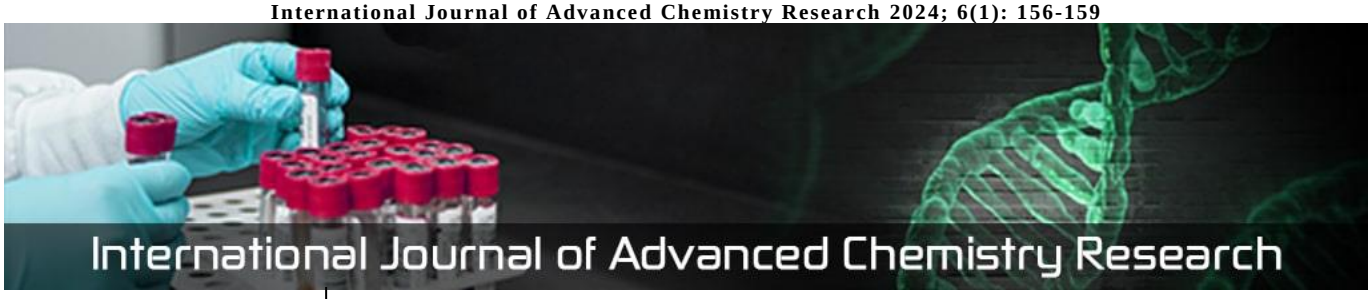

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Prevalence of magnesium deficiency in patients with type 2 diabetes mellitus from infection over 10 years in Iraq, Al-Diwaniyah city

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Abstract
Purpose: This study aims to evaluate the serum magnesium levels and dietary magnesium intake in patients diagnosed with type 2 diabetes mellitus (T2DM) for over 10 years, as well as in their healthy counterparts. In addition, a study was conducted to identify the most effective criteria for predicting changes in metabolic regulation and serum magnesium levels.
Materials and Methods: A series of clinical examinations were performed on a total of sixty individuals diagnosed with diabetes between January 2024 and April 2024 at Al-Diwaniyah General Hospital. The diagnosis is established via a clinical examination. A total of 35 individuals who were in good health and did not have any medical conditions were selected as the control group.
Results: An evaluation was conducted to investigate the impact of Magnesium symbols on diabetic patients with type 2 diabetes. Table with three items Figure 3 displays the average ± standard deviation (SD) of serum Magnesium levels, measured in mg/dl, in both normal control subjects and type 2 diabetic patients. The figure also includes the biostatistical calculation and the results of the student t-test. Diabetic patients with type 2 diabetes show a considerable drop in serum Magnesium levels compared to the control group. (p<0.0001)
Conclusion: A groundbreaking study was conducted in AL-Diwaniyah to examine the different forms of serum glucose and their impact on patients with type 2 diabetes. The study included a total of 60 patients, with 30 females and 30 males, aged between 35 and 66 years. Additionally, 35 individuals without diabetes were included as normal healthy controls, consisting of 23 females and 17 males, aged between 45 and 65 years.
The subsequent variables were quantified: Glucose and magnesium (Mg+2) tests. The data acquired in this investigation demonstrated.
There was a substantial rise in the levels of glucose in the blood, when compared to those of the healthy individuals in the control group. There is a notable reduction in serum magnesium levels compared to those of the healthy controls, and there is no noticeable difference in magnesium levels between male and female diabetic patients.

Keywords: Magnesium, diabetes mellitus type 2, magnesium deficiency, serum magnesium

Introduction
Diabetes mellitus type 2 (DM2) is a serious disorder public health concern due to its rising prevalence and long-term morbidity and asymptomatic long-time [1].
Magnesium (Mg) is a vital mineral that plays a crucial role in numerous metabolic processes and is involved in the control of cellular metabolism. Nuts, leafy greens, and whole grains are considered vital sources of magnesium. (Mg+2) [2].
According to a recent study, giving overweight individuals with insulin resistance magnesium supplements improved their response to insulin and fasting blood sugar levels [3].
Magnesium is an essential cofactor for a number of enzymes, including the sodium-potassium ATPase pump and the enzymes involved in the release of insulin [4]. A deficiency of magnesium hinders the capacity of cells to protect themselves against oxidative damage. This, in turn, makes cells more susceptible to the oxidative stress that diabetes causes, which speeds up the development of conditions connected to diabetes. Thus, hypomagnesaemia may worsen type 2 diabetes, but research has also indicated that consuming magnesium supplements lowers the incidence of both diabetes type 2 and metabolic syndrome by decreasing insulin resistance [5].

The magnesium ion is an essential cofactor for numerous enzymatic reactions involved in a wide range of metabolic processes, magnesium deficiency in type 2 diabetes mellitus and metabolic syndrome may have physiopathological and clinical significance. This deficiency may manifest as a latent subclinical magnesium deficiency rather than less common overt hypomagnesaemia. Magnesium is the most prevalent cellular divalent cation in the human body, but it is also the fourth most abundant mineral after calcium, sodium, and potassium as intracellular cations [6]. Magnesium is mostly found (98%), inside cells. In healthy settings, a dynamic balance between the intake of magnesium from food, intestinal absorption and excretion, renal excretion, bone storage, and the needs of different bodily tissues keeps serum levels (2% of the total) within a restricted rangem [7-9]. People with type 2 diabetes have higher blood glucose levels. Furthermore, the body may not be reacting to insulin as it usually does. It seems sense that low magnesium levels could exacerbate type 2 diabetes complications because magnesium is involved in the metabolism of glucose and insulin.

Additionally, in certain type 2 diabetics, the kidneys frequently don't function entirely normally. It's possible that your body will eliminate more magnesium than it should due to the elevated glucose levels [10].

In this study, we will clarify the association between hypomagnesaemia and diabetes type 2 by focusing on the effects of Mg2+.

Clinical manifestations of magnesium

Magnesium is a neuroprotective component in multiple cellular processes. Magnesium reduces the release of glutamate from vesicles in a physiological context, hence reducing the excessive activation of glutamate receptors [11]. Magnesium is essential for maintaining intracellular calcium homeostasis. Physiologically, there is a significant imbalance in the distribution of Ca2+ on either side of the cell membrane. The electrochemical gradient is maintained by the transport mechanism and modulation of calcium permeability in biological membranes. Excessive stimulation of NMDA receptors can lead to a significant influx of calcium ions, resulting in an overload of calcium. Excessive calcium levels can subsequently trigger calcium-dependent enzyme systems, generate reactive oxygen species, modify nuclear chromatin, degrade proteins, oxidize lipids, and induce neuronal cell death [12]. Clinical studies have linked magnesium deficiency to hyper excitability, sleeplessness, elevated diastolic blood pressure, and chronic fatigue syndrome. Serum magnesium deficiency in erythrocytes has been associated with both higher resting and stress blood pressure and coronary artery spasms [13, 14].

Patients and Methods

This cross-sectional study examined diabetes patients who visited AL-Diwaniyah teaching hospital and diabetic center lab as outpatients, namely from January 2024 to April 2024. The study aimed to include a total of 60 cases, consisting of 60 patients and 35 controls. The specimens were collected subsequent to obtaining a brief medical background from each subject. During the measurement of serum blood sugar and serum magnesium, we collected data on age, gender, weight, height, and the presence of diabetes mellitus as a medical condition. Our patients were divided into two groups: There were a total of 60 cases of diabetic patients, with 30 being male and 30 being female. Additionally, there were 35 cases of control patients.

Data collection

A total of 6 mL of venous blood was taken using a fully sterile procedure after fasting for at least 10 hours. Three milliliters of blood were distributed into EDTA tubes, while the remaining two milliliters were deposited into gel separator tubes. A mechanized method was utilized to ascertain the fasting blood sugar (F.B.S) using the sample enclosed in the EDTA tube.

To acquire the serum, the gel separator tubes were placed inside a centrifuge and spun at a velocity of 3000 revolutions per minute for a period of 5 minutes. The Cobas e 411 equipment was employed to quantify the concentration of Magnesium in the serum.

(1). Subsequently, a technician verified the outcomes. Serum Magnesium levels below 0.85 to 1.10 mmol/L were classified as insufficient. The patient's profile contained information on the length of infection, diabetes, and melite use. A worksheet was generated and all the data was stored.

Results

The symbols representing glucose levels were measured in order to assess its impact on individuals with type 2 diabetes, as shown in Table 1. Figure 3.1 displays the average ± standard deviation (SD) of serum glucose levels, measured in mmol/L, for both normal control subjects and patients with type 2 diabetes. The figure also includes biostatistical calculations and the results of a student t-test.

There is a strong correlation between the levels of glucose in the blood of diabetic patients and the length of time they have had the disease. This correlation is observed in both patients who have had the disease for less than 10 years and those who have had it for more than 10 years, as indicated in Table 2 and Table 3. Additionally, a biostatistical calculation and t-test were conducted to compare the levels of magnesium in the blood of diabetic patients and healthy individuals.

In contrast, there is no notable disparity between males and females in diabetes patients with type 2, as seen in the table. (4).

Statistical Analysis

All the data has been inputted onto an Excel spreadsheet. We shall utilize suitable statistical analysis methods to examine all of the data.

Table 1: Performing biostatistical calculations and conducting a t-test to compare the glucose levels (measured in mmol/l) in the serum of diabetes patients, specifically between females and males.

Glucose mmol/l	Patient	
sex	female	male
Sample size	30	30
Mean ±SD	12.90707 ±5.179403	9.76306 ±10.6770
Rang	6.9-23	6-19
Standard error of mean	0.9127294	0.8737832
T- test	1.979	
Probability	0.2427 NS	

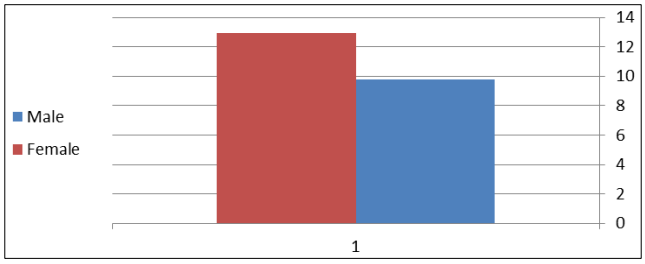

Fig 1: The serum glucose levels (measured in mmol/L) of diabetes patients were compared between females and males.

Table 2: Performing biostatistical calculations and conducting a t-test to analyze the glucose levels (measured in mmol/l) in the serum of diabetes patients based on the duration between measurements. (< 10 & >10) years.

Glucose mmol/l	Patient (by duration)	
Group	**< 10 years**	**>10 years**
Sample size	30	30
Mean ±SD	9.78108±5.075805	13.92748±4.907661
Rang	5.1-22.0	4.8-21
Standard error of mean	0.8344572	1.023318
T- test	2.268	
Probability	0.0268 significant	

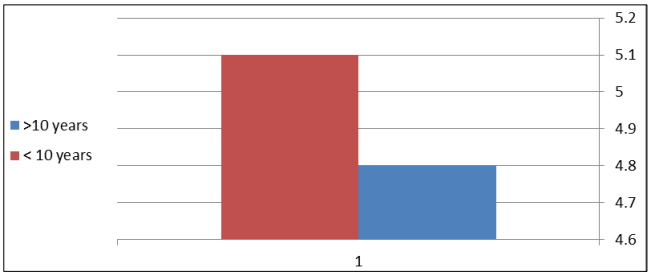

Fig 2: Glucose test of diabetic patient by duration between (< 10 & >10) years

Table 3: Performing a biostatistical analysis, specifically a t-test, to compare the magnesium levels (measured in mg/dL) in the serum of diabetic patients and normal healthy individuals (Controls).

Mg mg/dl	Normal healthy controls	Patient >10 years With D.M type2
Sample size	35	60
Mean ±SD	3.143±0.6636388	1.072722±1.088728
Rang	6.1-24.0	0.19-2.89
Standard error of mean	0.1049304	1.01204439
T- test	4.455	
Probability	<0.0001 Highly significant	

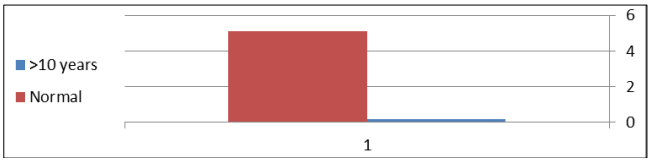

Fig 3: The serum magnesium levels (measured in mg/dL) in diabetic patients and normal healthy individuals (Controls).

Table 4: Performing biostatistical calculations and conducting a t-test to compare the magnesium levels (measured in mg/dl) in the serum of diabetes patients, specifically focusing on the differences between females and males.

Mg mg/dl	Patient	
Sex	**Female**	**Sex**
Sample size	30	30
Mean ± SD	1.391580±1.301175	1.152151±0.6899980
Range	0.8 - 2.8	0.1 - 2.5
Standard error of mean	0.2317274	0.1327902
T − test	0.845	
probability	0.4014 Ns	

Discussion

The four main causes of hypomagnesaemia are related to the patient's environment and include decreased intake, gastrointestinal loss, renal loss, and subsequent to drugs [15, 16]. A number of factors can lead to hypomagnesaemia in people with type 2 diabetes (T2DM), including insufficient intake, complications from the diabetes such as diarrhea and gastroparesis, increased glomerular hyper filtration, renal magnesium loss, metabolic acidosis, glycosuria from osmotic diuresis, and impaired magnesium resorption in the kidneys as a result of insulin resistance related to diabetes [17, 18] glucose levels are the main factors influencing hypomagnesaemia, with a significant frequency of occurrence in diabetic patients. A growing body of research indicates that hypomagnesaemia is common in diabetic patients, however, the frequency varies depending on the study design. Hypomagnesaemia is mostly linked to advanced age, the duration of diabetes, Diabetic micro- and macrovascular problems, treatment features, and diabetes severity [19, 20].

It should be noted the discovery that PPI use is common among diabetics with dyspeptic problems such as diabetic gastro paresis may not come as a surprise.

Nonetheless, it is important to consider the use of PPI in people with diabetes and hypomagnesaemia, as indicated by the fact that half of the patients had both conditions. Compared to people with diabetes and hypomagnesaemia, the proportion of SGLT-2 inhibitor usage was found to be considerably greater in people with diabetes who had normal magnesium levels.

The question of whether this is a coincidence or if using SGLT-2 inhibitors prevents hypomagnesaemia is raised by this discovery. Magnesium levels are marginally but considerably raised by SGLT-2 inhibitors, according to a meta-analysis of randomized controlled studies [21].

Out of 60 diabetic patients, the highest rate of serum magnesium deficiency was found in females and males with diabetes Mellitus type2 during a duration over 10 years as compared with patient less than 10 years.

Magnesium levels were examined to evaluate its impact on persons with type 2 diabetes. Table number three. The figure displays the serum magnesium levels (mg/dl) of both type 2 diabetic patients and normal controls, along with the biostatistical calculation and student t-test. (3) as mean ± SD.

When comparing type 2 diabetic patients to the control group, there is a highly significant drop in serum magnesium levels (p<0.0001).

As indicated by table (2) and Fig (2), there is a strong link between the serum magnesium levels in diabetic patients and the length of the disease in patients (duration <5) & (duration > 5) years

On the other hand, as table (4) illustrates, there is no discernible variation in magnesium levels between male and female diabetic patients.

Conclusion

Serum Mg2+ concentration and Type 2 diabetes incidence rate are inversely proportional. A two-fold rise in incidence rate was noted in the Atherosclerosis Risk in Communities Study from the highest to the lowest serum Mg2+ content, based on the prospective analysis.

Hypomagnesemia is associated with inadequate management of Type 2 Diabetes Mellitus, and the depletion of magnesium in the blood increases rapidly as the disease progresses.

Our current investigations on patients from AL-Diwaniyah City indicate that there is no correlation between Magnesium level and gender, age, weight, or height. The fasting blood sugar test is a reliable method for detecting diabetes diagnosis, although people with T2DM are most commonly affected by magnesium insufficiency. Individuals infected for a duration of ten years or more exhibit a pronounced and noteworthy insufficiency in their magnesium levels, as compared to those infected for less than ten years. Adhering to doctors' recommendations to take supplements will help prevent the gradual impact of magnesium deficiency on nerves and kidney illness, as well as enhance insulin function. In this investigation on patients with type 2 diabetes, it was observed that hypomagnesemia was associated with insufficient glycemic control and contributed to the development and progression of microvascular complications.

According to this study, there is a significant incidence of hypomagnesaemia in people with diabetes, and measuring magnesium levels should be part of of routine screening, particularly in those with diabetes who have been diagnosed with hypomagnesaemia in the past, are older, have had diabetes for a longer period of time, and have impaired glycemic control.

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