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ARSENIC LEVELS IN DRINKING WATER AND ASSOCIATED HEALTH RISK IN DISTRICT SHEIKHUPURA, PAKISTAN

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ABSTRACT

Arsenic (As) contaminated drinking water poses serious threat to human health.It accumulates in the human body in various organs, hence cause acute and chronic health problems. This study aimed at monitoring the drinking water quality in terms of arsenic concentration as well its health impacts on female population of District Sheikhupura, Punjab. For the health assessment of females, health demographic data as well as dietary habits of the respondents of the study area was collected through a questionnaire. The concentration of Arsenic in drinking water from different sources used by the inhabitants was measured by using atomic absorption spectrophotometer. Arsenic concentration in drinking water samples was high in the hand pump water. The Tehsil Sheikhupura was among the worst affected study area. The results suggest that the level of arsenic in drinking water in certain parts of district Sheikhupura is higher than the permissible limits of WHO and NDWQS. Hence mitigation and preventive measures are required to reduce possible threat to human and ecological health.

Keywords: Arsenic, drinking water, contamination health assessment and anthropogenic sources.

INTRODUCTION

Arsenic (As) contamination of drinking water has become a major health concern all over the world. Arsenic is a toxic heavy metal that poses serious hazards to human's and ecological health. Besides its natural occurrence in ground water; the uncontrolled and unchecked anthropogenic activities are causing multiplier effect on its spread and contributing towards its increasing levels in drinking water in various parts of the world. The concentration of arsenic in different natural water bodies varies from sea water to ground water. In sea water, concentration of arsenic is lower than in rivers and lakes, whereas it is higher in ground water. The high levels of arsenic in ground water are attributed to volcanic rocks and/or arsenic-rich mineral deposits (Cullen and Reimer, 1999). As a result of industrial processes and/or volcanic activity, arsenic is released into atmosphere and attaches to particles that are dispersed by the wind and fall back to the ground (Nordstrom, 2002). In environment, concentration of arsenic varies being lowest in air particularly in remote and rural areas where as; it is highest in industrial settings (Bhumbla and Keefer, 1994).

Being soluble in water, arsenic exists in two primary forms: arsenite (As^{+3}) and arsenate (As^{+5}). Both the forms cause acute and chronic toxicity to a wide variety of organisms including humans (Kitchin, 2001).Arsenate is the most commonly occurring form as it is quickly absorbed by the human body and has acute lethal effects at high doses. Most affected organs such as skin, kidneys, lungs, liver and intestine of human are among major organs affected by arsenic since these are involved in absorption, accumulation and excretion (Otles and Cagindi, 2010).

The total exposure of arsenic in human beings come from diet, drinking water, direct ingestion of soil and dust, inhalation of arsenic particles and percutaneous absorption (Roychowdhury *et al.* 2003). The total human body content of arsenic has been estimated to be between 3 - 4 mg (WHO, 2003). Exposure to inorganic arsenic can cause various health effects, such as irritation of the stomach and intestines, decreased production of red and white blood cells, abdominal pain, muscular pain, skin changes and lung irritation as well as other skin changes such as hyperkeratosis and pigmentation changes (Hughes, 2002). Increased risks of lung and bladder cancer and of arsenic-associated skin lesions have been reported to be related with ingestion of drinking water having arsenic concentrations 50ppb (Steinmaus *et al.* 2003).

Kahlown *et al.*,(2002) carried out a study in Punjab which showed that 20% of the population is exposed to arsenic contamination of 10 ppb in drinking water while nearly 3% of the population is exposed to contaminated drinking water having arsenic concentration of 50 ppb. A survey of arsenic concentration in ground water from drinking water supply wells in Pakistan conducted by Shrestha (2002) found that hot spots of arsenic enrichment occur in parts of the Indus alluvial basin. Nickson *et al.*, (2005) revealed that the highest arsenic concentration was 906 ppb in the Muzaffargarh district (southwest Punjab) Pakistan.

According to a report of the Pakistan Council of Research in Water Resources (PCRWR) (PCRWR, 2003) after India and Bangladesh, now Pakistan is also facing a growing threat of arsenic contamination in drinking water. During surveys and studies conducted by PCRWR on sub-soil water analysis in collaboration with UNICEF, ground water was declared 'dangerous' having Arsenic contamination above the permissible level of WHO guide line (10 ppb) in the Punjab districts and in Sindh, predominantly in Dadu and Khairpur. The Government of Pakistan has promulgated National Drinking Water Quality Standards (NDWQS) of Pakistan in the year 2010 and prescribed the permissible level as 50 ppb in the country (NDWQS, 2010).District Sheikhupura is highly contaminated District with reference to arsenic concentration in drinking water. Drinking water is the direct source of ingestion in to the young female. Hence preventive measures are required to reduce possible level of arsenic in drinking water. The present study was carried out to find out the arsenic level in drinking water and different drinking water sources used by the female inhabitants of Sheikhupura district. The aims and objectives of the present study are:

1. Determine the level of Arsenic in drinking water in different tehsils of the study area.
2. To identify the types of arsenic related common diseases among female population of age group 15-25 years within the study area, through a specifically designed questionnaire.

MATERIALS AND METHODS

Study Area: The study area for the present research work was District Sheikhupura, which is an industrial cum agricultural city in the province of Punjab, Pakistan. The district is comprised of five Tehsils namely Sheikhupura, Muridke, Sharaqpur, Ferozewala and Farooqabad. The study covers both urban and rural areas of all these Tehsils. One hundred (100) water samples were collected from the sources of the drinking water of the respondents. These samples include Tehsil Sheikhupura (28), Tehsil Muridke (26), Tehsil Sharqpur (20), and Tehsil Safdarabad (14). The respondents were also asked questions about their daily intake of food and their common diseases.

Collection of Water Samples: One hundred drinking water samples were collected from houses of female respondents in 100 ml polythene plastic bottles. The samples include both from shallow water source including 23 tubewells, 65 motor pumps and 12 hand pumps. Normal depth range for these water sources includes: hand pumps: 40-50 ft; domestic motors: 80-120 ft and Tubewells: 100-200ft. respectively.

Pretreatment of Water Samples: Water samples were pretreated for arsenic detection by adding 5ml of conc. HNO_3 in a ratio of 1:2 in 10ml of filtered water samples in round bottom flask. The content of flask was kept overnight and then filtered again by using Whatman filter paper (2 micron).The solution was refluxed at water bath to remove fumes of HNO_3 for 15-20 minutes. An aliquot was separated for analysis on graphite furnace atomic absorption spectrophotometer for detection of Arsenic in the laboratory.

Analysis of Water Samples: The concentration of Arsenic contamination in drinking water samples from different sources was measured by using standard procedure through Atomic Absorption Spectrophotometer. (AAS, Model No. 08260033, Thermo Electron Corporation, UK).

Data Collection from Questionnaire: For the assessment of general health status and drinking water practices of female population from the study area, the data was collected by administrating a specially designed questionnaire. Questioned focused on households, profile, drinking water practices, dietary habits, health condition especially regarding arsenic related diseases such as respiratory diseases, liver disorder, reduced weight, skin infection, blood pressure, diabetes, muscular pain etc. This was a baseline data to know the perception of the respondents about the association of their diseases with contamination of drinking water.

Statistical Analysis: Results were statistically analyzed for mean, standard error mean, standard deviation and T-test by using *Minitab version 13* software. Results about health and socio economic data were tabulated for graphical representation.

RESULTS

The major source of drinking water (65%) was domestic motor pumps with normal depth range of around 80 to 120 ft and only 23% respondents were using drinking water provided by the municipal committee or tube wells used for irrigation purpose (depth range 100-200 ft). While 12% respondents were using hand pump as their major source of drinking water, with a normal depth range of 40-50 ft.

Overall, Analysis of drinking water samples across the district showed that high mean value of Arsenic concentration was found in hand pump samples (76.22±20.73) ppb and lower in bottle water (7.742±3.066) ppb as compared to WHO value (10 ppb) as shown in fig.1.

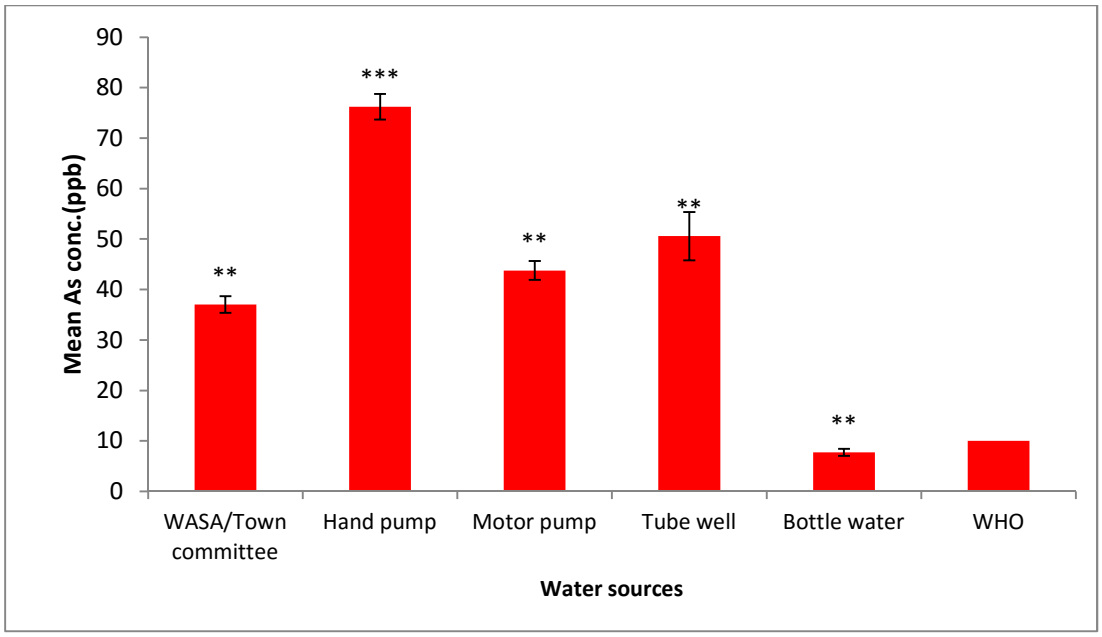

Fig. 1. Arsenic concentration in different sources of water samples and its comparison with WHO.

With refernec to areas, high mean arsenic concentration was found in tehsil Sheikhupura and lower was found in tehsil Muridke (65.4±24.1) and (40.3±22) respectively as shown in fig. 2. The comparison of average arsenic concentration in drinking water samples showed that high mean arsenic concentration(101±15.2) was found in rural areas as compared to water samples collected from urban areas(62.6 ±6.7) and NDWQS value (50 ppb) as shown in fig.3. Wheat and rice are major crops being cultivated in the study area. Phosphate fertilizers are being used for both crops. In case of rice, extensive quantity of water is used and it is assumed that this water contains high concentration of arsenic and phosphates. There are studies suggesting the presence of arsenic in rice grain due to high level of arsenic in water being used for irrigation purpose(Gabriela *et al.*1998).

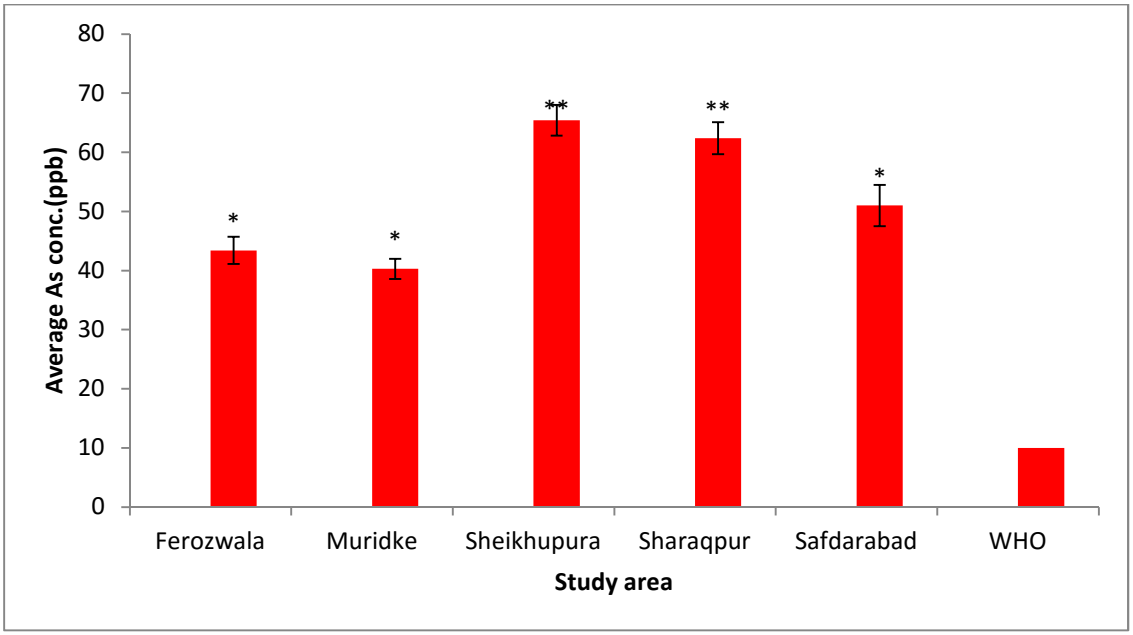

Fig.2. Comparison between mean arsenic conc. in different tehsils with WHO value.

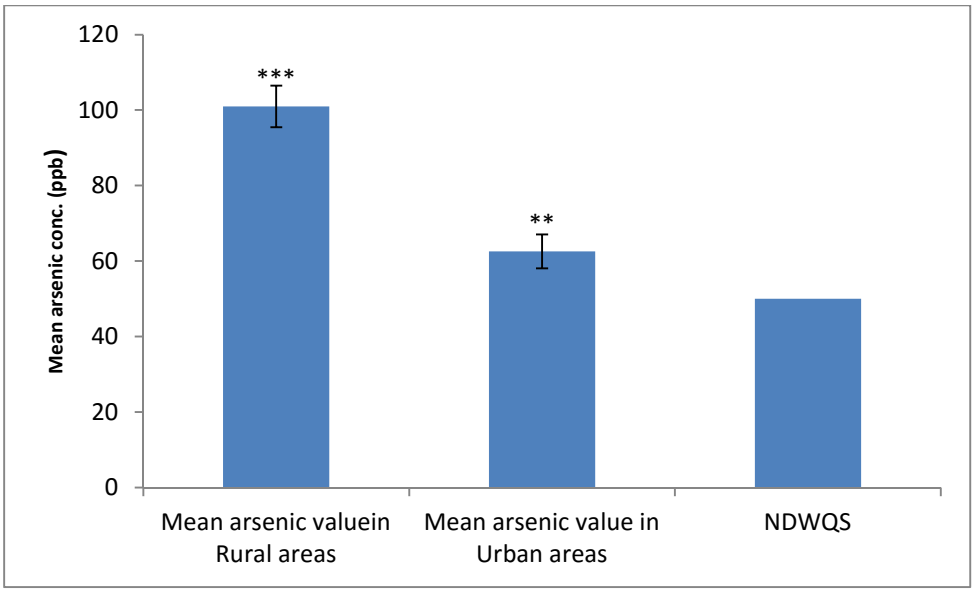

Fig. 3. Graph showing the comparison between mean value of arsenic concentration in rural and urban areas with NDWQS standard.

It was found that most of the respondents were having at least one disease associated with contaminated drinking water. These diseases were of minor nature among most of the respondents while blood pressure, muscular pain and abdominal pain were among most common diseases. For the assessment of general health status of female population from the study area, the data were collected using a specially designed questionnaire regarding health related problems. It was found that 17 % had respiratory diseases, 14% of them had liver disorder, 5% had reduced weight, 11% had reduced bulk of limbs, 12 % of them had skin infection, 27 % of respondents complained about blood pressure blood pressure, 8% diabetes, and 22% had muscular pain and 23% respondents etc. This was a baseline data to know the perception of the respondents about the association of their diseases with contamination of drinking water Fig.4.

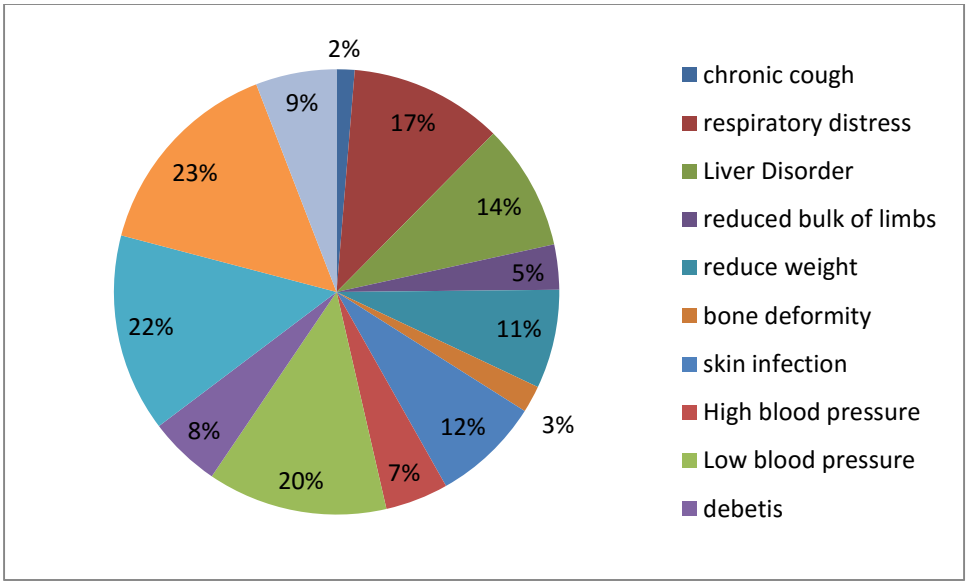

Fig.4.Percentage of major diseases among respondents.

DISCUSSION

Like India, Bangladesh and other countries that are exposed to exceedingly high levels of arsenic in their drinking water as previously described (Nordstrom, 2002). Pakistan is now facing the menace of arsenic contamination. During surveys and studies conducted by Pakistan Council of Research in Water Resources on sub-

soil water analysis in collaboration with UNICEF, ground water was declared 'dangerous' having arsenic contamination above the permissible level of WHO guide line in the Punjab districts and in Sindh predominantly in Dadu and Khairpur as previously described (NDWQS, 2010).

Results of the present study shows that most of the residents of the study have access to drinking water with depth range from 50 – 200ft since hand pumps and domestic motor pumps are among major source of drinking water. This was observed that the level of arsenic in hand pumps was higher than motor pumps.

Presence of high arsenic concentration in ground water in study area is because of both natural and anthropogenic sources including industry and chemical fertilizers being used for agriculture. According to Rahman *et al.* (2001) it was reported that in 1983-85, in south Bengal 14 villages were affected by chronic arsenic toxicity due to industrial contamination. A study carried out by Chatterjee *et al.*, (1993) found that due to discharge of industrial effluent, after production of the insecticides Paris Green (copper acetoarsenite) by a local factory at the Behala, ground water has become contaminated with arsenic. In the present study, high concentration of arsenic was found in rural areas, it may be due to high use of fertilizers.

It was noted by Potatueva and Zalegina (1981) that the chemistry of phosphate and arsenic are related. Arsenic in drinking water of study area can be attributed to application of fertilizers on crops, especially rice crop. Super phosphate fertilizers which are used for irrigation of rice crop, contain very high level of phosphate which in turn cause increase in arsenic concentration in various medium.

It is well documented that besides water, arsenic in food or food grown on such contaminated soil could also be the source of arsenic exposure in human (Malik *et al*. 1994). Same conclusion is also drawn by the work of Gabriela *et al.* (1998) in Northern Argentina that arsenic concentration was higher in major food all of which were prepared by using arsenic contaminated local water. In the study area, most commonly cultivated crop is rice and chemical fertilizers are most commonly used instead of organic fertilizers. This clearly depicts that female population of district Sheikhupura probably ingest arsenic from rice they mostly take along with the amount in drinking water.

In Pakistan, rapid growth in industrialization and development is the major source of introduction of noxious chemical wastes in natural resources causing persistent health effects among individuals. Contaminated drinking water is the major issue causing many hazardous effects to health of general population. The situation of drinking water in study area demands urgent mitigation measures such as to make arsenic testing compulsory, establishing a guideline value for arsenic, short term and long term mitigation policy, compulsory screening for arsenicosis in government hospitals especially in arsenic affected areas.

Conclusions: Presence of arsenic with variable range above the permissible levels of WHO i.e. 10 ppb poses a growing threat to human health. It is evident from the results of the study that the quality of the water in Sheikhupura district is not satisfactory and hence can cause problems for the public health and general environment. The situation demands urgent and effective remedial and mitigation measures in this regard.

REFERENCES

Bhumbla, D. K. and R.F. Keefer (1994). Arsenic Mobilization and Bioavailability in Soils. In: Arsenic in the Environment, Part I: Cycling and Characterization. Ed. Nriagu, J.O. John Wiley & Sons; New York. 51–82 p.

Chatterjee, M., D. Das and D. Chakaraborti (1993). A study of ground water contamination by arsenic in the residential area of Bbehala, Calcutta due to the industrial pollution. Environmental Pollution. 80**:**57-65.

Cullen, W.R. and K.J. Reimer (1999). Arsenic speciation in the environment. Chemistry Review 89**:** 13–764.

Gabriela, C., N. Barbro and V. Marie (1998).Metabolism of inorganic arsenic in children with chronic high arsenic exposure in Northern Argentina. Environmental Health Perspective. 106: 123-136.

Hughes, M. F. (2002).Arsenic toxicity and potential mechanisms of action.Toxicology Letters. 133: 1–16.

Kahlown, M.A., A. Majeed and M.A. Tahir (2002).Water Quality Status in Pakistan. Pakistan Council of Research in Water Resources (PCRWR); Ministry of Science & Technology. Pakistan. 13 p.

Kitchin, K.T. (2001). Recent advances in arsenic carcinogenesis: modes of action, animal model systems, and methylated arsenic metabolites. Toxicology and Applied Pharmacology. 172**:** 249–261.

Malik, M.A., A. Ghafoor, M. Saleem and M.M. Ahmad (1994). Preservation of watermelon squash using sodium benzoate and potassium metabisulphite. Pakistan J. Agri. Sci. 31**:** 58-60.

National Drinking Water Quality Standards (NDWQS). (2010). Ministry of Environment.Government of Pakistan http://www.waterpakistan.com/2010-drinking-water-standards-pakistan.

Nickson, R.T., J.M. McArthur, B. Shrestha, T.O. Kyaw – Myint, and D. Lowry (2005). Arsenic and other

Drinking water Quality Issues, Muzarffargarh District, Pakistan. Applied Geochemistry. 20**:** 55–68.

Nordstrom, D. K. (2002). Worldwide occurrences of arsenic in groundwater. Science 296**:** 2144–2145.

Otles, S. and O. Cagindi (2010). Health importance of arsenic in drinking water and food. Environmental Geochemistry and Health 32**:** 1573-2983.

PCRWR (2003). Arsenic Contamination in Groundwater of Southern Punjab0, Pakistan Council of Research in Water Resources Ministry of Science and Technology. Islamabad.

Potatueva, Y.A. and V.A. Zalegina (1981). Agrochemical importance of arsenic: Content in fertilizer, soil and plants. Agrokhimiya. 7**:** 138-14.

Rahman, M.M., K.U. Chowdhury and S.C. Mukherjee (2001). Chronic arsenic toxicity in Bangladesh and West Bengal, India- A review and commentary. J. Clinical Toxicology. 39**:** 683-700.

Roychowdhury, T., H. Tokunaga and M. Ando (2003). Survey of arsenic and other heavy metals in food composites and drinking water and estimation of dietary intake by the villagers from an arsenic-affected area of West Bengal, India. Sci. Total Environ. 308 (1-3)**:** 15–35.

Shrestha, B. (2002). Drinking Water Quality: Future Directions for UNICEF in Pakistan. Consultancy Report 2 of 3. Water Quality; SWEET Project. UNICEF. Islamabad.

Steinmaus, C., Y. Yuan, M.N. Bates and A.H. Smith (2003). Case-control study of bladder cancer and drinking water arsenic in the western United States. American J. Epidemiology. 158**:** 1193-201.

World Health Organization (WHO). (2003). United Nations Synthesis Report on Arsenic in Drinking Water.