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Original Article

Correlation Between Fasting Blood Glucose and Serum Zinc Levels in Libyan Patients with Type 2 Diabetes Mellitus

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Abstract

It has been suggested that the pathophysiology of T2DM is influenced by abnormal zinc levels. Nevertheless, there are few and often conflicting epidemiological research studies on the connection between plasma zinc levels and diabetes. This study was conducted to examine the relationship between the concentration of serum zinc and blood glucose levels in Libyan type 2 diabetic patients. The study was carried out during the period of July and August 2024 and included 50 T2DM adult patients who were chosen from the Diabetes and Endocrinology Centre of Ibn Al-Nafees Hospital, Tripoli, Libya. The control group included 30 healthy subjects. Serum zinc (Zn) levels were measured using a spectrometry method by Evolution 3000. The serum zinc levels were statistically significantly lower in the T2DM patients, with a mean of 59.3 µg/dl, than the control group at 75.0 µg/dl with a p-value less than 0.001. T2DM patients have significantly lower mean serum zinc levels compared with healthy controls

Key words: *Fasting Blood Glucose, Serum Zinc, Type 2 Diabetes Mellitus*.

Introduction

Type 2 diabetes mellitus (T2DM) is becoming more common worldwide and is found to be increasing globally. Ageing populations, economic growth, and rising urbanisation are the main causes of this increase, resulting in sedentary lifestyles and higher intake of unhealthy foods associated with obesity [1,2]. Earlier detection of diabetes, better care, and a longer lifespan are also driving up prevalence. It is important to note that microvascular conditions including diabetic kidney disease, retinopathy, and peripheral neuropathy, as well as macro-vascular issues like coronary heart disease and stroke, are complications often experienced by T2DM patients [3]. The International Diabetes Federation (IDF) Diabetes Atlas (10^{th} Edition 2021) has found that in 2021 (for those aged 20-79) 10.5% of the global adult population had diabetes. This prevalence is predicted to increase to 12.2% in 2045 [4].

The prevalence of diabetes in Libya in 2021 According to the IDF Diabetes Atlas (10th Edition 2021) (for those aged 20-79) is 9% [4]. This high figure makes further studies of this disease necessary in order to understand and treat effectively diabetes. A study in Misurata, Libya showed that T2DM affected 87% of all patients, compared to type 1 diabetes with 9.9%. 73% of all patients had a history of diabetes in their families. 52% of diabetic patients had obesity, with women being more likely to be obese (70% of females) than men (33.8 % of males). Patients with T2DM had higher rates of obesity (56.8%) than those with type 1 diabetes (11.5%) [5].

It is evident that zinc has a significant impact on the structural integrity of insulin as well as its synthesis, storage, and secretion. Insulin resistance may also develop as a result of the decreased zinc, which impacts the pancreatic islet cells' capacity to make and secrete insulin, making the condition worse, especially in T2DM [6]. Previous research has indicated that glycaemic patients have considerably lower serum zinc levels than healthy persons [7]. Furthermore, studies point to a link between reduced zinc levels and a higher chance of acquiring T2DM later [8]. Researches also indicate that glycaemic management may benefit from zinc supplementation combined with medicine, exercise, and weight loss [9–11]. We have undertaken our own study on T2DM patients in Tripoli Libya in order to examine the correlation between serum zinc levels and blood glucose levels.

Methods

The study was carried out during the period of July and August 2024 and included 50 T2DM patients who were selected from adult diabetic patients attending the Diabetes & Endocrinology Centre, Tripoli, Libya and 30 healthy subjects (control group). Selection of both patients and healthy controls by a random sampling technique was undertaken. The control group had blood glucose measurements taken to verify no evidence of diabetes was present. Zinc serum levels were measured in both diabetic patients and healthy controls. A structured questionnaire was used and completed in person. Weight was recorded for subjects in both groups. A sample of venous blood was taken from each participant in the study after overnight fasting for 8 hours. Zinc serum level measurement was carried out in Genetica laboratories using the spectrometry method by the Evolution 3000. Fasting blood sugar (FBS) levels were determined by using the fully automated ACCENT MC240. The statistical package SPSS version 26.0 (SPSS, IBM® SPSS® Statistics 26) was used for statistical analysis. Significant difference was considered when P < 0.05.

Results

A total of 50 T2DM Libyan patients, attending the Diabetes & Endocrinology Centre in Tripoli, Libya, participated in this study. Of these 20 (40%) were males and 30 (60%) were females. The data in Table 1 showed no significant statistical differences between either gender of T2DM patients with the various parameters. Male patients in the group had a lower average age (59.5 ± 8.72 years) compared to female patients (60.43 ± 9.60 years), with p-value of 0.363. Males were found to have suffered from diabetes for a longer period on average (15.80 ± 9.65) than that of females (12.93 ± 8.52) however the difference was not found to be statistically significant with a p-value of 0.146. Female patients had a slightly higher average weight compared to males, but the difference was not statistically significant (p = 0.326). On the other hand, males had a higher average zinc level (63.20 ± 16.5µg/dl) compared to females (56.70 ± 14.2µg/dl), with a p-value of 0.080 closer to the statistically significant level. Lastly, female patients had a higher average fasting blood sugar level (251.21 ± 110.1mg/dl) compared to males (222.34 ± 86.6mg/dl), although the difference was not statistically significant (p = 0.155762).

Table 1. Comparison of age, duration of diabetes, weight, zinc and FBS levels between male and female T2DM patients.

Parameters	Males (n=20)	Females (n=30)	P-value
Age (years)	59.5 ± 8.72	60.43 ± 9.60	0.363
Duration of diabetes	15.80 ± 9.65	12.93 ± 8.52	0.146
Weight (Kg)	81.85 ± 18.7	84.44 ± 20.4	0.32
Zinc Level (µg/dl)	63.20 ± 16.5	56.70 ± 14.2	0.08
FBS Level (mg/dl)	222.34 ± 86.6	251.21 ± 110.1	0.15

In the non-diabetic group, there were 30 subjects, of which 9 (30%) were males and 21 (70%) were females. The data in Table 2 shows the statistical differences between the gender of control group and various parameters. Female subjects in the group had a lower mean age (49.14 ± 7.0 years) compared to males (55.8 ± 5.78 years), with a statistically significant p-value of 0.0044. Male participants had a slightly higher average weight compared to females, and the difference was found to be statistically significant (p-value=0.016). Males also had a higher average zinc level (80.4 ± 23.3µg/dl) compared to females (72.7 ± 18.9µg/dl), with a p-value of 0.2039. Lastly, male samples had a higher average fasting blood sugar level (98.7 ± 8.12mg/dl) compared to females (95.1 ± 11.4 mg/dl), although the difference was not found to be statistically significant (p = 0.1854).

Table 2. Comparison of age, weight, zinc and FBS levels between control group's genders.

Parameters	Male (n=9)	Female (n=21)	P-value
Age (years)	55.8 ± 5.78	49.14 ± 7.0	0.004
Weight (kg)	85.8 ± 15.2	73.0 ± 12.18	0.016
Zinc Level (µg/dl)	80.4 ± 23.3	72.7 ± 18.9	0.204
FBS Level (mg/dl)	98.7 ± 8.62	95.1 ± 11.4	0.185

Figure 1 illustrates the family history of diabetes among the participants (patients and control group). Among the diabetic patients, 27 (54%) had a history of diabetes in their family, while 23 (46%) did not. On the other hand, among the non-diabetic group, only 9 (30%) had a family history of diabetes, while 21(70%) did not. This suggests that a higher proportion of diabetic patients have inherited predisposition to diabetes than the non-diabetic control group.

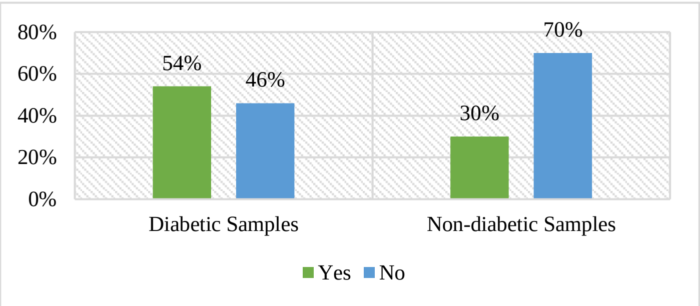

Figure 1. Percentage of subject's family history of diabetes in both patients and control group

Table 3 shows comparisons in various parameters between T2DM patients (50) and the control group (30). The mean values of fasting glucose levels, weight, and age were significantly higher in the T2DM group compared with the control group, whereas zinc levels were significantly lower in T2DM patients compared to the control group. Statistically significant differences between the two groups were observed for all the parameters measured. In terms of age distribution, the average age of the T2DM patients was 60.06 years, significantly higher than the control group at 51.1 years with a p-value of less than 0.001. The average weight of the T2DM patients was 83.4 kg, significantly higher than the control subjects at 76.8 kg with a p-value less than 0.001. The zinc level in the T2DM patients was 59.3 µg/dL, lower than the control group at 75.0 µg/dL with a p-value less than 0.001. Similarly, the mean fasting blood sugar level in the T2DM group was much higher at 239.6 mg/dl compared to 96.2 mg/dl in the control group with a p-value less than 0.001. Overall, the data indicates a clear difference between the concentration of serum zinc and blood glucose levels in Libyan T2DM patients.

Table 3. Comparison of age, weight, zinc and FBS levels between control group and T2DM patients.

Parameters	Cases	Controls	P-value
Age (years)	60.06 ± 9.27	51.1 ± 7.34	P <0.001*
Weight (Kg)	83.4 ± 19.8	76.8 ± 14.4	P <0.001*
Zinc Level (µg/dl)	59.3 ± 15.5	75.0 ± 20.6	P <0.001*
FBS Level(mg/dl)	239.6 ± 102.3	96.2 ± 10.7	P <0.001*

The data in Table 4 illustrates the correlation between zinc serum levels and various parameters in T2DM patients. No significant correlation was obtained between zinc serum levels and any of the four parameters age (r = -0.0294, p = 0.42006), the duration of the disease (r = -0.0431, p = 0.41131), weight (r = -0.0257, p = 0.44684) and FBS levels (r = -0.2003, p = 0.14566).

Table 4. Investigation of correlation of zinc serum level with age, duration of diabetes, weight and FBS levels among T2DM patients' group.

Parameters	r	p-value
Age(years)	-0.0294	0.42
Duration of diabetes	-0.0431	0.41
Weight (Kg)	-0.0257	0.44
FBS (mg/dl)	-0.2003	0.14

Discussion

Zinc plays a variety of important roles in cell activity and there is a likelihood that changes in zinc levels can cause unexpected reactions that might impact health. This research is the first study conducted in Tripoli, Libya which aimed to examine the correlation between zinc and FBS levels in T2DM patients. When comparing the zinc levels in T2DM patients to those in the control group, it was found to be statistically significantly lower in patients. This is in line with an earlier study that found the serum zinc levels were lower in T2DM patients than the control group [12]. This present study in Libya found that there was no significant correlation between decreasing zinc levels among T2DM patients and glucose levels. Previous research performed in Bani Waleed city, Libya, studied the correlation between HbA1C and zinc levels. Their findings were consistent with the current study, as no correlation between HbA1C and zinc levels (p= 0.43) [13] was found although a different glycaemic parameter was studied.

Other researchers found a negative correlation between glycaemic indicators (FBS, 2-hour glucose, and homeostatic model assessment of insulin resistance, or HOMA-IR) and plasma zinc levels [14]. However, a cross-sectional study conducted in the United States on 5153 adults revealed that a higher serum zinc concentration was linked to an increased risk of both diabetes and pre-diabetes conditions [15]. A similar strong correlation between zinc levels and T2DM risk was found in 2220 Finnish males, aged 42–60 years old, in the Kuopio Ischaemic Heart Disease Risk Factor Study (KIHD) in 1984–1989 and also participated in a 20-year prospective follow-up study [16]. Comparisons across different sample sizes, populations and lifestyles as well as time scale used could help explain the apparent contradiction in results found.

In this Libyan T2DM population study of 50 subjects, it was observed that the serum zinc level was higher in males compared to female patients. However, the difference in zinc levels between sexes was found to be not statistically significant (P > 0.05). Similar results were also obtained in a study conducted in Assam, India, which found no significant difference in serum zinc levels between male and female T2DM patients [17].

Given the foregoing, it can be concluded that T2DM patients have considerably lower zinc levels than healthy individuals, although it is still unclear which occurred first: the impact of diabetes mellitus on zinc metabolism, or the consequences of changes in zinc homeostasis on the metabolism of carbohydrates. There is evidence that hyperglycaemia causes hyperzincuria by interfering with the active transport of zinc back into the renal tubular cells. Furthermore, by improving insulin's capacity to

attach to its receptors, zinc also raises insulin sensitivity [6]. Clearly, there is a series of complex interactions and multiple effects that zinc serum levels play in T2DM development.
The findings from the current study in Tripoli Libya, suggest it that it would be interesting, in subsequent studies, to examine the correlation of zinc levels and FBS in a larger group of patients and controls over a longer time scale.

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