
Bad	47	21.3
Depressed	68	30.7
Embarrassed	221	100
Pain & uneasiness	59	26.7
Tired	77	34.8
Fear, Anxiety, tension	76	34.4
No such specific feeling	72	32.5
Total	221	100

Table 3. Reasons for inability to work due to illness caused by arsenicosis.

Reasons for inability to work	No.	% on population unable to work	p-value
Can't work like earlier	49	20.5	0.923
Lethargic	187	78.2	0.394
Weaknesses	195	81.6	0.322
Total	239	100.0	

Table 4 Distribution of population according to their feelings towards arsenicosis patients and cases of social exclusion

Feelings and Behavior towards arsenicosis patients	Frequency	Percent on Total responded
No bad feelings	1084	88.0
Feeling afraid	127	10.3
Avoiding	17	1.4
Not allowing children to mix with arsenicosis cases	4	0.3
Total Responded	1232	100.0

Table 5. Estimated population exposed to arsenic contaminated water above 50 µg/L in the surveyed affected blocks of the affected 6 districts of West Bengal and Approximate number of arsenicosis patients

Districts	Total population ¹⁵ Of affected blocks	Estimated populn. exposed to As. >50µg/L ¹⁵	% of people with arsenicosis	Estimated no. of people suffering from arsenicosis
North-24-Parganas	4290233	959377	6.8 ⁸	65237
South-24-Parganas	2577369	524922	4.6 ²	24146
Murshidabad	5249116	1208863	19 ¹⁰	229683
Nadia	3855122	589810	15.43 ¹¹	91007
Maldah	2751151	571224	8.3 ⁷	47411
Total	18,722,991	3,854,196		457,484

[*Current study]

Subhir Kumar Dulta Former Professor, Department of Biochemistry, University of Calcutta, Kolkata, India
ShyamalKantiPalit, InrulKaies, Ajoy Kishore Barua, and Khondaker Abdul Asad Dhaka Community

Health seeking behavior and attitude towards getting treatment

When enquired about their health seeking behavior, only 57 (18.9%) patients out of 446 cases identified, stated that they visited doctors for treatment of their illness. Out of 35 cases, who didn't attend doctors, stated various reasons for not attending the

doctors. Seventeen patients had no faith in doctors, 12 patients had no time while 6 patients felt afraid to attend doctors. The remaining patients did not give any specific reason for not going to doctors.

Knowledge and perception among surveyed people

Out of 509 participants who responded 313 (61.5%), didn't have any idea whether arsenicosis was a treatable disease. However, 178 (35%) persons considered it as treatable disease, while 18 (3.5%) persons did not think so.

Out of 1272 participants who responded, 111 (8.7%) considered it to be a communicable disease. Out of these 35 (31.5%) subjects felt tension and anxiety for fear of contacting the disease by contact with an arsenicosis case

Regarding social exclusion, majority (1084, 88%) of 1232 participants, who responded, had no bad feelings (empathy) towards arsenicosis cases, but 127 (10.3%) people expressed some fear about the diseased cases. Only 17 participants (1.4%) wanted to avoid to mix with arsenicosis patients (1.4%) and 4 participant did not allow their children to mix with the diseased persons. [Table 4].

Knowledge about arsenic contamination status of home tube wells

People from 1441(86%) families out of 1676 households, who responded, did not have any knowledge about contamination status of water of their home tube wells which they were using for drinking purpose. Only 100 (6%) families knew these to be contaminated while 135 (8%) families knew these as uncontaminated.

Effect of intake of arsenic safe water on arsenical symptoms

Out of 172 arsenicosis patients who were found to be drinking arsenic safe water 101(58.7%) patients had some improvement and 49 (28.5%) patients had much improvement of their skin symptoms. Only 22 (12.8%) patients did not have any improvement of skin lesion.

Estimated population exposed to arsenic contaminated water above 50 µg/L in the surveyed affected blocks of the affected 6 districts of West Bengal and approximate number of arsenicosis patients in each affected blocks are shown in Table 5.

DISCUSSION

The present epidemiological study showed a prevalence of arsenicosis in 8.3% of people out of the population studied in all the arsenic affected blocks of district of Malda, West Bengal. Similar cross sectional study, done in all the 17 arsenic affected blocks of the district of Nadia, West Bengal, showed clinical features of arsenicosis in 15.43% of population studied. Prevalence of arsenicosis varied widely in different district of West Bengal. Prevalence, estimated in three other major arsenic affected districts of the of West Bengal, namely, South 24 Parganas, ⁽²⁾ North 24 Parganas ⁽⁸⁾ and Murshidabad, ^(9,10) was found to vary from 4.6 to 19 percent (Table 4). Extrapolating the prevalence data on the reported exposed population in the five major arsenic affected districts of West Bengal, ⁽¹⁵⁾ an estimated total disease burden of arsenicosis cases appear to be 457,484 of people in the state. [Table 4]

Majority of the arsenicosis cases in Malda had mild skin lesion. Arsenical skin lesions were also found to be mild in majority (87.57%) of the cases in Nadia also. ⁽¹¹⁾ As mild skin lesion clears from drinking arsenic safe water, ^(4,12) it is a matter of great relief that majority of people affected with arsenicosis in West Bengal are mild and could be relieved of symptoms if arsenic safe water is available to them.

In this study 98% of participants were found to be using home tube well water for drinking purpose in Malda. Home tube well water, tested for arsenic, was found to be contaminated in large number (60.48%) of samples. On enquiry it was also observed that majority (86%) families did not have any knowledge about contamination status of water of their home tube wells which they were using for drinking purpose. It appears that large numbers of people were drinking water from their arsenic contaminated home tube wells without being aware of it. Public Health Engineering Department, Govt. of West Bengal, the nodal agency entrusted in arsenic mitigation in the state, took decision to test only Govt. tube wells, not the private

ones. ⁽¹⁴⁾ There is no control on installation, monitoring, and control in use of arsenic contaminated private wells by arsenic affected villagers from private sources. So policy should be taken to test all private tube wells and take control of the installation and monitoring of private tube wells for effective prevention of arsenic exposure to people from drinking arsenic contaminated water from private tube wells in the state.

Psychosocial, behavioral & economic issues

Majority of head of families of the study population in Malda belonged to low socioeconomic class as majority of them belonged to BPL (Below Poverty Line) category and had education up to primary level. Significant numbers (48%) of head of families were daily laborer. Occurrence of arsenicosis among low socio-economic class had also been reported from other studies in arsenic exposed population in West Bengal and Bangladesh. ^(10,11,16-18)

Though 38% of Patients were not aware of their arsenical illness, all those who were aware felt embarrassed. Many of these patients felt bad and depressed and had anxiety and tension. Studies in China have shown that mental health problems (e.g. depression) are more common among the people affected by arsenic contamination. ⁽¹⁹⁾ A study from the United States reported ⁽²⁰⁾ that people with higher arsenic contamination suffered more from depression, even though the arsenic level in drinking water in that study was not as high as found in Malda. A cross-sectional study in two villages in Inner Mongolia, China found that the mental health of the subjects in the arsenic-affected village was worse than in those in the arsenic-free village (OR= 2.5, 95% CI=1.1.–6.0). ⁽²¹⁾

It was a matter of concern that majority (61.5%) of patients, who responded, didn't know that arsenicosis was a treatable disease. Regarding health seeking behavior, only small number of patients (18.9%) visited doctors for treatment of their illness. Majority of those

who did not visit doctors gave any specific reason for not attending doctors for their treatment. For successful mitigation program, it was therefore essential to carry out proper awareness campaign on health effects of chronic arsenic exposure causing symptoms and efficacy of drinking arsenic free water and treatment for relief of its symptoms. They need to be emphasized that lot of relief could be given to symptoms of arsenicosis by getting treatment from physicians. Further supportive counseling need to be given to the patients for relief of their mental agony and stress.

Though only small percent of people (8.7%) considered arsenicosis as communicable disease still majority of arsenicosis patients felt that their status had been changed within the community. Brinkel J et al, ⁽²²⁾ Chowdhury *et al* ⁽²³⁾ and Nasreen ⁽²⁴⁾ have described the extreme instability of social life in Bangladesh due to arsenicosis. Arsenic was producing social stigmatization and discrimination. Unaffected people are generally scared of arsenicosis, therefore they tend to avoid and isolate arsenic victims. ⁽²³⁻²⁶⁾

The experience in Malda was different from those reported from Bangladesh regarding the issue of occasion of social exclusion by the community. When people were asked about their feeling in regard to cases of arsenicosis, majority (88%) of 1232, who responded, had no bad feelings (empathy) towards arsenicosis cases. Only small number of people wanted to avoid to mix with arsenicosis patients and few participants did not allow their children to mix with the diseased persons.

Regarding occurrence of marital problem, only small (3.1%) number patients encountered marital problem due to arsenicosis. The small response of occurrence of marital problem in this study may be due to shyness of participants in disclosing their personal issues. Studies from Bangladesh reported a break-down of the marital relationships such as wives were divorced or separated or sent back to their parents' house because of the arsenicosis

disease. ^(23,27) There were also occasions that wives left arsenic affected husbands because they were afraid of arsenicosis. ⁽²⁴⁾ Problems before marriage were also notable. For example, it was difficult to find a spouse for an arsenic victim. ⁽²³⁾

Arsenic affected patients face lot of economic hardship because of inability to work properly. Majority (71.5%) of patients had to change their profession, termination of job occurred in many (67%) cases. Study from Bangladesh also reported similar observation such as losing jobs, barriers to access new jobs and social rejections. ^[28] About 20-70% of arsenicosis patients did not receive any treatment in Bangladesh due to financial problems. ⁽²³⁾ This lack of treatment further deteriorated the overall health and economic conditions of arsenicosis victims. Because of social impact on livelihood of arsenic affected families because of inability to carry out strenuous jobs properly and loss of jobs from employers for various reasons, consideration for alternate livelihood for these people need to be considered by the State Government as part of arsenic mitigation program.

Though small numbers of arsenicosis cases were found to drink arsenic safe water, skin symptoms improved in significant number (78%) of patients who took arsenic free water. As majority of arsenicosis cases in Malda was found to have mild skin lesion (66-70%) such improvement was expected. It has also been reported in earlier studies from India and China that drinking predominantly arsenic free water increased the probability of regression of skin lesion in subjects with mild stage lesions. ^[4,29]

CONCLUSION

The present epidemiological study showed a prevalence of 8.3%, of arsenicosis cases amongst arsenic exposed population in the district of Malda. The prevalence in other four major arsenic affected districts of West Bengal namely, Murshidabad, Nadia, North and South 24 Parganas varied from

4.6% to 19% amongst the arsenic exposed population of those districts. Major cause of arsenic exposure of the people was through drinking of arsenic contaminated water taken from home tube wells.

The study further showed a wide range of psycho-social, behavioral and economic consequences associated with chronic arsenic toxicity in the society. Vigorous behavioral change communication (BCC) and information-education-communication (IEC) campaigns should be undertaken to make people aware about the real causes and consequences of arsenic toxicity. Psychosocial support and employment opportunities should be provided to the arsenicosis patients to overcome the socio-economic crisis. Victims need adequate health information as well as supportive counseling to improve their stress situation.

ACKNOWLEDGEMENT

The project has been implemented with funding from UNICEF, West Bengal, and the Health directorate, Govt. of West Bengal, Ref. Memo No HOH/1D-19-213/207 dated 25.7.2013 from Director of health Services, Govt. of West Bengal.

The Foundation expresses deep gratitude to Mr. SN Dave, WASH Specialist, UNICEF, Kolkata and to all the state level officials of the PHED and Dept of Health and Family Welfare Govt. of West Bengal and district, block and Panchayat level officials of Malda district for providing full support in carrying out the study. Water samples collected from households of study participants were tested by chemist of PHED department from the Malda District laboratory for which we offer gratitude to Director, WSSO, PHED for giving permission. The Foundation expresses great appreciation to all the team members of the study, Dr. Soumendu Mondal, Ranjit Sardar, Ayankanrar, Debalina Roy Chowdhury, Rumia Roy Chowdhury, Kaushikpada Chakraborty for the tireless service given by them during field work and data management at the

office, without which the study would not have been possible.

REFERENCES

1. IARC, World Health Organization. 2004. Some drinking-water disinfectants and contaminants, including arsenic. IARC Monograph on the Evaluation of Carcinogenic Risks to Humans
2. GuhaMazumder DN, Haque R, Ghosh N, De BK, Santra A, Chakraborty D, Smith AH. 1998 Arsenic levels in drinking water and the prevalence of skin lesions in West Bengal, India. *Int J Epidemiol.*;27:871–7.
3. NRC (National Research Council) 1999. Arsenic in drinking water. Washington DC: National Academic Press;
4. GuhaMazumder DN. Chronic Arsenic toxicity: Clinical features, epidemiology and treatment : Experience in West Bengal. *Journal of Environmental Science and Health* 2003;38(1):141-163.
5. Saha KC. Saha's grading of arsenicosis progression and treatment. 2003. In: Chappell WR, Abernathy CO, Calderon RL, Thomas DJ, editors. *Arsenic Exposure and Health Effects V*. Vol-30. UK: Elsevier BV;. pp. 391–414.
6. Caussy D, editor. 2005. A field guide for detection, management and surveillance of arsenicosis cases. Vol-30. New Delhi: WHO Regional Office for South East Asia; WHO Technical Publication; pp. 19–22.
7. GuhaMazumder DN, Chakraborty AK, Ghosh A, Das Gupta J, Chakraborty DP, Dey SB, Chattopadhyaya N. Chronic arsenic toxicity from drinking tube-well water in rural West Bengal. *Bull World Health Organ* 1988; 66: 499-506..
8. Rahaman MM, Mondal BK, Roy Chowdhury T, Sengupta MK, Chowdhury UK, Lodh D, Chanda CR, Basu GK, Mukherjee SC, Saha KC and Chakraborti D. Arsenic Groundwater Contamination and Sufferings of People in North 24-Parganas, One of the Nine Arsenic Affected Districts of West Bengal, India , *Journal of Environmental Science and Health, Part A – Toxic Hazardous Substances & Environmental Engineering*. 2003; 38 (1): 25-59.
9. Rahaman MM, Sengupta MK, Mukherjee SC, Pati S, Ahamed S, Lodh D, Das B, Hossain MA, Nayak B, Saha KC, Palit SK, Kaies I, Barua AK, Asad KA, Mukherjee A, and Chakraborti D. Murshidabad – One of the Nine Groundwater Arsenic- Affected Districts of West Bengal, India. Part I: Magnitude of Contamination and Population at Risk. *Clinical Toxicology*, 2005; 43:823-834.
10. Mukherjee SC, Saha KC, Pati S, Dutta RN, Rahman MM, Sengupta MK, et al. Murshidabad – one of the nine groundwater arsenic- affected districts of West Bengal, India. Part II: Dermatological, neurological and obstetric, Finding. *ClinToxicol*. 2005; 43:835-48.
11. GuhaMazumder DN, Ghosh A, Majumdar KK, Ghosh N, Saha C, GuhaMazumder RN. Arsenic contamination of Ground Water and its Health Impact on Population of District of Nadia, West Bengal, India. *Ind. J of Community Medicine*. 2010;35,331-338.
12. GuhaMazumder, D. N., Saha, A., Ghosh, N. and Majumder, K.K. (2016). Effect of drinking arsenic safe water for ten years in an arsenic exposed population: Study in West Bengal, India. *Arsenic Research and Global Sustainability – Bhattacharya, Vahter, Jarsio, Kumpiene, Ahmad, Sparrenbomb, Jacks, Donselear, Bundschuh, & Naidu (Eds.), Taylor & Francis Group, London*.
13. State of environment report West Bengal 2016 West Bengal Pollution Control Board.http://www.wbpcb.gov.in/writereaddata/files/SOE_Report_2016.pdf.consulted dated 15.10.2016.
14. Water Testing Laboratories – Web Portal WBPHEd.www.wbphed.gov.in/en/pages/water-testing-laboratories/ consulted dated 15.9.2016
15. Chakraborti D, Das , Mohammad MR, Chowdhury U K, Biswas B, Goswami AB, Nayak B, Pal A, Sengupta MK, Ahamed S, Hossain A, Basu G, Roychowdhury T and Das D. Status of groundwater arsenic contamination in the state of West Bengal, India: A 20-year study report .*Mol. Nutr. Food Res*. 2009, 53, 542–551
16. GuhaMazumder DN, Chakraborty AK, Ghose A, Gupta JD, Chakraborty DP, Dey SB,N. Chattopadhyay. 1988. Chronic arsenic toxicity from drinking tubewell water in rural West Bengal. *Bull World Health Organ.*;66:499–506. [PMC free article]

17. Mondal BK, Roy Chowdhury T, Samanta S, Basu G, Choudhury PP, Chanda CR. 1996. Arsenic in ground water in seven districts of West Bengal, India: The biggest arsenic calamity in the World. *Curr Sci.*;70:976–86.
18. Ahmad SA, Faruquee MH, Sayed MH, Khan MH, Jalil MA, Ahmed R. 1998. Chronic arsenicosis: Management by vitamin A.E. *C regimen.*;17:19–26.
19. Guo X, Fujino Y, Kaneko S, Wu K, Xia Y, Yoshimura T. 2001. Arsenic contamination of ground water and prevalence of arsenical dermatosis in the Hetao plain area, Inner Mongolia, China. *Mol Cell Biochem.*; 222:137–40
20. Zierold MK, Knobeloch L, Anderson H. 2004. Prevalence of Chronic Diseases in Adults Exposed to Arsenic-Contaminated Drinking Water. *Am. J. Public Health.*; 94:1936–1937.
21. Fujino Y, Guo X, Liu J, You L, Miyatake M, Yoshimura T. 2004. Japan Inner Mongolia Arsenic Pollution (JIAMP) Study group. Mental health burden amongst inhabitants of an arsenic-affected area in Inner Mongolia, China. *Soc. Sci. Med.*; 59:1969–1973
22. Brinkel J, Khan MH, Kraemer A. 2009. A systematic review of arsenic exposure and its social and mental health effects with special reference to Bangladesh. *Int J Environ Res Public Health.* May;6(5):1609–19.
23. Chowdhury MAI, Uddin MT, Ahmed MF, Ali MA, Rasul SMA, Hoque MA, Alam R, Sharmin R, Uddin SM, Islam MS. 2006. Collapse of Socio-economic base of Bangladesh by arsenic contamination in groundwater. *Pakistan J. Biol. Sci.*;9:1617–1627.
24. Nasreen M. 2003. Social impacts of arsenicosis. In: Ahmed MF, editor. *Arsenic contamination: Bangladesh Perspective.* ITN-Bangladesh; Dhaka, Bangladesh. pp. 340–353.
25. Sarker PC. 1999. Proceedings of Joint Conference of AASW, IFSW, AASW and AAWWF. Brisbane; Australia: Beliefs and arsenicosis and their impact on social disintegration in Bangladesh: Challenges to social work interventions; pp. 217–221.
26. Tsutsumi A, Izutsu T, Islam MDA, Amed JU, Nakahara S, Takagi F, Wakai S. 2004. Depressive status of leprosy patients in Bangladesh: Association with self-perception of stigma. *Leprosy Rev.*;75:57–66.
27. Keya MK. Mental health of arsenic victims in Bangladesh. 2004. *South African Anthropol.*;4:215–223
28. Khan, M.M.H.; Aklimunnessa, K.; Kabir, M.; Mori, M. Case-control study of arsenicosis in some arsenic contaminated villages of Bangladesh. *Sapporo Med. J.* 2006, 75, 51-61
29. Sun, G. Li X, Pi J, Sun Y, et al (2006). Current research problems of chronic arsenicosis in China. *J Health PopulNutr.* 24(2):176-81.

How to cite this article: Majumdar KK, Ghosh AK, Majumder PK et.al. Arsenical disease burden and psychosocial, behavioral & economic issues associated with chronic arsenic exposure: a study in Malda district, West Bengal. *International Journal of Research and Review.* 2018; 5(12):156-165.
