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IMPACT OF LEAD AND CADMIUM IN DRINKING WATER

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Abstract-In this study drinking water and urine of people living inGwalameji,Yelwatudu, Shadawanka barrack, Wunti and Wunti Dada within Bauchi metropolis ofBauchi state of Nigeria were analysed for their lead(Pb) and cadmium (Cd) content. This is done in order to know the relationship between chronic disease, like Renal failure that have been frequently reported in these areas, and the heavy metals. Renal failure is related to contaminated drinking water withPb and Cd. A strong relationship between contaminated drinking water with heavy metals like Pb and Cd from above named areas and Renal failure has been identified in this study. This study revealed that frequent occurrence of this disease in the above named area is related to agricultural activities and industrial wastes that release hazardous and toxic materials into ground water and thus contaminate drinking water. Judging by the results obtained from this study, the highest level of Cd in drinking water was recorded from Gwalameji with a concentration of 0.23mg/L and the lowest was detected from Yelwa and Wunti dada with a concentration of 0.02mg/L. While lead depicted a range of (0.02 – 0.24) with highest concentration coming from Wunti and lowest from Wunti-dada. For urine samples analysed for Cd, Cd exhibited a concentration range of (0.01 – 0.16mg/L). Gwalameji gave the highest value of 0.16mg/Lwhile all other areas recorded the lowest value. Gwalamejialso recorded the highest Pb level of 0.14mg/L in urine with Wunti, Wunti dada, Shidawanka Barracks showing the lowest level of 0.01mg/L.

Generally, in majority of the areas sampledPb and Cd levels in both water and urine exceeded the maximum allowable limits of 0.1mg/L and 0.01mg/L respectively.

Key Words: Lead (Pb), Cadmium (Cd), Urine, Water and disease

I. INTRODUCTION

Virtually all drinking water supply system in Nigeria tend to rely on surface water resources such as lakes, rivers and reservoirs, these include the system serving in many large metropolitan areas. Similar systems are more likely to use ground water, particularly in regions with limited surface water resources. More than half of Nigeria population receives its drinking water from ground water that is, through wells drilled into aquifers.[1].

Drinking water can be contaminated from many sources especially through anthropogenic activities such as pesticide and fertilization applications. Aquifers and surface waters that provide drinking water can be contaminated by many sources. For instance, chemicals, like trace metals such as Pb and Cd from disposal sites or underground storage facilities can migrate into aquifers with the following contaminants like organic solvents (e.g. some VOCs) petroleum products, and trace metal like Pb and Cd, contaminants can also enter ground water or surface water as a result of pesticide and fertilization application to farmland. Pesticides and fertilizer compounds (e.g. nitrate) can be carried into lake and streams by rainfall runoff or snow melt or percolate through the ground and enter aquifers. Industrial waste can contaminate drinking water sources if injected into containment wells or discharged into surface waters, as can mine waste (e.g. Trace metals) if not properly contained [2],[3].

Other sources of drinking water contaminants are natural sources. As ground water travels through rock and soil it can pick up natural occurring contaminants such as arsenic, other trace metals or radionuclides. Some aquifers are naturally unsuitable for drinking because the local geology happens to include high level of certain contaminants. Microbial pathogen is another source of drinking water contaminants. Human waste from sewage and septic systems can carry harmful microbes into drinking water sources, as can waste from animal feed lots and wildlife. Major contaminants from human waste include Giardia, cryptosporidium, and E.Coli. Coliform bacteria from human and animal wastes also may be found in drinking water if the water is not properly finished; these bacteria may indicate that other harmful pathogens are present as well [4].

Drinking water containing high levels of toxic and essential trace metals like lead, (Pb), Cadmium (Cd), Chromium (Cr), Nickel (Ni), Manganese (Mn), Zinc (Zn), and Calcium (Ca) may be hazardous to our health. The contamination of water is directly related to the degree of contamination of our environment. Medical geology is or subfield of geology that studies the effects of chemicals in the environment, especially trace metals on the health of human and animals. As a result of wide spread of Renal failure disease in recent time at Gwalameji, Yelwatudu, Shadawanka barrack, Wunti and Wunti Dada within Bauchi metropolis in Bauchi State of Nigeria due to water pollution, air pollution and hazard over uses of pesticides in agriculture and industrial waste deposits, it is important to identify the correlation between levels of Pb and Cd in contaminated drinking water, urine and the diseases associated with their high level in human body [5].

Thus, the aim of this study is to find out the levels of Pb and Cd in contaminated drinking water and urine and their effects on human health as presence of these metals in the urine implies their presence in the body.

II. MATERIALS AND METHODS

Urine sample were collected in clean plastic sample bottles from five different areas namely Gwalameji, Yelwatudu, Shadawanka barrack,Wuntiand Wunti Dada, within Bauchi metropolis in Bauchi state of Nigeria, Fig.1.Within an area drinking water samples were collected from ten different houses known to be harboring people suffering from Renal failure disease. Urine samples of fifty (50) people suffering from above named ailment (Renal failure) were collected in the houses where drinking water samples were collected in clean plastic sample bottles.

Levels of Pb and Cd in the drinking water samples were analysed using Atomic absorption spectrophotometer as adopted in [6] while the urine samples were analysed for similar heavy metals using the method in [7]. This was done in order to detect possible presence of Pb and Cd metals in their urine which will imply the presence of the metals in their bodies.

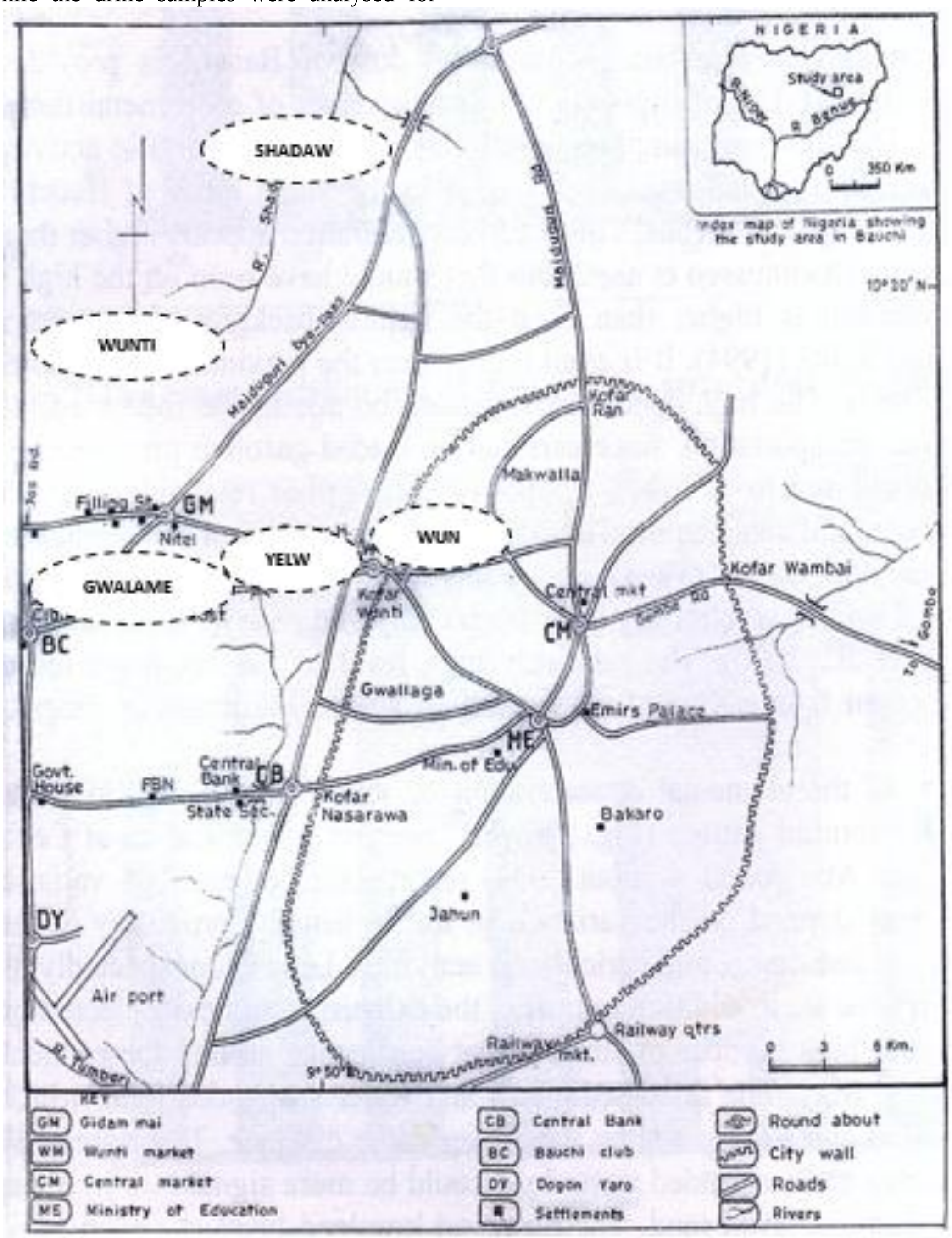

Fig. 1: MAP OF BAUCHI METROPOLIS SHOWING SAMPLING SITES

III. DISCUSSION OF RESULT

Table 1 shows the levels of Pb and Cd in mg/L in drinking water (DW) and urine(U) of people suffering from Renal failure from Gwalameji, Yelwatudu, Shadawanka barrack, Wunti and Wunti Dada. Figures 2a and 2b illustrate Column representation of the levels of these metals. Wunti and Gwalameji recorded the highest level of Pb in drinking water (DW) with 0.24mg/L and 0.17mg/L respectively. Level of Pb in drinking water in majority of the areas, like Gwalameji, Yelwatudu and Wunti, sampled exceeded the standard limit (0.1mg/L). Urine sample analysis indicated presence of high level ofPb in Gwalameji and Yelwatudu. Urine sample from people in Gwalameji recorded the highest Pb level of 0.14while the least Pb level of 0.01mg/L were recorded from Wunti, Shadawanka barrack and Wunti dada.

The highest Cd level of 0.23mg/L in drinking water were recorded from Gwalameji while the lowest was detected at Yelwa and Wunti dada with a concentration of 0.02mg/L.

Cd levels in majority of drinking water sampled exceeded the standard limit of 0.01mg/L. Analysis of urine samples show the presence of Cd in the urine of all the people suffering from Renal failure.

It is very important to know the relationship between the presence of Pb and Cd in drinking water (DW) and the prevalence of renal failure disease. The prevalence of this disease was on the increase in the last few years due to air pollution, water pollution and hazards over uses of pesticides in agriculture. These metals are not harmful to our health when they are present in water in trace level. Infact, some metals are essential to sustain life. For example calcium, magnesium, potassium and sodium must be present for normal body functions. Cobalt, Copper, Iron, Manganese, Molybdenum, Selenium and Zinc are needed in trace levels as catalyst for enzyme activities. Drinking water containing high levels of these essential metals, or toxic metals such as cadmium, lead, chromium, mercury, selenium, aluminum, arsenic, barium, and silver may be hazardous to our health.,

Metals may occur in our water naturally or through contamination. Naturally occurring metals are dissolved in water when it comes into contact with rock or soil material. Other sources of metal contamination are corrosion of pipes and leakage from waste disposal sites.

One of the major symptoms of chemical toxicity seems to be a breakdown of the immune system, which opens the gate way for all kinds of diseases in the body. Also another major symptom seems to be damage to the central nervous system and increased nervousness. Toxic doses of chemicals cause either acute or chronic health effects. The levels of chemicals in drinking water, however, are rarely high enough to cause acute health effects. They are more likely to cause chronic health effects that occur long after exposure to small amounts of a chemical. Health effects include damage to immune system, cancer, disorders of the nervous system, birth defect and organ damage [8]. Pb, Cd, Cr, Cu, Zn, Mn, Ni, Co and Mo are toxigenic and carcinogenic agent normally found as contaminant in human drinking water supplies in many areas around the world [5].

This study reveals a strong correlation between Pb and Cd and renal failure.

People suffering from Renal failure were related to contaminant drinking water containing majorly of Pb and Cd. Pb is a dangerous element, and harmful even in small amounts. It enters the human body through many ways, such as inhale in dust from lead paints, or waste gases from leaded gasoline. It is found in various foods like fish, which are heavily subjected to industrial pollution. Some old homes have lead water pipes which can contaminate drinking water. Most of the Pb we take in is removed from our bodies in urine, however, there is still risk of build-up, particularly in children. Exposure to Pb is cumulative over time. High level of Pb in the body can cause death or permanent damage to the central nervous system, the brain and kidney. The damage normally result in to behaviour and learning problems (like hyperactivity), memory and concentration problems, high blood pressure, headaches, slow growth, hearing problems, reproductive problems in men and women muscle and joint pain and digestive problems.

Lead is considered the membrane health threat to children and the effects of Pb poison can last a lifetime. Pb poisoning not only stunt children’s growth, damage the nervous system, and cause learning disabilities but also now linked to crime and anti-social behaviour in children [8].

On the other hand, Cd is classified as toxic trace element. It is found in trace amount in rocks, coal and petroleum and often in combination with Zinc. Geologic deposit of Cd can serve as sources to ground water and surface water, especially when in contact with soft, acidic waters. There is no proven evidence that cadmium is essential to humans. It accumulates with age especially in the kidney and is considered as a cancer and cardiovascular diseases. It has been reported that Cd in human health causes:

i. Bone and renal disease in populations exposed to industrial contaminated drinking water.
ii. Lung and renal dysfunction in industrial workers exposed to air-borne Cd and
iii. Human hypertension [9].

Cd is used in Galvanized steel which is plated with zinc that contains about 1% Cd. Cd is also used in paint, photograph and nickel-cadmium batteries.

Some cases of Cd poisoning are linked to cadmium – plated food utensils. It is introduced into the environment from paint and pigments and plastic stabilizers mining and smelting operations and industrial operations like electroplating, reprocessing cadmium scrap and incineration of cadmium containing plastics. Cadmium emissions are from fertilizer application, sewage sludge disposal and fossil fuel use. It may enter drinking water through corrosion of galvanized pipes and handfill leahates.

In low doses, it can produce vomiting, coughing and headache, while in larger doses it accumulate in kidney and liver and can replace calcium in bones, leading to painful bone disorders and renal failure. The kidney is the major target organ in humans chronically exposed to Cd by ingestion[10]. Cd that is taken into the body usually remains there. Inhaled Cd is more hazardous than ingested Cd. A major source of inhaled Cd is tobacco smoke. Trace metals like Pband Cd will interfere with essential nutrients of similar appearance, such as calcium and zinc. Because of charge and size similarities, Pb can substitute for calcium and included in bone. Children are susceptive to Pb because of developing skeletal systems require high calcium levels. Pb that is stored in the bone is not harmful, but if high levels of calcium are ingested later, the Pb in the bone may be replaced by calcium and mobilized. Once free in the system, Pb may cause hypertension, neurotoxicity and nephrotoxicity. The pollution of drinking water with Pb and Cd arise from anthropogenic and industrial sources at the studies areas and renal failures were related to them.

Table 1: Levels of Pb and Cd(mg/L) in Drinking water(Dw) and Urine(U) in sampling sites

Gwalangi				Yelwa				Wunti				Shadawanka Barrack				Wuntidada			
Cd		Pb		Cd		Pb		Cd		Pb		Cd		Pb		Cd		Pb	
Dw	U	Dw	U	Dw	U	Dw	U	Dw	U	Dw	U	Dw	U	Dw	U	Dw	U	Dw	U
0.21	0.11	0.15	0.07	0.02	0.01	0.08	0.03	0.03	0.01	0.18	0.10	0.04	0.01	0.07	0.01	0.03	0.01	0.03	0.03
0.16	0.08	0.16	0.14	0.04	0.02	0.14	0.11	0.04	0.02	0.19	0.07	0.07	0.03	0.06	0.04	0.09	0.02	0.08	0.02
0.11	0.06	0.17	0.12	0.06	0.03	0.11	0.04	0.03	0.01	0.11	0.06	0.03	0.01	0.06	0.03	0.03	0.02	0.06	0.04
0.15	0.12	0.16	0.13	0.02	0.01	0.13	0.10	0.04	0.02	0.13	0.10	0.07	0.02	0.08	0.02	0.04	0.10	0.06	0.02
0.20	0.07	0.14	0.12	0.04	0.02	0.14	0.02	0.09	0.03	0.13	0.02	0.04	0.01	0.09	0.05	0.02	0.01	0.07	0.04
0.17	0.06	0.15	0.12	0.07	0.04	0.13	0.06	0.07	0.04	0.15	0.02	0.08	0.02	0.06	0.04	0.07	0.03	0.02	0.10
0.23	0.16	0.14	0.12	0.05	0.07	0.14	0.10	0.03	0.01	0.14	0.11	0.09	0.03	0.04	0.02	0.06	0.02	0.06	0.02
0.15	0.10	0.13	0.1	0.04	0.02	0.11	0.02	0.07	0.02	0.13	0.10	0.06	0.04	0.09	0.04	0.07	0.04	0.04	0.02
0.19	0.12	0.17	0.12	0.02	0.01	0.14	0.02	0.03	0.01	0.24	0.12	0.14	0.02	0.07	0.03	0.03	0.04	0.03	0.01
0.13	0.11	0.12	0.06	0.03	0.01	0.15	0.12	0.07	0.12	0.04	0.01	0.05	0.02	0.06	0.02	0.08	0.03	0.08	0.02

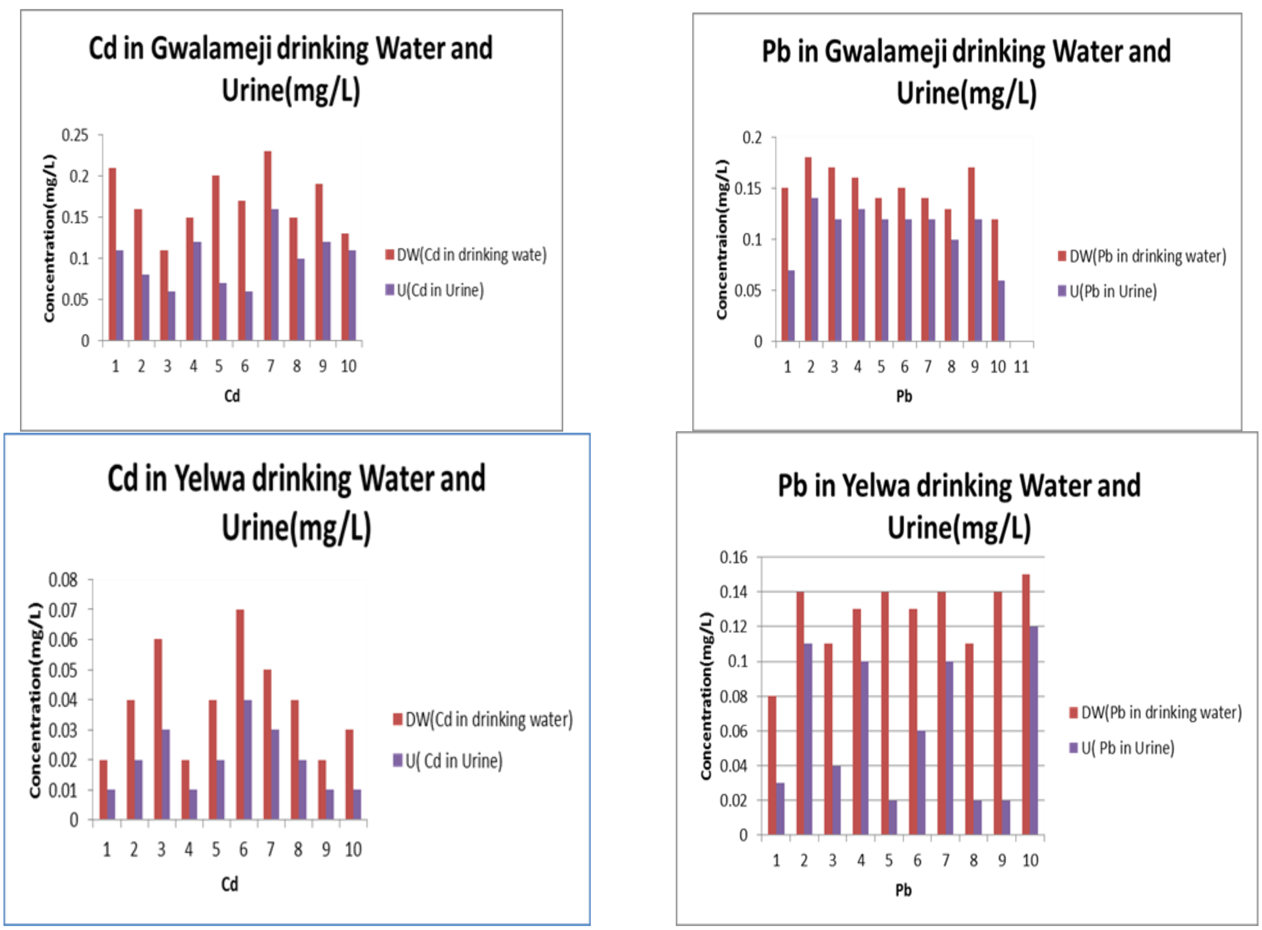

Fig. 2a: Column Representation of Levels of Pb and Cd in Drinking water(Dw) and Urine(U) in the Sampling Sites

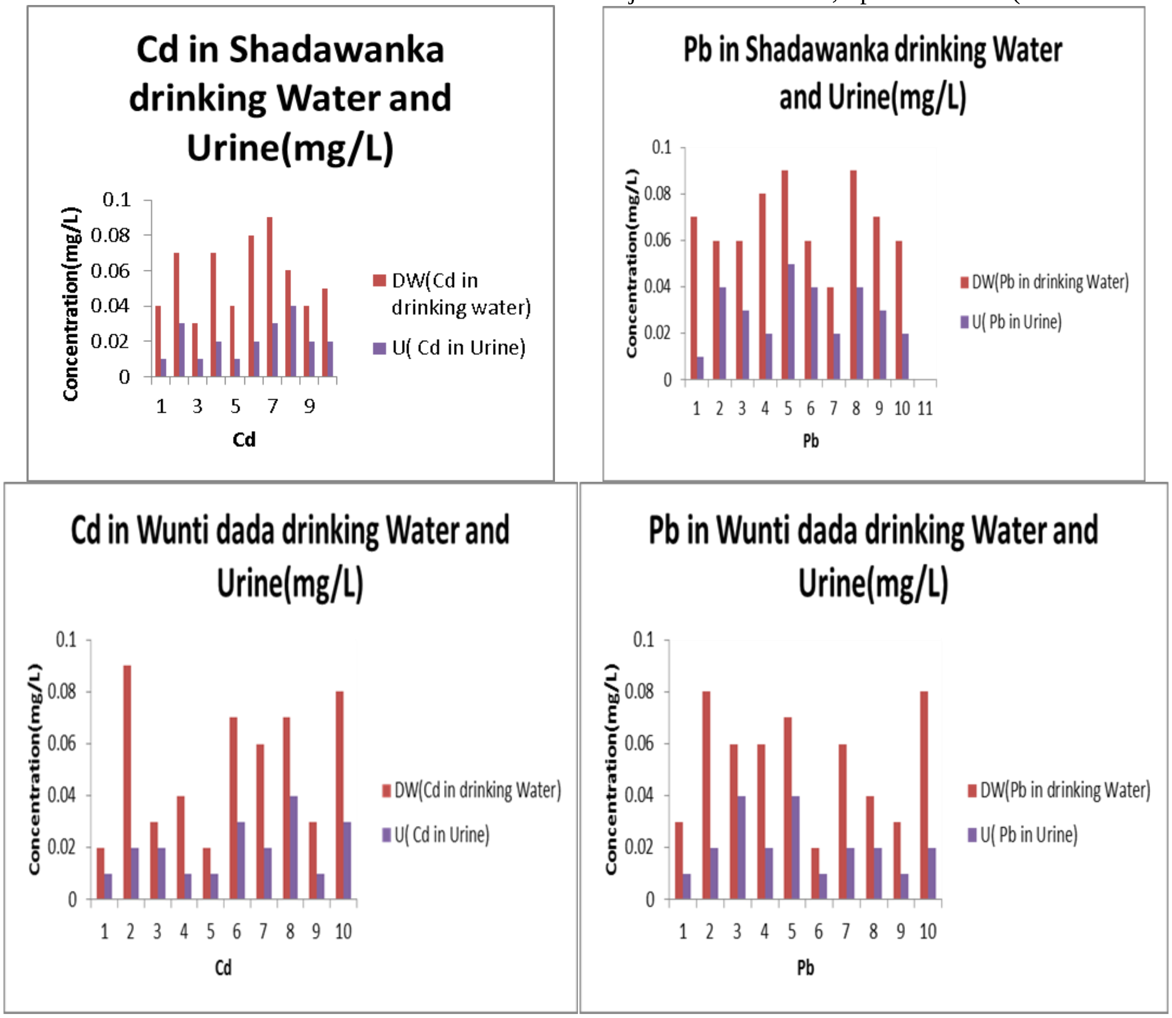

Fig. 2b: Column Representation of Levels of Pb and Cd in Drinking water(Dw) and Urine(U) in the Sampling Sites

IV. CONCLUSION

Study of Renal failure disease in a particular area is related to waste and agricultural activities that released hazardous and toxic materials in to ground water of the area and thereby led to contamination of the drinking water in the area. This disease is somehow related to contaminated drinking water with trace metals like Pb, Cd, Cr, Ni, and Cu.

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