Assessment of Serum Zinc and Copper Levels among Sudanese Patients with Diabetes Mellitus Type 2 in Khartoum State-Sudan

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Authors' contributions

This work was carried out in collaboration among all authors. Author TEO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author STAE managed the analyses of the study. Author AAS managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Background: Diabetes population in Sudan is around one million 90% have type 2 diabetes. In Sudan diabetes is as increasing problem, being responsible for 10% of hospital admission and mortality.
Measurement of zinc and copper is an important in decrease development of complication of DM, any disturbance in level of both zinc and copper have role in pathogenesis, prognosis of type 2 DM. This study aimed to assess the relationship between DM type 2 and trace elements by measured serum zinc and serum copper levels among Sudanese DM type 2 in Khartoum state.
Materials and Methods: This is a descriptive, case control study, was conducted in Khartoum state, Sudan. During the period from April to July 2018. Forty Sudanese patients with DM (20 controlled patients with DM and 20 uncontrolled patients with DM) Diabetes patients were divided

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into controlled and uncontrolled groups by measuring HbA1C. (Female 25% and male 15%), with different age. were selected as case and 30 apparently healthy individuals were selected as control group. Serum zinc and copper levels were analysis using Atomic Absorption Spectroscopy and ichroma for HbA1c, the obtained results were analyzed using social science software package.

Results: This study showed significant lower of serum zinc in diabetes type 2 patients comparison with control group and on another hand showed significant increase of serum copper in diabetes type 2 patients.

We concluded serum zinc significant lower in both diabetes group than healthy group, copper significant high in both diabetes group than healthy group, gender have significant effect in serum zinc and copper, weak positive correlation between zinc and HbA1C and weak negative correlation between copper and HbA1C.

Conclusion: This study concluded that the serum levels of Zinc significant lower in type 2 diabetes than healthy individuals. Serum levels of Copper significant increase in type 2 diabetes than healthy individuals as have been found in present study. Gender have significant effect in serum Zn and Cu in diabetic patients.

Weak Positive correlation between serum Zinc with HbA1c and weak negative correlation between copper with HbA1c.

1. BACKGROUND

Diabetes type 2: Type 2 DM is due primarily to lifestyle factors and genetics a number of lifestyle factors are known to be important to the development of type 2 DM, including obesity, lack of physical activity, poor diet, stress [1].

In Sudan diabetes is an increasingly important problem, being responsible for 10% of hospital admissions and mortality [2]. Recently increase in incidence of DM has been observed especially among population indicating that DM is emerging as important health problem [3]. The result of study carried out indicated that diabetes population in Sudan is at around one million, 90% of them have type 2 diabetes. It also showed a prevalence of 3.4% of type 2 DM [4].

Zinc and DM: Zinc serves an essential role as cofactor for more than 200 metal enzyme, many of which regulate the metabolism of carbohydrate, lipids, protein. Insulin itself is stored in the presence of zinc [5].

Zinc ions in the secretary granules of beta cells are known to insulin molecules, when the secretary granules open to the surface, the zinc ion pressure decrease rapidly and pH level change from acid to physiology levels, which result in free insulin monomer and zinc ion will be release from the pancreas [6]. Thus zinc is require for insulin synthesis and storage there is accumulating evidence that the metabolism of zinc is altered in IDDM and that zinc might have specific role in the pathogenesis and progress of this disease, increased urinary loss of zinc is a commonly encountered feature of diabetes [7].

Copper and DM: Copper is present in the body combined with enzymes to form metalloenzymes such as ceruloplasmin and superoxide dismutase (SOD), these enzyme play major role in redox reaction, and antioxidant defense. It has been postulated that copper possesses insulin-like activity and promotes lipogenesis [8]. Human studies demonstrate that diabetic patients may have abnormal levels of serum copper 13 in facts copper has an important role in the body and it most important antioxidant. Cu imbalance is implicated in cholesterol elevation by disrupting normal HDL and LDL balance. Cu also activates cytochrome oxidase which is involved in the electron transport chain of the mitochondria [9].

In case of copper deficiency, cytochrome oxidase reduces its activity which might lead to the distortion of mitochondria in metabolically active tissues such as pancreatic a cinar cells, hepatocytes etc. [10]. More recently, it has been reported that disturbances in copper levels in various bio fluids and tissues are associated with abnormalities implicated in metabolic pathways of diabetes and its complications [11].

2. MATERIALS AND METHODS

This is a descriptive, case control study, was conducted in Khartoum state, Sudan. Forty Sudanese patients with DM (20 controlled patients with DM and 20 uncontrolled patients

with DM) Diabetes patients were divided into controlled and uncontrolled groups by measuring HbA1C. (Female 25% and male 15%), with different age, were selected as case and 30 apparently healthy individuals were selected as control group. Serum zinc and copper levels were analysis using Atomic Absorption Spectroscopy and ichroma for HbA1c, the obtained results were analyzed using SPSS.

Data Collection: This data is collected through interview using self-administered questionnaire.

Sampling: Blood samples were collected from peripheral vein (3 ml) from each subject in plain container and centrifuged at 4000 rpm for 5 minutes to obtain serum that were stored at - 20°C.

Inclusion criteria: Patients were diagnosed with DM type2 Healthy individuals not know to have DM.

Exclusion criteria: Patient suffering from carcinoma, smoker, pregnancy, renal disease, alcoholism, take drugs contain zinc or copper were excluded using questionnaire.

Materials required: Syringe, plain container, alcohol swabs, cotton and marker pen, centrifuge, reagent, sample.

Measurement of serum zinc and copper: By using Atomic absorption spectroscopy.

Measurement of HbA1c: Measured by ichroma.

Statistical Analysis: All data was performed using the Statistical Package for the Social Sciences software package (SPSS), Values with normal distribution was presented as mean and standard deviation. The student t-test was used for two group comparison and level of significant was set as $p < 0.05$.

3. RESULTS

Shows significant different between the mean of zinc in controlled diabetic group (n=20) and healthy individual (n=30), their mean and SD is (85.05, 5.6)/(95.4, 3.8), respectively. And copper in controlled diabetic group and healthy individual, their mean and SD is (162.4, 6.4)/ (129.2, 8.3), respectively Table 1.

Shows significant different between the mean of zinc in uncontrolled diabetic group (n=20) and healthy individual (n=30), their mean SD is (91.2, 5.7)/(95.4, 3.8), respectively. And copper in uncontrolled diabetic group (n=20) and healthy individual (n=30), their mean SD is (155.6, 11.1)/(129.2, 8.3), respectively Table 2.

Shows significant different between the mean & standard deviation of serum copper and zinc in controlled (162.4, 6.4)/(85.05, 5.6) and uncontrolled diabetic group (155.6, 11.1)/(91.2, 5.7), respectively Table 3.

Comparison of mean and standard deviation of serum zinc and copper between female (91, 6.1)/(158.6, 11) and male (83.0, 1.9)/(159, 4.7), respectively. Show a significant different between serum zinc and copper in gender in Table 4.

Shows the correlation between the HbA1c and copper (r= -0.3, p value=0.002) show significant different between copper and Hba1c in Fig. 1.

Shows the correlation between HbA1c and zinc (r=0.5, p value = 0.001) significant different between zinc and HbA1c in Fig. 2.

4. DISCUSSION

This case control study conducted in Khartoum state during the period from April to August 2018, including 40 diabetic patients (20 controlled diabetes patients and 20 uncontrolled diabetes patients) and 30 Healthy individuals.

Table 1. Comparison between the means of serum zinc, copper in controlled diabetic patients and in healthy individuals

Variables	Controlled diabetes (Mean±SD) (n=20)	Healthy individual (Mean±SD) (n=30)	P- value
Zinc	85.05 ug/L ±5.6	95.4 ug/L±3.8	0.001*
Copper	162.4 ug/L±6.4	129.2 ug/L±8.3	0.001*

Significance of p.value = < 0.05

Table 2. Comparison between the means of serum zinc, copper in uncontrolled diabetic patients and the in healthy individuals

Variables	Uncontrolled diabetes Mean±SD)(n=20)	Healthy individual (Mean±SD) (n=30)	P- value
Zinc	91.2ug/L ±5.7	95.4ug/L±3.8	0.010*
Copper	155.6ug/L±11.1	129.2ug/L±8.3	0.001*

Significance of p.value = < 0.05

Table 3. comparison between the means of serum copper, zinc in control diabetic patients and in uncontrolled diabetic patients

Variables	Controlled diabetes (Mean±SD) (n=20)	Uncontrolled diabetes (Mean±SD) (n=20)	P- value
Zinc	85.05ug/L ±5.6	91.2ug/L±5.7	0.01*
Copper	162.4ug/L±6.4	155.6ug/L±11.1	0.02*

Significance of p.value = < 0.05

Table 4. Comparison between the means of serum zinc, copper in female &male patients

Variables	Female (Mean±SD) (No=25)	Male (Mean±SD) (No=31)	P- value
Zinc	91ug/L ±6.1	83.0ug/L ±1.9	0.008*
Copper	158.6ug/L±11	159ug/L±4.7	0.001*

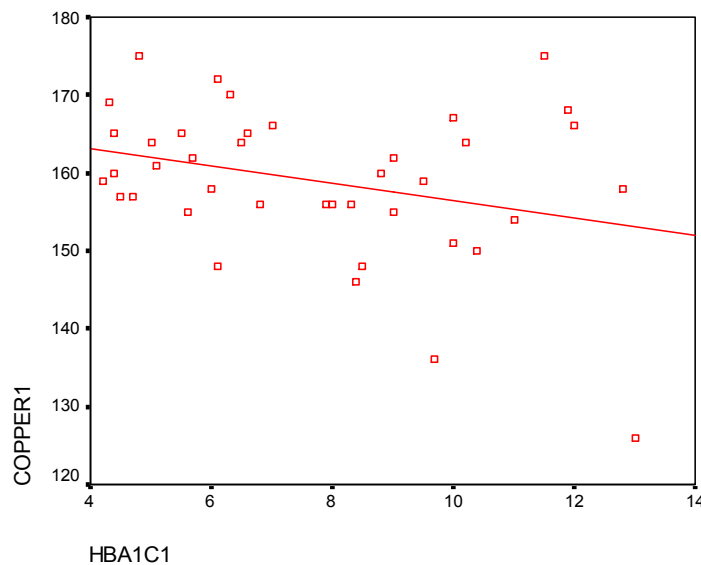*Significance of p.value = < 0.05*

Fig. 1. Relationship between HbA1c with serum copper in case group
R= - 0.3, r^2 =0.002

In this study, Zn levels in controlled diabetic patient (Mean = 85.05, SD = 5.6) and uncontrolled diabetic (Mean = 91.2, SD = 5.7) were lower than the healthy group with P-value <0.001, 0.01 respectively, that mean there was statistically lower significant effect of diabetes on serum Zn by decreasing it. This finding was agree with study conducted by Devi, et al. [12] and disagree with study conducted by A.H. Zargar, et al. [13] that they found there was no significant difference between test and control and also agree with study conducted by M. Basaki, et al. [14] that they found significant decrease in Zn.
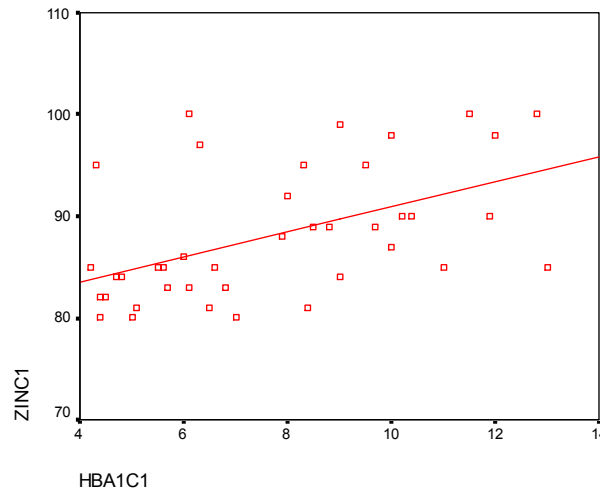
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Fig. 2. Relationship between HbA1c with serum zinc in case group
r=0.5, r^2 =0.001

The mean of Zn in male and female is (83.0±1.9)/ (91±6.1), respectively with P-value 0.008.

There was weak positive correlation between Zn and HbA1C, r=0.5.

Present study shown increase in Cu levels in both diabetic groups, controlled and uncontrolled (mean 162.4 SD 6.4)/(mean 155.6 SD 11.1), respectively than the healthy group, with P-value <0.001 in both, that mean there was statistically highly significant effect of diabetes on serum Cu by increasing it. Similar finding has been observed by other studies as Thiyam Romola Devi, Davina Hijam, Abhishek Dubey., et al and agree with other studies conducted by Olaniyan, et al. [12] and A.H. Zargar, et al. [13] and disagree with study conducted by M. Basaki, et al. [14] that they found significant decrease in copper in test group than control group.

The mean of Cu in male and female is (159±4.7)/ (158.6 ±11), respectively with P-value >0.001.

There was negative correlation between Cu and HbA1C, r=-0.3.

In the present study there exists antagonistic relationship in the levels of Cu and Zn in diabetes.

5. CONCLUSION

This study concluded that the serum levels of Zn significant lower in type 2 diabetes than healthy individuals. Serum levels of Cu significant increase in type 2 diabetes than healthy individuals as have been found in present study. Gender have significant effect in serum Zn and Cu in diabetic patients.

Weak Positive correlation between serum Zn with HbA1c and weak negative correlation between Cu with HbA1c.

CONSENT AND ETHICAL APPROVAL

After explaining the details and utility of the study, informed consent was taken from both cases and controls; ethical clearance was taken from the ethical committee of Sudan.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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