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Effect of Water Pollution on Blood Elements in the Human Population of Hail, KSA

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ABSTRACT

The relationship between contaminated drinking water with trace elements and thyroid diseases hypertension, liver functions disorder and kidney functions disorder was studied in this research. The thyroid diseases hypertension, liver functions disorder and kidney functions disorder are due to contaminant drinking water with trace elements. The present study concerned with water toxicity. The heavy metals belonging to the most important pollutants. A strong relationship between contaminated drinking water with heavy metals from some of the stations of water shopping in Hail, KSA and thyroid diseases hypertension, liver functions disorder and kidney functions disorder has been identified in this study. These diseases are apparently related to contaminant drinking water with heavy metals such as Pb, Cd, Cu, Mo, Zn, Ni, Mn, Co and Cr. kidney functions disorder is related to contaminate drinking water with lead and cadmium, liver functions disorder to copper and molybdenum, and thyroid functions disorder to iodide, copper, and cadmium. Long-term exposure to lead, cadmium, zinc, iron, and arsenic in drinking-water is mainly related to primarily in the form of thyroid, liver, and kidney functions disorder. Studies of these diseases suggest that abnormal incidence in specific areas is related to toxic materials in the groundwater and thereby led to the contamination of drinking water in these areas. The result of this study showed that increase in the thyroid hormones, and liver functions test as AST and ALT enzymes. Also, there were increase in the hypertension and kidney functions test as creatinine and uric acid. These increases due to the pollution of drinking water by heavy metals.

Keywords: Thyroid disorder, liver functions, kidney functions, heavy metals

INTRODUCTION

The study of water pollution is very important to keep human in health. The fresh water is essential to human but it is becoming a limited resource due to the influence of population growth, pollution, and global warming [1]. Levey defined pollution as any substance affecting the environment by human activities that could have hazardous effects on human health, damage living resources and ecosystems, environment [2], destroy the structure or interfere with the genuine use of the environmental resources [3]. Environmental sources of cadmium toxicity include foods such as sea food, vegetables and cereals, residence in cadmium polluted areas and Indian medicinal herbs [4]. Affected individuals presented with anaemia, severe bone pain and reduced kidney function and kidney failure [5,6]. Cadmium has long biologicale, ranging from 7.4 to 16 years [7,8]. Environmental sources of arsenic include ground water, pesticides (by causing food contamination) and sea food [9]. High drinking water arsenic levels have been associated with increased mortality from chronic kidney disease (CKD) [7,8]. Arsenic levels in serum and blood cells correlate with worsening kidney disease [10], with the development of CKD attributed to arsenic-induced oxidative stress [11]. Environmental sources of mercury include contaminated fresh water fish [12]. There is relationship between contaminated drinking water with trace elements from some of the water shops of in Hail, KSA and chronic diseases such as renal failure, liver cirrhosis, and chronic anaemia has been identified in this study. These diseases related to contaminate drinking water with trace elements such as Pb, Cd, Cu, Mo, Zn, Ni, Mn, Co and Cr. Renal failure is related to contaminate drinking water with lead and cadmium, liver cirrhosis to copper and molybdenum, and chronic anaemia to copper and cadmium. The aim of this study is to determine the relationship between the contaminant drinking water and its impact on human health.

MATERIAL AND METHODS

Collect the blood samples to determine the heavy metals in blood samples for patients in three hospitals, Studying the types of prevalence diseases among the patients. Drinking water samples were collected from some of the stations of water shopping and wells in Hail, KSA. Heavy metal analysis in drinking water was done to analyze lead (Pb), zinc (Zn), copper (Cu), cobalt (Co), cadmium (Cd), nickel (Ni), chromium (Cr), molybdenum (Mo), and manganese (Mn). These samples were analyzed by using ICP emission instrument on Perkin Elmer ICP-400 at the university of hail, KSA. Each station is represented by 10 drinking water samples for chemical and blood analysis with a total of 50 samples.

Statistical analysis

Data were expressed as M±SD. The SPSS program version 15 was used in analysis. One way analysis of variance (ANOVA) followed by Duncan post hoc test and/or t-test were used in analysis. Pearson correlation coefficient was used to study correlations. P-values less than 0.05 was significant.

RESULTS

All areas have exceeded the standard limit (0.1 ppm) in most of the drinking water samples. The highest concentrations of molybdenum were represented by stations 2 and 4. The concentration of cadmium slightly exceeded the standard limit (0.01 ppm) from all stations. Nickel also, the highest concentrations were represented in stations 1 and 3. The concentration of zinc in all areas fell low than the standard limit (2.00 ppm, Table 1). The concentration of cobalt fell in all areas within the standard limit (1.00 ppm), which varies from 0.05 ppm to 0.1 ppm. The highest concentration of manganese was represented in stations 3, and 5 as shown in Table 1. All areas exceeded the standard limit (0.05 ppm) in most of the drinking water samples as showed in Table 1. The highest nickel concentrations were reported from stations 1 and 3 respectively.

Table 1 Concentration of heavy metals in ppm from 5 stations of drinking water in Hail, KSA

Elements	Station 1	Station 2	Station 3	Station 4	Station 5
Cu	1.00	1.00	1.01	0.91	1.00
Ni	0.41	0.06	0.41	0.06	0.05
Co	0.05	0.09	0.05	0.09	0.05
Zn	0.12	0.12	0.12	0.12	0.17
Pb	0.11	0.10	0.11	0.07	0.10
Cd	0.01	0.03	0.01	0.03	0.02
Cr	0.01	0.01	0.01	0.01	0.01
Mo	0.03	0.10	0.03	0.10	0.07
Mn	0.00	0.00	0.01	0.00	0.01

The blood glucose and electrolytes from three different hospitals in Hail are included in Table 2. All the blood glucose and electrolytes parameters were not significant ($p<0.05$) as shown in Table 3.

Table 2 The level of blood glucose and blood electrolytes in the blood sample from three different hospitals in Hail

Area	Hospital 1	Hospital 2	Hospital 3
Contents	Mean ± SE	Mean ± SE	Mean ± SE
Glucose	5.1 ± 0.35294	5.49 ± 0.54655	6.2 ± 0.8529
Na	136.3 ± 0.118	137.56 ± 0.7775	138.1 ± 0.711
K	4.1 ± 0.7882	4.3 ± 0.8125	4.6 ± 0.425
Cl	98.1 ± 0.8941	99.3 ± 0.1875	102.1 ± 0.083
Ca	1.8 ± 0.57059	2.1 ± 0.5445	2.3 ± 0.5113

The mean values of age, hypertension, TSH and T3 &T4 levels in the three groups are presented in Tables 3 and 4. The groups were different by age and significantly different were noted among groups for serum TSH, T4 and T3 concentrations (p>0.05). As shown in Table 3. Also, there were significantly different in their hypertension in three groups according to age as shown in Table 4.

Table 3 Mean values of TSH and T3 &T4 levels in the blood sample from three different hospitals in Hail

Area	Hospital 1	Hospital 2	Hospital 3
Contents	Mean ± SE	Mean ± SE	Mean ± SE
TSH (IU/ml)	1.5 ± 0.12	1.42 ± 0.56	1.35 ± 0.18
T3 (pmol/l)	1.42 ± 0.74	2.00 ± 0.21*	2.33 ± 0.36*
T4 (pmol/l)	12.02 ± 0.89	12.87 ± 0.85	13.22 ± 0.71*
Ratio T3/T4	0.13 ± 0. 83	0.16 ± 0. 24*	0.17 ± 0.51*
*Significantly different from normal- weight group, p<0.05			

Table 4 Mean values of hypertension, TSH and T3 &T4 levels in the blood sample from three different hospitals in Hail

Area	Hospital 1	Hospital 2	Hospital 3
Contents	Mean ± SE	Mean ± SE	Mean ± SE
Age	48 ± 0.41	58 ± 0.74	63 ± 0.82
Hypertension	149 ± 0.24	155 ± 0.26	161 ± 0.75
Blood pressure, systolic (mmHg)	149 ± 0.24	155 ± 0.26	161 ± 0.75
Blood pressure, diastolic (mmHg)	99.1 ± 0.25	100.2 ± 0.42*	103.3 ±0.91*
*Significantly different from normal- weight group, p<0.05			

Tables 5 and 6 showed that the urea, creatinine, and uric acid in the blood sample from three different hospitals in Hail were not significant increase in this population as shown in Table 6. The liver enzymes AST, ALT and ALP were a significant increase in blood of human in this population. The effect of water pollution on blood AST, ALT and ALP showed that only the variety Tamesrit had a significate increase on blood sample from three different hospitals in Hail as shown in Table 5.

Table 5 Mean values of AST, ALT, and ALP in the blood sample from three different hospitals in Hail

Area	Hospital 1	Hospital 2	Hospital 3
Contents	Mean ± SE	Mean ± SE	Mean ± SE
AST	23.11 ± 7.67	28.86 ± 17.48	25.64 ± 13.11
ALT	42.28 ± 12.95	41.72 ± 14.44	42.02 ± 13.5
ALP	143.46 ± 76.89	146.91 ± 59.67	144.98 ± 69.2

Table 6 Mean values of Creatinine, Uric acid, and Urea in the blood sample from three different hospitals in Hail

Area	Hospital 1	Hospital 2	Hospital 3
Contents	Mean ± SE	Mean ± SE	Mean ± SE
Creatinine	211.11 ± 164.63	195.87 ± 130.96	204.41 ± 149.47
Uric acid	6.36 ± 1.90	6.42 ± 2.67	6.38 ± 2.25
Urea	11.63 ± 7.48	12.77 ± 8.82	12.13 ± 8.05

DISCUSSION

The levels of chemicals in drinking water, however, are seldom 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. Examples of chronic health effects include cancer, birth defects, organ damage, disorders of the nervous system, and damage to the immune system [13]. The present study showed that concentration of heavy metals in all areas have exceeded the standard limit (0.1 ppm) in most of the drinking water samples. The highest concentrations of molybdenum were represented by stations 2 and 4. The concentration of cadmium slightly exceeded the standard limit (0.01 ppm) from all stations. Nickel also, the highest concentrations were represented in stations 1 and 3. The concentration of zinc in all areas fell low than the standard limit (2.00 ppm, Table 1). The concentration of cobalt fell in all areas within the standard limit (1.00 ppm), which varies from 0.05 ppm to 0.1 ppm. The highest concentration of manganese was represented in stations 3, and 5. All areas exceeded the standard limit (0.05 ppm) in most of the drinking water samples. The highest nickel concentrations were reported from stations 1 and 3 respectively. Pb, Cd, Cu, Mo, Zn, Ni, Mn Co and Cr are toxigenic and carcinogenic agents consistently found as contaminants in human drinking water supplies in many areas around the world [14,15]. This study shows a strong relationship between heavy metals such as lead, copper, nickel, chromium, cadmium and molybdenum and renal failure, liver cirrhosis, hair loss and chronic anaemia diseases. Exposure to lead is cumulative over time. High concentrations of lead in the body can cause death or permanent damage to the central nervous system, the brain, and kidneys [9,14]. This damage commonly results in behaviour and learning problems (such as hyperactivity), memory and concentration problems, high blood pressure, hearing problems, headaches, slowed growth, reproductive problems in men and women, digestive problems, muscle, and joint pain. There is no evidence indicating its essentiality to humans. Also, the present study demonstrated that the blood glucose and electrolytes from three different hospitals in Hail were not significant ($p<0.05$). Values of age, hypertension, TSH and T3 &T4 levels in the three groups were different by age and significantly different were noted among groups for serum TSH, T4 and T3 concentrations ($p>0.05$). Also, there were significantly different in their hypertension in three groups. ALP, the higher level of the enzyme was detected in the higher concentration of uric acid. Cd appears to accumulate with age, especially in the kidney and it is considered also as a cancer and cardiovascular diseases. Webb [4] reported that geochemical implications of Cd in human health related to: (a) bone and renal disease in populations exposed to industrially contaminated drinking water, (b) lung and renal dysfunction in industrial workers exposed to air-borne Cd and (c) implication in human hypertension. Galvanized steel is plated with zinc, which is normally contains about in low doses, cadmium can produce coughing, headaches, and vomiting. In larger doses, cadmium can accumulate in the liver and kidneys, and can replace calcium in bones, leading to painful bone disorders and to a renal failure. The kidney is considered to be the critical target organ in humans chronically exposed to cadmium by ingestion. Patients suffer from liver cirrhosis in this study were related to contaminant drinking water mainly with copper and molybdenum. Copper is essential substance to human life, but chronic exposure to contaminant drinking water with copper can result in the development of anaemia, liver, and kidney damage [7,8,14]. This disease was a result of drinking water contaminated from corrosion of water pipes made of copper and industrial wastes. The urea, creatinine, and uric acid in the blood sample from three different hospitals in Hail were not significant increase in this population. The liver enzymes AST, ALT and ALP were a significant increase in blood of human in this population. The effect of water pollution on blood AST, ALT and ALP showed that only the variety Tamesrit had a significate increase on blood sample from three different hospitals in agreement with Shokr, et al. and Jennings et al. Molybdenum is an essential dietary nutrient, which is a constituent of several mammalian enzymes including xanthine oxidase, sulphite oxidase and aldehyde oxidase [16]. Although molybdenum is an essential mineral, no deficiencies have been reported in humans. Molybdenum is present in very small amounts in human body. Its content can be varied in tissues such as liver, kidney and bone depending on the dietary intake [11]. High levels ingested molybdenum may be associated with potential mineral imbalance by increasing serum ceruloplasmin and urinary extraction of copper. Excretion of sufficient quantities of this element may put humans at risk for the hypochromic microcytic anaemia associated with dietary copper deficiency [12,17]. The present study illustrated that the higher level of uric acid was detected in the medium group for uric acid level. The association between uric acid range-groups and the other kidney function tests, electrolytes, and glucose. Highly significant association was found between uric acid and urea ($p=0.002$). For calcium, the higher level of the metal was detected in the middle concentration group of uric acid while the higher level of potassium was found in the higher uric acid group. White, et al. reported that copper-molybdenum interaction appears to be critical to the development of gout-like symptoms at very high levels of molybdenum [18]. Patients suffer from hair loss in this study were related to contaminant drinking water with nickel and chromium. It is considered as carcinogenic to human. Ambrose, et al. reported that high-dose of nickel in rats and dogs were significantly decreasing their body weights [19]. Kaaber, et al. reported worsening of eczema for human exposed to high level for nickel [20,21]. Chromium often accumulates in aquatic life, adding also to the danger eating fish that may have been exposed to high levels of chromium. Chronic exposure to contaminant drinking water with cadmium can result in the development of chronic anaemia [5,6]. Cadmium poisoning has been associated with kidney disease, hypertension, and chronic anaemia [9,22]. Cadmium may interfere with the metallothionein's ability to regulate zinc and copper concentrations in the body that some patients showed some elevation in zinc in their urine samples. Metallothionein is a protein that binds to excess essential metals to render them unavailable. When cadmium induces metallothione in activity, it binds to copper and zinc disrupting the homeostasis levels [23]. Cadmium is used in industrial manufacturer and is a by-product of the metallurgy of zinc. Our results show that patients suffered from renal failure could be related to their contaminated drinking water with lead and cadmium, liver cirrhosis to copper and molybdenum, hair loss to nickel and chromium, and chronic anaemia to contaminant drinking water with copper and cadmium. The present study was performed on a total of 50 patients for demographic characteristics of patients

[24-26]. World Health Organization reported that the renal failure is related to contaminate drinking water with lead and cadmium, liver cirrhosis to copper and molybdenum, hair loss to nickel and chromium, and chronic anaemia to copper and cadmium [27]. Metals should be removed from drinking water if they are present at high levels for human safety. The aim of this study is to determine the relationship between the contaminant drinking water and its impact on human health.

CONCLUSION

Environmental factors are an important cause of acute and CKD, especially in the developing world. It is important to note that most environmental renal disease is in fact multifactorial. As an example, only approximately 1% to 2% of the residents' endemic nephropathy progress to the disease. Studies for these diseases suggest that abnormal incidence in specific areas is related the groundwater and thereby led to the contamination of drinking water in these areas. These diseases are apparently related to contaminant drinking water with heavy metals.

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