IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 7 Ver. I (July 2016), PP 66-70
www.iosrjournals.org

Status of Serum Zinc and Magnesium among Type 2 Diabetic Subjects in Maiduguri

Y. P. Mamza[1]*, Z. B. Abdullahi[1], R. M. Gali[1], DS Mshelia[2], R.Y.Genesis[3], S.A. Habu[3]

[1]*Department of Medical Laboratory Science,*
[2]*Department of Chemical Pathology, College of Medical Sciences University of Maiduguri, Nigeria*
[3]*Department of Chemical Pathology Laboratory, University of Maiduguri Teaching Hospital Nigeria*

Abstract: *Disturbances in trace element status in diabetes may contribute to insulin resistance and the development of diabetes and diabetes complications. This study was undertaken to evaluate the status of serum zinc and magnesium among type 2 diabetic subjects attending endocrinology Clinic of University of Maiduguri Teaching Hospital, Maiduguri. One hundred and thirty (130) subjects participated in this study which comprised of eighty (80) confirmed type 2 diabetic subjects and fifty (50) non diabetics as controls. Glucose oxidase-peroxidase, Xylidyl Blue colorimetric endpoint and colorimetric test with 5-Brom-PAPS methods were used for the measurement of fasting plasma glucose (FPG), serum magnesium and zinc respectively. Student's t-test and pearson's correlation coefficient were used to determine the statistical significance. There was significantly ($p<0.05$) high mean zinc concentration in diabetics as compared to that of the controls (15.67±0.58 versus 12.67±0.55) µmol/L. However, no significant difference ($p>0.05$) was detected in the mean of serum magnesium concentration of diabetics and that of control subjects (0.79±0.02 versus 0.74±0.02)mmol/L. A significant positive correlation ($r = 0.25$; $p<0.05$) was observed between magnesium and age. However, there was no significant ($p>0.05$) difference in the correlation between magnesium and FPG, also no significant ($p>0.05$) correlation was also observed between serum zinc with age and FPG. In this study, zinc was found to be higher in diabetics as compared to controls.*

Keywords: *Type 2 diabetes, Zinc, Magnesium, Correlation*

I. Introduction

Type 2 diabetes mellitus is characterized by insulin resistance, which may be combined with relative insulin secretion. The defective responsiveness of the body tissues to insulin is believed to involve the insulin receptor. However, the specific defects are not well understood. Type 2 diabetes is the most common. In the early stage of type 2, the prominent abnormality is reduced insulin sensitivity. At this stage, hyperglycemia can be reversed by variety of measures and medications that improves insulin sensitivity or reduce glucose production by the liver [1]

Minerals are structural components of body tissues as well as involved in various processes like co-factor of several enzymes. They also play an important role in energy production [2]. Zinc is an essential trace element that is directly involved in the synthesis, storage and secretion of insulin, as well as conformational integrity of insulin. Zinc is also required for normal immune function, taste acuity and enhances the in vitro effectiveness of insulin. The function of zinc in the body metabolism is based on its enzymatic affinity and way of a zinc-enzyme complex or metallo-enzyme. Zinc is required for insulin synthesis and storage and insulin is secreted as zinc crystals. It maintains the structural integrity of insulin [3]. Zinc has an important role in modulating the immune system and its dysfunction in diabetes mellitus may be related in part to the status of zinc [4].

Magnesium plays an essential physiological role in many functions of the body. It may play a role in glucose homeostasis, insulin action in peripheral tissues, and pancreatic insulin secretion [5, 6], although the exact mechanisms are not well understood. First, magnesium functions as a cofactor for several enzymes critical for glucose metabolism utilizing high energy phosphate bonds [5]. Diminished levels of magnesium were observed to decrease tyrosine kinase activity at insulin receptors [7] and to increase intracellular calcium levels [6] leading to an impairment in insulin signaling. Thus, intracellular magnesium levels have been hypothesized to be important for maintaining insulin sensitivity in skeletal muscle or adipose tissue [8, 6]. Additionally, intracellular magnesium levels may also influence glucose-stimulated insulin secretion in pancreatic β-cells through altered cellular ion metabolism [6] oxidative stress [9], endothelial function, and the pro inflammatory response [10, 11].

Diabetes mellitus is associated with diverse clinical conditions; clinical assessment is focused on keeping blood glucose as close to as normal as possible. Disturbances in trace element status and increased

oxidative stress in diabetes may contribute to insulin resistance and the development of diabetes and diabetic complications [12, 13]. It is in view of this that this study is intended to determine the status of serum zinc and magnesium level in diabetes mellitus for management.

II. Materials and Methods

A total of 150 subjects were recruited for the study. This consisted of 100 known type 2 diabetic subjects attending endocrinology Clinic of University of Maiduguri Teaching Hospital (UMTH), and 50 non diabetic subjects as controls.

Subjects clinically not diagnosed of type 2 diabetes mellitus were excluded from the study; type 1 diabetic subjects were also excluded from the study.

Informed consent was sought from the subjects on willingness to participate in the study. Ethical approval was obtained from the ethical committee of UMTH, in accordance with the Helsinki declaration. Five milliliter (5ml) of blood was collected from the left or right superficial veins of the antecubital region. The blood was drawn using the vacutainer syringe, 2ml of the blood was taken into fluoride oxalate container for fasting plasma glucose immediately and the remaining 3ml was dispensed into the vacutainer plain bottle, and allowed to clot at room temperature. It was centrifuged at 4000 revolution per minute (rpm) for 10mins. The serum was collected and transferred into storage cryovials, labeled and stored frozen at 4^0c until the time for analysis.

Fasting plasma glucose (FPG) concentrations were measured using glucose oxidase peroxidase method by Trinder [14]. The reagent diagnostic kit was obtained from Randox Laboratories limited. Serum magnesium was measured colorimetrically using Xylidyl Blue [15]. Serum zinc was measured colorimetrically with2-(5-Bromo-2-pyridylazo)-5-(N-propyl-N-sulfopropylamino-) phenol [16]. The data obtained were analyzed using the statistical package for social sciences (SPSS) version 16.0 for windows. Student's t' test was used to compare the means of fasting plasma glucose, serum zinc and magnesium of subjects with type 2 diabetes mellitus and the controls; Pearson's linear coefficient was used to determine the correlation between fasting plasma glucose, serum zinc and magnesium of diabetic subjects. Microsoft Excel was used to plot the correlation graph. A p-value of equal to or less than 0.05 ($p \leq 0.05$) was considered as statistically significant.

III. Results

A total of one hundred and thirty (130) subjects were recruited for the study. Table 1 shows the frequency distribution according to sex for diabetic and control subjects, of which eighty (80) (61.5%) were type 2 diabetic subjects and (50) (38.5%) were non diabetic subjects. From the (80) diabetic subjects, (30) (37.5%) were males and (50) (62.5%) were females. For the controls, 34 (68.0%) were males and 16 (32%) were females.

Table 1: Frequency distribution according to sex for diabetics and controls

	Sex	Frequency	percentage
Diabetics	Male	30	37.5
	Female	50	62.5
	Total	80	100
Controls	Male	34	68.5
	Female	16	32.0
	Total	50	100

The mean systolic BP was significantly higher ($p<0.05$) in type 2 diabetic subjects as compared to the controls, while there is no significance difference in the mean age, diastolic BP and BMI in type 2 diabetics when compared to the controls (table 2).

Table 2: Comparison of means ± SD of demographic variables in type 2 diabetic subjects and controls

Demographic variables	Type 2 diabetics n =80	Controls n =50	P-value
Age (yrs)	46.82±0.79	44.94±1.66	0 .255
Systolic BP(mmHg)	137.75±2.26	126.40±2.25	0 .001
Diastolic Bp (mmHg)	85.00±1.15	80.40±1.21	0 .009
BMI (kg/m^2)	26.89±0.61	26.78±0.62	0 .907

The means of serum zinc and FPG were significantly ($p<0.05$) higher in diabetic subjects as compared to the controls. There was no significant difference ($p>0.05$) in the mean serum magnesium of diabetics as compared to the controls (table 3).

Table 3. Comparison of means ± SD of biochemical parameters in type 2 diabetic subjects and controls

Biochemical variables	Type 2 diabetic subjects	Control subjects	P - value
FPG	8.46 ± 0.58	4.43 ± 0.12	<0 .001
Zn	15.67 ± 0.58	12.61 ± 0.55	<0.001
Mg	0.79 ± 0.02	0.74 ± 0.02	0.123

As presented in table 4, the negative correlation observed between serum zinc and FPG, serum magnesium and FPG were not significant (p>0.05). The correlation plots are shown in figures 1 and 2 respectively.

Table 4: Correlation between serum zinc, magnesium and FPG in diabetic subjects**.**

Parameters	**r- values**	**P- values**
Zn and FPG	- 0.09	0.334
Mg and FPG	- 0.02	0.570

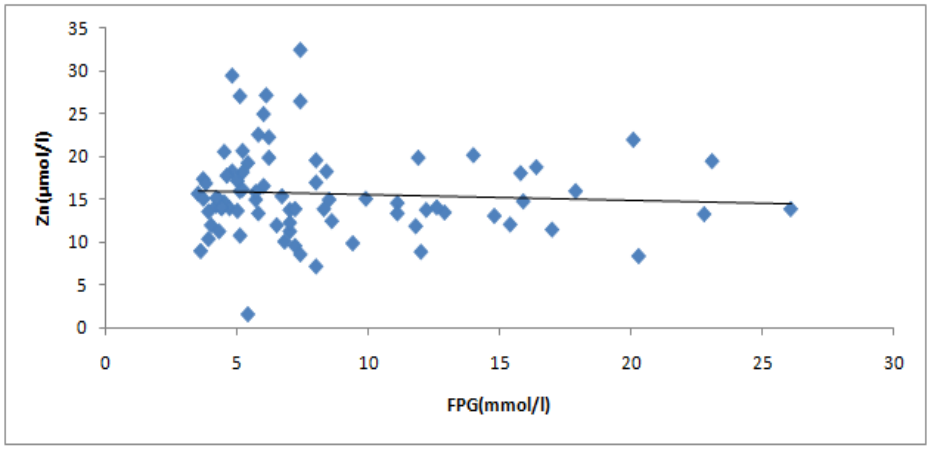

Figure 1: correlation plot between zinc and FPG glucose in diabetic subjects

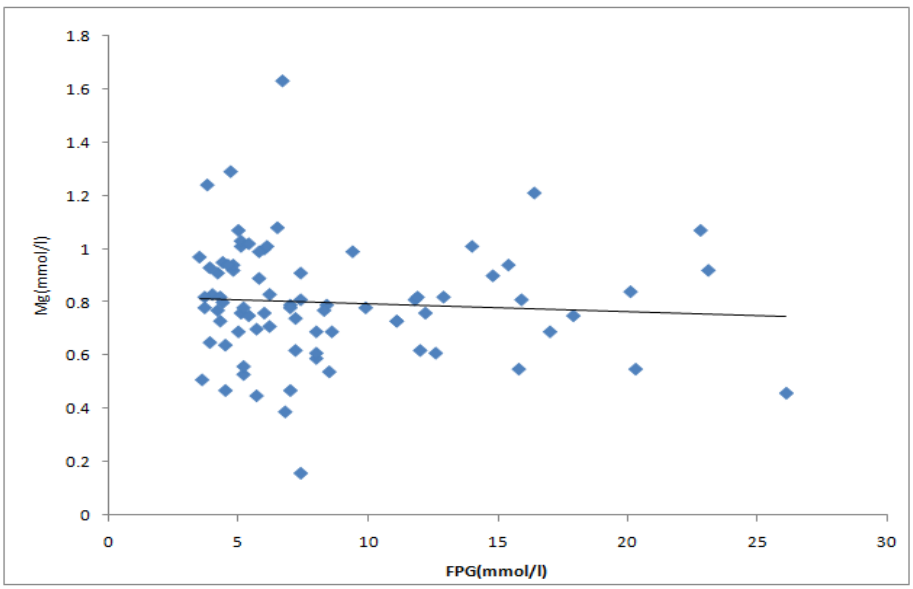

Figure 2: correlation plot between magnesium and FPG in diabetic subjects

There was a positive and significant (p<0.05) correlation between magnesium and age. No significant (p>0.05) correlation was observed between zinc and age (table 5). The correlation plots are shown in figures 3 and 4

Table 5: Correlation between serum zinc, magnesium and age in diabetic subjects

Variables	**r- values**	**P- values**
Zn and age	0.05	0.68
Mg and age	0.25	0.03

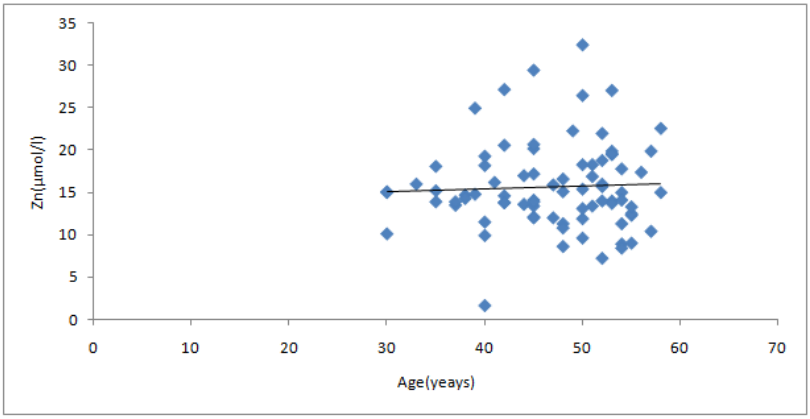

Figure 3: correlation plot between zinc and age in diabetic subjects

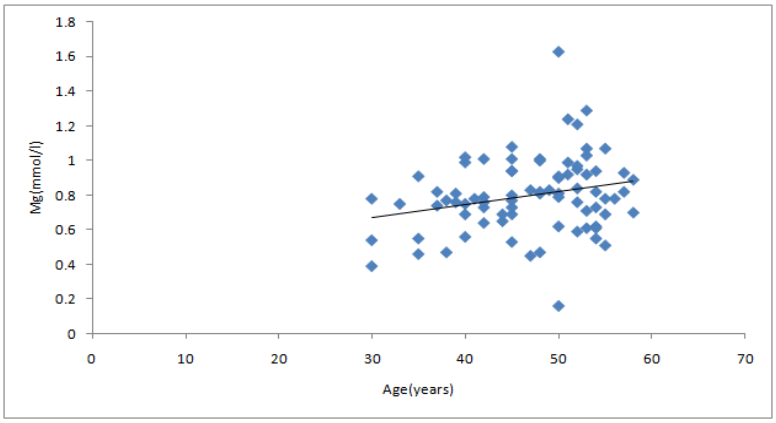

Figure 4: correlation plot between magnesium and age in diabetic subjects

IV. Discussion

Diabetes mellitus, one of the commonest diseases of the mankind is linked with alteration in mineral metabolism. The serum levels of zinc and magnesium in type 2 diabetics and controls were determined in this study and related to fasting plasma glucose (FPG) and age.

In our study, it was observed that mean serum zinc level was found to be significantly higher in type 2 diabetics as compared to the control group. The effect of zinc on insulin secretion is biphasic, that is very high or very low zinc plasma concentrations impair insulin secretion [17-19]. Our finding concurs with that of Mateo *et al.,* Ocon *et al.,* and Osman *et al.,* [20-22]. The increase in zinc levels in diabetics could be explained by the finding that oxidative stress in diabetics could lead to destruction of ß-cells, leading to release of high amounts of zinc from the cells into blood stream [23, 24]. The increase of plasma zinc can also reflect a deficient storage or a chronic hyper secretion of insulin in hyperglycemic patients [20]. These findings do not concur with that of Saha-roy *et al.,* [25]. In their study, there was significantly low level of serum zinc in diabetics as compared to controls. Same study were carried out by Nsonwu et al. [26], Chausmer et al.[3], Naila et al.[27] and Alena et al.[28] and serum zinc was found to be significantly lower in diabetic group. In our study, there was no significant difference in the means of serum magnesium in type 2 diabetics as compared to controls. This finding agreed with that of Walter *et al.*[29] and Naila *et al.*[27], who also reported that there were no significant differences in the means of magnesium of diabetic and the control subjects. In contrast to this study, Tripathy *et al.*[30] and Diwan *et al.*[31] reported that serum levels of magnesium were significantly lower in diabetic patients when compared with the control group. In our study, no significant correlation was observed between serum Zinc with FPG and age; Magnesium and FPG. This study was similar to that of Naila *et al.*[27]. However, a positive and significant correlation was observed between magnesium and age**.** The complications of diabetes may be mediated at least in part through oxidative stress, and zinc plays a key role in the cellular anti-oxidative defense [3]. Hence, it has been suggested that an abnormal zinc metabolism may play a role in the pathogenesis of diabetes and some of its complications [32].

V. Conclusion

In conclusion, Zinc was found to be higher in diabetics as compared to the control group, while magnesium shows no significant difference between the diabetics and the controls.

Acknowledgements

We are grateful to the Department of Chemical Pathology Laboratory University of Maiduguri Teaching Hospital for providing the facilities used for our analysis.

Conflicts of Interest

No conflicts of interest in this study.

References

[1]. Shoback, D.(2011). Greenspan's basic and clinical endocrinology. In: David G. Gardner. Dolores(eds); 9th ed. 17, New York: Mc Graw-Hil medical.
[2]. Belete, V., Dib, R., Attah, A.(2007). Zinc supplement for the prevention of type2 Diabetes mellitus. Cochran database of systematic review, Nim.Gov; (1) CD 005525
[3]. Chausmer, A.B.(1998). Zinc, insulin and diabetes. Journal of American College Nutrition; 17 (2) : 109-15
[4]. Mocchegiani, E., Giacconi, R.(2008). Malavolta, M. Zinc signalling and subcellular distribution: emerging targets in type 2 diabetes. Trends of Molecular Medicine; 14: 419–428
[5]. Saris, N.E, Mervaala, E., Karppanen, H., Khawaja, J.A., Lewenstam, A.(2000). Magnesium: An update on physiological, clinical and analytical aspects. Clin Chim Acta; 294: 1-26.
[6]. Barbagallo, M., Dominguez, L.J., Galioto, A.(2003). Role of magnesium in insulin action, diabetes and cardio-metabolic syndrome X. Molecular Aspects of Medicine; 24 (1-3): 39-52.
[7]. Suarez, A., Pulido, N., Casla, A., Casanova, B., Arrieta, F.J, Rovira, A.(1995). Impaired tyrosine kinase activity of muscle insulin receptors from hypomagnesaemic rats. Diabetologia; 38(11): 1262-1270.
[8]. Paolisso, G. & Barbagallo, M.(1997). Hypertension, diabetes mellitus, and insulin resistance: the role of intracellular magnesium. American Journal of Hypertension; 10: 346-355.
[9]. Giugliano, D., Paolisso, G., Ceriello, A.(1997). Oxidative stress and diabetic vascular complications. Diabetes Care; 19: 257-267.
[10]. Weglicki WB, Phillips TM, Freedman AM, Cassidy MM, Dickens BF.(1992). Magnesium-deficiency elevates circulating levels of inflammatory cytokines and endothelin. Molecular Cell Biochemistry; 110 (2), 169-173.
[11]. Kurantsin-Mills, J., Cassidy, M.M., Stafford, R.E., Weglicki, W.B.(1997). Marked alterations in circulating inflammatory cells during cardiomyopathy development in a magnesium-deficient rat model. British Journal of Nutrition; 78(5): 845-855.
[12]. Cheng, Y., Tseng, White, M. F.(2000).Insulin signaling meets mitochondria in metabolism," Trends in Endocrinology and Metabolism; 21, (10): 589–598.
[13]. Friedrich, M., Hansell, P., Palm, F.(2009). Diabetes Oxidative stress, nitric oxide and mitochondria function. Current Diabetes Review; 5(2): 120-144
[14]. Trinder, p.(1969). Determination of glucose in blood using glucose oxidase with an alternative oxgen receptor. Ann. Clin. Biochem; 6:24-27
[15]. Mann, C.K. & Yoe J.H.(1957). Spectrophotometric determination of magnesium analysis. Chem Acta;16: 155-60
[16]. Johnson & Eliasson, R.(1987). Evaluation of a commercially available kit for the colorimetric determination of zinc. International Journal Andrology; (2): 435-440.
[17]. Figlewicz, D.P., Formby, B., Hodgson, A.T, Schmid, F.G., Grodsky, G.M.(1979). Kinetic of zinc uptake and distribution in fractions from cultured rat islets of Langerhans. Diabetes; 29: 767-773.
[18]. Figleswicz, D.P., Held, A., Forhan, S.E., Grodsky, G.M.(1980). Effect of exogenous zinc on insulin secretion in vivo. Endocrinology; 108:730-732
[19]. Levine A.S., Mc Clain, C.J., Handwerger, B.S., Brown, D.M., Morley, J.E.(1983). Tissue zinc status of genetically diabetic and streptozotocin-induced diabetic mice. American Journal Clinical Nutrition; 37: 382-386.
[20]. Mateo, M.C., Bustamante, J.B., Cantalapiedra, M.A.(1978). Serum, zinc, copper and insulin in diabetes mellitus. Biomedicine; 29(2): 56-58.
[21]. D'Ocon, C., Alonso de Armino V, Frasquet, I.(1987). Levels of Zn and Cu in the serum of a diabetic population. Rev Esp Fisiol; 43 (3): 335-338.
[22]. Osman E., vliyaoğl, Levent, K., Nuriye, U., Nazife, K., Baysal, K., Ruhan, K., Naciye, Y.(2004). "Correlations of Serum Cu^{+2}, Zn^{+2}, Mg^{+2} and HbA1c in Type 2 and Type 2 Diabetes Mellitus". Turkish Journal of Endocrinology and Metabolism; 8(3): 75-79.
[23]. Faure, P., Roussel, A., Coudray, C., Richard, M.J, Halimi, S., Favier, A.(1992). Zinc and insulin sensitivity. Biology of Trace Elements Res; 32: 305-310.
[24]. Quilliot D., Dousset B., Guerci B., Dubois F., Drouin P., Ziegler, O.(2001). Evidence that diabetes mellitus favors impaired metabolism of zinc, copper, and selenium in chronic pancreatitis. Pancreas Apr ;22 (3): 299-306.
[25]. Saha-Roy Santa, Bera Swati, Choudhury Kanika M., Pal Santasmita , Bhattacharya Aruna, Sen Gargi , Gupta Soma.(2014). Status of serum magnesium, zinc & copper in patients suffering from type-2 diabetes mellitus. Journal of Drug Delivery & Therapeutics; 4(1): 70-72.
[26]. Nsonwu, A. C., Usoro, C.A.O., Etukudo, M.H.(2009). Glycemic control serum and urine levels of zinc and magnesium in diabetics in calabar, Nigeria. Pakistan Journal of Nutrition; 5 (1): 75-78.
[27]. Naila, Masood., Ghulam Hussain Baloch, Rafi Ahmed Ghori, Igbal Ahmed Memon, Muhammad Anwar Memon, Muhammad Sadik Memon(2009). Serum zinc and magnesium in type 2 diabetic patients. Journal of the college of physicians and surgeons Pakistan; 19 (8): 483-486.
[28]. Alena Viktorinova, Eva Toserova, Marian Krisko & Zdenka Durackova(2009). Altered Metabolism of Copper, Zinc, and Magnesium is Associatedwith Increased levels of Glycated Hemoglobin in patients withDiabetes Mellitus. Diabetes; 58: 1477-82.
[29]. Walter, R.M., Uriu-Hare, J.Y., Olin, K.L., Oster, M.H., Anawalt, B.D., Critchfield, J.W. (1991).Copper, zinc, manganese and magnesium status and complications of diabetes mellitus. Diabetes Care; 14:1050-6.
[30]. Tripathy S., Sumanthi, S., Raj, G.B.(2004). Minerals nutritional status of type 2 diabetic subjects. International journal of Diabetes Develop Countries; 24: 27-8.
[31]. Diwan, A.G., Pradhan, A.B., Lingojwar, D., Krishna, K.K., Almelka, S.I.(2006). Serum Zinc Chromium, and Magnesium levels in type 2 diabetes. Journal of International Diabetes in Develop countries; 26(3): 122-123.
[32]. Rai, I., Iyer U., Mani I. & Mani U. V.(1997). Serum Biochemical changes in insulin dependent and non-insulin dependent diabetes mellitus and their role in the development of secondary complications. *Inter. J. Diab. Dev. Countries*; 17