

Original Research Article

Evaluation of Macro minerals in Patients with Type II Diabetes Mellitus in Southern Nigeria

ABSTRACT:

AIMS: To evaluate serum sodium, potassium, magnesium, chloride, magnesium, phosphorus and sulphur in patients with type 2 DM and compare with non-diabetic subjects.

STUDY DESIGN: A cross sectional study

PLACE AND DURATION OF STUDY: Department of Chemical Pathology, Ekiti State University Teaching Hospital, Ado Ekiti and Federal Medical Centre, Ido Ekiti, Ekiti State, between April 2013 and February 2014.

METHODOLOGY: This study was conducted on 150 subjects, out of which 100 were type II diabetes mellitus patients and 50 were non diabetic (control) subjects. Glucose level was determined by Glucose oxidase – Peroxidase method, serum calcium, potassium, sodium and chloride concentrations were measured using Biolyte *Spin 6*, Full Automated Electrolyte Analyzer while magnesium was analyzed by Atomic Absorption Spectrophotometry. Phosphorus concentrations were determined by spectrophotometer using BioSystem reagent kit specific for phosphorus and Sulphur concentrations were measured using auto analyzer.

RESULTS: The results showed that sodium, potassium, chloride, calcium, phosphorus and magnesium were significantly lower ($P < .001$) in diabetic subjects when compared with the control subjects whereas the mean sulphur concentration was significantly higher ($P < .001$) in diabetic subjects when compared with the non-diabetic (control) subjects.

CONCLUSION: Impaired metabolism of these macro minerals may have a contributory role in the progression of DM and its complications.

Keywords: (Macro minerals, Diabetes Mellitus, Full Automated Electrolyte Analyzer, Atomic Absorption Spectrophotometry (AAS), Auto analyzer)

1. INTRODUCTION

Type 2 diabetes mellitus (DM2) is a chronic and progressive metabolic disorder characterized by insulin resistance and pancreatic beta islet cell failure. Three specific abnormalities that contribute to hyperglycemia in DM2 are: impaired insulin secretion, increased hepatic glucose production, and decreased insulin-stimulated uptake of glucose in peripheral tissues. The macro minerals in serum include sodium, potassium, calcium, magnesium, chloride, sulphur and phosphorus. Macro minerals play an important role in intermediary metabolism and cellular function, including enzyme activities and electrical gradients[1]. Serum concentrations of these minerals have been shown to change with plasma glucose levels[2]. Disturbances in the levels of macro minerals were found to be associated with diabetes mellitus[3],[4],[5]. In addition, hypomagnesaemia and diuretic associated hypokalemia may lead to a higher incidence of DM[6], mild electrolyte changes such as low Mg levels can predict mortality in type 2 DM[7], and oral magnesium supplementation has been found to reduce fasting plasma glucose levels in DM patients[8]. Macro minerals are accepted as essential for optimum health, because of their diverse metabolic characteristics and functions and its alteration can result in several complications among which is diabetes mellitus type II.

2. MATERIAL AND METHODS

2.1. STUDY SUBJECTS: The subjects used for the present study were made up of two groups. Group 1 comprised of 100 diagnosed type II diabetic patients and group 2 was made up of 50 non-diabetic aged matched control subjects. Among the total diabetic subjects, 43 were male and 57 were female while that of non-diabetic group were 26 males and 24 females. Both groups were of age range 35 – 80 years.

2.2. SAMPLE COLLECTION: 5 ml of fasting blood sample was collected from antecubital vein into plain bottles from each of the subjects. The whole blood samples were allowed to clot and were

centrifuged at 4000 rpm for 15 minutes. The supernatant serum was taken and delivered into plastic tubes with screw caps and was used for the analysis of macro-minerals (sodium, potassium, calcium, magnesium, chloride, sulphur and phosphorus).

2.3. LABORATORY ANALYSIS: Glucose level was determined by Glucose oxidase –Peroxidase method[9], calcium, potassium, sodium and chlorine concentration were measured using Biolyte Spin 6, Full Automated Electrolyte Analyzer, magnesium was analyzed by flame atomic absorption spectrophotometry, Serum phosphorus concentrations were determined by spectrophotometer using BioSystem reagent kit specific for phosphorus[10] and Serum Sulphur concentrations were measured using auto analyzer.

2.4. STATISTICAL ANALYSIS: Data analysis was performed using Statistical Package for Social Science (SPSS) for Windows version 16. The statistical significance was determined by one-way analysis of variance (ANOVA). The p-value less than .001 ($P<.001$) was considered as significant.

3. RESULTS AND DISCUSSION

3.1. RESULTS

One hundred diabetic patients (43 Males and 57 Females) and fifty non-diabetic (control) subjects (26 Males and 24 Females) defined by clinical examination and with no history of any disease were compared for glucose levels and macro-elements. All values were expressed as mean $\pm$ SD.

Table I: Comparison between the glucose levels of diabetic group and control group

Parameter	Diabetic Group N = 100 (Mean $\pm$ SD)	Control Group N = 50 (Mean $\pm$ SD)	P-value
Glucose (mg/dL)	160.94 $\pm$ 61.81	67.41 $\pm$ 7.95	<.001

The mean and SD of glucose in control group was (67.41 $\pm$ 7.95) which was significantly lower ($P<.001$) than that of the diabetic group (160.94 $\pm$ 61.82). **Table I**

Table II: Comparison between serum macro-elements of diabetic group with control

Parameter (mg/dL)	Diabetic Group N = 100 (Mean $\pm$ SD)	Control Group N = 50 (Mean $\pm$ SD)	P-value
Na	301.47 $\pm$ 8.16	318.44 $\pm$ 6.22	<.001
K	15.33 $\pm$ 1.47	17.57 $\pm$ 1.82	<.001
Cl	345.68 $\pm$ 8.81	355.00 $\pm$ 6.81	<.001
Ca	12.01 $\pm$ 1.36	13.43 $\pm$ 0.41	<.001
P	2.10 $\pm$ 0.95	3.46 $\pm$ 0.58	<.001
Mg	0.85 $\pm$ 0.22	1.11 $\pm$ 0.24	<.001
S	3.78 $\pm$ 0.78	2.84 $\pm$ 1.10	<.001

The results showed that, Sodium (301.47 $\pm$ 8.16 mg/dL, $P<.001$), Potassium (15.33 $\pm$ 1.47 mg/dL, $P<.001$), Chloride (15.33 $\pm$ 1.47 mg/dL, $P<.001$), Calcium (12.01 $\pm$ 1.36 mg/dL, $P<.001$), Phosphorous (2.10 $\pm$ 0.95 mg/dL, $P<.001$) and Magnesium (0.85 $\pm$ 0.22 mg/dL, $P<.001$) were significantly lower in diabetic subjects when compared with the control subjects (318.44 $\pm$ 6.22 mg/dL), (17.57 $\pm$ 1.82 mg/dL), (355.00 $\pm$ 6.81 mg/dL), (13.43 $\pm$ 0.41 mg/dL), (3.46 $\pm$ 0.58 mg/dL) and (1.11 $\pm$ 0.24 mg/dL) respectively. Conversely, the mean Sulphur (3.78 $\pm$ 0.78 mg/dL, $P<.001$) was significantly higher in diabetic subjects when compared with the control group (2.84 $\pm$ 1.10 mg/dL). **Table II**

3.2. DISCUSSION

Type 2 Diabetes mellitus is one of the most serious public health problems been faced globally. It may therefore be prudent in medical practice to periodically monitor the macro minerals status of diabetics. Evaluation of these minerals may help in suggesting adequate management for type II diabetic mellitus. In the present study, serum magnesium levels were found to be significantly reduced in the diabetic patients ($P<.001$), when compared with the control group this was in correlation with the findings of Berhane et al.[11], Chetan et al.[12], Diwan et al.[13], Tosiello,[14], Walter et al.[15], Tripath et al.[16], McNair et al.[17], Anetor, et al.[18], Supriya et al.[19] and Sharma et al.[20]. Magnesium is an essential element which is involved in glucose homeostasis at multiple levels, it is an integral part of the activated MgATP complex regulating protein kinases which is directly involved in the control of glucose metabolism. Low levels of magnesium can reduce secretion of insulin by the pancreas (Durlach et al.[21]). The cause of diabetic hypomagnesaemia is multifactorial; Osmotic actions of glycosuria and hyper glycaemia may work together in causing hypomagnesaemia and hyper glycaemia, which are known to depress the net tubular reabsorption of magnesium in normal humans (Elaine et al.[22], Ishrat et al.[23]). Increased urinary Mg

excretion has also been reported in hyper glycaemia, osmotic action and glycosuria thereby, contributing to hypomagnesaemia seen in diabetes (Nsonwu, et al.[24].

Sodium depletion is another common feature of type 2 diabetes, In this study, the serum sodium levels were found to be significantly lowered in diabetic group ($P<.001$) when compared with control subjects, this result was consistent with the findings of Hasan et al.[25], Al-Rubeaan et al.[4]. The sodium depletion might be due to inhibition of the rennin-angiotensin-aldosterone system, which plays a key role in the regulation of fluid and electrolyte balance. This enzyme system has been reported to be affected in many endocrine and cardiovascular diseases particularly diabetes[26].

Potassium, the main intracellular cation in the human body is required for vital cellular processes. Recent research has led to renewed interest in low potassium as a possible risk factor for diabetes. In this study, the serum potassium levels were found to be significantly lowered in diabetic group ($P<.001$) when compared with control subjects, which was in accordance with findings of Hasan et al.[25], (Ranee et al.[27], Al-Rubeaan et al.[4]. The observed reduction in serum potassium in diabetic subjects might be a result of electrolyte loss which arises due to dehydration or a result of kidney dysfunction and diabetic nephropathy. Potassium depletion was associated with a decrease in pancreatic β -cell sensitivity to hyperglycemia with a reduction in insulin release; it is a well-established correlate of disturbances in glucose metabolism. Potassium depletion might also occur due to inhibition of the rennin-angiotensin-aldosterone system, which plays a key role in the regulation of fluid and electrolyte balance in the body. In this study, serum chloride levels were also found to be significantly lowered in diabetic group ($P<.001$) when compared with control subjects, this result was in correlation with findings of Hasan et al.[25]. The observed reduction in serum chloride in diabetic subjects might be a result of electrolyte loss which arises due to dehydration or a result of kidney dysfunction or diabetic nephropathy.

Sulphur containing compounds have been established as risk factor for cardiovascular diseases and occur with high prevalence in patients with type 2 diabetes. A large amount of evidence supports increased plasma sulphur containing compounds in type 2 diabetes, this can be found in the findings of [Emoto et al.[28], Fiorina et al.[29], Hultberg et al.[30], Chico et al.[31], Stabler et al.[32], Buysschaert et al.[33]. In this study, serum sulphur concentrations were significantly higher ($P<.001$) in diabetic subject when compare with controls.

This study also showed that the mean levels of serum calcium were significantly lower ($p<0.01$) in the serum of types II diabetic patients when compared with the control group, similar results were recorded by Djalali et al.[34] and Anastassios et al.[35]. The loss of these elements might be attributed to impaired absorption and/or the excessive excretion of these elements in urine (glycosuria) in these patients, which may induce a deficiency or marginal state of these minerals in blood of diabetic patients [Brown et al.[36], Isbir et al.[37].

Analysis of serum phosphorus in this study revealed a significantly lower level ($P<.001$) in diabetic patients when compared with control group, similar result has also been recorded by Djalali et al.[35]. This reduction in phosphorus level may be due to loss as a result of increase glucosuria. The evidence of the occurrence of a paradoxical imbalance in phosphate metabolism from the early onset of diabetes mellitus has indicated that this imbalance may lead to a reduction of high energy phosphates. Cellular phosphorus depletion and hypophosphatemia have played a role in the development of acute, occasionally life-threatening complications in diabetic mellitus. When insufficient phosphate and oxygen are available for adenosine triphosphate (ATP) synthesis, cell homeostasis cannot be maintained and may result in cell lyses; this has been recognized as a cause of morbidity and mortality in Diabetic ketoacidosis[38].

4. CONCLUSION

Alterations in Macro minerals levels may underlie many of the pathophysiologic and clinical characteristics of diabetes and as such must be routinely assay in Diabetic patients so as to prescribe appropriate management which could prevent complications.

ETHICAL APPROVAL

This study was approved by the Department of Biochemistry of Ekiti State University, Ado Ekiti, Department of Chemical Pathology of Ekiti State University Teaching Hospital, Ado Ekiti and Federal Medical Centre of Ido Ekiti, Ekiti State, Nigeria. All procedures followed were in accordance with the ethical standards Ministry of Health, Nigeria.

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