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Geographical renogram scanning for patients of renal Diseases

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ABSTRACT

Geochemical environment is indeed a significant factor in the serious health problems.Many people have suffered from diseases that led to serious studies to find out the relationship between drinking water and chronic diseases. The chemistry of drinking water commonly has been cited as an important factor in many diseases. A strong relationship between contaminated drinking water with heavy metals from some of the governorates in Egypt and chronic diseases such as renal failure has been identified in this study. These diseases are apparently related to contaminant drinking water with heavy metals such as Fe, Pb, Cd, Mn and Ni. Renal failure is related to contaminated drinking water with lead (Pb) and cadmium (Cd). There is a relationship between chronic diseases and geologic environment. The purpose of the present study is to assess and compare drinking water quality with WHO standards and its related renal diseases in seven governorates in Egypt: Cairo, Giza, El-Sharkia, El-fayoum, Bani-Sweif, Sohag and Aswan. Water samples have been taken for each governorate from drinking water tap. Data collection based on laboratory analyses of water samples and patients with renal diseases that undergoing investigation for diagnosis in Nuclear Medicine Department using Glomerular Filtration Rate (GFR) as indicator for renal function status. Some physical and chemical parameters are examined to find out quality of drinking tap water. The data reveal that percentage of renal failure and obstructed kidneys are in progress in surveyed geographical areas. Situation was much worse for Aswan where the percentage of renal failure was about 76.41% then El-Fayoum with about 66.67%, Sohag with about 66.28%, Bani-Sweif with about 64.49%, El-Sharkia with about 64.29%, Cairo about 53.19% and Giza with about 49.65%. The patients with obstructed nephrouropathy were much worse for Giza (about 26.95%), El-Sharkia (about 26.67%) and Cairo (about 25.53%). The percentage of patients with hydronephrotic kidneys was the highest in Upper Egypt. To save local residents study suggests; regular monitoring of water quality should be practiced to provide safe drinking water and regular monitoring of renal functions to protect the kidney from different diseases.

INTRODUCTION

Physical, chemical and biological characteristics of water are considered as a main health controlling factor and the state of disease in the living organisms. Safe and good quality drinking water is one of the most important human needs. (Kazi *et al*., 2009). Drinking water is one of the basic needs of life and essential for survival. Still more than one billion people all over the world do not have ready access to an adequate and safe water supply and more than 800 million of those unsaved live in rural zones (Kumar, &Puri, 2012).

Glomerular filtration rate provides an excellent measure of the filtering capacity of the kidneys.Chronic kidney disease, a major public health problem whose prevalence is constantly increasing worldwide, is traditionally diagnosed and monitored by assessment of glomerular filtration rate (GFR) (Myers *et al*., 2006;

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Thomas and Huber, 2006). In accordance with the Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines, estimates of glomerular filtration rate (GFR) are the best overall indices of the level of renal function (National Kidney Foundation, 2002). It can be used as an index of functioning renal mass; and changes in GFR can delineate progression of kidney disease, the level of GFR being a strong predictor of the time to onset of kidney failure and the risk of complications of chronic kidney disease (CKD) such as cardiovascular disease, hypertension, anemia, malnutrition, bone disease, neuropathy, decreased quality of life anddeath (Levey *et al*., 2005; National Kidney Foundation, 2002).Rapid and accurate estimation of the glomerular filtration rate (GFR) is required for many major clinical decisions in patients with chronic nephropathies. Direct GFR measurement is time-consuming and expensive, frequently requires urine collection and isotope use, and is routinely available in only a few medical centers (Stevens *et al*., 2006).

The gamma camera uptake method with ^{99m}Tc- DTPA is simple and less time consuming for the determination of the glomerular filtration rate (GFR) (Itoh, 2003). In ^{99m}Tc-DTPA renography, the glomerular filtration rate (GFR) is calculated without blood or urine sampling (Prigent *et al*., 1999). Estimation of the glomerular filtration rate (GFR) is required in the assessment of patients with chronic kidney disease (CKD) in order to provide information regarding the functional status of the kidneys. (Agaba *et al*., 2009).

A strong relationship between contaminated drinking water with heavy metals from some of the Cities, Egypt and chronic diseases such as renal failure, liver cirrhosis, hair loss, and chronic anemia has been identified (Salem *et al*., 2000). End stage renal disease (ESRD) is emerging as a major health problem in Egypt. The prevalence of dialysis patients is presumed to have increased from 10 per million in 1974 to about 165 per million in 1995 (Afifi and Karim, 1996). The growing number ofpatients suffering from ESRD places a great demand on the health care resources in Egypt due to the high cost of dialysis and transplantation. The causes and risk factors for the development of ESRD vary worldwide (Kamel and El-Minshawy 2010).

MATERIALS AND METHODS

The study aim was to determine the relationship between the drinking water and its impact on human health especially kidney in different areas in Egypt(El-Sharkia, Cairo, Giza, El-Fayoum, Bani-Sweif, Sohag and Aswan) and investigate the possible causes of ESRD and determine the levels/concentration of some of the physicochemical parameters, heavy metals (Fe, Mn, Ni, Pb, Cd) and some elements (Si and F) in drinking water in different governorates of Egyptand compare the values with international organization (like WHO) recommended drinking water standards.

Fig. 1: location of study governorates in Egypt.

1. Drinking Water Analysis:

In the present study, drinking water samples are collected from different governorates in Egypt. Samples are collected from residential tap water. [From patients who lived in these zones and suffered from different renal diseases and these patients are complained from tap water in their houses] Mineral contents of drinking water are carried out according toJackson (1967) and are determined by the following determinations: Sodium (Na) and potassium (K) are determined by using Flame Photometer.Calcium (Ca) and magnesium (Mg) are determined by titration with versenat (EDTA); chlorine (Cl) is determined by titration with $AgNO_3$;bicarbonate (HCO_3) is determined by titration with HCl;sulphate (SO_4) is calculated by difference between anions and cations; lead (Pb), nickel (Ni), manganese (Mn), silicon (Si), cadmium (Cd) and iron (Fe) are analyzed by using Inductively Coupled Plasma (ICP) Spectrometry (Ultima 2 JY Plasma). Electrical conductivity (EC) is determined in water according to Chapman and Pratt (1961)by using Electrical Conductivity Meter modelMettler Toledo Conductivity. Fluorine is determined by using Calorimetric Method Spectrophotometer UV-VIS-Recording (UV-2401PC, Shimadzu, Japan).pH values are determined in water according to Chapman and Pratt (1961) using pH-Meter model PMX 3000.

2.Renography:

Diagnoses of different renal diseases are carried out by renal scan (Renography) by Gate method (Gates, 1982;1983).The renal uptake of the ^{99m}Tc-DTPA 2 to 3 minutes after tracer arrival in the kidney is proportional to GFR.The total GFR is calculated using a formula derived from regression analysis comparing 24 hours creatinine clearance to percent renal uptake, as:

$$\text{GFR (ml/min)} = (\%\ \text{renal uptake}).\ R - 6.82519 \qquad (1)$$

Where R is the regression coefficient (= 9.8127) and 6.82519 is the y-intercept. The percent renal uptake in the GFR equation is calculated according to the following formula (Pegasys Ultra Reference Manual, 1997):

$$\%\ \text{renal uptake} = \left[\frac{\frac{(\text{Rt kidney cts} - \text{bkg})}{e^{-\mu x}} + \frac{(\text{Lt kidney cts} - \text{bkg})}{e^{-\mu x}}}{(\text{preinj . cts} - \text{postinj . cts})}\right] \times 100 \qquad (2)$$

Where;

Rt kidney cts and Lt kidney cts: the right and left kidney counts measured by region of interest,
bkg: background of kidney region of interest (ROI),
preinjcts: preinjection counts,
postinjcts: postinjection counts,
μ: equals 0.153 is the attenuation coefficient of ^{99m}Tc in soft tissues and
x: equals the kidney depth in centimeters (Pegasys Ultra Reference Manual, 1997).

The uptake percentage of the left and right kidney at 2 to 3 minutes post-injection was calculated by dividing the background and depth-corrected kidney counts by the total net counts injected and multiplying the result by 100. These values (the normalized and depth-corrected kidney counts and the total net counts) are obtained from the nuclear medicine renogram study.

^{99m}Tc-DTPA is prepared in Radioisotope Laboratories in King Fahd Unit, Cairo University Hospitals (Egypt) using a commercially available freeze-dried kit. A dose is ranged from 5 mCi and is administered to 959 patients with different renal diseases, Prior to the administration, the pre-injection syringe with straight needle is counted by two different devices: 1) dose calibrator (ATOMLAB 100) and 2) gamma camera(Siemen, Orbit, Single head), which was attached to a Low-Energy General-Purpose Parallel-Hole Collimator. The patient lay down on a bed in the supine position and the image will acquired a posterior.^{99m}Tc-DTPA is given through abutterfly needle into vein and was followed by injection of 5 ml of normal saline then 2 ml lasix.

RESULTS AND DISCUSSION

Medical geology is a rapidly emerging discipline that examines links between geological maps and spatial/temporal distribution of human diseases. In Egypt health problems arising from interactions with the natural environment have been observed for many years. Indeed, many of the leading causes of death in Egypt, as in other developing regions of the world, could be linked to factors of the environment. Water pollution causes diarrhoeal diseases and other water-related illnesses; water hardness has been implicated in some forms of renal disorders. This section attempts to summarize the present state of knowledge based on work done and studies that are ongoing in Egypt on medical geology. The need to address the types of data needed for drawing up correlations between patterns of trace element distribution and environmental diseases along the Nile main stream and its two branches. At each sampling location, random samples of water are taken, and their physical and chemical properties are measured and recorded to assess the water quality.

The distribution values of chemical analysis for different geographical zones in Egypt, and its permissible limits of minerals contents, heavy metals and physical parameters according to WHO are illustrated in figure2 to figure 18.

It is noticed from the figures that:

Sodium (Na): Proper quantity of sodium in human body prevents many fatal diseases like kidney damages, hypertension, headache, etc., in most of the countries, majority of water supply bears less than 20 mg/l while in some countries the sodium quantity in water exceeded from 250 mg/l. According to WHO standard (WHO, 1984), concentration of sodium in drinking water was 200 mg/l. As presented in figure 2 the results showed that sodium concentration in water was 16.86 and 60.95 mg/l in Aswan and El-Fayoum, respectively. Sodium quantity in drinking water in El-Sharkia, Giza, Sohag and Aswan were quietly lower than in Cairo, El-Fayoum and Bani-Sweif which could be harmful for the health of local inhabitants.

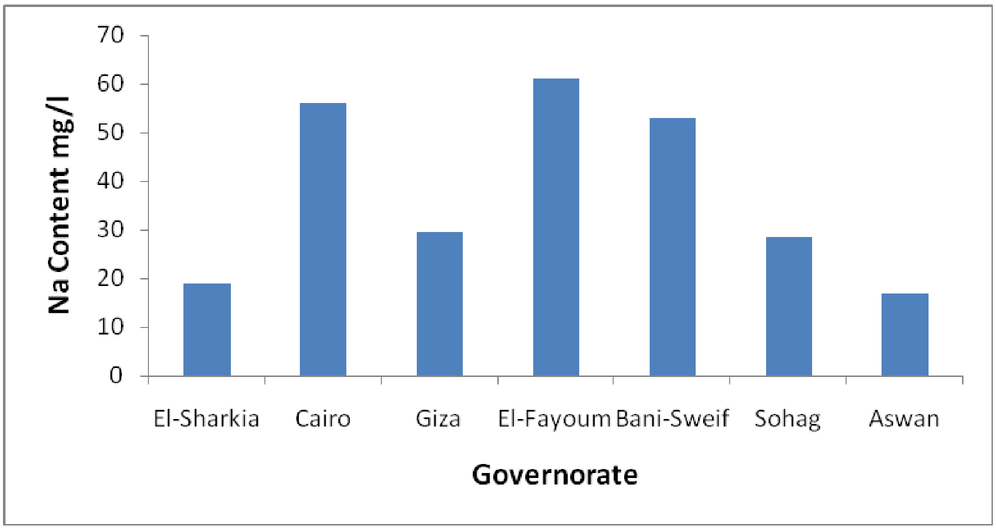

Fig. 2: Presents of sodium (Na) content in surveyed geographic areas.

Potassium (K): The total potassium amount in human body lies between 110 to 140 g. It is vital for human body functions like heart protection, regulation of blood pressure, protein dissolution, muscle contraction, nerve stimulus, etc., potassium is deficient in rare but may led to depression, muscle weakness, heart rhythm disorder, etc. (Mohsin *et al.*, 2013).According to WHO standards (WHO, 1984), the permissible limit of potassium was 12 mg/l. As presented in figure 3 the results showed that the concentration of potassium was ranging from 2.73 mg/l in Sohag and Cairo to, 8.19 mg/l in Giza. These results were meet the WHO standards and may become preventive for diseases associated potassium extreme deficiency.

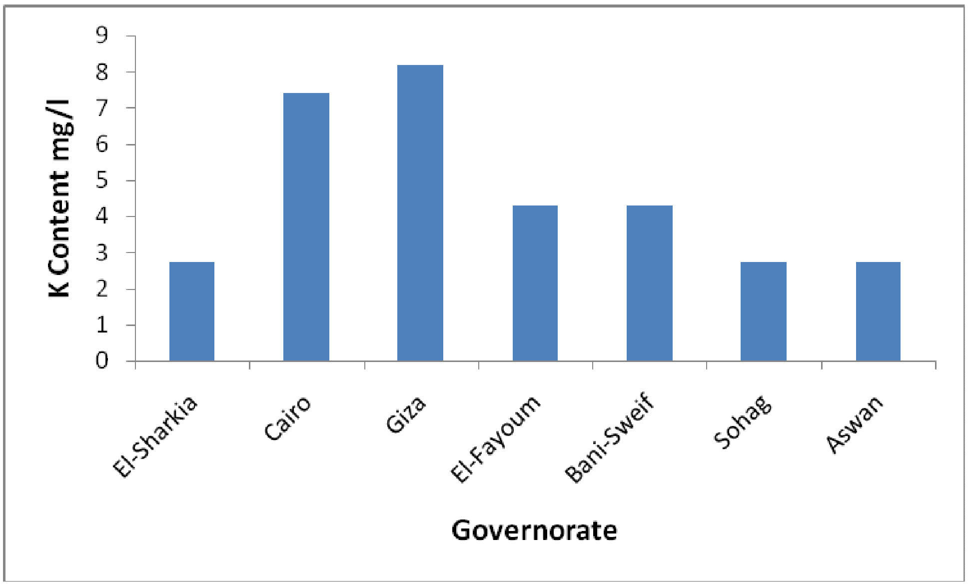

Fig. 3: Presents of potassium (K) content in surveyed geographic areas.

Calcium (Ca): Calcium is very important for human cell physiology and bones. About 95% calcium in human body stored in bone and teeth. The high deficiency of calcium in humans may cause rickets, poor blood clotting, bones fractures, etc., and the exceeding limit of calcium produced cardiovascular diseases (Mohsin *et al*., 2013).According to WHO (1996) standards its permissible range in drinking water was 75 mg/l, however, an adult require 1000 mg/day to work properly. In concerned governorates, as presented in figure 4 the results showed that the concentration of calcium was 21 mg/l in El-Sharkia, Giza and Aswan, 24.6 mg/l in Sohag, 31.8 mg/l in Bani-Sweif, 38.6 mg/l in El-Fayoum and 39.2 mg/l in Cairo. Wide variations in values of Ca in surveyed governorates are observed.

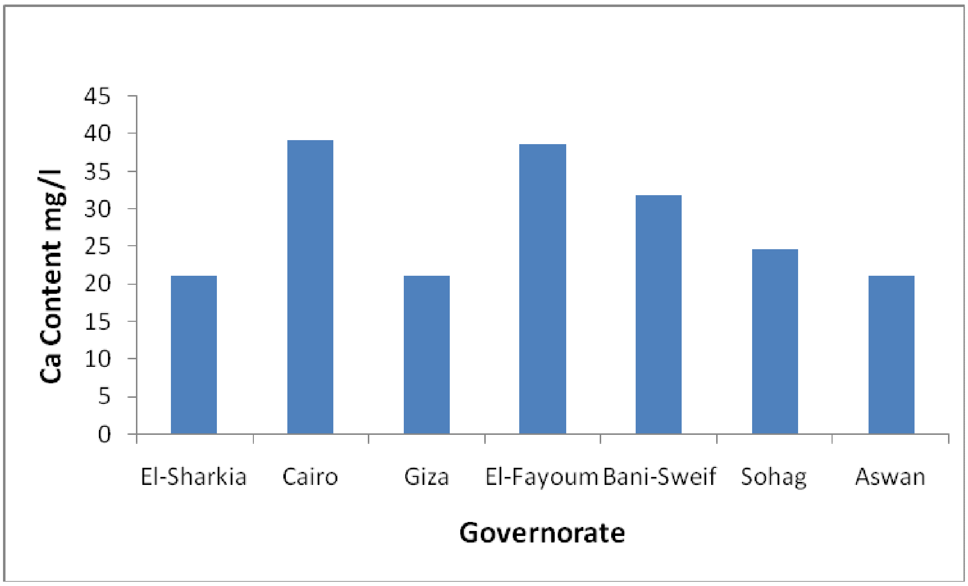

Fig. 4: Presents of calcium(Ca) content in surveyed geographic areas.

Magnesium (Mg): Magnesium is natural constituent of water. It is an essential for proper functioning of living organisms. Human body contains about 25g of magnesium (60% in bones and 40% in muscles and tissues) (Mohsin *et al*., 2013). According to WHO (1984) standards the permissible range of magnesium in water should be 150 mg/l. As presented in figure 5 the concentration of magnesium was 8.16 mg/lin Sohag, 8.52 mg/l in El-Sharkia and Aswan, 8.64 mg/l in El-fayoum, 11.04 mg/l in Bani-Sweif and 11.28 mg/l in both Cairo and Giza. The quantity of magnesium was significantly low in the studied geographic areas in comparison to WHO limits. Such a low concentration will effect on health of residents as it is essential for human body. If anybody drinks low magnesium or low calcium water, it means that he/she is at higher risk for some diseases but it does not mean that he/she will certainly develop the disease. This situation is easily comparable with drinking water containing a contaminant in amounts let's say by 300% higher than the limit allowed, a man drinking such water may not develop the disease possibly caused by the given contaminant, since the limits are established to cover a sufficient safety factor. Nevertheless, the man is at higher risk for the pollutant-related disease. Although the risks are comparable, if the risk from low magnesium water is not higher, the regulatory and enforcement mechanisms for undesirable contaminants are very strong, while those for naturally present beneficial elements such as Mg and Ca are very weak, if any at all.

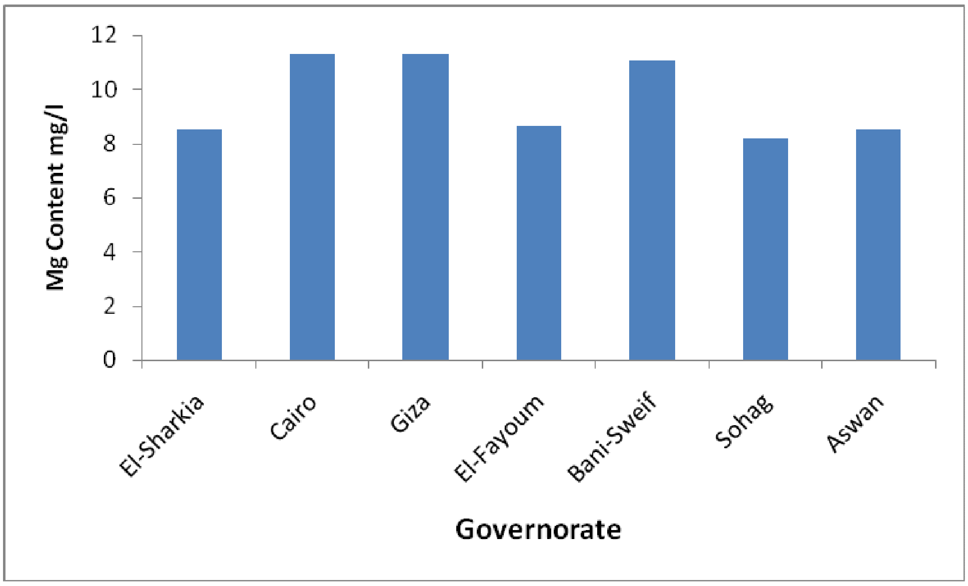

Fig. 5: Presents of magnesium (Mg) content in surveyed geographic areas.

Chloride (Cl): Excessive chloride concentration increase rates of corrosion of metals in the distribution system (Burande, 2013). According to WHO (1996) standards, the concentration of chloride should not exceed 250 mg/l. In the Governorates under study, as presented in figure 6 the chloride value was 13mg/l in El-sharkia, Sohag and Aswan, 26.25 mg/l in Bani-sweif, 35mg/l in El-Fayoum, 42.7 mg/l in Giza and 46.9 mg/l in Cairo. All samples have lower concentrations of chloride.

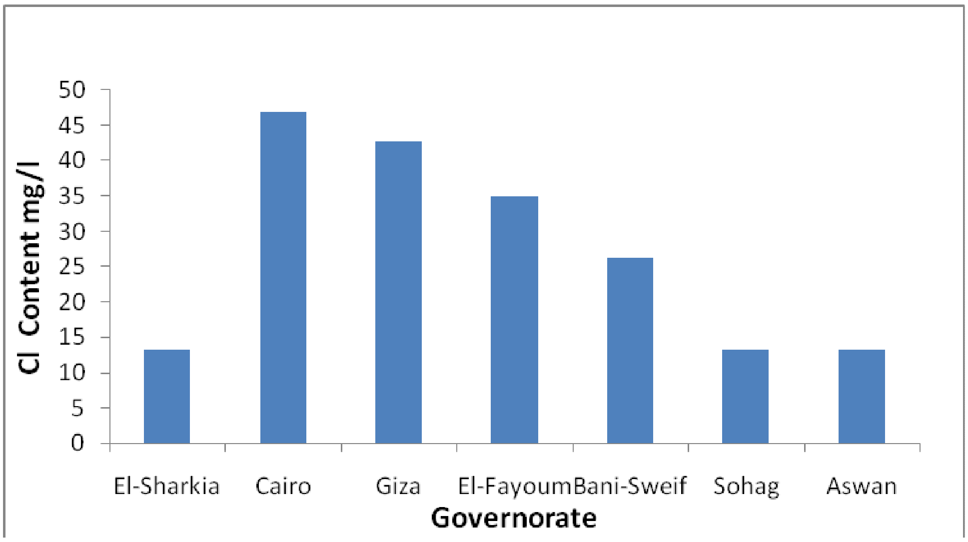

Fig. 6: Presents of chlorine (Cl) content insurveyed geographic areas.

Sulfate (SO_4): Sulfate concentration in natural water ranges from a few to a several hundred mg per liter but no major negative impact of sulfate on human health is reported (Mohsin *et al*., 2013). The WHO (2004) has established 250 mg/l as the highest desirable limit of sulfate in drinking water. As presented in figure 7 the concentration of sulfate was 55.2 mg/l in El-sharkia and Aswan, 56.16 mg/l in Giza, 68.64mg/l in Cairo, 77.76 mg/l in Sohag, 131.52 mg/l in Bani-Sweif and 143.52 mg/l in El-Fayoum.

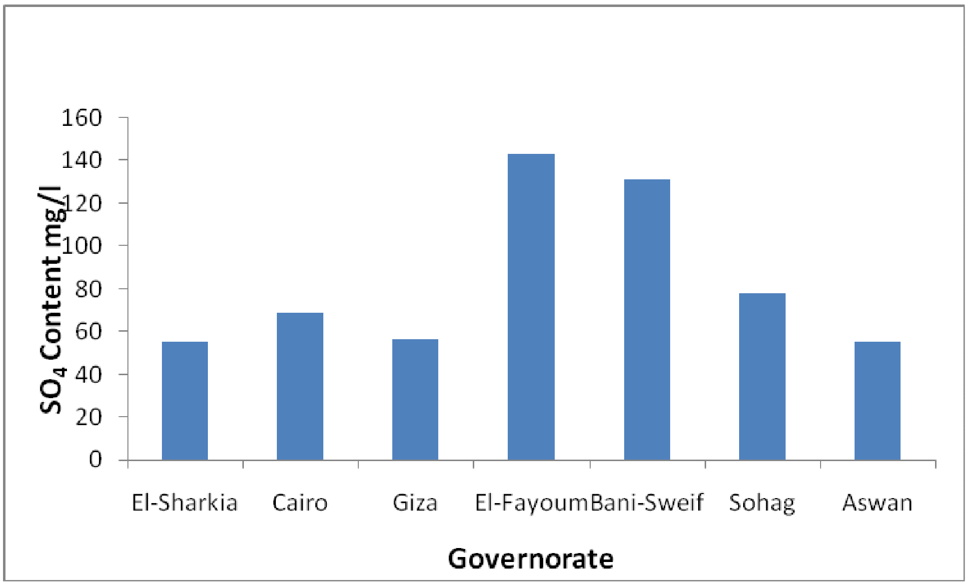

Fig. 7: Presents of Sulfate (SO_4) content in surveyed geographic areas.

Bicarbonates (HCO_3): Mostly bicarbonates are soluble in water, i.e., bicarbonate of magnesium and calcium, etc., are the main causes of hardness of water. The hard water is not suitable for drinking purpose and causes the gastro diseases (Mohsin *et al*., 2013). As presented in figure 8the data showed that, the concentrations of bicarbonates were 67.1 mg/l in Giza, 68.93 mg/l in El-sharkia and Aswan, 75.03 mg/l in Sohag, 86.62 mg/l in El-Fayoum and Bani-sweif and 125.05 mg/l in Cairo.

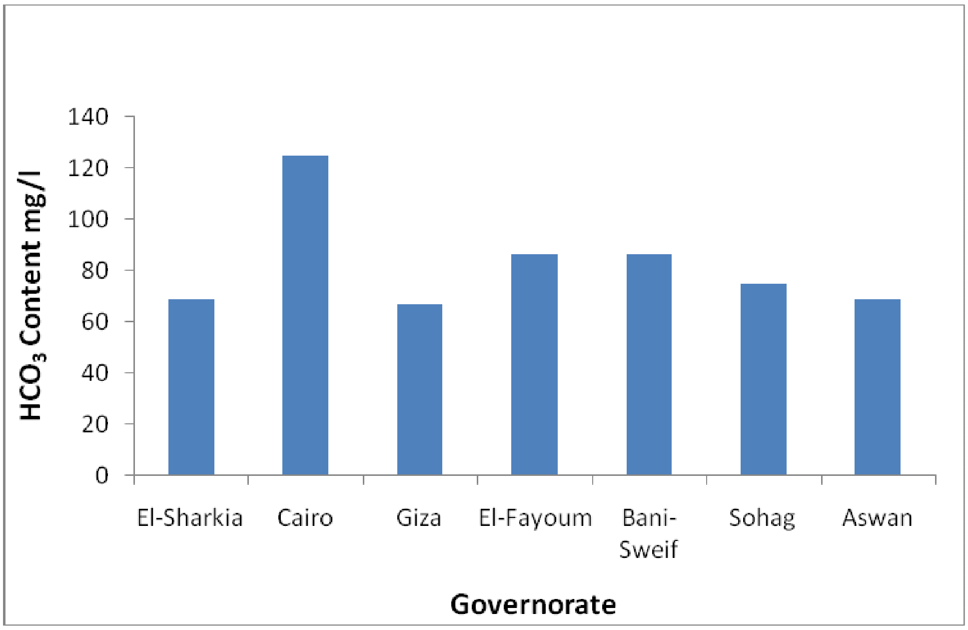

Fig. 8: Presents of bicarbonate content(HCO_3) in surveyed geographic areas.

Electrical conductivity: Electrical conductivity (EC) is actually measures the ionic process of a solution that enables it to transmit current (Mohsin *et al*., 2013). Pure water is not a good conductor of electric current rather a good insulator. Increase in ions concentration enhances the electrical conductivity of water. Generally, the amount of dissolved solids in water determines the electrical conductivity. According to WHO (2004) standards, EC value should not exceeded 400 µS/cm. It is clear from the table that, EC values were 270 µS/cm in El-sharkia and Aswan and ,320 µS/cm in Sohag, 340 µS/cm in Giza, 460 in µS/cm Cairo and Bani-Sweif, and 550 µS/cm in El-Fayoum as presented in figure 9. These results indicated that drinking water in Cairo, Bani-Sweif and El-Fayoum has the higher level of ionic concentration conductivity due to excessive dissolve solids.

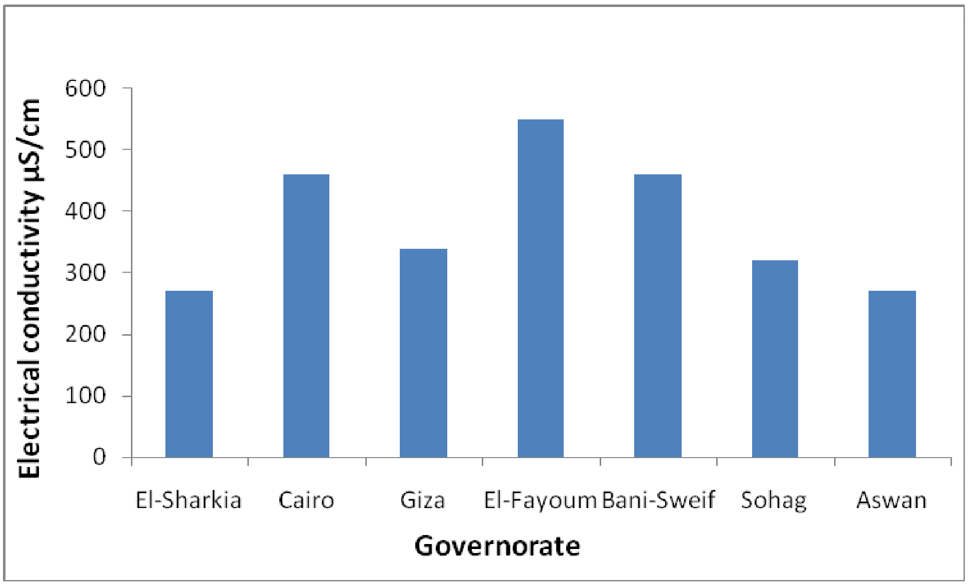

Fig. 9: Presents values of electric conductivity(EC) in surveyed geographic areas.

Total dissolved solids (TDS): Water has the ability to dissolve a wide variety of inorganic and some organic minerals or salts such as potassium, calcium, sodium, bicarbonates, chlorides, magnesium, sulfate, etc. These minerals produced un-wanted taste and diluted color in appearance of water. Therefore, TDS test is considered a sign to determine the quality of water (Mohsin *et al*., 2013). High values of TDS in ground water were generally not harmful to human beings but high concentrations of these may affect persons who are suffering from kidney and heart diseases (Burande, 2013). As presented in figure 10 the data showed that, the value of TDS was 173 ppm in El-sharkia and Aswan, 218 ppm in Giza, 205 ppm in Sohag, 294 ppm in Cairo and Bani-Sweif and 352 ppm in El-Fayoum. Hence, these values were acceptable and concentrations of TDS were not harmful.

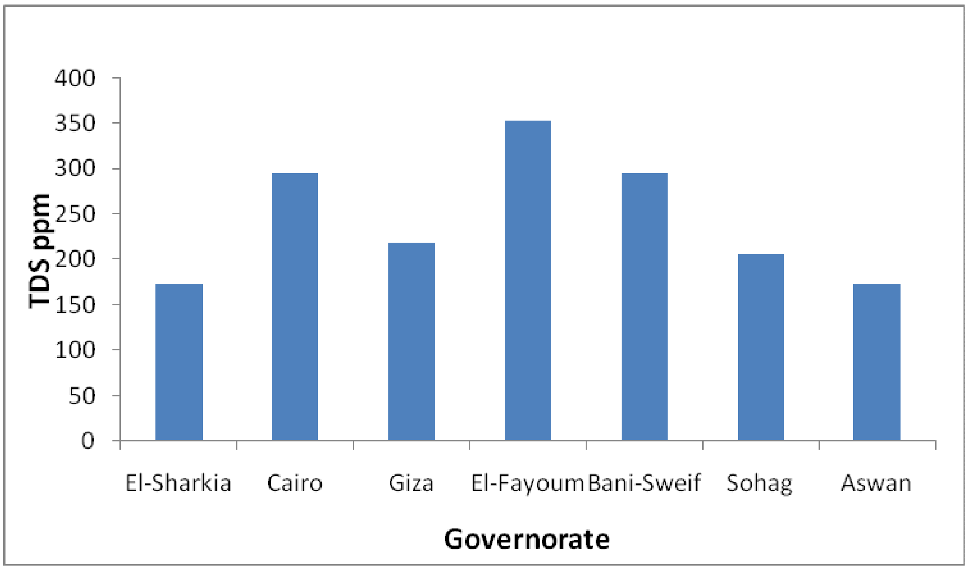

Fig. 10: Values of TDS in surveyed geographic areas.

Iron (Fe): The excess amount of iron causes slightly toxicity; give stringent taste to water (Stewart *et al*., 1989). Concentrations of iron in drinking-water are normally less than 0.3 mg/liter(WHO, 1996). Iron is an essential element in human nutrition. Estimates of the minimum daily requirement for iron depend on age, sex, physiological status, and iron bioavailability and range from about 10 to 50 mg/day.As a precaution against storage of excessive iron in the body, Joint Expert Committee on Food Additive (JECFA) established a provisional maximum tolerable daily intake (PMTDI) in 1983 of 0.8 mg/kg of body weight (FAO/WHO, 1983). As presented in figure 11 concentrations of iron were 0.007 mg/l in El-Shakia, 0.012 mg/l in Giza, 0.016 mg/l in El-fayoum and 0.021mg/l in Cairo. Iron is not detectable in water of Bani-Sweif, Sohag and Aswan.

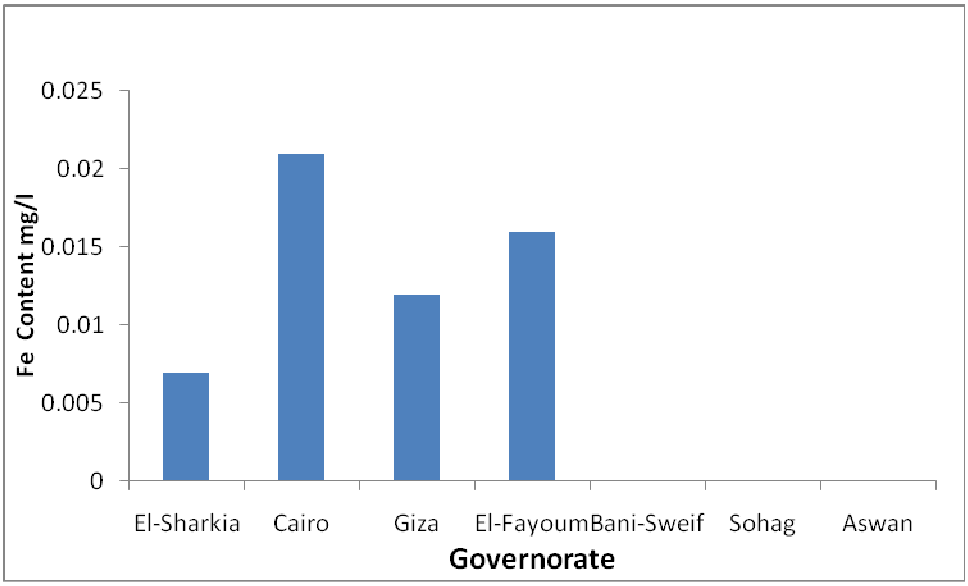

Fig. 11: Presents of iron(Fe) content in surveyed geographic areas.

Manganese (Mn): Manganese is a naturally-occurring element that can be found ubiquitously in the air, soil and water. Manganese is also an essential nutrient for humans and animals (U.S. EPA, 2003). Although manganese is an essential nutrient at low doses, chronic exposure to high doses may be harmful. (U.S. EPA, 2003). Mn is present in all tissues of the body, the highest levels usually being found in the liver, kidney, pancreas, and adrenals (Sumino *et al*., 1975). As presented in figure 12 values of Mn detected were 0.001 mg/l in Bani-Sweif, 0.002 mg/l in El-Sharkia and Sohag , 0.004 mg/l in Giza and 0.005 mg/l in Cairo and Aswan.

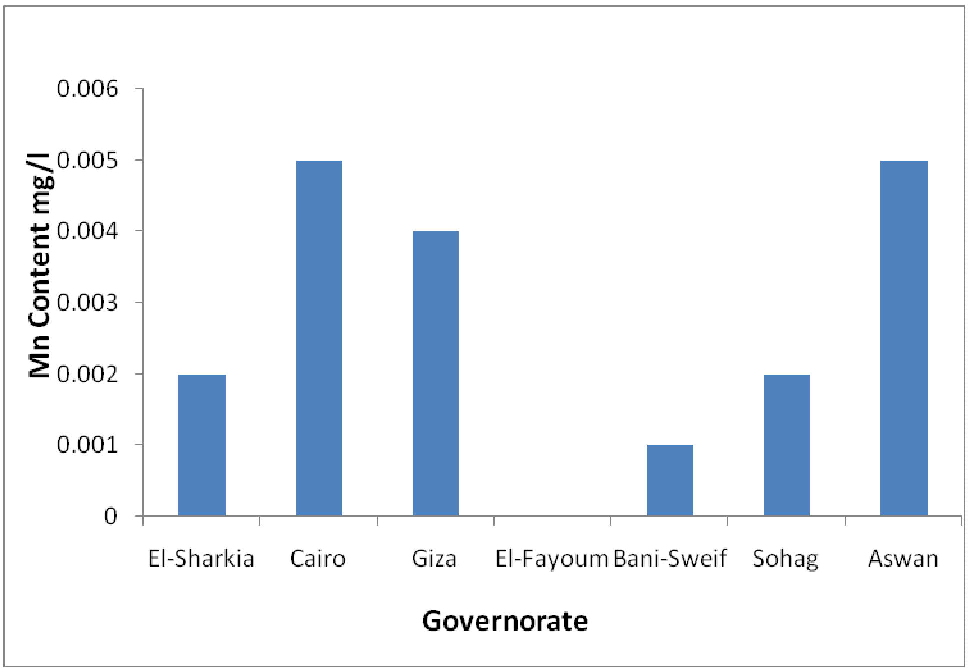

Fig. 12: Presents of manganese(Mn) content in surveyed geographic areas.

Nickel (Ni): Nickel is used principally in its metallic form combined with other metals and non-metals as alloys (IARC, 1990). Effects on kidney function, including tubular and glomerular lesions, have been reported after parenteral administration of high nickel doses of between 1 and 6 mg/kg of body weight intraperitoneally. Intramuscular injection of the insoluble compound nickel subsulfide caused acute kidney damage. Increased relative kidney weight was observed in patients exposed to high dose of nickel (as nickel sulfate) (WHO, 1998). As presented in figure 13the values of Ni presented in Cairo was 0.001mg/l, while was not detected in El-

Sharkia, Giza, El-Fayoum, Bani-sweif, Sohag and Aswan. Long exposure to drinking water with high content of Ni lead to hydronephrotic and chronic kidney diseases turn over permanent renal failure patients.

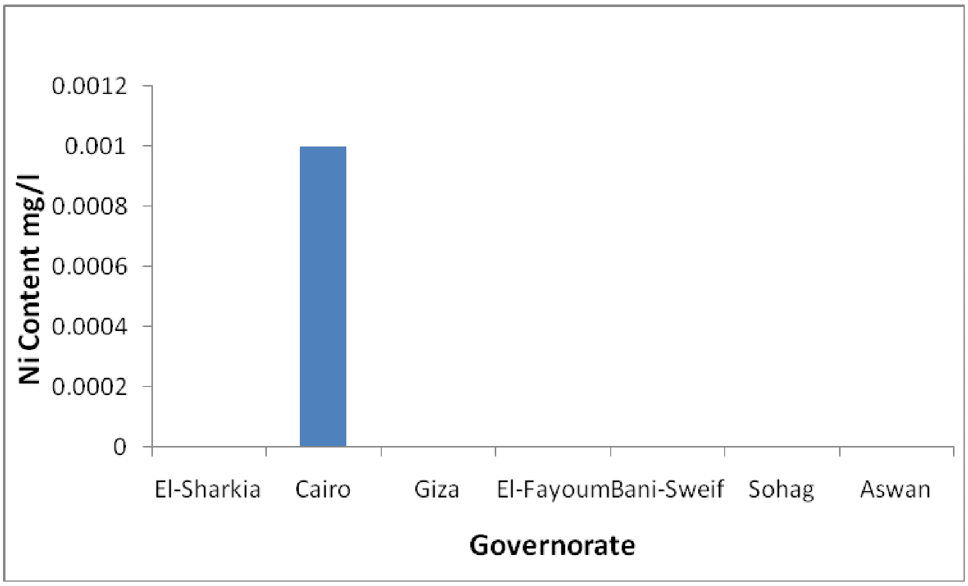

Fig. 13: Presents of nickel (Ni) content in surveyed geographic areas.

Lead (Pb): Acute exposure to lead is known to cause proximal renal tubular damage (WHO, 1995). Long-term lead exposure may also give rise to kidneydamage (Mortada *et al*., 2001). According to WHO (1995) standards concentration of lead should not exceed 0.01 mg/l. As presented in figure 14 in the investigated governorates (Cairo, El-fayoum, Bani-Sweif and Sohag), the values were more than 0.01 mg/l which may cause kidney damage on long-term lead exposure. It is also noticed that, there was a wide variation in Pb content in the different zones under study.

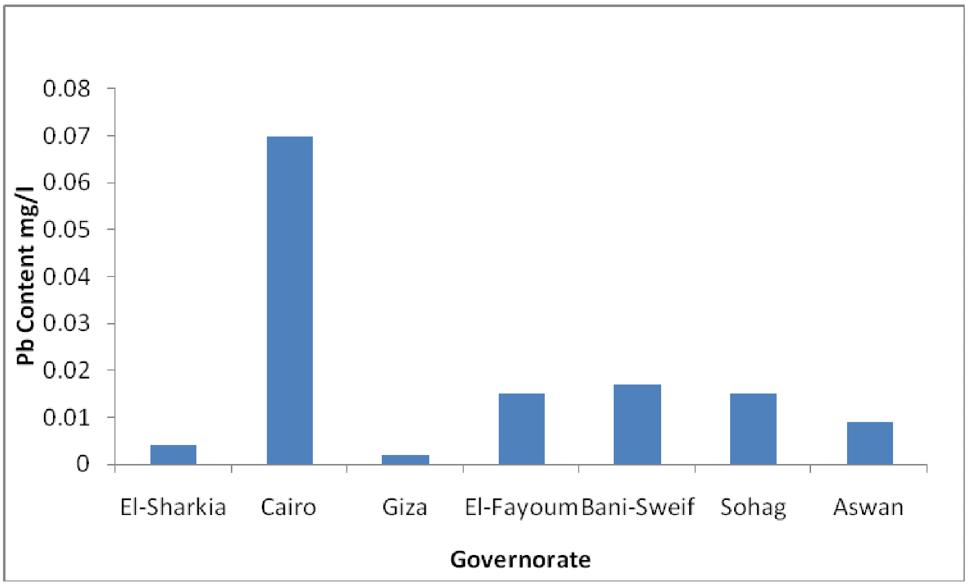

Fig. 14: Presents of lead (Pb) content in surveyed geographic areas.

Cadmium (Cd): Cadmium occurs mostly in association with zinc and gets into water from corrosion of zinc coated ("galvanized") pipes and fittings. At higher concentrations, it is known to have a toxic potential. The main sources of cadmium are industrial activities; the metal is widely used in electroplating, pigments, plastics, stabilizers and battery industries (Nassef *et al*., 2006). Cadmium is highly toxic and responsible for several cases of poisoning through food. Small quantities of cadmium cause adverse changes in the arteries of human kidney. It replaces zinc biochemically and causes high blood pressures, kidney damage etc(Rajappa *et al*., 2010). It interferes with enzymes and causes a painful disease called Itai-itai. In the present study, cadmium is detected in water only from El-Sharkia, El-Fayoum, Bani-Sweif, Sohag and Aswan and not detected in water from Cairo and Giza, where Cd value is above the WHO (2008) recommended value (0.003 mg/l) in the samples analyzed with mean concentration of 0.0086 mg/l and varies from 0.007 mg/l to 0.01 mg/l as presented in figure 15.

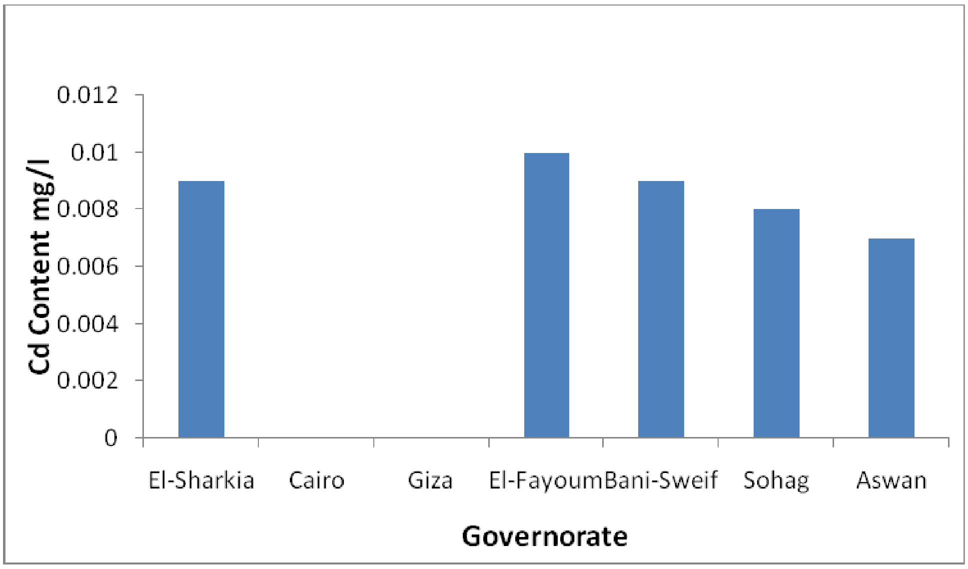

Fig. 15: Presents of cadmium (Cd) content in surveyed geographic areas.

Silicon (Si): Finely ground silicate minerals from eroded acid granite in drinking water has been linked to 'Endemic or Balkan Nephropathy', which is inflammation of the kidneys (interstitial nephritis) (Dobbie, & Smith, 1986). Chronic hemodialysis patients are potentially at risk from the accumulation of silicon. The high silicon levels of these patients have been associated with nephropathy, neuropathy, chest disease, bone diseases and liver disease (Hosokawa& Yoshida, 1990; Hosokawa *et al*., 1990; D'Haese at al., 1995). Silicon in drinking water is derived from the weathering of rocks and soil minerals and since different types of minerals weather at different rates, the concentration of Si in water is dependent upon the surrounding geology (Jugdaohsingh, 2007).Values of Si contentwere 2.90 mg/l in Giza, 1.23 mg/l in Aswan, 0.70 mg/l in Bani-Sweif, 0.79 mg/l in El-Fayoum, 0.80 mg/l in Sohag, 0.12 mg/l El-Sharkia and 0.231 mg/l in Cairo. The silicon content in Giza, Aswan, El-Fayoum, Bani-Sweif, and Sohag exceeded the normal range (0.095–0.61 mg/l)according to Powel *et al*. (2005) as presented in figure 16.It is noticed that, there was a wide variations in Si contents in the surveyed geographic areas, this contribute in interpretation the results of renal hydronephrotic and mild kidney diseases in surveyed governorates.

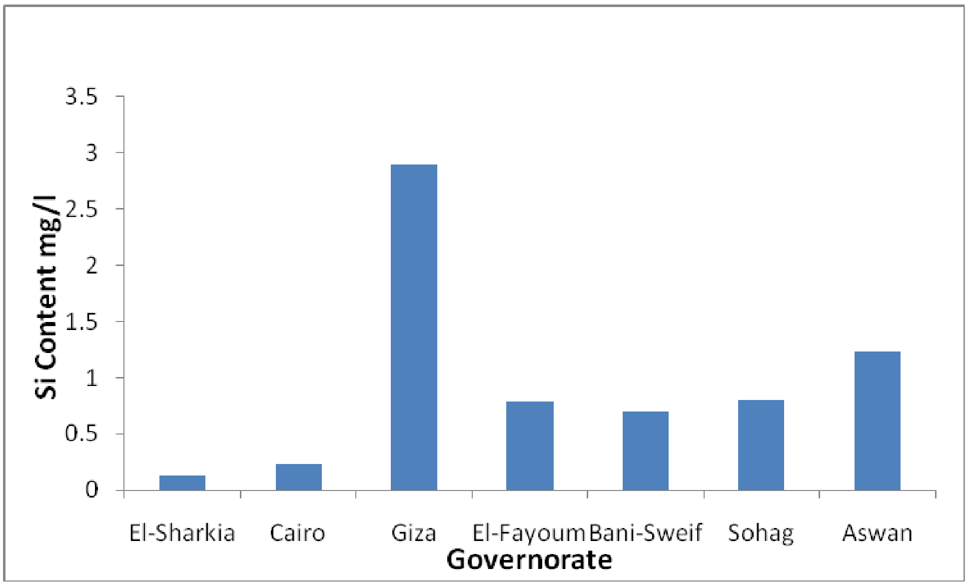

Fig. 16: Presents of silicon(Si) content in surveyed geographic areas.

Fluorine (F): Fluorine is an essential trace element for human being and animals. Fluoride is frequently added to drinking water, toothpaste, mouth rinses, and other dental products to prevent caries. Excessive fluorine in drinking water is totally in an ionic form and hence, it rapidly, totally, and passively passes through the intestinal mucosa and interferes with major metabolic pathways of living system. Chronic fluoride intoxication causes damages to osseous tissue (teeth and bone) and soft tissues (liver, kidney, brain, etc). Liver and kidney are the target organs markedly attacked by excessive amount of fluoride. High doses of fluoride intake lead to changes of structures, function and metabolism in liver and kidney. High level of fluoride in drinking water is harmful to both animals and human beings. Fluoride might cause damages to liver and kidney in manner of oxidative damage, and Ca^{2+} metabolism disturbance and cell apoptosis (Yang& Liang, 2011). As indicated in medical statistics of the surveyed areas contributed, it is noticeable a wide variation values of fluorine content ranges from 0.21 mg/l to 0.43 mg/l as presented in figure 17. The high fluorine was not only a possible risk factor but it was possible that there was some relationship with the diseases. For instance, the variability in Na and Ca in water and Ca saturation factor in the presence of fluorine may prove to be an important parameter in the cause of diseases (Chandrajith *et al*., 2011).

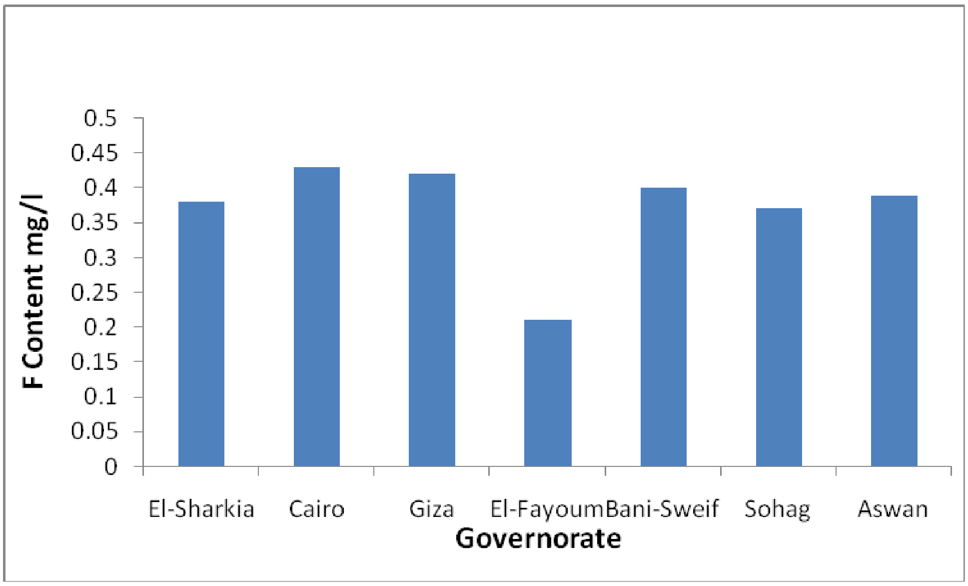

Fig. 17: presents F content in surveyed geographic areas.

pH: Beyond the desirable limit pH causes bitter taste to water, affects mucous membrane, causes corrosion and also affects aquatic life (Burande, 2013). As presented in figure 18,the current study revealed that, pH values were from 6.3 to 7.45 in the studied governorates that within the normal range.

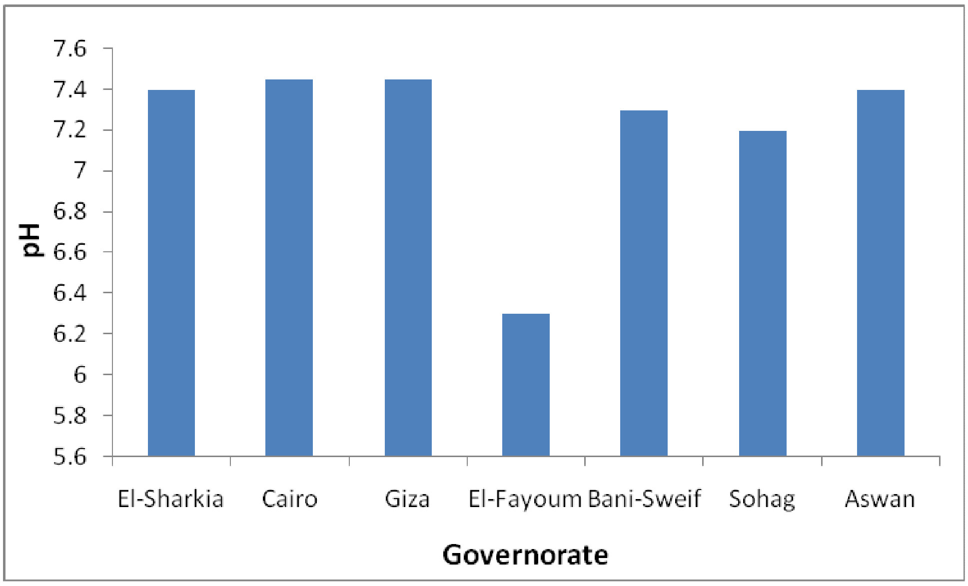

Fig. 18: presents pH in surveyed geographic areas.

Tables 1, 2, 3, 4, 5, 6 and 7 illustrate different renal diseases and their percentages in the areas under investigation, according to glomerular filtration rate (GFR) that calculated in Nuclear Medicine Department which reflect the renal function for 959 cases undergoing investigation for evaluate renal function status at different geographical governorates in Egypt, and the percentage of each disease from the total number of patients.

Table 1. Number of patients and percentages of renal diseases in El-Sharkia

Types of renal diseases	Numbers of patients	Percentage
Renal failure	135	64.29%
Obstructed nephrouropathy	56	26.67%
Hydronephrotic and mild renal diseases	12	5.71%
Normal kidney function	7	3.33%
Total	210	100%

Table 2. Number of patients and percentages of renal diseases in Cairo

Types of renal diseases	Numbers of patients	Percentage
Renal failure	75	53.19%
Obstructed nephrouropathy	36	25.53%
Hydronephrotic and mild renal diseases	13	9.22%
Normal kidney function	17	12.06%
Total	141	100%

Table 3. Number of patients and percentages of renal diseases in Giza.

Types of renal diseases	Numbers of patients	Percentage
Renal failure	70	49.65%
Obstructed nephrouropathy	38	26.95%
Hydronephrotic and mild renal diseases	15	10.64%
Normal kidney function	18	12.76%
Total	141	100%

Table 4. Number of patients and percentages of renal diseases in El-Fayoum.

Types of renal diseases	Numbers of patients	Percentage
Renal failure	34	66.67%
Obstructed nephrouropathy	7	13.73%
Hydronephrotic and mild renal diseases	6	11.76%
Normal kidney function	4	7.84%
Total	51	100%

Table 5.Number of patients and percentages of renal diseases in Bani-Sweif.

Types of renal diseases	Numbers of patients	Percentage
Renal failure	89	64.49%
Obstructed nephrouropathy	33	23.91%
Hydronephrotic and mild renal diseases	10	7.25%
Normal kidney function	6	4.35%
Total	138	100%

Table 6. Number of patients and percentages of renal diseases in Sohag.

Types of renal diseases	Numbers of patients	Percentage
Renal failure	114	66.28%
Obstructed nephrouropathy	17	9.88%
Hydronephrotic and mild renal diseases	38	22.09%
Normal kidney function	3	1.75%
Total	172	100%

Table 7. Number of patients and percentages of renal diseases in Aswan.

Types of renal diseases	Numbers of patients	Percentage
Renal failure	81	76.41%
Obstructed nephrouropathy	10	9.43%
Hydronephrotic and mild renal diseases	13	12.27%
Normal kidney function	2	1.89%
Total	106	100%

It is clear from the tables that, the percentages of renal failure in El-Fayoum, Bani-Sweif, Sohag and Aswan were more than that in El-Sharkia, Giza and Cairo, while the percentage of obstructed nephrouropathy in El-Sharkia, Cairo and Giza were high in comparison with the other governorates. The percentage of patients that have normal renal function and patients suffering from hydronephrotic kidneys and mild renal disease were low in comparison with the number of patients that suffering from different renal diseases in surveyed governorates.

The following figures illustrate different renal diseases in the governorates under investigation, which reflect the renal function of different patients for different geographical areas in Egypt, and the percentage of each disease from the total number of patients.

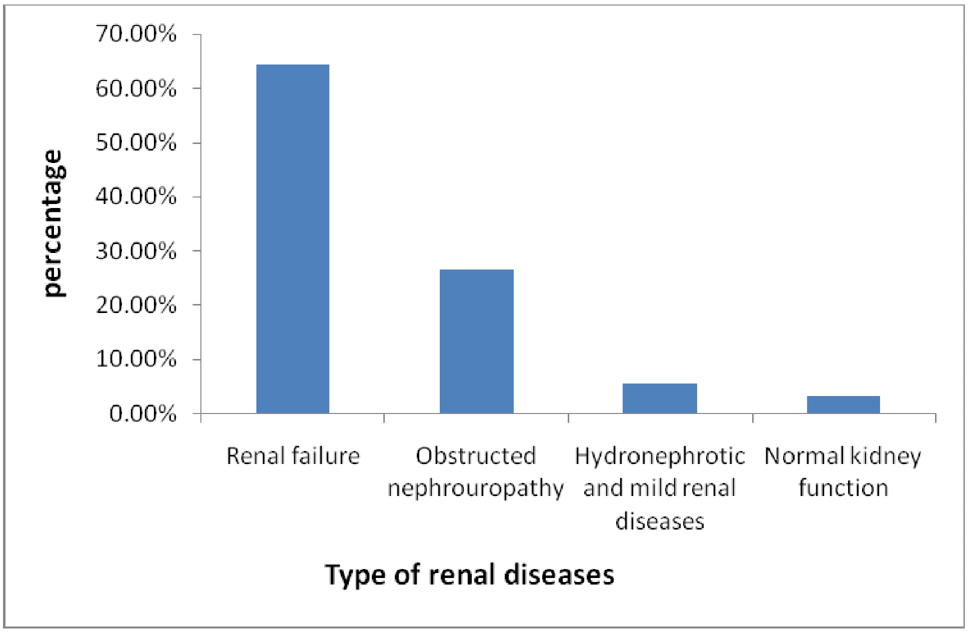

Fig. 18: Shows the different renal diseases in El-Sharkia.

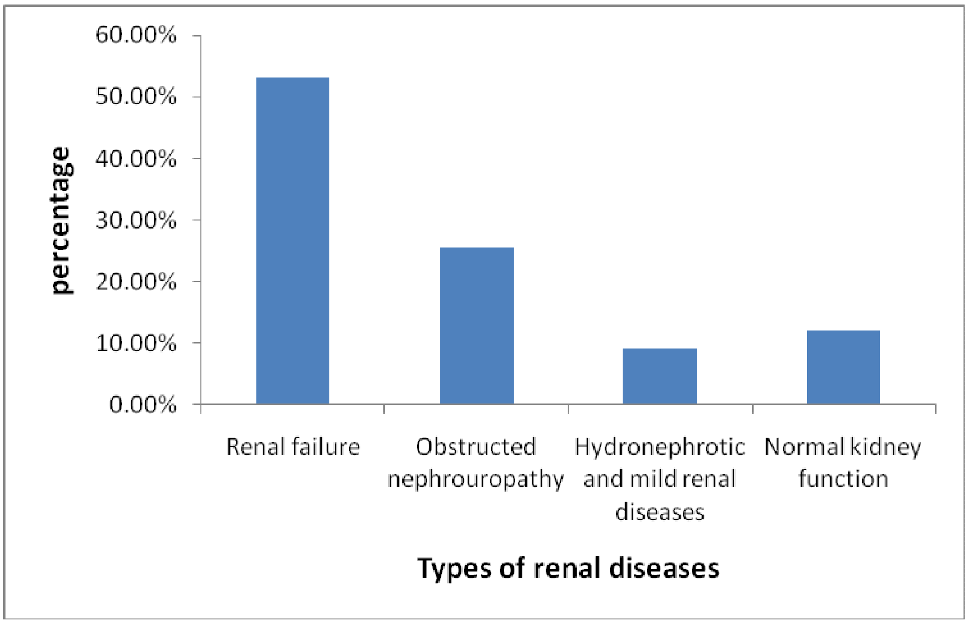

Fig. 19: Shows the different renal diseases in Cairo.

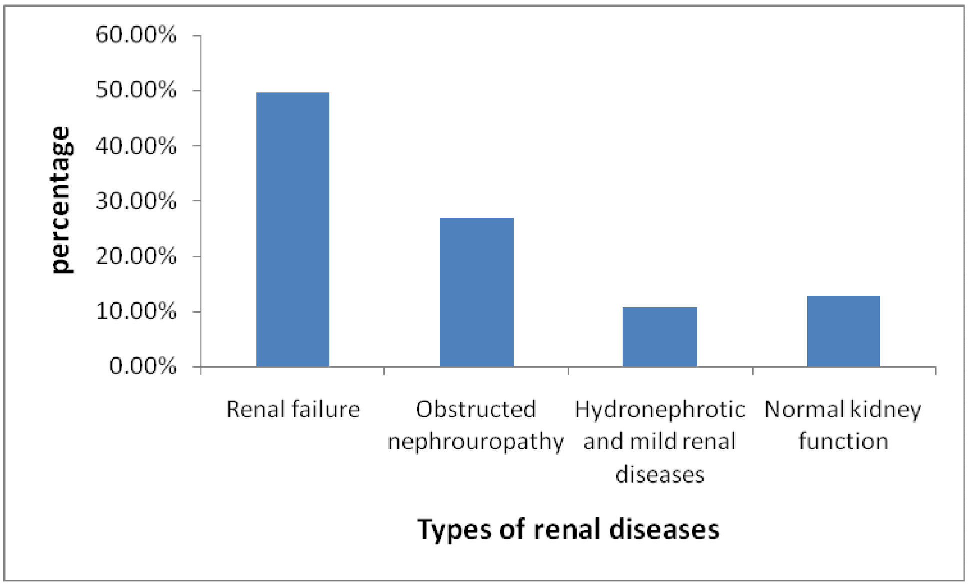

Fig. 20: Shows the different renal diseases in Giza.

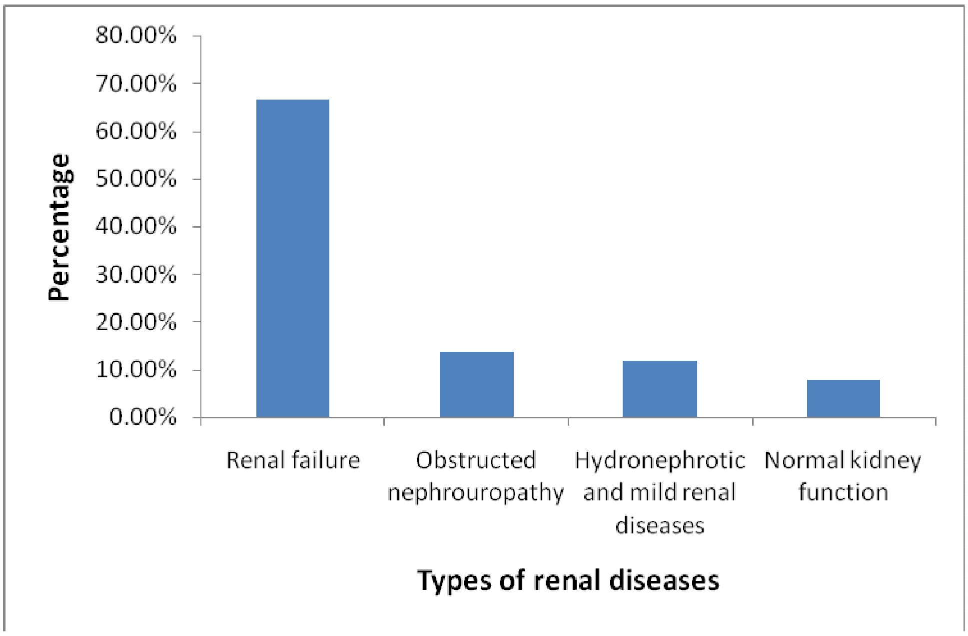

Fig. 21: Shows the different renal diseases in El-Fayoum.

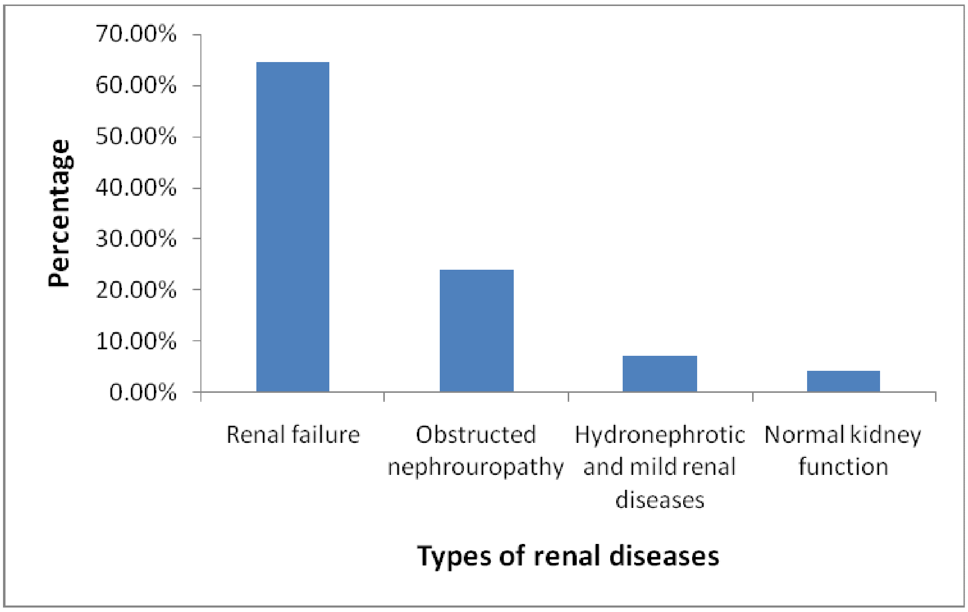

Fig. 22: Shows the different renal diseases in Bani-Sweif.

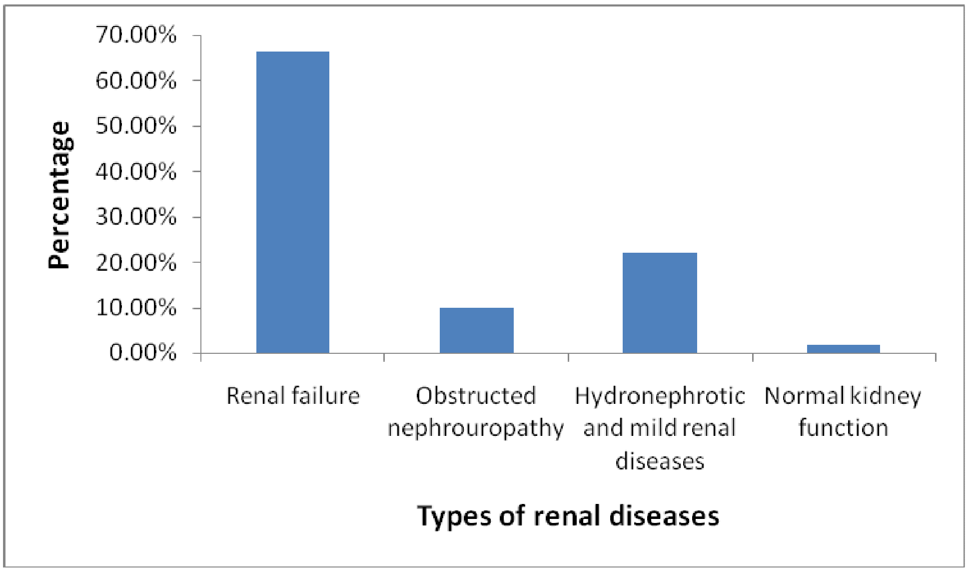

Fig. 23: Shows the different renal diseases in Sohag.

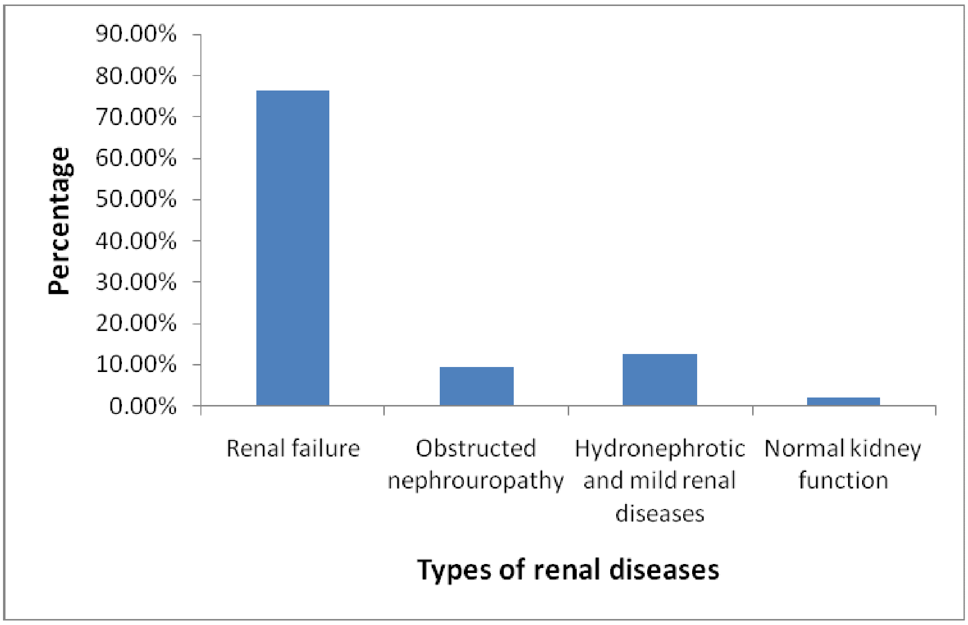

Fig. 24: Shows the different renal diseases in Aswan.

In spite of the chronic kidney disease (CKD) has been identified in certain geographical region of different governorates in Egypt for more than a decade, the etiology still remains unclear. Environmental factors are mostly considered to explain the etiology of CKD.

The drinking water analysis carried out in chronic kidney disease of uncertain etiology (CKDue) in governorates in Egypt illustrates that the most of drinking water contains low to high levels of minerals and heavy metals Na, K, Ca, Mg, Cl, SO_4, HCO_3, Mn, Fe, Ni, Pb, Si, Cd and F. The present study attributed the etiology of CKDue to the elevated concentration of some heavy metals Fe, Mn, Ni, Cd and Pb. Therefore, the involvement of Na, K, Ca, Mg, Cl, SO_4, HCO_3, F and Si on the CKDue can be affected.

The most dangerous heavy metal is Cd because of its association with chronic kidney diseases. It is present in El-Sharkia, El-Fayoum, Bani-Sweif, Sohag, and Aswan and not present in Cairo and Giza as presented in figure 15. Cd concentration in El-Sharkia, El-Fayoum, Bani-sweif, Sohag and Aswan is more than the permissible limit of Cd 0.003 mg/l. Because it is highly toxic and small quantities of Cd cause adverse changes in arteries of human kidney (Rajappa *et al.*, 2010). It replace zinc biochemically and causes high blood pressure and kidney damages (Rajappa *et al.*, 2010) and this show why the percentage of renal failure is very high in El-Sharkia, El-Fayoum, Bani-Sweif, Sohag and Aswan (64.29%, 66.67%, 64.49%, 66.28% and 76.41% respectively). But it is also found that there are patients suffering from renal failure in Cairo (53.19%) and Giza (49.65%) with small percentages than other governorates. The presence of lead (Pb) in drinking water of surveyed governorates also another cause for CKD where the Pb content in Cairo, El-Fayoum, Bani-sweif and Aswan is more than permissible limit 0.01 mg/l. Acute exposure to lead is known to cause proximal renal tubular damage (WHO, 1995). Long-term lead exposure may also give rise to kidney damage (Mortada *et al.*, 2001). Another reason for this percentage of renal failure in Cairo and Giza is the presence of silicon in drinking water. Silicon content is present in all governorates. But in Giza, El-Fayoum, Bani-Sweif, Sohag and Aswan the silicon content in drinking water in more than permissible limit (0.095-0.61) mg/l. A silicate mineral in drinking water has been linked to ‘Endemic or Balkan Nephropathy’, which is inflammation of the kidneys (interstitial nephritis) (Dobbie, & Smith, 1986). So the presence of silicon in drinking water is another reason for occurrence of chronic kidney diseases in surveyed governorates. Ni is found in Cairo only and not found in other governorates. Ni concentration in Cairo is less than the permissible limit of Cd.So the increased of patients that suffering from renal failure in surveyed governorates due presence of high concentrations of Cd, Pd, Si in drinking water.

To demarcate the geographical distribution of CKDue in Egypt, population screening programmers in high and low prevalent region and location of patient within the region will be extremely important. Systematic mapping of (CKDue) patient has not yet been carried out and geographic localization will be the first step in a series of investigation into the potential etiology of CKD which could facilitate further epidemiological and environmental studies.

Conclusion:

Egypt represents a natural field laboratory for studies in medical geology, since the majority of its people live close to the land, depending on drinking water sources in their immediate vicinity.

Extreme conditions of weathering, leaching and eluviation in a humid, tropical setting have led to marked redistribution of elements, both nutritional and toxic, in the surficial environment, carving out distinct zones of element excesses and deficiencies. These factors enhance the credibility of correlations drawn between certain environmental diseases and the biochemical, biophysical or geochemical interactions within the bedrock, groundwater, soil, and food and human/animal tissue continuum. Drawing up such correlations, however, relies on the availability of very high-quality analytical data for element concentrations and their distribution in environmental samples. The content of certain critical elements (sometimes down to microgram per liter level) needs to be accurately known. But the need for quality assurance still bedevils analytical work in many Egyptian geochemical laboratories. There are too few technicians with sufficient expertise for proper installation, maintenance and repair of today’s analytical instruments. One important consequence of the rather poor geochemical database is the fact that many environmental diseases that result from excess or deficiency of certain key elements are poorly diagnosed. The production of a high-precision geochemical map of Egypt would be a cost-effective method of indirectly investigating the chemical composition will offer a particularly valuable opportunity for examining the relationship between geochemistry and health. Such baseline data would aid in the understanding of the hydrological, chemical and biological processes that determine the behavior of chemical elements in this part of the earth’s surface, in relation to how they may affect the life of human. Significant correlations could then be conveyed to the medical profession, to heighten awareness of the huge potential significance that factors of the geo-environment can have on disease causation and thereby serve to broaden the diagnostic.

In light of the results and the experience and knowledge acquired during practice, the following recommendations may be useful for future research:

- The sampling points should be increased to enhance the accuracy of estimation in areas;
- Taking the direction of the water into account would produce better results;
- Carrying out further studies which highlight seasonal distribution and spatiotemporal; and

Physicians should therefore encourage their patients to check the mineral content of their drinking water and to drinking water that is most appropriate for their significance.

REFERENCES

Afifi, A., M.A. Karim, 1999. Renal replacement therapy in Egypt: first annual report of the Egyptian Society of Nephrology, 1996. East Mediterr Health J. 5: 1023-9.

Agaba, E.I., C.M. Wigwe, P.A. Agaba and A.H. Tzamaloukas, 2009. Performance of the Cockcroft-Gault and MDRD equations in adult Nigerians with chronic kidney disease. Int. Urol. Nephrol., 41(3): 635-642.

Burande, A., 2013. Design and development of environmental mathematical model for water quality analysis and its impact on human health in Latur region. *Australian Journal of Basic and Applied Sciences,* 7(10): 354-363.

Chandrajith, R., S. Nanayakkkara, K. Itai, T.N. Aturaliya, C.B. Dissanayake, T. Abeysekera, K. Harada, T. Watanabe and A. Koizumi, 2011. Chronic kidney diseases of uncertain etiology (CKDue) in Sri Lanka: geographic distribution and environmental implications. Environmental Geochemistry and Health, 33(3): 267-278.

Chapman, H.D. and R.E. Pratt, 1961. *Methods of analysis for soil, plants and water.* Department of Soil, Plant Nutrition, University of California, U.S.A.

D'Haese, P.C., F.A. Shaheen, S.O. Huraid, L. Djukanovic, M.H. Polenakovic, G. Spasovski, A. Shikole, M.L. Schurgers, R.F. Daneels, L.V. Lamberts, G.F. Van Landeghem and M.E. De Broe, 1995. Increased silicon levels in dialysis patients due to high silicon content in the drinking water, inadequate water treatment procedures, and concentrate contamination: a multicentre study. *Nephrology Dialysis Transplantation,* 10: 1838-1844.

Dobbie, J.W. and M.J.B. Smith, 1986. Urinary and serum silicon in normal and uraemic individuals. In: D. Evered, M. O'Connor (Eds.), Silicon Biochemistry, Ciba Foundation Symposium, 121: 194-208). John Wiley and Sons Ltd.; Chichester.

FAO/WHO, 1983. Joint Expert Committee on Food Additives (JECFA). Toxicological Evaluation of Certain Food Additives and Food Contaminants. Cambridge, Cambridge University Press, WHO Food Additives Series, No. 18.

Gates, G.F., 1982. Glomerular filtration rate: Estimation from fractional renal accumulation of ^{99m}Tc-DTPA (stannous). American Journal of Roentgenology, 138: 565-570.

Gates, G.F., 1983. Split renal function testing using ^{99m}Tc-DTPA, a rapid technique for determining differential glomerular filtration. Clinical Nuclear Medicine, 8: 400-407.

Hosokawa, S. and O. Yoshida, 1990. Silicon transfer during haemodialysis. International Urology and Nephrology, 22: 373-378.

Hosokawa, S., A. Oyamaguchi and O. Yoshida, 1990. Trace elements and complications in patients undergoing chronic hemodialysis. Nephron., 55: 375-379.

International Agency for Research on Cancer (IARC), 1990. Nickel and nickel compounds. *In: Chromium, nickel and welding.* Lyon, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, 49: 257-445.

Itoh, K., 2003. Comparison of methods for determination of glomerular filtration rate: ^{99m}Tc-DTPA renography, predicted creatinine clearance method and plasma sample method. Ann. Nucl. Med., 17: 561-565.

Jackson, M.L., 1967. *Soil chemical analysis.* Prentice-Hall India Private Limited, New York.

Jugdaohsingh, R., 2007. Silicon and Bone Health. Journal of Nutrition Health and Aging, 11(2): 99-110.

Kamel, E.G. and O. El-Minshawy, 2010. Environmental Factors Incriminated in the Development of End Stage Renal Disease in El-Minia Governorate, Upper Egypt. Int J NephrolUrol, 2(3): 431-437.

Kazi, T.G., M.B. Arain, M.K. Jamali, N. Jalbani, H.I. Afridi, R.A. Sarfraz, J.A. Baig and A.Q. Shah, 2009. Assessment of water quality of polluted lake using multivariate statistical analysis: a case study. Ecotoxicology and Environmental Safety, 72: 301-309.

Kumar, M. and A. Puri, 2012. A review of permissible limits of drinking water.Indian Journal of Occupational and Environmental Medicine, 16(1): 40-44.

Levey, A.S., K.U. Eckardt, Y. Tsukamoto, A. Levin, J. Coresh and J. Rossert, 2005. Definition and classification of chronic kidney disease: A position statement from kidney disease: Improving Global Outcomes (KDIGO). Kidney Int., 67: 2089-100.

Mohsin, M., S. Safdar, F. Asghar and F. Jamal, 2013. Assessment of drinking water quality and its impact on residents health in Bahawalpur City. International Journal of Humanities and Social Science, 3(15): 114-128.

Mortada, W.I., M.A. Sobh, M.M. El-Defrawy and S.E. Farahat, 2001. Study of lead exposure from automobile exhaust as a risk for nephrotoxicity among traffic policemen. American Journal of Nephrology, 21: 274-279.

Myers. G.L., W.G. Miller, J. Coresh, J. Fleming, N. Greenberg, T. Greene, T. Hostetter, A.S. Levey, M. Panteghini, M. Welch and J.H. Eckfeldt, 2006. Recommendations for improving serum creatinine measurement: a report from the Laboratory Working Group of the National Kidney Disease Education Program. Clinical Chemistry, 52: 5-18.

Nassef, M., R. Hannigan, K.A. EL Sayed and M.S.El. Tahawy, 2006. Determination of some heavy metals in the environment of Sadat industrial city. Proceeding of the 2nd Environmental Physics Conference, Cairo University, Egypt, pp: 145-152.

National Kidney Foundation, 2002. K/DOQI clinical practice guidelines for chronic kidney disease: Evaluation, classification, and stratification. American Journal of Kidney Diseases, 39(1): S1-S266.

Pegasys Ultra Reference Manual, 1997. 2: 9201-0200A, Rev. A.

Powell, J.J., S.A. McNaughton, R. Jugdaohsingh, S. Anderson, J. Dear, F. Khot, L. Mowatt, K.L. Gleason, M. Sykes, R.P.H. Thompson, C. Bolton-Smith and M.J. Hodson, 2005. A provisional database for the silicon content of foods in the United Kingdom. British Journal of Nutrition, 94: 804-812.

Prigent, A., P. Cosgriff, G.F. Gates, G. Granerus, E.J. Fine, K. Itoh, M. Peters, A. Piepsz, M. Rehling, M. Rutland and A. Taylor Jr, 1999. Consensus report on quality control of quantitative measurements of renal function obtained from the renogram: International consensus committee from the Scientific Committee of Radionuclides in Nephrourology. Semin. Nucl. Med., 29: 146-159.

Rajappa, B., S. Manjappa and E.T. Puttaiah, 2010. Monitoring of heavy metal concentration in groundwater of HakinakaTaluk, India. Contemporary Engineering Sciences, 3(4): 183-190.

Salem, H.M., E.A. Eweida and A. Farag, 2000. Heavy metals in drinking water and their environmental impact on human health. The International Conference for Environmental Hazards Mitigation (ICEHM2000), Cairo University, Egypt, September, pp: 542-556.

Stevens, L., J. Coresh, T. Greene and A. Levey, 2006. Assessing kidney function: Measured and estimated glomerular filtration rate. N. Engl. J. Med., 354: 2473-2483.

Stewart, J.C., A.T. Lamely, S.I. Hogan and R.A. Weismiller, 1989. Health Effects of Drinking Water Contaminants. Cornell University and the University of Maryland. Fact Sheet 2.

Sumino, K., K. Hayakawa, T. Shibata and S. Kitamura, 1975. Heavy metals in normal Japanese tissues. Amounts of 15 heavy metals in 30 subjects. Archives of Environmental Health An International Journal, 30: 487-494.

Thomas, L. and A.R. Huber, 2006 Renal function-estimation of glomerular filtration rate. Clinical Chemistry *and* Laboratory Medicine, 44: 1295-1302.

U.S. EPA., 2003. *Health Effects Support Document for Manganese. U.S. Environmental Protection Agency, Office of Water.* EPA. EPA-822-R-03-003. Washington, D.C.

World Health Organization (WHO), 1984. *Guidelines for Drinking Water Quality.* Health Criteria and Other Supporting Information, 2, Geneva.

World Health Organization (WHO), 1995. Lead Environmental Health Criteria. Vol. 165, Geneva.

World Health Organization (WHO), 1996. *Guidelines for Drinking Water Quality*.2nd Ed., Vol. 2, Geneva.

World Health Organization (WHO), 1996. *Guidelines for Drinking Water Quality*. Recommendation, Vol. 1, Geneva.

World Health Organization (WHO), 1998. *Guidelines for Drinking Water Quality*. 2nd Ed., Vol. 2, Geneva.

World Health Organization (WHO), 2004. *Guidelines for Drinking Water Quality*. 3rd Ed., Vol. 1, Geneva.

World Health Organization (WHO), 2008 Guidelines for drinking water quality, World Health Organization, Geneva.

Yang, K. and X. Liang, 2011. Fluoride in drinking water: effect on liver and kidney function.Introductory Article Reference Module in Earth Systems and Environmental Sciences, from Encyclopedia of Environmental Health, pp: 769-775.