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Evaluation of Hyponatremia among Type 2 Diabetes Patients in Sudan

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ABSTRACT

Hyponatremia is the most common electrolyte abnormality in clinical practice and is associated with increased morbidity and mortality. Decreased serum sodium levels are occasionally observed in patients with type 2 diabetes mellitus (T2DM) due to numerous underlying pathogenesis mechanisms especially among patients with poorly controlled Diabetes Mellitus (DM). Therefore this cross sectional study designed to assess sodium level among T2DM in Sudan, who were over 5 years since got diagnosed with T2DM. Increased levels of glucose, HbA1c and decreased sodium level observed among uncontrolled T2DM than who were on control. As many studies results, in this one hypernatremia accompanied with T2DM.

Key words: Diabetes mellitus, Sodium and HbA1c.

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INTRODUCTION

Diabetes mellitus is a combination of heterogeneous disorders commonly presenting with episodes of hyperglycemia and glucose intolerance, as a result of lack of insulin, defective insulin action, or both (Sicree et al., 2006). Diabetes is justly recognized as an emerging global epidemic, representing one of the leading causes of morbidity and mortality worldwide (Giacco and Brownlee, 2010; Hassan, 2014). Type 2 diabetes accounts for approximately 90 to 95% of all diagnosed cases of diabetes (American Diabetes Association, 2002). T2DM usually affects people with age more than 30 years old and obese (Guyton and Hall, 2006). Under normal physiological conditions, plasma glucose concentrations are maintained within a narrow range, despite wide fluctuations in supply and demand, through a tightly regulated and dynamic interaction between tissue sensitivity to insulin (especially in liver) and insulin secretion (Defronzo and Ferrannini, 1988). In type 2 diabetes these mechanisms break down, with the consequence that the two main pathological defects in type2 diabetes are impaired insulin secretion through a dysfunction of the pancreatic β-cell, and impaired insulin action through insulin resistance (Holt, 2004). Type 2 diabetes mellitus has a greater genetic association than type 1 DM, the pathogenesis of type 2 diabetes mellitus is characterized by impaired insulin secretion and insulin resistance (Kaprio et al., 1992). Glycation is the non-enzymatic addition of sugar to amino groups of proteins. While virtually any protein in the body can be glycated, for convenience and ease of obtaining a sample, glycated hemoglobin is measured in the blood obtained from a patient. Blood glucose concentrations exhibit wide diurnal fluctuations due to food ingestion, exercise, and other factors.

In contrast, the concentration of glycated hemoglobin remains relatively stable with time. This is due to the life span of red blood cells, which are usually 120 days. In individuals with a normal erythrocyte life span, glycated hemoglobin is directly proportional to the blood glucose concentration over the preceding 8 to 12 weeks (Sacks et al., 2002). Electrolyte disorders are common and being associated with increased morbidity and mortality (Liamis

Table 1. Mean+SD of age and gender involved.

	Number	Percentage
Age (years)	59.5±10.5	
Male	37	(46.3%)
Female	43	(53.7%)

Table 2. Indepenant T-test for F.B.S, Na+ and Hb A1c level among groups.

Parameters	On Control Group	Out-Control Group	P value
	Mean±SD	Mean±SD	
FBG	125.38±43.79	218.22±96.35	0.000
Hb A1c	6.11±0.79	10.40±2.47	0.000
Na+	132.81±3.83	129.44±3.83	0.004

Significant difference p value <0.005.

et al., 2009, 2013) and related to poor prognosis (Liamis et al., 2013). DM is included among the diseases with increased frequency of electrolyte abnormalities given that the aforementioned factors (especially impaired renal function, malabsorption syndromes, acid-base disorders and multidrug regimens) are often present in diabetics (Elisaf et al., 1996). Hyponatremia associated with normal or even increased tonicity. Hyponatremia is usually due to the coexistent hyperglycemia (Milionis et al., 2012). Glucose is an osmotic active substance. Thus, in cases of marked hyperglycemia Posm is increased leading to movement of water out of cells and subsequently to a reduction of serum sodium levels (dilutional hyponatremia). In such cases the corrected, for the degree of hyperglycemia, serum sodium value should be calculated (Hillier et al., 1999). The most common cause of hypotonic hyponatremia in patients with diabetes is osmotic diuresis-induced hypovolemia (Liamis et al., 2014). Patients with diabetic ketoacidosis the excretion of β-hydroxybutyrate and acetoacetate obligate urine sodium losses resulting in aggravation of hypovolemia (Chiasson et al., 2003). Hypovolemia can also be due to diabetes mellitus-associated complications, such as diarrhea and vomiting. Serum sodium levels in poorly controlled patients with diabetes mellitus vary, since these levels are the result of hyperglycemia-induced hyponatremia (dilutional hyponatremia), osmotic diuresis-induced hypotonic losses (losses of water in excess of electrolytes), which tend to increase serum sodium levels, and hypovolemia–induced decrease in serum sodium levels (Lyssenko et al., 2009).

MATERIALS AND METHODS

In this cross sectional study involved an eighty (80) subjects who were diagnosed of having T2DM; they were referred to Specialized Center in Khartoum state. The study targeted T2DM who were not observed with systemic complications. While smoker, renal disease and alcoholism were excluded. Patients were sorted according to HbA1c level which can be provided by sticking to regular diet and organized treatment program to on control group with HbA1c up to 7% and out-control group with HbA1c more than 7%. Blood samples were collected under hygienic conditions, heparinized blood used for Na and FBG and ethylene diamin tetra acetic acid (EDTA) added one for HbA1c. Biochemical methods used to determine levels of serum Na and FBG by means of eazylight trade device and Mindray BC380 trade device, respectively, and immunochromatography method was used for HbA1c level via Card™ READER II.

Data analysis was conducted with statistical package for social science (SPSS) software version 21. This study was approved by Ethical Committee of Alneelain University, College Of Medical Laboratory Sciences, Department of Clinical Chemistry.

RESULTS

An 80 T2DM subjects were involved in this study, they were divided according to dietary intake and regulation of treatment to on control and out-control. As in Table 1, mean±SD of age and gender distribution is presented. 16 (20%) patients were on control, while the rest (64) 80% were out of control. FBG), HbA1c and Na levels mean±SD presented in Table 2, the out-control group has significant increased difference for FBG and HbA1c with P value 0.000 and 0.004, respectively in comparison with on control group. According to normal range of Na, both T2DM involved revealed low Na level and significant decreased observed on Na among out-control group as p value 0.004.

Person's correlation conducted revealed FBS level is inversely correlated with Na (r = -0.416, *p-value* 0.000) which presented in Figure 1. The inversely correlation brought out with level of Na with HbA1c (r = -0.399, *p-value* 0.000) as in Figure 2.

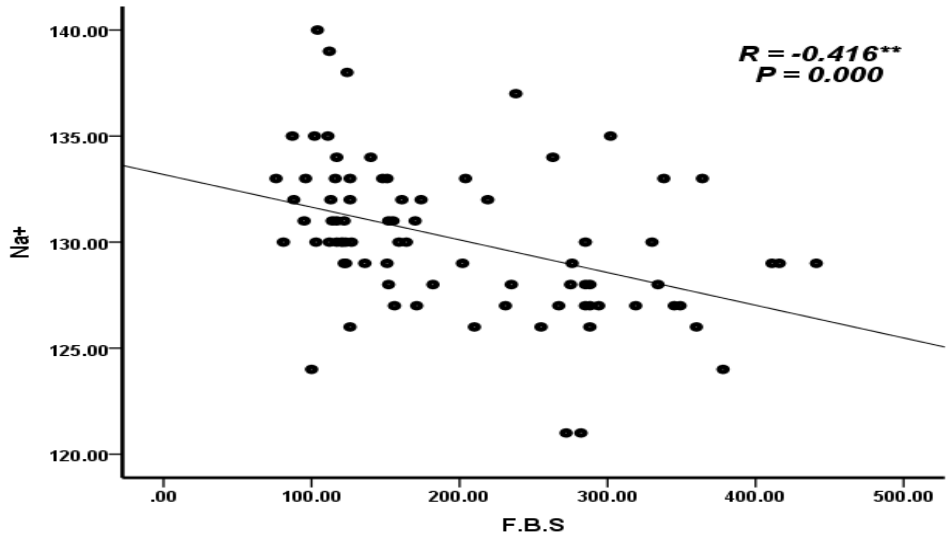

Figure 1. Pearson's correlation FBG against Na level among T2DM.

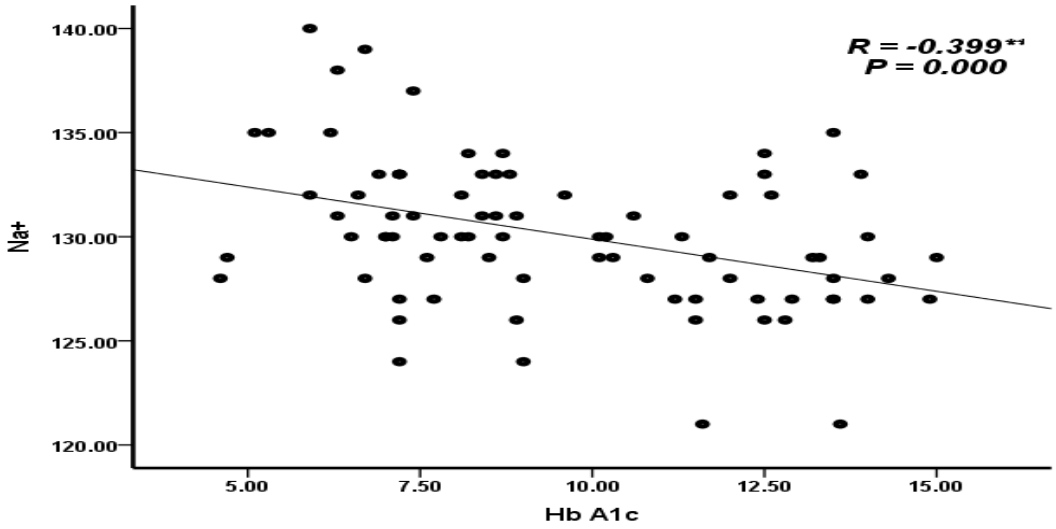

Figure 2. Pearson's correlation Na against HbA1c level among T2DM.

DISCUSSION

The incidence of diabetes is increasing at an alarming rate, with a predicted worldwide incidence of more than 640 million people by 2040. The vast majority of persons with diabetes have type 2 diabetes. Variations in genes that increase a person's susceptibility to diabetes (Lyssenko et al., 2009). In this study data showed consequences of uncontrolled DM, as measureable parameters included Na, FBG and HbA1c. Increasing evidence electrolyte imbalances are early biochemical events responsible for long-term diabetic complications. We found that sodium concentrations among both groups of diabetic involved were lower the normal range of Na of healthy subjects but increased levels among controlled T2DM subjects than controlled group's results, this agrees with findings obtained with any studies at the same manner, one of them mentioned that DM is linked to both hypo- and hyper-natremia reflecting the coexistence of hyperglycemia-related mechanisms, which tend to change serum sodium to opposite directions (George et al., 2014). As DM is a well-known cause of dysnatremias *via* several underlying mechanisms (Liamis et al., 2008, 2013). Glucose is an osmotically active substance. Hyperglycemia increases serum osmolality, resulting in movement of water out of the cells and subsequently in a reduction of serum sodium levels Na^+ by dilution. Therefore, in hyperglycemic patients, the corrected Na^+ should be taken into account, which is calculated by adding to measured Na^+ 1.6 mmol/L for every 100 mg/dl (5.55 mmol/L) increment of serum

glucose above normal; a correction factor by 2.4 mmol/L is used when serum glucose concentrations are higher than 400 mg/dl (22.2 mmol/L) (Hillier et al., 1999; Liamis et al., 2011).

It is worth mentioning that the corrected Na^+ after adjustment for the dilutional effect of hyperglycemia should be considered as a useful tool for the monitoring of treatment in hyperglycemic states (Liamis et al., 2000). Uncontrolled DM can also induce hypovolemic-hyponatremia due to osmotic diuresis. Moreover, in diabetic ketoacidosis ketone bodies (b-hydroxybutyrate and acetoacetate) obligate urinary electrolyte losses and aggravate the renal sodium wasting (Liamis et al., 2011; Chiasson et al., 2003). Consequently, in patients with uncontrolled DM serum concentration of Na^+ is variable, reflecting the balance between the hyperglycemia-induced water movement out of the cells that lowers Na^+, and the glucosuria-induced osmotic diuresis, which tends to raise Na^+ (Liamis et al., 2008; Beukhof et al., 2007). HbA1c data for both diabetic sub-groups, controlled and uncontrolled were more than reference range but among controlled T2DM subjects were less than uncontrolled one, that in agreement with study conducted, concerned with monitoring glucose level, it revealed the positive correlation between blood glucose level and increased HbA1c (David, 2007). Other study moved at the same track of observation, focusing on the effect of treatment on rate of glycaemia in blood, it mentioned that sodium-glucose transporter 2 inhibitors are latest oral treatment contribute in preserving blood glucose down high without causing hypoglycemia, also preventing hypertension (Karthic et al., 2016) and that what this study observed among T2DM subjects who were under control program of the disease.

CONCLUSION

As diabetes considered as systemic disease, more awareness should be planned to conduct, include monitoring clinical parameters and treatment to maintain healthy state beneath normal.

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