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Serum Selenium Levels in Type 2 Diabetes Mellitus Patients

Baneen Sami Tarif[1], Zainab Hussein AL-Hellawi[2*]

[1,2]Department of Chemistry, Faculty of Science, Kufa University, Najaf, Iraq

*Corresponding author: Zainab Hussein AL-Hellawi, Department of Chemistry, Faculty of Science, Kufa University, Najaf, Iraq, Email: Zainab.alhillawi@uokufa.edu.iq

ABSTRACT

Diabetes mellitus type 2 (T2DM) is a long-term metabolic disorder characterized by high blood glucose levels. T2DM is caused by insufficient insulin secretion by pancreatic β-cells and an inability of insulin-sensitive tissues to respond appropriately to insulin. In 2019, there are over 463 million people worldwide who have T2DM. Sixty T2DM patients and thirty healthy people served as controls. In terms of age and body mass index (BMI), these patients were comparable to a control group. This study determined demographics and serum selenium (Se). The findings of this study indicated a significant decrease in serum Se in T2DM patients compared to the healthy group. Many T2DM complications are caused by uncontrolled blood glucose and a decrease in antioxidant agents. Increased HbA1c is associated with an increased risk of serious microvascular and macrovascular complications. Low Se levels, on the other hand, increase reactive oxygen species (ROS), and Se deficiency is linked to a number of cardiovascular diseases, including myocardial infarction, cardiomyopathy, atherosclerosis, and coronary heart disease.

Keywords: *Selenium, oxidative stress, hyperglycemia and cardiovascular diseases*

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a broad term for a variety of metabolic disorders characterized by chronic hyperglycemia. The causes are insufficient insulin secretion by pancreatic-cells and an inability of insulin-sensitive tissues to respond appropriately to insulin (Galicia-Garcia et al 2020). By 2019, the number had risen to over 463 million people, and by 2030, it is expected to increase 578 million (Saeedi et al 2019). Diabetes patients usually metabolic disorders of nutrients like glucose, fat, and protein due to hyperglycemia and insulin resistance. In β-cells, glucose metabolism is necessary for the production of insulin, and highly activated glucose metabolism results in the production of reactive oxygen species (ROS), which reduces insulin secretion. The dual effects of ROS may be related to this contradictory mechanism (Mukai et al 2022). Contrarily, it has been discovered that diabetes is linked to lower levels of intracellular antioxidants like glutathione or vitamins C and E (Rains et al 2011). In several studies, it was discovered that the levels of oxidative stress (OS) biomarkers linked to T2DM had increased significantly and abnormally (Banik et al 2021) induced overproduction of ROS and OS contributes significantly to endothelial dysfunction and is associated with the pathogenesis and development of metabolic diseases (Jasvinder et al 2022). Endothelium is involved in nutrient and metabolite transport and forms an interface between blood

and adjacent tissues in cardiovascular physiology (Alexander et al 2021). When compared to the general population, adults with T2DM are thought to have a 2- to 4-fold higher risk of developing cardiovascular disease (CVD) and passing away (Harding et al 2019). Several metabolic processes, including defense against oxidative stress and healthy cardiovascular function, require selenium (Se), an important trace element. Se plays an essential function in cardiovascular health, as is generally acknowledged (Shimada et al 2021). Se combats free radicals and lowers OS, both of which are thought to improve insulin resistance (Eguchi, et al 2021). Se are essential for the health of the human endocrine, cardiovascular, nervous, and muscle systems as well as the immune and central nervous systems (Roman et al 2014). Prolonged Se deficiency in humans causes serious illnesses because it negatively impacts the functioning of the cardiovascular system and can be a direct cause of myocardial infarction (Shahid et al 2018).

MATERIALS AND METHODS
Subjects
Patients
33 women and 27 men who had T2DM were selected. They are between the ages of 50 and 65. beginning in September 2022 and ending in January 2023. All samples were gathered at the Al-Najaf Hospital in the Iraqi province of Najaf. With fasting plasma glucose (FBG) levels of 7.0 mmol/L and HbA1c levels greater than 6.5%, all patients were diagnosed with diabetes according to WHO guidelines. Based on their medical histories, patients were assessed to determine if they had any systemic disorders that might have an impact on the parameters being studied. Patients with thyroid disease, kidney disease,

liver disease, heart disease, or elevated CRP were disqualified from the study.

Control group
Thirty subjects were formed—13 men and 17 women—all of whom appeared to be in good health. Their ages matched those of the patients under investigation. Healthy groups with negative or elevated CRP levels were excluded from the study.

Anthropometric values
Body mass index (BMI), which was calculated using the following formula: BMI (kg/m2) = Weight (kg) / (Height)2 (m2), was used to define obesity. Adults will be categorized in this study as being underweight (BMI 18.5 kg/m2), normal weight (BMI 18.5-24.9 kg/m2), overweight (BMI 25.0-30.0 kg/m2), or obese (BMI > 30.0 kg/m2).

Biochemical Investigations
Blood specimens A 5 mL sample of venous blood from each patient or control was drowned using plastic syringes with single-use needles. Two tubes were used to separate the samples. 2 ml of recently drawn venous blood were collected in an EDTA tube to determine the HbA1c level. In order to separate the serum, 3 ml of blood was centrifuged at 3000 rpm for ten minutes after being left at room temperature for 30 minutes to allow for clotting. The serum was then transferred to a fresh, disposable plain tube (hemolysis samples were discarded) and kept in the freezer (-20 °C) until analysis

Experimental Apparatus

TABLE 1: Laboratory apparatus and equipment

Instruments	Company	Origin
Centrifuge	Hettich	Germany
Deep freezer	Hitachi	Japan
ELIA Microplate reader	BioTek	USA
Glass gel tube	Q.L.lab	China
Micropipette	Dragon	China

Refrigerator	Hitachi	Japan
Spectrophotometer	Spctra721	Taiwan

Chemicals

TABLE 2: Chemicals and kits used in the study.

Type of Kits	Company/Country
Blood Glucose Kit	Spinreact/Spain
CRP	LTD/Britain
HbA1c	BT LAB/ China
Selenium Kit	BT LAB/ China

Statistical Analysis

The Kolmogorov-Smirnov test was employed to look into the results group's distribution types. Variable results are classified as either nonparametric or normally distributed according to a statistical distribution. The results were presented as (mean standard deviation) for the normally distributed variable. The Pooled t-test was used to compare the control, patient, and divided groups in the measured parameters. The difference between groups is regarded as statistically significant when p 0.05. SPSS Statistics Base 26 and IBM-USA were used for all statistical analysis. The data was examined using Microsoft Excel 2016 software.

RESULTS AND DISCUSSION

Table 3 shows the demographic and clinical data for T2DM and the control group.

TABLE 3: displays demographic and clinical information about study participants.

Variable	Patients (60) Mean±SD	Controls (30) Mean±SD	p-value
Age (year)	58.1±8.93	58.13±5.23	0.991
No. of male/female	27/33	13/17	0.882
Duration disease (year)	11.98±7.04	-	-
Smoking (Yes/No)	9/51	8/22	0.222
BMI (kg/m2)	28.89±4.49	28.01±4.43	0.6074
FBG (mg/dl)	289.23±80.01	98.33±5.6	<0.0001
HbA1c %	9.02±1.53	5.54±0.59	<0.0001
Family History of diabetes (Yes/No)	32/28	0/30	-
CRP P/N	0/60	0/30	-

BMI: Body mass index, **FBG**: Fasting blood glucose, **HbA1c**: Glycated hemoglobin, **p**: positive, **N**: negative

Age and BMI do not significantly differ between patients and controls. Age-related T2DM is on the rise, and being more obese is a major risk factor. In young adults, a higher BMI is also independently linked to a higher risk of developing diabetes. (Chen et al 2018). In T2DM compared to the healthy group, there is an expected significant increase in FBS (p0.001) and HbA1c. HbA1c testing is regarded as a crucial diagnostic tool for tracking dietary restrictions and treatment plans during the course of diabetes treatment. (Rodas et al 2022). The HbA1c assay accurately and precisely determines chronic glycemia and is associated with a higher risk of developing diabetes complications. (Nusca et al 2019). When the patients' HbA1c is less than 7%, glycemic control has been attained. (Nuha et al 2023). In this study, the patients had uncontrolled blood sugar, with a mean HbA1c of 8.521.53%. The risk of serious microvascular and

macrovascular complications increases with HbA1c. (Imai at al 2021). One of the clinical factors that affects patients' glycemic control is long-term T2DM disease. (Traoré et al 2021). Long-term diabetes is linked to worsening beta cell function, which makes blood glucose control challenging. (Kim et al 2014). When a patient had diabetes for more than seven years, the rate of uncontrolled blood glucose was 1.79 times higher than when the patient had diabetes for less than seven years that the longer a person has diabetes, the higher the rate of uncontrolled blood glucose (Ahn J at al 2021).

Heart-related autonomic neuropathy is more common in people with type 2 diabetes when glycemic control is poor and the disease is chronic. (Nagalakshmi et al 2016). Increased levels of circulating free fatty acids and adipokines brought on by obesity decrease insulin sensitivity, increase reactive oxygen species, and possibly impair insulin secretion. (Vrachnis et al 2012).

Additionally, patients with young-onset obesity may have been exposed to maternal undernutrition or overnutrition early in life, which is linked to an increased risk of complications from type 2 diabetes (Reinehr et al 2016).

Hyperinsulinemia, hyperglycemia, and inflammation that causes OS all cause vascular remodeling. (Ohishi et al 2018). T2DM patients are more likely to die from any cause and develop cardiovascular disease (CVD), especially if they also have conventional CVD risk factors like hypertension, hyperglycemia, abdominal obesity, and dyslipidaemia. (Rawshani et al . 2018). An Egyptian study on diabetic patients discovered that the patients' level of education, line of work, and smoking habits all affected how well their diabetes was controlled. Also mentioned were factors that affected glycemic control, but these were specific to primary care physicians and included things like living in a rural area, taking part in diabetes training, being older, having dealt with diabetic patients for a longer period of time, and how well they were following the recommendations (Azzam et al 2021).

Serum Selenium
Patients with T2DM have significantly lower serum Se levels than the healthy group ($p=0.027$).
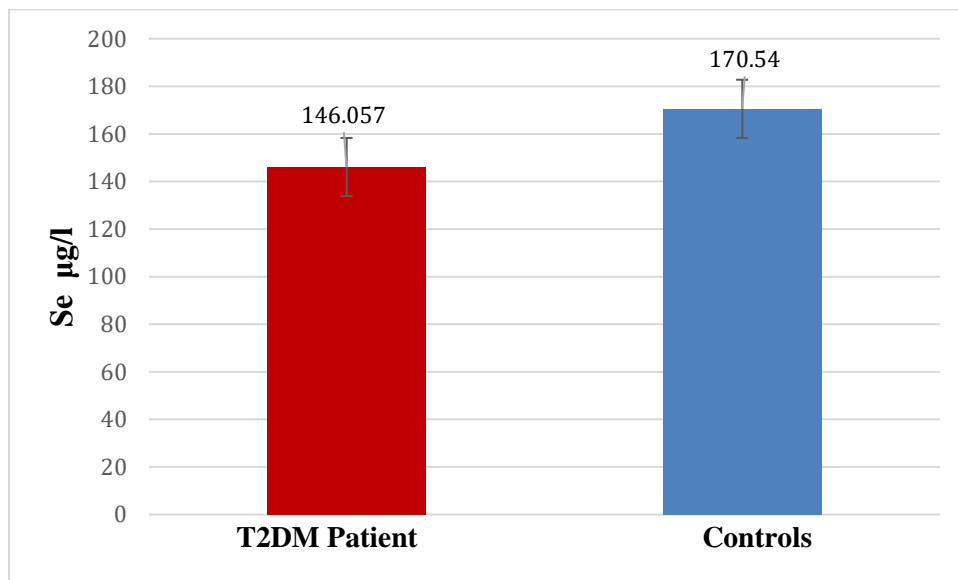
FIGURE 1: Serum Se in T2DM patients and Controls in bars plot.

Selenium (Se) is a crucial element for a variety of biological processes, including the protection against OS and inflammation and function as vital enzymes for redox homeostasis. (Zhang et al 2017). A low level of Se impairs important metabolic processes by increasing ROS and

decreasing mitochondrial function. (Shimada et al 2021). The relationship between Se status and glucose regulation extends to hypoglycemia as well as hyperglycemia. (Wang et al 2020). Numerous studies have suggested altered Se concentrations and increased metabolic needs for Se in patients with diabetes, which is characterized by a hyperglycemic state that may lead to OS and inflammatory activation. (Wang et al 2017). Among adults with T2D, a recent study discovered a linearly inverse relationship between serum selenium concentrations and heart disease mortality. (Zixin et al 2022). Cardiomyopathy, atherosclerosis, and coronary heart disease, as well as heart failure, myocardial infarction, and heart failure, are all linked to se deficiency. (Rayman et al 2008). Se deficiency has been linked to heart disease, including Keshan disease, in other studies (Liu et al 2019). On the other hand, a study found that supplementing with Se may help to prevent heart diseases. (Wang et al 2020). In an animal study, it was discovered that Se therapy may improve mice with atherosclerosis. (Guo et al 2020). Given that T2DM is linked to OS, it was initially anticipated that Se would help diabetic patients. At high supranutritional doses, Se (as selenate) does, in fact, have anti-diabetic and insulin-mimetic effects (Steinbrenner et al 2013). Se performs a variety of tasks in the body's cells, including fighting free radicals and lowering OS, which is thought to improve insulin resistance. (Eguchi at al 2021). Numerous observational studies conducted in various nations found that gestational DM pregnant women had lower Se levels than euglycemic pregnant women. (Moshfeghy at al . 2020).

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