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Evaluation Of Heavy Metal Concentrations In Major Sources Of Drinking Water In Bulumkuttu Ngomari, Maiduguri, Northeastern Nigeria

Musa Alhaji Haruna

Yahaya Inuwa Garba

Departments of Medical Laboratory Science, College of Medical Sciences, University of Maiduguri, Nigeria

Mohammed Fema

Department of Pathology (Chemical Pathology Unit), State Specialist Hospital Maiduguri, Nigeria

Abstract: ***Presence of heavy metals and their levels of contaminations were investigated in some source of drinking water collected from different part of Bulumkuttu area of Maiduguri, Borno state, Nigeria. The various sources of the drinking water include nine (9) Wash Boreholes Water (WBW), four (4) Deep Boreholes Water (DBW) and three (3) Sachet water (SW). The samples were analyzed at NAFDAC Area Laboratory Maiduguri using Atomic Absorption Spectrophotometer (AAS). The result obtained showed that all the water investigated contain high concentrations of Hg, Pb, Cd, Ni above the Maximum Contamination Limit (MCL) set by both USEPA and NIS. Fe was present in high concentration in only one of the water sources (S14 (DBW)). This study therefore showed that multiple heavy metals exist at high concentration (exceeding MCL set by USEPA, WHO and NIS). This means that people consuming these waters may be at high risk of heavy metal contamination and its consequences on human health.***

Keywords: Evaluation, Heavy Metal, Concentrations, Sources, Drinking Water

I. INTRODUCTION

Water is one of the most essential substances required for the sustenance of both plants and animals including man. It is use for consumption and other domestic purposes e.t.c. All water made for human consumption should be potable, free from disease-causing organisms, minerals and other organic substances that could impair human health (Ademoroti 1986,1996; Obaro, Elinge and Nwanko 2012; Shabanda and Shabanda 2015).

Due to human and environmental factors the drinking water quality has been greatly affected. As ground water flows through the ground heavy metals (HMs) such as nickel, lead, mercury, iron, arsenic, chromium, copper and cadmium e.t.c, are dissolved and may later be found in high concentrations in the water (Malik and Khan, 2016). HMs are metallic chemical elements that have a relatively high density and are toxic or poisonous at high concentrations. They are natural components of the earth crust. To a small extent they enter our bodies via food, drinking water and air. Some HMs (e.g. CU, Se, Zn) are essential for the maintenance of metabolism of human body. However, at high concentrations, they can be toxic and poisonous (www.pollutionissues.com; Waller and Roger, 1982). Among the heavy metals As, Cd, Pb, Cr, Cu, Hg and Ni are of major concern mainly due to their presence at relatively high concentrations in drinking water and their effects on human health (ATSDR, 2015). Cd is linked to kidney damage and cancer. Kidney and liver damage from Hg, Cd contaminated drinking water is also linked to chronic renal failure (Bawaskar and Bawaskar,2010; ATSDR, 2015). Gobe and Crane (2010) reported kidney failure due to long term exposure to Cd. Lead and cadmium have been reported to high blood pressure, kidney damage. Cadmium in addition causes liver damage and anemia. Other metals such as mercury has also been reported to cause acute and chronic toxicity causing kidney damage and nervous system disorders (USEPA).

Boreholes and Wells are ground water types that form an integral part of water supply systems in urban and rural communities of Nigeria, and so can be described as indispensable because of inadequate potable public water

supply systems in most communities in Nigeria (Shabanda and Shabanda 2015).

In this study, the study area is an area claimed to have high prevalence rate of renal disease and implicating the source of their drinking water. The major sources of drinking water are largely wash boreholes, hand pumps, sachet water (Pure Water), and limited number of deep boreholes which the local population depends on. Consequently, this study was aimed at determining the HMs and their concentrations in the drinking water sources of this area.

STUDY AREA

The study area is Bulumkuttu ward in Maiduguri, the state capital of Borno state. Borno state lies on latitude 115^{o}N and longitude 135^{o}E in Northeastern Nigeria and occupies an area of about 61,435 square kilometers. The state is bordered to the north by Niger republic, Chad to the northeast and Cameroun to the east. The population of Borno state according to the 2006 national census provided a total of about 4,151,193. The state is inhabited by vast of ethnic groups in Nigeria but however the principal ethnic group is Kanuri (www. Bornostate.gov.ng). It is one of the major agricultural zones in the country. Majority of the populace are farmers.

JUSTIFICATION FOR THE STUDY

The authors hope to provide detailed information about the status of the heavy metals from the various sources of drinking water in this study area (Bulumkuttu). The outcome may justify the claim that heavy metals are suspected to exist in high concentrations in sources of water for consumption of this area, which the populace seems to suspect to cause high death rate from kidney diseases observed from this area.

II. MATERIAL AND METHODS

Materials used include syringe, sterile universal contain, AAS, smart spectrophotometer test tubes test tube rack, micropipette, pipette tips.

Study Area

SAMPLE COLLECTION

Samples were collected from residential area of Bulumkuttu ward, Maiduguri.

The water samples were collected from various sources of drinking water which include nine (9) Wash Borehole Water (WBW), four (4) Deep Boreholes Water (DBW) and three (3) Pure water (Sachet water) (PW(SW)).

III. RESULT

Table1 shows the different sources of drinking water analyzed and their Locations. All the sources of the water are located in the study area, Bullumkuttu.

SOURCES OF DRINKING WATER	LOCATIONS
S1 (WBW)	Mallam Kalla wash borehole along Borno Holiday Inn, Bulumkuttu
S2 (WBW)	Wash Borehole beside IDP(Primary health care clinic) adjacent to Bulumkuttu Ngomari primary school
S3 (WBW)	Wash Borehole along former River Benue hotel off Borno holiday inn
S4 (WBW)	Wash borehole layin Aminu mai gyaran keke, Bulumkuttu kasuwa
S5 (WBW)	Wash borehole around former Bright Star hotel near Garba Adama along Borno holiday inn
S6 (WBW)	Wash borehole after former ORTIV Hotel behind Borno holiday inn
S7 (WBW)	Wash borehole along EYN Church, Bulunkuttu tsakiya
S8 (WBW)	Wash borehole behind EYN Church, Bulunkuttu tsakiya
S9 (WBW)	Wash borehole near Alhaji Umaru ngelzarma house along Lawan Jidda street, Bulumkuttu ngomari
S10(PW/SW)	Albarka Pure Water off Lawan Jidda Street, Bulumkuttu ngomari
S11(PW/SW)	Babultu pure water, Bulumkuttu Ngomari Bus stop
S12(PW/SW)	Ihsan pure water , Bulumkuttu Ngomari Bus stop
S13(DBW)	Deep borehole opposite Borno Holiday inn, Bulumkuttu ngomari
S14(DBW)	Lawan Shuwa deep borehole along lawan jidda street, Bulumkuttu ngomari
S15(DBW)	Deep Borehole near Friday Mosque, Bulumkuttu Ngomari Bus stop
S16(DBW)	Bulumkuttu Ngomari primary school deep borehole

KEY:
S1-S16= Samples 1-16
DBW= Deep Borehole Water
PW(SW)= Pure Water (Sachet Water)
WBW= Wash Borehole Water

Table 1: shows the different sources of drinking water analyzed and their Locations

Table2 shows prevalence of Heavy Metals (HMs) found in different sources of drinking water in Bulumkuttu. The result shows that all the water contain Hg at concentrations greater than MCL (0.001ppm). The result also shows that 3 out of 4 DBW, 2 out of 3 PW, and 4 out of 9 WBW contain Cd at a concentration greater than the MCL (0.003ppm). Also 1 out of 4 DBW, 1 out of 3 PW/SW, and 4 out of 9 WBW contain Lead at concentration greater than MCL(0.01ppm).The result also shows 2 out of 4 of DBW, 2 out of 3 SW, and all (9) of the WBW contain Nickel at concentration greater than MCL of 0.02ppm. However, only 1

out of 4 DBW contain iron (Fe) at concentration greater than MCL of 0.30ppm.

ELEMENTS	SOURCES OF DRINKING WATER			TOTAL N= 16 (%)
	DBW n= 4 (%)	PW/SW n= 3 (%)	WBW n= 9 (%)	
Mercury				
≤ 0.001ppm	0 (0)	0 (0)	0 (0)	0 (0)
>0.001ppm	4 (25)	3(18.75)	9(565)	16 (100)
Lead				
≤ 0.01ppm	3 (18.75)	2 (12.5)	5(315)	10(62.5)
> 0.01ppm	1 (6.25)	1 (6.25)	4 (25)	6 (37.5)
Cadmium				
≤ 0.003ppm	1 (6.25)	1 (6.25)	5(315) 4	7 (43.8)
> 0.003ppm	3 (18.7)	2 (12.5)	(25)	9 (56.2)
Nickel				
≤ 0.02ppm	2 (12.5)	1 (6.25)	0 (0)	3 (18.7)
> 0.02ppm	2 (12.5)	2 (12.5)	9(56.)	13(81.3)
Iron				
≤ 0.30ppm	3(18.7)	3 (18.7)	9(56.)	15(93.7)
> 0.30ppm	1(6.27)	0 (0)	0 (0)	1 (6.3)

KEY:
DBW= Deep Borehole Water
PW(SW)= Pure Water (Sachet Water)
WBW= Wash Borehole Water

Table 2: shows prevalence of Heavy Metals (HMs) found in different sources of drinking water in Bulumkuttu

Table 3 shows concentration of HMs in ppm in each source of drinking water studied. S1 - S9 are wash boreholes water (WBW), S10 – S12 are Sachet water (SW) and S13 – S16 are deep borehole water (DBW) as presented.

SOURCES OF DRINKING WATER	ELEMNTS				
	Hg	Pb	Cd	Ni	Fe
S1(WBW)	**0.030**	**-0.90**	**0.002**	**1.040**	**0.017**
S2(WBW)	**0.022**	**0.20**	**0.008**	**0.082**	**0.010**
S3(WBW)	**0.003**	**-0.40**	**0.005**	**0.089**	**0.015**
S4(WBW)	**0.008**	**-0.80**	**0.004**	**0.084**	**0.030**
S5(WBW)	**0.006**	**-0.40**	**0.001**	**0.034**	**0.011**
S6(WBW)	**0.035**	**0.80**	**0.003**	**0.078**	**0.017**
S7(WBW)	**0.010**	**0.20**	**0.005**	**0.039**	**0.021**
S8(WBW)	**0.004**	**2.40**	**0.002**	**0.057**	**0.011**
S9(WBW)	**0.009**	**-0.40**	**0.002**	**0.044**	**0.016**
S10(PW(SW))	**0.021**	**0.70**	**0.004**	**0.019**	**0.010**
S11(PW(SW))	**0.004**	**-0.70**	**0.004**	**0.030**	**0.023**
S12(PW(SW))	**0.003**	**-0.20**	**0.003**	**0.051**	**0.012**
S13(DBW)	**0.015**	**-0.60**	**0.001**	**0.093**	**0.013**
S14(DBW)	**0.004**	**-0.10**	**0.004**	**0.019**	**0.036**
S15(DBW)	**0.004**	**0.70**	**0.007**	**0.014**	**0.014**
S16(DBW)	**0.003**	**-0.10**	**0.004**	0.051	0.015
MCL(USEPA)	**≤0.002ppm**	**≤0.015ppm**	**≤0.005ppm**	**≤0.020 ppm**	**≤0.030ppm**
MCL (NIS)	**≤0.001ppm**	**≤0.010ppm**	**≤0.003ppm**	**≤0.020 ppm**	**≤0.030ppm**

KEY
S1 – S16 = Sample 1 -16
DBW= Deep Borehole Water
PW(SW)=Pure Water (Sachet Water)
WBW= Wash Borehole Water
MCLs= Maximum Contamination Limits

Table 3: shows concentration of HMs in ppm in each source of drinking water studied

Table 4 shows mean concentration of HMs from drinking in Bulumkuttu. The mean concentrations are 0.010 ± 0.10; 0.050 ± 0.880; 0.004 ± 0.002; 0.130 ± 0.250; 0.170 ± 0.070 for Hg, Pb, Cd, Ni and Fe respectively. The mean concentrations are all above the MCL of the respective metals as set by USEPA and Nigerian Industrial Standard (NIS) with exception of Fe whose mean concentration is less than the MCL.

ELEMENTS	MEAN ± S.D	RANGE	MAXIMUM CONTAMINATION LIMITS (MCLs) (WHO & NIS)
Hg	0.010 ± 0.010	0.003 – 0.035	≤0.001 ppm
Pb	0.050 ± 0.830	-0.90 – 2.40	≤0.01 ppm
Cd	0.004 ± 0.002	0.001 – 0.008	≤0.003 ppm
Ni	0.130 ± 0.250	0.014 – 1.040	≤0.02 ppm
Fe	0.170 ± 0.070	0.100 – 0.360	≤0.30 ppm

Table 4: shows mean concentration of HMs from drinking in Bulumkuttu

IV. DISCUSSIONS

Although a few heavy metals are essential for human health, an excess amount of these metals in our drinking water can have negative effects (Malik and Khan, 2016). Studies report various effects of heavy metals in drinking water (USEPA,2015; ATSDR,2015 and Malik and Khan,2016). Among the heavy metals As, Cd, Pb, Cr, Cu, Hg and Ni are of major concern mainly due to their presence at relatively high concentrations in drinking water and their effects on human health (ATSDR,2015). Kidney and liver damage from Hg, Cd contaminated drinking water is also linked to chronic renal failure (Bawaskar and Bawaskar,2010; ATSDR, 2015). Gobe and Crane (2010) also reported kidney failure due to long term exposure to Cd. Pb and Cd has also been reported to cause high blood pressure and kidney damage. Other metals such as Hg has also been reported to cause acute and chronic toxicity causing kidney damage and nervous system disorders (USEPA from www.epa.gov/safewater/mcl). Our study shows that the most common heavy metals are Hg, Pb, Cd, Ni, and Fe. These metals are found to be present at relatively high concentration in all the water analyzed exceeding MCL set by WHO (1996), USEPA (2015) and NIS (2007) except for Fe which was found to be relatively high concentration in only one of the waters (S14). Similar findings were also reported by Ehi and Okiei (2012) in some part of Lagos metropolis where Pb and Cd were found in water and their concentration were found to be above the MCL set by WHO (1996). Also, Nnabo (2015) reported similar findings where Cd, Pb, and Ni were found to be present in drinking water from Enyigba Pb-Zn District South Eastern Nigeria. The concentrations of the HM were found to be above MCL set by WHO (1996). Another study reported by Shittu (2016) from Dutse Town, Jigawa state, Nigeria indicated that Fe, Pb, and Hg were found in drinking waters collected from Local Wells and Boreholes. The concentrations of these metals were found to be above the MCL set by WHO (1996). Similar result was also reported by shabanda and Shabanda (2015) from northeastern Nigeria indicates that Fe, Pb and Ni were found in ground water with

concentration above the MCL set by WHO (1996) and USEPA (2015). These reports are in agreement with findings of our study. The high concentrations of these heavy metals might be due to the fact that northern Nigeria is endowed with and rich in various metallic mineral compound including heavy metals. As ground water flows through the ground, these heavy metals are dissolved and may later be found in high concentration in our sources of drinking water. The high concentrations of these metals in this area might also be due to the fact that northern Nigeria particularly Borno state is the major agricultural zone in the country. Agricultural waste water containing high concentration of HMs may be discharged into the environment and thus depositing in the soils around reservoirs and then enter the water along with the surface runoff thereby contaminating the sources of water.

V. CONCLUSION

From this study it shows that multiple heavy metals exist at high concentration (exceeding MCL set by USEPA, WHO and NIS). This means that people consuming these waters may be at high risk of heavy metal contamination and its consequences on human health.

VI. RECOMMENDATION

- ✓ Government should provide potable water for consumption in both rural and urban areas
- ✓ Government should enforce the standard set by its regulatory body (Nigerian standard for drinking water) on all the sources of water both commercial and government own

Advance and comprehensive technologies for removal of heavy metals from drinking water should be introduced.

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