ORIGINAL ARTICLE

FOOD HABITS AMONG THE ARSENIC EXPOSED POPULATION IN THE RURAL AREAS OF NEPAL AND BANGLADESH

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ABSTRACT

Arsenicosis, the illness due to chronic arsenic toxicity is prevalent in both Nepal and Bangladesh. The occurrence of arsenicosis depends upon many factors including food and nutrition. The objective of this study was to find out any difference of food habits among the arsenic exposed households of both countries and the relationship with the occurrence of arsenicosis. This was a cross-sectional comparative study, conducted among the arsenic exposed rural households of Nawalparasi district in Nepal and Faridpur district in Bangladesh. A total of 190 and 200 female rural households from Nepal and Bangladesh were selected respectively as the respondents. The majority of the respondents of both countries were under the age of 40 years. The prevalence of arsenicosis was found significantly low (x^2 = 8.847; p=.002) among the Nepalese households (7.3%) than that of Bangladeshi households (11.0%). As a staple food, rice, vegetables and pulses were more common among the Nepalese households in comparison to that of Bangladesh (x^2=5.739; p=.017). In addition to staple food Nepalese households were found to take significantly more (p<.05) bread (74.7%), egg (73.2%), milk (68.9%) and fruits (58.4%). In contrast, Bangladeshi households took a little more meat (59.0%) and fish (73.5%). To get arsenic-safe water, 39.5% Bangladeshi households used a filter while a few Nepalese households (2.6%) used that. Nepalese households were found to take more protein and vitamins rich foods as staple food compared to that of Bangladeshi households, which might play a role in the low occurrence of arsenicosis amongst them.

Keywords: *Arsenic, Arsenic toxicity, Arsenicosis, Food, Nutrition, Food habit*

INTRODUCTION

Arsenic contamination of groundwater in Bangladesh and Nepal was discovered in the year 1993 and 1999 respectively. Initially, in Bangladesh, the contamination was detected in Gangetic Delta, which is in lower Gangetic plain, later the contamination has been found in most of the plain sediment areas except hilly and terraced land. While in Nepal the arsenic contamination was found in Terai region which is the lowland of Nepal and northern extension of the upper Gangetic plain. In both areas, arsenic contamination in ground water is found in the alluvial sediments aquifers. Terai constitutes only 23% of the total land area of Nepal but about 50 % of its population lives in this plain land. People of both Terai region and Bangladesh are highly dependent on ground water for domestic use as well as for agricultural purpose. They are exposed to arsenic through using arsenic contaminated ground water and are at risk of developing chronic arsenic toxicity[1-4].

Arsenicosis, the illness due to chronic arsenic toxicity is prevalent both in Nepal and Bangladesh. In both countries, skin manifestations such as melanosis and keratosis are common and prime amongst the arsenicosis patients[2,3,5-9]. The average arsenic concentration of tube well water in the areas in Nepal where arsenicosis patients were found was 0.440 mg/L and 0.471 mg/L. Similarly, in Bangladesh, in the areas where arsenicosis patients were found, the average arsenic concentration in the tube well water was 0.240 mg/L and 0.480 mg/L[2,8,10]. Amongst the arsenicosis patients, males found to be suffered more and commonly below 50 years of age, which is the most active part of life. Most of the arsenicosis patients of both countries are from rural areas and low socioeconomic conditions; share more or less similar environment and lifestyle. The prevalence of arsenicosis as well as severe arsenicosis patients, are found to be more in Bangladesh compared to that of Nepal. The majority of the identified patients of both countries were in the mild and moderate stage. If these patients take proper nutrition and vitamin rich foods along with the use of arsenic safe water most of them are expected to recover from their illness[1-3,8,10].

Both in Nepal and Bangladesh, not all the arsenic exposed people are found to be suffering from arsenicosis. The occurrence of arsenicosis depends upon many factors. Some of the factors such as socioeconomic conditions, food and nutrition, age and sex are found to be associated with the

occurrence of arsenicosis as revealed in studies. Both countries have almost a similar socioeconomic context, even food habits. However, in Nepal, a lower proportion of the arsenic exposed population is found to be suffering from arsenicosis compared to arsenic exposed population in Bangladesh. In studies, food and nutrition have been found to contribute an important role in the occurrence for arsenicosis[1,2,5,11-15]. But, no such study could be located which compare the role of food habits in relation to the occurrence of arsenicosis both in Nepal and Bangladesh. The purpose of this study was to explore any difference of food habits among the arsenic exposed population between two countries and to find out any relation with the occurrence of arsenicosis.

MATERIALS AND METHODS

This study was a cross-sectional comparative study, carried out to explore the food habits, amongst the households who consumed arsenic contaminated water. The households were selected from the arsenic affected rural areas of Bangladesh and Terai region, Nepal. In Bangladesh, the study was conducted in an arsenic affected village of Sadar upazilla of Faridpur district and in Nepal in a village of Nawalparasi district of Terai region. Women, aged 20 to 60 years from the household had been consuming arsenic contaminated water at least five years and who were available during the data collection period and agreed to participate in the study, were selected as the respondents for this study. Accordingly, from Nawalparasi a total of 190 and from Faridpur 200 female households could be included as respondents. Data collection was done through face to face interview of the respondents of both countries by utilising the same questionnaire but in the respective language. Initially, the questionnaire was developed in English then translated into Bangla and Nepalese language and pretested in the both countries respectively before finalisation.

RESULTS

A total of 190 and 200 respondents from the arsenic exposed households of Nawalparasi district; Terai, Nepal and Faridpur district of Bangladesh were interviewed. The mean age of the respondents was 37.8±12.37 years and 37.5±10.18 years respectively. Maximum respondents of both countries were within 40 years of age. Almost half of the respondents of both Nepalese households (48.9%) and Bangladeshi households (45.0%) had no formal education. Only 16.3% of the Nepalese and 28.0% of the Bangladeshi respondents had a secondary or intermediate level of education. None of the respondents had a graduate level of education. The monthly income of the households of both countries was U$85 (Taka=6635) and U$ 98(Taka=7609) respectively. Among the Nepalese respondents besides housewife more than one-third (37.4%) of the respondents had an occupation like daily labour, agricultural worker etc. In Bangladesh almost all (94.5%) respondents were a housewife. Nepalese households had larger family size (6.1) and Bangladeshi households had smaller family size (4.6) and the difference was statistically significant (t=7.95; p=0.000). Regarding the type of house, the proportion of *Pucca* house was more among the Nepalese households (33.2%) while among Bangladeshi households the proportion of Tin or *Tali* (47.5%) house was higher, but the difference was not statistically significant (x^2=1.567; p=.457)(Table-1).

Regarding current sources of water, most (95.7%) of the households of Nepal used tube well as a source of drinking water and agricultural purpose while in Bangladesh about half (49.0%) of the households used tube well water. The remaining sources of water were ponds and deep tube wells. In addition to that in Bangladesh, 39.5% of the households used a filter to get arsenic-safe water and in Nepalese households, only 2.6% used a filter (Table-2). Among the Nepalese household members, the prevalence of arsenicosis was 7.3%, while among the household members of Bangladesh the prevalence was11.0% and the difference was statistically significant (x^2 =8.847; p=.002). Of the total households, 61(32.1%) in Nepal and 98 (49.0%) in Bangladesh had Arsenicosis patients and was statistically different (x^2 =11.517; p=.001). The majority (75.0%) of Nepalese arsenicosis patients was suffering for 10 years while amongst the Bangladeshi the majority (59.4%) of the arsenicosis patients was suffering for more than 10 years. More than 50% of the total Arsenicosis patients of both countries mentioned that there was no improvement of arsenicosis and remained as before while 31.0% Nepalese and 40.6% Bangladeshi patients mentioned that their condition was better than before. A few of the arsenicosis patients (11.9% and 8.9% respectively) mentioned that their illness was not improving, rather becoming worse (Table-3).

For the management of arsenicosis, patients were advised to take more locally available protein and vitamin rich foods as a special food. It was found that out of 61 Nepalese households having arsenicosis patients, 48 (78.7%) of them took special foods while among the 98 Bangladeshi households having arsenicosis patients 44 (44.9%) of them took special food and the difference was

statistically significant (x^2 = 24.533; p=.000). In this regard, it was found that as a special food Nepalese arsenicosis patients (64.6%) took more vegetables and fruits compared to that of arsenicosis patients of Bangladesh (61.3%). While arsenicosis patients of Bangladesh took a little more meat and fish (18.2%) compared to that of the Nepalese arsenicosis patients (10.4%) but not statistically significant (Table-5). This study also revealed that most of the households in Nepal and Bangladesh (92.0% and 95.0%, respectively) did not believe any food taboo regarding management of arsenicosis.

Table-1 Socio-demographic characteristics of the respondents

Characteristics	Nepal N=190) n(%)	Bangladesh (N=200) n(%)	Total N=390 n(%)	Statistics
Age (years)				
≤30	70(36.8)	68(34.0)	138(35.4)	
31-40	57(30)	68(34.0)	125(32.1)	x^2=5.696;
41-50	29(15.3)	42(21.0)	71(18.2)	p=0.127
51-60	34(17.9)	22(11.0)	56(14.4)	
Mean±SD	37.8±12.37	37.5±10.18	37.7± 11.29	t=0.202; p=0.840
Education				
Illiterate	93(48.9)	90(45.0)	183(46.9)	x^2=8.183;
Primary	66(34.7)	54(27.0)	120 (30.8)	p=0.017
SSC & above	31(16.3)	56(28.0)	87(22.3)	
Income (Taka)				
≤5000	110(57.9)	103(51.5)	213(54.6)	
5001-10000	42(22.1)	63(31.5)	105(26.9)	x^2=4.704;
10001-15000	24(12.6)	20(10.0)	44(11.3)	p=0.319
15001-20000	04(2.1)	05(2.5)	09(2.4)	
≥20000	10(5.3)	09(4.5)	19(4.9)	
Mean±SD	6635±6513	7609±7047	7129±6801	t=-1.429; p=0.507
House wife				
Yes	119(62.6)	189(94.5)	308(78.9)	x^2=28.826;
No	71(37.4)	11(5.5)	82(21.1)	p=0.000
Family Size				
Up to 5	96(50.5)	159(79.5)	255(65.4)	x^2=36.139; p=0.000
More than 5	94(49.5)	41(20.5)	135(34.4)	
Mean±SD	6.1±2.19	4.6±1.47	5.3±2.00	t=7.95; p=0.000
House Type				
Katcha	46(24.2)	50(25.0)	176(45.1)	x^2= 1.567; p=0.457
Tin/*Tali*	81(42.6)	95(47.5)	118(30.3)	
Pucca	63(33.2)	55(27.5)	96(24.6)	

Table-2 Sources of water and purpose of use

Water Sources	Nepal N=190 n (%)	Bangladesh N=200 n (%)
Cooking		
Tubewell	182(95.7)	98(49.0)
Deep Tubewell	04(2.1)	04(1.0)
Pond & other	04(2.1)	108(54.0)
Drinking*		
Tubewell	182(95.8)	85(42.5)
Deep Tubewell	04(2.1)	04(2.0)
Pond & River	00(0.0)	44(22.0)
Filter	05(2.6)	79(39.5)

***** Multiple Responses

Table-3 Distribution of households by status of arsenicosis

Status of Arsenicosis	Nepal n(%)	Bangladesh n(%)	Statistics
Household	N=290	N=200	
Yes	61(32.1)	98(49.0)	x^2=11.517; p=0.001
No	129(67.9)	102(51.0)	
Household Members	N=1155	N=916	
Yes	84(07.3)	101(11.0)	x^2 =8.847; p=0.002
No	1071(92.7)	815(89.0)	
Duration	N=84	N=101	
<10 years	63(75.0%)	41(40.6)	x^2=22.055; p=0.000
≥10 years	21(25.0%)	60(59.4)	
Prognosis	N=84	N=101	
As usual	48(57.1)	51(50.5)	
Better	26(31.0)	41(40.6)	x^2=1.956; p=0.376
Worst	10(11.9)	09(8.9)	

Table 4- Distribution by staple and other food

Food	Nepal (N=190) n(%)	(Bangladesh N=200) n(%)	Statistics
Staple Food			
Rice, Pulse & Vegetables	184(96.8)	179(89.5)	x^2=8.151; p=0.004
Rice & vegetables	06(3.2)	21(10.5)	
Bread (*Roti*)			
Yes	142(74.7)	119(59.5)	x^2=10.219; p=0.001
No	48(25.3)	81(40.5)	
Food Items (once/week)*			
Meat	102 (53.7)	118 (59.0)	x^2= 1.120; p=0.290
Fish	130 (68.4)	147 (73.5)	x^2= 1.221; p=0.269
Egg	139 (73.2)	116 (58.0)	x^2= 9.891; p=0.002
Milk	131 (68.9)	58 (29.0)	x^2= 62.254; p=0.000
Fruits	121 (63.7)	20 (10.0)	x^2=121.653; p=0.000

** Multiple responses*

Table 5 - Distribution by taking special foods and management of arsenicosis

Special Food Take special food	Nepal n(%) N=61	Bangladesh n(%) N=98	Statistics
Yes	48(78.7)	44(44.9)	x^2 =24.533; p=0.000
No	13(21.3)	54(55.1)	
Food Items	N=48	N=44	
More vegetables	12(25.0)	09(20.5)	x^2=2.761; p=0.252
Vegetables & Fruits	31(64.6)	27(61.3)	
Meat & fish	05(10.4)	08(18.2)	

DISCUSSION

More than twenty years passed, arsenicosis the illness due to chronic arsenic toxicity has been identified in Bangladesh but till date, no specific treatment for chronic arsenic toxicity is available in Bangladesh and elsewhere. Similarly, in Nepal also no particular treatment has been practised for arsenicosis management. In Bangladesh consumption of arsenic safe water both for drinking and cooking purposes are advised, which is the key stay for the arsenicosis patient management. In addition, patients are advised to take more protein by increasing intake of locally available protein rich foods and vitamin A (ß-carotene), E (Tocopherol), and C (Ascorbic acid) through foods and medicinal supplement. Patients with keratosis are advised to apply keratolytic ointment to remove keratotic lesions of the palm and sole[1,11, 16,17]. In Nepal also similar management for arsenicosis patients are advised[2,5,19]. In the current study, 7.3% of the arsenic exposed households of Nepal and 11.0% of the arsenic exposed households of Bangladesh were reported

to be suffering from arsenicosis. This low prevalence of arsenicosis in Nepal was statistically significant (x^2 =8.847; p=.002) and was supported by other studies[2,3,5]. Amongst the Nepalese and Bangladeshi households, 78.7% and 44.9% respectively mentioned that they took special foods as a management of arsenicosis. The special foods were more vegetables and various fruits. In addition, arsenicosis patients of Bangladesh were found to take more fish and meat compared to that of Nepal. Regarding the prognosis of the arsenicosis, about 10% of the patients of both countries mentioned that their illness became worse. Comparatively a higher proportion (40.6%) of the arsenicosis patients of Bangladesh mentioned that they were improving. More than fifty percent of the arsenicosis patients of both countries mentioned that they were as before. They also mentioned that the arsenicosis manifestations, particularly the severe keratotic lesions did not improve much. Though a higher proportion of Nepalese arsenicosis patients took vitamin and protein rich foods as advised but not found to be improved much, rather a higher proportion of arsenicosis patients of Bangladesh were found to be improved. The reason might be that a larger proportion of households in Bangladesh were found to use arsenic-safe water in terms of filter water, pond water and deep tube well water.

The socioeconomic and environmental condition of Terai, Nepal and Bangladesh did not differ much. The population of both countries mostly depends on tube well water for household and agricultural purpose. The current study also revealed that the staple food taken by the households of both countries was almost similar in composition. However, significantly a higher proportion of Nepalese households were found to take more bread (*roti*), fruits, egg and milk compared to that of households in Bangladesh. Further, it was found that Nepalese households significantly take more pulses and vegetables as regular food. Traditionally, the Nepalese households took these types of foods as a common staple food [20]. Bangladeshi households took less pulse and vegetables as regular food compared to that of Nepalese households. In a study conducted in Bangladesh also found a low intake of egg, milk and pulse among the arsenic exposed population[14]. Moreover, it was found that almost all the Nepalese household (97.5%) cooked their food with mustard oil whereas in Bangladesh the households (96.5%) cooked their food with soybean oil. However, in this study, the prevalence of arsenicosis amongst the Nepalese arsenic exposed households was found to be significantly low (32.1%) compared to that of arsenic exposed households in Bangladesh (49.0%). In other studies also the prevalence of arsenicosis was found low in Nepal in comparison to that of Bangladesh while the exposure to arsenic through contaminated water in terms of arsenic concentrations in tube well water did not differ much[2,3,5].

In human, the role of nutrition in the development of arsenic toxicity is not clear. However, Arsenicosis and poor nutritional status of the patients were found to be associated in many studies. On the contrary, it has been found in a study that arsenic exposure through arsenic contaminated water increased the occurrence of underweight or poor nutrition. However, in other studies, poor nutrition was found to be associated with chronic arsenic toxicity and metabolism of arsenic[12,21,22]. Increased susceptibility to arsenic toxicity was found among individuals with lower body weight or poor nutrition [23]. Studies suggest that poor nutrition results in decreased methylation of arsenic owing to decreased supply of the methylation substrate thus leads to enhanced arsenic toxicity. In animal studies also showed that with low protein intake, there was an effect of metabolising arsenic and a decreased urinary excretion of arsenic metabolites[12,24]. From this perspective, it can be said that more intake of protein and vitamins in terms of pulse- like Masur, Arhar, egg and milk; vegetables and fruits and mustard oil as well, might play a role in the low occurrence of arsenicosis amongst arsenic exposed population in Nepal.

Arsenic exposure through contaminated tube well water and nutrition is appeared to create a vicious cycle between poor nutrition and toxicity, in which arsenic toxicity exaggerates malnutrition and malnutrition, in turn, exaggerate toxicity[12]. Thus, measures should be undertaken to interrupt this vicious cycle in order to alleviate the arsenic toxicity and to reduce the prevalence of malnutrition in both countries.

CONCLUSION

Nepalese arsenic exposed households were found to suffer from arsenicosis significantly lower than that of arsenic exposed households of Bangladesh. As a staple food, Nepalese households took more protein and vitamins rich foods compared to that of Bangladeshi households that might play a role in the low occurrence of arsenicosis amongst arsenic exposed population in Nepal. On the other hand, a few of the Nepalese households used water filter while more than one-third of the Bangladeshi households used water filter as a source of arsenic safe water which might result in the improvement of illness of a higher proportion of arsenicosis patients in Bangladesh.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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