Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol 2, No.6, 2012

Serum Chromium, Zinc and Testosterone Levels in Diabetics in University of Calabar Teaching Hospital Calabar Nigeria

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Abstract
This study was aimed at determing the possible effects of obesity and glycaemic control on serum Chromium, Zinc, and Testosterone levels in diabetics and non-diabetic subjects. Twenty five (25) diabetics aged between 35-68years and thirty nine (39) non-diabetics aged matched were investigated for Serum Chromium, Zinc, and Testosterone, and Fasting Plasma glucose and glycosylated haemoglobin using standard methods. Body Mass indices of subjects were also determined. The result shows that Serum zinc levels in diabetics were significantly higher when compared with the non-diabetics ($p<0.05$) while serum testosterone was significantly lower in obese non-diabetics and obese diabetics with poor glycaemic control when compared to their non-obese counterparts ($p<0.05$). Serum zinc correlated positively with fasting plasma glucose in non-obese non-diabetics ($r=0.4388$, $p<0.05$) while Serum chromium correlated positively with glycosylated haemoglobin in obese diabetics ($r=0.9877$, $p<0.05$). Serum testosterone correlated negatively with serum zinc in obese diabetics, and with fasting plasma glucose in obese non-diabetics respectively ($r=-0.9639$, $r=-0.7364$, $p<0.05$) while a negative correlation was observed between fasting plasma glucose and glycosylated haemoglobin in diabetics ($r=0.3830$, $p<0.05$). In conclusion, Obesity and the control of diabetes did influence serum testosterone levels. Serum chromium and zinc levels were observed to be altered in diabetes mellitus condition.
Key words: chromium, zinc, testosterone.

Introduction

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycaemia resulting from defects in insulin secretion, action or both (Freeman, 2010). Research evidence has associated low testosterone levels, zinc and chromium deficiencies mainly with type 2 diabetes (Clements, 2010). Type 2 Diabetes is associated with chronic hyperglycaemia which damages blood vessels and nerve cells throughout the body, producing micro-vascular diseases as well as increased risk of cardiovascular diseases. As a consequence, type 2 Diabetes represents a major public health problem that causes high economic costs in industrialized countries (Kazi, 2008). Chronic hyperglycaemia may cause significant alterations in the status of some micronutrients resulting in deficiencies of certain minerals such as magnesium, zinc and chromium which leads to glucose intolerance and development of diabetic complications ((Zargar *et al*., 1998, Chen *et al*., 1995). Zinc is implicated in the improvement of insulin sensitivity and guards against diabetes, inhibits aromatase responsible for the conversion of testosterone to estrogen, improves sex drive and semen volume by enhancing the conversion of androstenedione into forms of testosterone (Clements, 2010) while chromium is essential for normal sugar metabolism (Reavley, 2009). Life style, medication, disease and ageing process have been found to contribute to the gradual and progressive decline in serum testosterone levels during life, as a result of a primary testicular and secondary hypothalamo-pituitary dysfunction (Harman et al, 2001). The aim of this study is to assay the serum levels of chromium, zinc and testosterone and their association with glycaemic status in diabetic and non-diabetic subjects in Calabar Nigeria.

Materials and Methods

A total of sixty four (64) subjects were enrolled into this study. Twenty five (25) of them were known type 2 diabetic subjects who were all Nigerians aged 30 – 68 years attending the University of Calabar Teaching Hospital diabetic clinic (UCTH) Calabar and thirty nine (39) age-matched apparently healthy individuals from the general population whose blood glucose levels were below 5mmol/l were used as control subjects in this research. Their weights and heights were taken and was used to compute their body mass index (BMI) which was used to classify the diabetics and non-diabetics into obese ($\geq$30 kg/m^2) and non-obese ($\leq$29.9 kg/m^2) groups (Yoneda *et al.*, 1998). Structured questionnaire was used to obtain data on occupation, physical activity, diet, past and present illness and medication. Ten millilitres of fasting venous blood samples were collected aseptically from the subjects and placed into appropriate sample bottles. Two millilitres was placed in 0.1ml of fluoride oxalate for fasting plasma glucose, three

millilitres into 0.08ml of sequesterene for glycosylated haemoglobin and five millilitres into plain bottle for serum chromium, zinc, and testosterone. Standard methods of Trinder, 1969 and Trivelli, 1971 were used for fasting plasma glucose and glycosylated haemoglobin estimations respectively. ELISA kit method purchased from DRG Instruments GmbH, Germany, was used for serum testosterone estimation while absorption spectrophotometric technique was used for the determination of serum chromium and zinc. The generated data were systematically analysed as appropriate for means, standard deviation, Student's t-test, and Pearson's correlation analysis on Microsoft excel and SPSS software version 18 (California Inc.). Results are presented as the Mean ± Standard deviation. A two sided $P<0.05$ was considered statistically significant for t-test (used to determine the differences between the groups) and Pearson's correlation analysis, which was used to determine the inter-variable associations of the various groups (Armitage and Berry, 1994).

Results

Table 1 shows means for Age, body mass index (BMI), blood pressure, fasting plasma glucose (FPG), glycosylated haemoglobin (HbA1c), serum chromium, serum zinc, and testosterone levels of all the diabetics and non-diabetics enrolled in this study. The means of fasting plasma glucose (9.71±4.66mmol/L), glycosylated haemoglobin (8.93±3.37%) and zinc levels (97.33±12.16µg/dl) were significantly higher in diabetics when compared with non-diabetics (4.78±1.14mmol/L, 5.80±1.19%, 88.54±15.17µg/dl) while serum chromium levels (0.0032±0.0019µg/dl) were significantly lower in diabetics when compared with non-diabetic (0.0046±0.0021µg/dl) subjects. Figure 1 shows scatter plot of fasting plasma glucose against glycosylated haemoglobin in diabetics ($r=-0.3830$, $p<0.05$), figure 2 shows fasting plasma glucose against serum testosterone in non-diabetics($r=-0.7364$, $p<0.05$), figure 3 fasting plasma glucose against serum zinc in non-obese non-diabetics ($r=0.4388$, $p<0.05$), fig 4 illustrates serum chromium against glycosylated haemoglobin in obese diabetics ($r=0.9877$, $p<0.05$) and fig 5 serum testosterone against serum zinc in obese diabetics ($r=-0.9639$, $p<0.05$).

Discussion

Medication adherence (Schectman *et al.,* 2002), physical activity (Kirk *et al.,* 2003), family support (Konen *et al.*, 1993) and coping mechanisms (Turan *et al.,* 2002) have been reported to correlate with glycaemic (diabetic) control. In the present study, glycosylated haemoglobin correlated negatively with fasting plasma glucose (fig.1-moderate association).This appears to be so because; the subjects were poorly controlled diabetics. The finding is at par with report of Rosediani, *et al*. 2006 who worked on diabetic subjects with good glycaemic control (HbA1c<7%). Serum zinc levels increased in diabetes mellitus condition (table1) and this is in line with Song's, *et al*. (2000) report. The reason for this finding could be due to the imbalanced rate of absorption to excretion of zinc. Furthermore, serum zinc correlated positively with fasting plasma glucose in non-obese non-diabetics (fig3-moderate association). The absence of an upsurge of fasting plasma glucose prevents insulin secretion, thus, the level of fasting plasma glucose and zinc remains low and within the reference range in these subjects. In line with the report of Hemmati, *et al*., 2011, serum chromium level in diabetics was observed to be significantly lower compared to the non-diabetics ($p<0.05$) (table1). Chromium is said to be decreased in hyperglycaemia, hyperinsulinaemia, insulin resistance, osmotic diuresis resulting from glycosuria (Normuhammadi, *et al*., 2001). However serum chromium correlated positively with glycosylated haemoglobin in obese diabetics (fig 4-strong association). Hyperinsulinemia due to obesity results in elevated serum chromium in the presence of hyperglycaemia which invariably results to increased glycosylated haemoglobin (Eckfeldt and Bruns, 1997). In accordance with the findings of Grossmann and his colleagues (2008), serum testosterone levels was significantly lower in obese non-diabetics as well as in obese diabetics with poor glycemic control compared to their non-obese counterparts (table 2). In Obesity, aromatase enzyme present in the fat cells, converts testosterone and androstenedione to estrogens, resulting in the depletion of testosterone in blood (Kapoor *et al.*, 2005). Serum testosterone correlated negatively with fasting plasma glucose (fig 2-strong association) in obese non-diabetics. Low sex-hormone binding globulin and serum testosterone predict higher glucose and insulin levels, and increased body mass index (Haffner et al., 1996). Serum testosterone correlated negatively with serum zinc (fig 5-strong association) in obese diabetics. This is in line with a study reported by Koehler, *et al*. (2009) that increased serum zinc levels did not show any effect on testosterone levels which remained low as observed in this study.

In conclusion, the findings of this work have shown that the control of diabetes did not influence serum chromium, and serum zinc. Diabetes significantly influences the serum concentrations of chromium, and zinc except for the serum testosterone level. Obesity did not influence serum concentrations of chromium, and zinc except for

serum testosterone in obese diabetics with poor glycaemic control and in obese non-diabetics enrolled into the study. Therefore, for proper management of diabetes mellitus, adequate and timely use of hypoglycaemic agents and nutritional supplements should be emphasized and encouraged.

Acknowledgement
I wish to profoundly acknowledge the assistance of Prof. G.C. Egezie for providing the materials used for the literature review, Prof. A.O. Emeribe for his generous financial assistance to the successful completion of this work. Also, I wish to thank Mr. Henry Efobi, Assistant Director, Laboratory Services, Chemical Pathology Department, University of Calabar Teaching Hospital and Mr. Bassey Icha, Principal Medical Laboratory Scientist, Chemical Pathology Department, University of Calabar Teaching Hospital, for their technical assistance to the success of this research work.

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Table 1: Mean Age, Body Mass Index (BMI), Blood Pressure, Fasting Plasma Glucose (FPG), Glycosylated Haemoglobin (HbA1c), Serum Chromium, Zinc and Testosterone levels in Diabetics and non-diabetics in the University of Calabar Teaching Hospital.

					Serum			Blood pressure	
Subjects	Age (Years)	BMI (Kg/m^2)	FPG (3.33-7.0 mmol/L)	HbA1c (6-8.3%)	Chromium (0.005-0.05 µg/dl)	Zinc (70-120 µg/dl)	Testosterone (3-10ng/ml)	Systolic (mmHg)	Diastolic (mmHg)
Non-diabetics (n_1=39)	48.85±9.20	26.87±4.99	4.78±1.14	5.80±1.19	0.0046±0.0021	88.54±15.17	8.03±3.79	40.23±20.38	83.33±13.88
Diabetics (n_2=25)	50.44±7.95	25.76±3.68	9.71±4.66	8.93±3.37	0.0032±0.0019	97.33±12.16	6.45±2.99	135.12±19.90	84.16±11.65
P value	P>0.05	P>0.05	P<0.05	P<0.05	P<0.05	P<0.05	P>0.05	P>0.05	P>0.05

t-test analysis
$p<0.05$ is significant
$p>0.05$ is not significant
n_1= Number of non-diabetics
n_2= Number of diabetics

Table 2: Effect of obesity and diabetic control on the serum chromium, zinc, and testosterone concentrations in non-diabetic and diabetic Subjects (figures given as Means ± SD).

Parameters	Groups	Obese	Non-obese	P-value	Comment
Chromium (µg/dl)	Non-diabetics	0.0048±0.0024 (n=12)	0.0044±0.0019 (n=27)	p>0.05	NS
	Diabetics	0.0033±0.0020 (n=4)	0.0032±0.0020 (n=21)	p>0.05	NS
	Good control (HbA1c:6-8%)	0.0015±0.0007 (n=2)	0.0028±0.0017 (n=11)	p>0.05	NS
	Poor control (HbA1c:>8.3%)	0.0050±0.0000 (n=2)	0.0037±0.0022 (n=10)	p>0.05	NS
Zinc (µg/dl)	Non-diabetics	89.35±14.64 (n=12)	88.18±15.66 (n=27)	p>0.05	NS
	Diabetics	98.95±15.86 (n=4)	97.02±11.80 (n=21)	p>0.05	NS
	Good control (HbA1c:6-8%	94.73±26.00 (n=2)	96.56±10.80 (n=11)	p>0.05	NS
	Poor control (HbA1c:>8.3%)	103.81±2.82 (n=2)	97.53±13.39 (n=10)	p>0.05	NS
Testosterone (ng/ml)	Non-diabetics	6.06±2.38 (n=12)	8.90±4.01 (n=27)	p<0.05	S
	Diabetics	5.35±2.94 (n=4)	6.66±3.02 (n=21)	p>0.05	NS
	Good control (HbA1c:6-8%)	6.55±4.45 (n=2)	6.16±2.90 (n=11)	p>0.05	NS
	Poor control (HbA1c:>8.3%)	4.15±0.49 (n=2)	7.21±3.21 (n=10)	p<0.05	S

n = Number of subjects for diabetics and non-diabetics.
NS = Non-significant
S = Signifinant

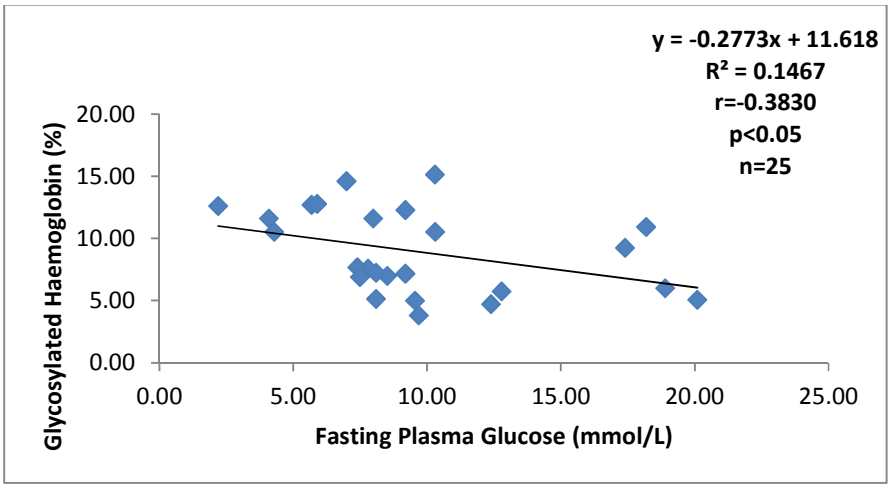

Fig 1: Correlation plot of glycosylated haemoglobin (HbA1c) against fasting plasma glucose (FPG) in diabetics.

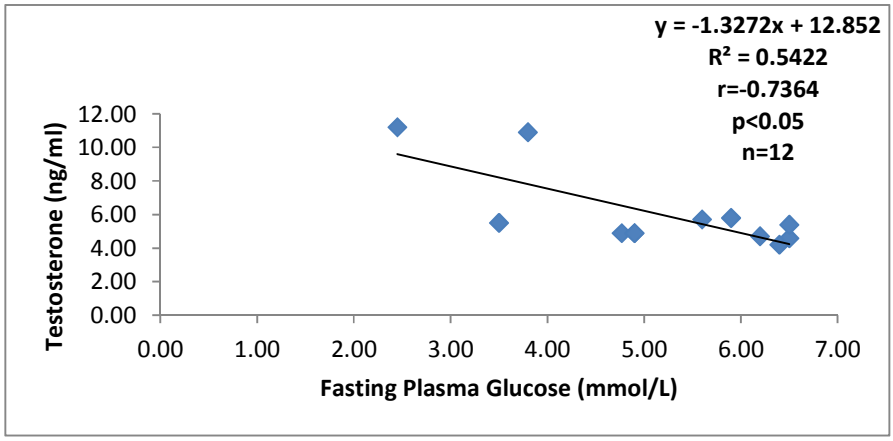

Fig 2: Correlation plot of serum testosterone against fasting plasma glucose (FPG) in obese non-diabetics.

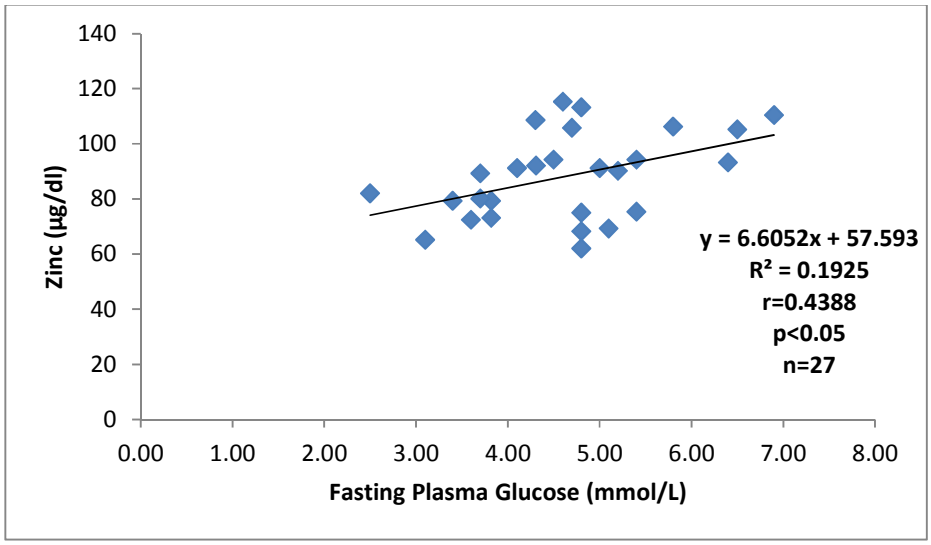

Fig 3: Correlation plot of serum zinc against fasting plasma glucose (FPG) in non-obese non-diabetics.

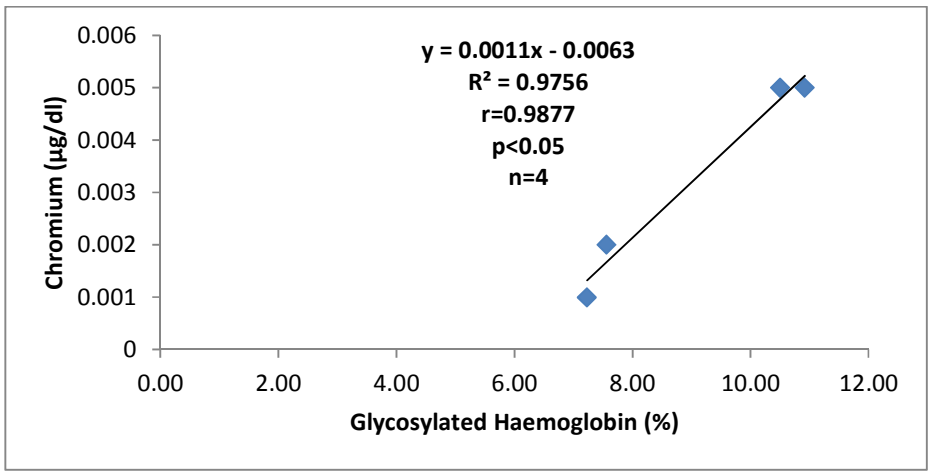

Fig. 4: Correlation plot of serum chromium (Cr) against glycosylated haemoglobin (HbA1c) in obese diabetics.

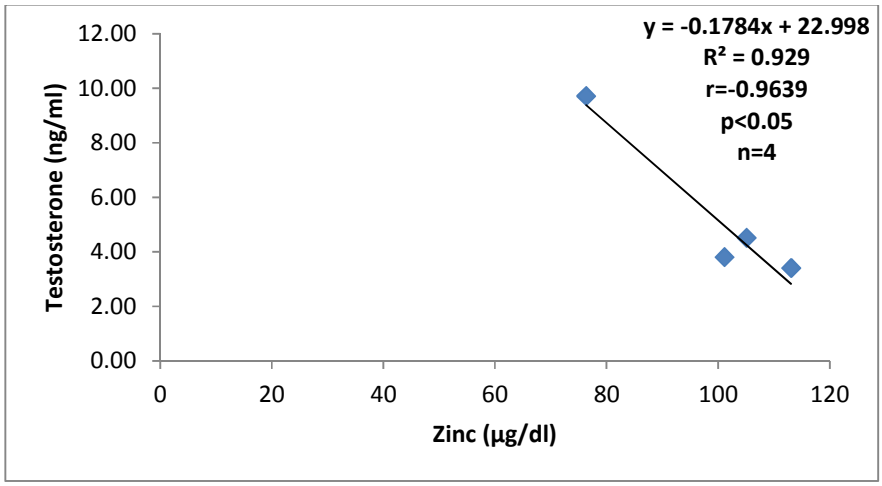

Fig 5: Correlation plot of serum testosterone against serum zinc (Zn) in obese diabetics.