*Journal of Environmental Science and Management 22-2: 1-5 (December 2019) ISSN 0119-1144*

# Correlation Studies of Arsenic Level in Drinking Water and Blood Samples of Females in District Sheikhupura, Pakistan


## ABSTRACT

*Arsenic contamination of drinking water has become a major health concern all over the world. Pakistan is also facing an arsenic contamination in drinking water. The present study determine the correlation of arsenic level in drinking water and blood sample of females of District Sheikhupura, Pakistan. The study area for the present research work is District Sheikhupura, which is an industrial as well as an agricultural city in the province of Punjab, Pakistan. The arsenic concentration in drinking water from different sources used by the inhabitants and blood samples of females was measured by using Atomic Absorption Spectrophotometer (AAS). The drinking water of tehsils Sheikhupura and Sharaqpur had higher arsenic as compared to other tehsils (64.25 ± 2.55 µg $L^{-1}$ and 61.63 ± 2.73 µg $L^{-1}$) respectively, and was highest in all hands pumping water (71.14 ± 2.6µg $L^{-1}$). Mean arsenic concentration in blood samples was highest in the age group of 23-25 years (3.2 ± 0.23 µg $L^{-1}$) and being highest among respondents of tehsil Sheikhupura. A positive correlation between drinking water and blood samples when analyzed with respect to area and drinking water sources was found. Evidences suggest that the presence of arsenic in drinking water is likely to affect general metabolism and its accumulation in human. This appears to be linked with exposure of varying magnitude and duration.*


**Key words**: *Arsenic, AAS, drinking water, blood, female population*


Moneeza Abbas[1*]
Kausar Jamal Cheema[1]

[1] Environmental Science Department, Lahore College for Women University, Lahore Jail Road, Lahore 54000, Pakistan

*Corresponding author: moneeza.rana@gmail.com


## INTRODUCTION

Pollution of water is a major hazard to the general health for the people of Pakistan. It is estimated that around 40% of all reported diseases in Pakistan are attributed to poor water quality. The standards set by the World Health Organization (WHO) and other organizations are openly violated. The main things are the exposure to chemicals, fertilizers and microbial contaminants that cause public to suffer from most of the health issues (*Azizullah et al. 2011*).

The most common form arsenate is quickly taken up by the human body having lethal effects at high doses. Vital organs like skin, liver, kidney and intestine are mostly targeted by arsenic as they are involved in the assimilation, breakdown, build up and excretion (*Otles and Cagindi 2010*). Exposure to arsenic is one of the major health issues affecting more than 300 million people worldwide. Cancers like bladder, kidney, liver, lung, skin, and prostate have been known to be caused by elevated levels of arsenic in drinking water (*Quansah et al. 2015*).

There are a variety of substances coming from different sources are added to water, air, soil and food chain. It is also accumulated in different environmental and biological samples such as hair, nails, blood and urine (*Villa-Lojo et al. 2002*). The amount of arsenic or its metabolites in biological materials such as blood, hair, nails and urine are used as biomarkers of arsenic exposure. Blood contamination of arsenic results in the transfer of this hazardous substance into the food chain, hence causing adverse impacts on various trophic levels and ultimately to consumers (*Abbas and Cheema 2014*). The blood arsenic level is useful for indicating either acute poisoning or repeated high-level exposures occurring over a long period (*Hall et al. 2006*). A survey was carried out by *Kazi et al.* (*2009*) on surface and groundwater Arsenic contamination and a relationship was developed between arsenic concentration in biological samples (hair and blood) and drinking water. Thi study was conducted to find out the level of Arsenic in drinking water of the study area and identification of point sources with high risk level with respect to Arsenic concentration. The arsenic concentration in blood samples of females were measured by using the AAS system to assess the acute Arsenic exposure of population. A significant correlation was explored between arsenic contamination level in drinking water and in the blood samples among

females for health risk assessment.

## MATERIALS AND METHODS

This study aims to find out the correlation of arsenic level in drinking water with a biological sample (blood) of the female population from district Sheikhupura.

### Study area

The study area for this research work was District Sheikhupura, which is an industrial as well as an agricultural city in the province of Punjab, Pakistan. District Sheikhupura comprises of five tehsils, including Sheikhupura, Ferozwala, Muridke, Sharaqpurand Safdrabad.

### Collection of Water Samples

Two hundred water samples were collected from females who volunteered to fill up the questionnaire and gave blood samples for the study. Water samples were taken in 100 ml polythene plastic bottles. The samples were properly labeled with area, identity number and date etc. The water samples were stored at 4°C.

### Determination of arsenic concentration in water samples

Water samples were pretreated for arsenic detection by adding 2 mL of 30% $H_2O_2$ into 100 mL of taking sample, then a few drops of concentrated $HNO_3$ were added. The solution was heated at 95ºC, until digestion was completed or until the volume is slightly less than 50 mL. After cooling, samples were transferred to a volumetric flasks and diluted to 50 mL with reagent water. A 5 mL of this digested solution was measured by pipette into a 10-mL volumetric flask, added 1 mL of the 1% nickel nitrate solution and diluted to 10 mL with reagent water (EPA7060-A 1994). The fresh solution was ready for analyses of arsenic on AAS Graphite furnace (Solar MKII-VI Thermo electron corporation UK).

### Collection of blood samples

Whole blood was analyzed for arsenic detection. Whole blood is the best specimen for detecting exposure to toxic elements such as arsenic and lead (*Keil et al. 2011*). Venous blood 5 ml was drawn from median cubital vein, i.e., from inside of elbow by using disposable sterilized 5 ml BD syringe. Personal written consent of the respondents taken prior to the drawl of blood. Collected blood was put in to ethylene diaminetetraacetic acid (EDTA) added screw capped sterilized blood tubes for arsenic detection.

### Determination of arsenic concentration in blood samples:

Acid digestion of the blood samples was done by adding 1 mL of concentrated $HNO_3$ into 0.5 mL of blood in a digestion flask. The digestion was maintained at 100°C for 40 min. After addition of 0.35 mL of each concentrated $H_2SO_4$ and $HClO_4$ (Merk and Co.USA), digestion was continued for another 60 min (*Wang et al. 1993*). For dilution of the samples, 0.5 ml of deionized water was added to the digestion flask and heated until a colorless solution was obtained. The solution was then diluted to 6 mL and measured for arsenic using an atomic absorption spectrophotometer.

## RESULTS AND DISCUSSION

This study was conducted for the determination of arsenic concentration in drinking water and blood samples of the female population of District Sheikhupura. Like India, Bangladesh, and other countries that are exposed to exceedingly high levels of arsenic in their drinking water (*Nordstrom 2002*), Pakistan is now facing the threat 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 guideline (10 µg $L^{-1}$) in the Punjab. The drinking water contamination of arsenic in Sheikhupura District is a matter of concern of this study. In some areas, the levels of arsenic in water and blood samples of females respondents were above the permissible limits.

The respondents belonged to 15-25 years of age and mostly were the students of intermediate and graduates. Results of 200 samples evidently showed that the concentration of detecting arsenic was much higher in drinking water samples from tehsil Sheikhupura and Sharaqpur being 63.4 ± 3.8 µg $L^{-1}$ and 61.6 ± 4.3 µg $L^{-1}$, respectively (**Figure 1**). The mean concentration of all the five tehsils was significantly higher than the permissible limit of WHO (10 µg $L^{-1}$). Sheikhupura is an industrial as well as an agricultural tehsil. The high concentration may be due to industrial untreated effluent or agricultural activities. According to *Rahman et al* (*2005*), it was reported that in 1983-1985, 14 villages in south Bengal 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.

Arsenic concentration was detected to be highest in water samples brought by female respondents (n=200) from hand pump being 70.0 ± 4.1 µg $L^{-1}$ (**Figure 2**). Similar results of higher arsenic concentration in drinking water samples collected from hand pump were reported by *Bhatia et al.* (*2014*). Analysis of samples from drinking water from hand-pumps in the study area, revealed that more than 50% of the hand-pumps having arsenic greater than 200 µg $L^{-1}$ were privately owned and lying in the shallow aquifer zone of 15-35 water depth.

Besides long term exposure, the acute exposure to arsenic also has health effects. The blood arsenic level is a reflection of the short term exposure. The results were compared tehsils wise and it was revealed from the comparison that significantly higher value of arsenic (2.60 ± 0.2 µg $L^{-1}$) in blood samples of females were found in respondents of tehsil Sheikhupura (**Figure 3**). Respondents of Sheikhupura tehsil drink more contaminated water and have a high accumulation of arsenic in blood samples as compared to respondents of other tehsils. The concentrations of Arsenic in blood were clearly increased in people consuming drinking water of high Arsenic concentration as compared to those people consuming municipal treated water of low level of Arsenic (*Kazi et al 2009; Abbas and Cheema 2015*).The findings are interesting and demand for more detailed studies pertaining to the exposure of such substances and their effects with reference to gender.

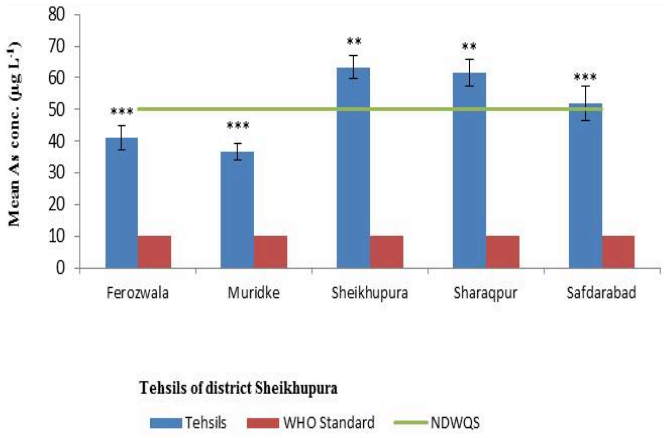


Figure 1. Comparison between mean arsenic concentration (µg $L^{-1}$) in drinking water samples from different tehsils brought by female respondents (n= 200) with WHO and NDWQS values.

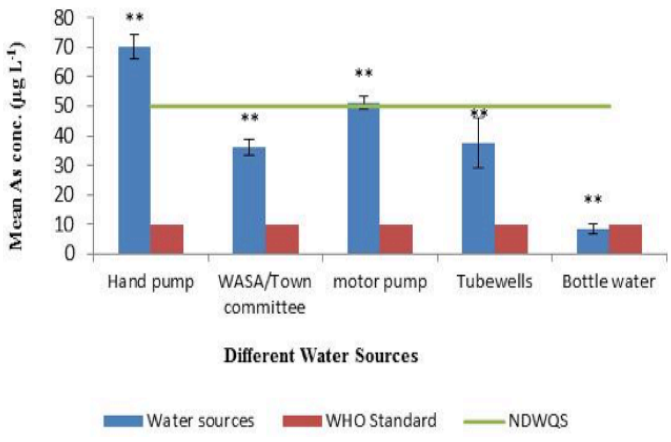


Figure 2. Comparison between mean arsenic concentration (µg $L^{-1}$) in different drinking water samples collected from different sources brought by female (n= 200) respondents.

The data were also analyzed on the basis of three age groups, i.e., 15-18 years of age, 19-22 years of age and 23-25 years of age. The maximum mean value of arsenic ± SEM was observed in the age group of 23-25 years with 3.2 ± 0.23 µg $L^{-1}$. The minimum mean value of arsenic ± SEM was observed in the age group of 15-18 years with 0.95 ± 0.1 µg $L^{-1}$ (**Figure 4**). The results pertaining to the analysis of blood are complementary to the results to the water sample analysis. It was also observed by *Stojsavljevic et al.* (*2019*) that the level of As, Cd, and Pb in the whole blood of adult Serbian population increased with years.

This study the measured level of arsenic among the older group may also be due to the comparatively longer period of exposure to arsenic contaminated water as has been suggested in another report. This trend reflects the increasing concentration of arsenic in the higher age groups which may be due to the longer and /or continuous

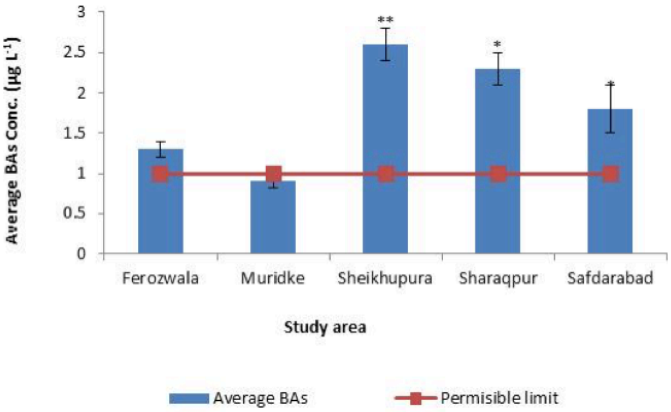


Figure 3. Comparison between mean As concentration (µg $L^{-1}$) in blood samples of female respondents belonging to different tehsils of district Sheikhupura.

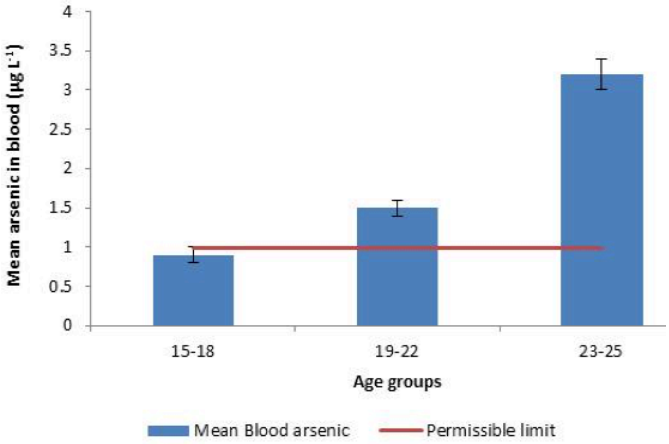


Figure 4. Comparison of mean blood arsenic concentration (µg $L^{-1}$) in female respondents of the study (age group wise).

exposure to arsenic contaminated water and/or may also be from various other sources such as food and the general environment.

A study conducted by *Katiyar and Sing* (*2014*) provides support to the findings pf this study that arsenic concentrations in blood significantly elevated with drinking arsenic contaminated water. *Katiyar and Sing* (*2014*) concluded that high blood arsenic content were significantly due to the long exposure time and with drinking arsenic contaminated water for populations living in arsenic contaminated areas.

The data were further analyzed to find out the correlation between mean arsenic concentration in drinking water samples and blood samples of female respondents with respect to area and age. It was found that there was positive correlation r= 0.99 between mean arsenic in blood samples and water samples of female respondents of different tehsils (**Figure 5**). There was also a positive correlation between arsenic concentration in water samples and blood samples of female of age groups, i.e., 15 to 25 years (r= 0.987) (**Figure 6**). A similar result in terms of positive correlation between arsenic concentration in drinking water and biological sample (hair) was found by *Abbas and Cheema* (*2014*). A study conducted by *Rahman et al.* (*2005*) to find the arsenic contamination in drinking water and biological samples (blood, nails and urine), they found a significant correlation between Arsenic in drinking water and in the biological samples.

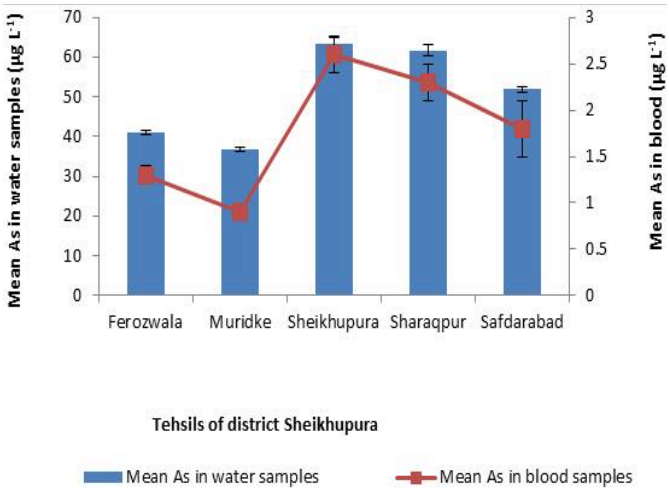


Figure 5. Correlation between mean arsenic concentrations in drinking water (µg $L^{-1}$) samples and blood (µg $L^{-1}$) of young females from different tehsils of district Sheikhupura (r=0.9).

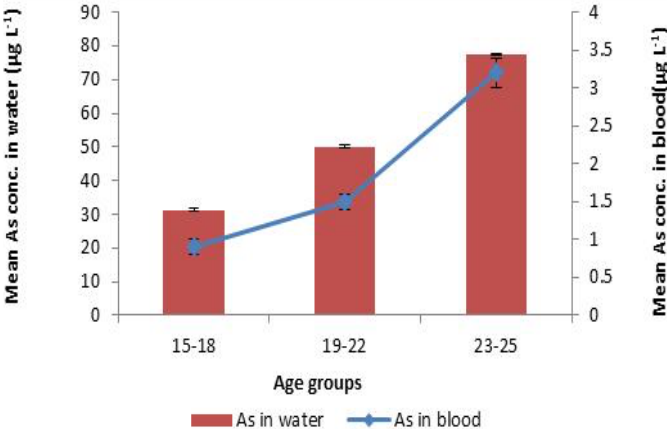


Figure 6. Correlation between arsenic concentration in drinking water samples and blood (µg $L^{-1}$) of young females of study area (r=0.987).

## CONCLUSION AND RECOMMENDATIONS

Drinking water is directly ingested by humans. It was found that all five tehsils of district Sheikhupura have average arsenic concentration above than the WHO reference value (10 µg $L^{-1}$). This study showed that in some areas the arsenic concentration in blood samples of respondents was above the value referred by ATSDR (<1) hence causing problems for the public health and general environment. The concentration of arsenic was found higher in hand pump water as compared to other sources of water, which evidently reflect the presence of arsenic in water drawn from shallow depth which was the source commonly used by the residents of the area. A strong correlation was found between arsenic concentration in drinking water and blood samples. It is evident that the drinking water quality of district Sheikhupura is

not satisfactory; hence causing ill effects to health of the people as well as to ecological health. The study provided enough data for future studies regarding water contamination and health effects also warrant urgency for preventive measures to reduce possible effects. It is strongly recommended that government should take immediate remedial and legislative measures to protect arsenic affected areas, both caused by natural water sources and through anthropogenic sources.

## REFERENCES

Abbas, M. and Cheema, K. J. 2014. "Correlation studies of arsenic level in drinking water and hair samples of females in district Sheikhupura". *International Journal of Current Microbiology and Applied Sciences* 3(8): 1-9.

Abbas, M. and Cheema, K.J. 2015. "Arsenic levels in drinking water and associated health risk in district sheikhupura, Pakistan". *Journal of Plant and Animal Sciences* 25(3):719-724.

Azizullah, A., Khattak, M.N.K., Richter, P. and Hader, D.P. 2011. "Water pollution in Pakistan and its impact on public health-A review". *Environment International* 37: 479-497.

Bhatia, S., Balamurugan, G. and Baranwal, A. 2014. "High arsenic contamination in drinking water hand-pumps in Khap Tola, West Champaran, Bihar, India". *Frontiers in Environmental Science* 2(49): 1-8.

Chatterjee, M., Das, D. and Chakraborti, D. 1993. "A Study of Ground water Contamination by Arsenic in the Residential Area of Behala, Cacutta dua to industrial Pollution". *Environment Pollution* 80 (1): 57-65.

EPA. 1994. Arsenic (Atomic Absorption, Furnace Technique). Environmental Protection Agency. EPA Contract No. 7060-A, Washington, DC, USA.

Hall, M., Chen, Y., Ahsan, H., Slavkovich, V., Geen, V.A., Parvez, F. and Graziano, J. 2006. "Blood arsenic as a biomarker of arsenic exposure: Results from a prospective study". *Toxicology* 225: 225–233.

Katiyar, S. and Sing, D. 2014. "Prevalence of arsenic exposure in population of Ballia district from drinking water and its correlation with blood arsenic level". *Journal of Environmental Biology* 35(3): 589-94.

Kazi, T. G., Arain, M. B., Baig, J. A., Jamali, M. K., Afridi, H. I., Jalbani, N., Sarfraz, R. J., Shah, A. Q. and Niaz, A. 2009. "The correlation of arsenic levels in drinking water with the biological samples of skin disorders". *Science of the Total Environment* 407(3): 1019-1026.

Keil, D. P., Ritchie, J. B. and McMillin, G. A. 2011. "Testing for Toxic Elements: A focus on arsenic, cadmium, lead, and mercury". *Lab Medicine* 42: 735-742.

Nordstron, D.K.2000. "Worldwide occurrence of arsenic in ground water." *Environmental Health Perspectives* 116: 158–164.

Otles, S. and Cagindi, O. 2010. "Health importance of arsenic in drinking water and food". *Environmental Geochemistry and Health* 32(4): 367-371.

Quansah, R., Armah, F. A., Essumang, D. K., Luginaah, I., Clarke, E., Marfoh, K., Cobbina, S. J., Nketiah-Amponsah, E., Namujju, P. B., Obiri, S. and Dzodzomenyo, M. 2015. "Association of arsenic with adverse pregnancy outcomes/ infant mortality: a systematic review and meta-analysis". *Environmental Health Perspectives* 123: 412–421.

Rahman, M. M., Sengupta, K. M., Ahamed, S., Chowdhury, K. U., Lodh, D., Hossain, A. M., Das, B., Chakraborti, D., Saha, C. K., Kaies, I. and Barua, K. A. 2005. "Status of groundwater arsenic contamination and human suffering in a Gram Panchayet (cluster of villages) in Murshidabad, one of the nine arsenic affected districts in West Bengal, India". *Journal of Water and Health* 3(5): 283-296.

Stojsavljević, A., Borković-Mitić, S., Vujotić, L., Grujičić, D., Gavrović-Jankulović, M and Manojlović, D. 2019. "The human biomonitoring study in Serbia: Background levels for arsenic, cadmium, lead, thorium and uranium in the whole blood of adult Serbian population". *Ecotoxicology and Environmental Safety*169:402-409.

Villa-Lojo, M.C., Rodriguez, E., Mahia, P.L., Mnuiategui, M. S. and Rodriguez, D. P. 2002. "Coupled high performance liquid chromatography – microwave digestion – hydride generation – atomic absorption spectrometry for inorganic and organic arsenic speciation in fish tissue." *Talanta* 57: 741–775.

Wang, C. T., Huang, C. W., Chou, S. S., Lin, D.T., Liau, S. R. and Wang R. T. 1993. "Studies on the concentration of arsenic, selenium, copper, zinc and iron in the blood of blackfoot disease patients in different clinical stages". *Clinical Chemistry and Laboratory Medicine* 31(11):759–764.