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Full Length Research Article

Relevance to Arsenicosis in Diabetes Mellitus- A Study among arsenic-affected population in Purbasthali block of Burdwan District, West Bengal

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ABSTRACT

Background: Chronic arsenic exposure due to natural contamination of ground water used for drinking purposes may lead to various health problems. In our study we have endeavoured to find out whether diabetes mellitus could be one effect of chronic arsenicosis.
Material and methods: Studies were performed in arsenic affected Purbasthali block of Burdwan district in West Bengal. Basic anthropometry along with fasting blood sugar (FBS) and Glycated HbA_1c were measured in previously proven cases of arsenicosis. Values were compared with those of unaffected persons in other blocks of the same district.
Results: The results show that the mean values of both FBS and HbA_1c were higher in the arsenic affected patients than the control population, but the difference was statistically significant only in case of FBS when a one tailed student's t test was applied. The percentage of diabetic and prediabetic patients were also higher in the arsenicosis population than the controls.
Conclusion: It can be concluded that within the limits of our study arsenicosis does induce diabetes mellitus to some extent. This finding, though not studied in great detail but does conform to early works in Taiwan, Bangladesh etc.

Key words:

Arsenicosis, Diabetes mellitus.

INTRODUCTION

Exposure to arsenic from the natural contamination of ground water derived from wells and tube-wells is a not so recently recognized phenomenon that affects up to 42 million people living in West Bengal. (Rahman *et al.,* 2005; Rahman *et al.,* 2005) and other areas of the Middle Ganga Plane such as Bihar. (Chakraborti *et al.,* 2003) Studies in India as well as Bangladesh which is facing a similar crisis, (Mahmood and Halder, 2011) as also to some extent Nepal, (Maharajan *et al.,* 2006) Indonesia (Ilyas *et al.,* 2009) and China (Sun *et al.,* 2006; Guo *et al.,* 2006) have begun to confirm risks posed by such contamination for symptomatic poisoning which includes gross skin lesions, neuropathy and neurovascular compromise and cancers of the skin, lungs and other organs. Recent research has also begun to suggest adverse effects on reproduction in adult females as well as neuro-development in fetuses and children. (Wasserman *et al.,* 2004) Recent epidemiological studies have conclusively proved that arsenic poisoning has become the biggest environmental disaster and a major public health issue in the last few years. (Mahmood *et al.,* 2004; Walter *et al.,* 2014)

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Over 100 million people in the world, including more than three million people in the US alone are chronically exposed to arsenic through drinking water, (Ahsan *et al.,* 2006) and apart from the previously mentioned countries, globally many other countries, viz., Chile, Argentina, Mexico, Taiwan and many others have shown human health effects of arsenic exposure from arsenic- contaminated drinking water. (Ahsan *et al.,* 2006) Arsenic (As) is a naturally occurring element in the earth's crust and traces of arsenic can be found throughout the environment. Arsenic is a chemical element with atomic number 33 and relative atomic mass 74.92. It is a metalloid and belongs to group V of the periodic table. (Wikipedia Arsenic, 2010; Tutor Vista, 2010) Exposure to arsenic from the ground water leading to chronic arsenic poisoning is suspected to have started in 1960s and the 1970s when the United Nations International Children's Emergency Fund (UNICEF) in collaboration with countries like India and Bangladesh, started to install hand-pumped deep tube wells to provide pathogen-free drinking water to the population, which had long been experiencing alarmingly high incidence and mortality rate of acute water borne infectious diseases, like cholera, gastro-enteritis, enteric fever and the like. Previously, people used to drink mostly surface water from rivers, ponds and lakes which led to these devastating epidemics and forced water World Health Organization (WHO) to think of alternate measures of drinking water in developing countries.

After about a decade of people drinking this new and apparently safe drinking water, reports of arsenicosis and chronic arsenic poisoning became surfaced in India and Bangladesh and in many other afore mentioned countries in a devastating way. In India, the first arsenicosis patient was diagnosed in 1983; in Bangladesh the first patient was diagnosed in 1987. Arsenic in drinking water was first internationally recognized as a global problem in 1995 at the First International Conference on Arsenic.

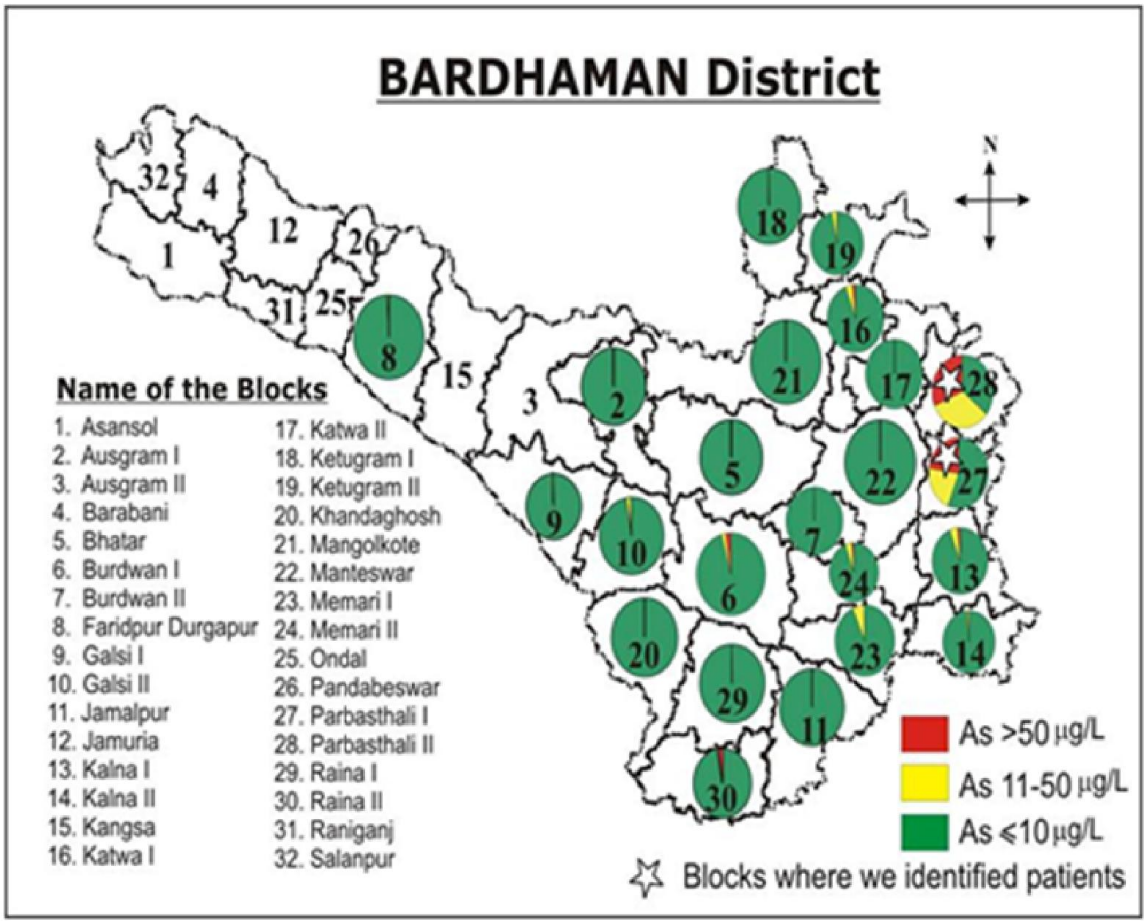
Prior to 1980s few had even heard of arsenicosis. Again, when the problem surfaced it was initially recognized as a dermatological problem. Patients present with mottled hyperpigmentation and hypopigmentation, known as "rain drops on a dusty roads", and palmoplantar keratosis all of which ultimately lead to multiple squamous cell and basal cell carcinoma. Later, chances of development of internal cancer were also revealed, most often involving the lungs and urinary bladder. The carcinogenic effects of As are also established at drinking water As concentration of > 100µg/L; the cancer risk at lower levels of arsenic in drinking water has not been well characterized. Apart from cancer and dermatological disorders, the other effects of arsenic seen are: anemia, neuropathy, mental retardation in growing children and adverse pregnancy outcomes. However, very little studies have been done on the effects of arsenicosis in development of Diabetes Mellitus (DM) and so is our efforts in this study.

MATERIALS AND METHODS

Period of study: The principal period of our study was for three years, from 01/04/2012 to 31/03/2015.

Choice of location: The location of our field study was chosen by Geographical Information System (GIS) which shows high arsenic content in drinking water in the area with extreme vulnerability of arsenic toxicity in the area, also the distance and accessibility of the area were considered. Those areas of our field work belong to Purbasthali I and II blocks, situated at the west bank of river Ganges(known as Bhagirathi river in the area) in the eastern part of Burdwan district, West Bengal, India. The total area and population of Purbasthali Block I are 148.44km^2 and 2,05,132 persons respectively, whereas PurbasthaliII block encompases 192.47 km^2 area and 2,14,200 persons as population. The latitude and longitude extention of the region is 80^0 10'E to 88^{o}25'E and 23^{o}20'N to 23^{0}35'N respectively. The ground water of the concerned area is severely contaminated with arsenic.

Confirmation of arsenic content of ground water in the study area:- The following data was at first obtained from the census data (2011) and the from the District laboratory, Public Health Engineering Department (PHED), Burdwan, West Bengal, India. Between the two blocks Purbasthali II block is more affected by arsenic contamination than block In Srirampur block the arsenic contamination of ground water shows a range of 7µg/L to 618µg/L of arsenic in ground water where as in Kalekhyatala II the ground water shows an arsenic concentration of 6µg/L to 572µg/L. In Nadanghat Gram Panchayat (GP) area there has been installation of arsenic free drinking water facilities. But, in fact, excluding the Nandanghat GParea, the whole of Purbasthali I and II blocks show an arsenic endangersd population in all GPs. Apart from the above data, we personnaly collected samples of ground water in clean glass test tubes and tested for the arsenic contents in order to confirm the arsenic toxicity of the drinking water samples in the area.



Collection of patients:- In our field survey after preliminary studies we hold direct interaction with the local people in the affected villages, both arsenicosis sufferers and non-sufferes, NGOs working in the area an arsenic poisoning, village elders, teachers, students, community leaders and local panchyatpradhans. After that we periodically held health checkup camps with prior preparation asking the patients to attend the camp in the morning in empty stomach. We arranged breakfast for all patients and also lunch for a few on all camp days.

Confirmation of arseniocosisin the patients: We kept only those patients in our study who had dermatological and or neurological or other signs and symptoms of arsenicosis and those arsenic contains in nails, hair and plasma were positive for arsenicosis as confirmed by tests done in reputed labatories.

Collection of data related to Diabetes Mellitus: In all we collected blood sample (fasting) and tested then for glucose content (GOD/POD methods) and also for glycosylated HbA_1c. A total of 162 arsenicosis affected patients and 200 non-arsenicosis affected control persons from safe area of the same district were studied. Patients who were on antidiabetic drugs were excluded from the study both in control group and arsenicosis group. Their other physical examination data like height, weight, BMI, general medical examination of the skin and different were also complied.

Final analysis: All these data obtained were synthesized and analyzed to compare patients' data with control by using statistical methods.

RESULTS

Results obtained are shown in the following table:

Table 1. Comparison between FBS and HbA_1c values of controls and arsenic patients

	FBS(mg/dl) (mean±SD)	Glycosylated HbA_1C (mean±SD)
Control	88.48± 20.08	6.09±4.12
Arsenicosis patients	105.31±45.32	6.12±1.02
t-value(one tailed)	8.88	0.45
t-value(two tailed)	1.78	0.91
p-value(one tailed)	<0.005	>0.05
p-value(two tailed)	>0.05	>0.05
Level of significance(one tailed)	Highly significant	Not significant
Level of significance(two tailed)	Not significant	Not significant

DISCUSSION

Results show that the mean value of fasting blood glucose in the control population (±SD) is 88.48± 20.08 compared to the same value in arsenicosis population being 105.31±45.32. This value is obviously greater in the arsenicosis population but when a two tailed Student's t-test was applied the difference was not significant. However when a one tailed test was used the difference became highly significant ($p<0.005$). Again the mean value of glycated hemoglobin A_1c in the control population was 6.09±4.12 (expressed as percentage) whereas the same measured in arsenicosis population was 6.12±1.02. This value was slightly highier in the arsenicosis population but the difference was not statistically significant – neither in one tailed nor in one tailed Student's t test.

Again when the number of diabetics was calculated it was found that in the control population the number of diabetics was 14 (including prediabetics) out of 200, ie 7% of the control population. In contrast to that the number of diabetics (including prediabetics in the arsenicosis population was 44 out of 162 ie, 27.16% meaning there was apparently a huge difference in the percentage of diabetics in arsenic affected patients compared to non arsenicosis population. A dose-response relation between cumulative arsenic exposure and prevalence of diabetes mellitus was observed in Taiwan following a study on 891 persons living in arsenic endemic areas. The status of diabetes mellitus in that study was determined by an oral glucose tolerance test and a history of diabetes regularly treated with antidiabetic agents. The relation remained significant after adjustment for age, sex, BMI, and activity level by a multiple logistic regression analysis giving a multivariate adjusted odds ratio of 6.61 and 10.05, respectively, for those who has a cumulative arsenic exposure of 0.1-15.0 and > 15.0mg/L. year compared with those who were unexposed. (Lai *et al*., 1994)

Again from Bangladesh significantly increased prevalence of diabetes mellitus was reported due to drinking arsenic contaminated water among subjects with keratosis compared to subjects who did not have such lesion. (Rahman *et al.,* 1998) A significant trend in risk between an approximate time-weighted arsenic exposure and the prevalence of DM strengthened the possibility of a causal association. However the lack of comprehensive, systematic long term sampling of the water supplies in the study area is a limitation of the study because directly measured individual exposure data over time would have been desirable. However, these results like ours suggests that chronic arsenic toxicity may induce diabetes mellitus in humans.

Conclusion

As a conclusion it can be said that within the limited resources of our study arsenicosis does induce diabetes mellitus to some extent. This finding, though not studied in great detail but does conform to early workers in Taiwan, Bangladesh etc.

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