

## Biochemical variations of serum magnesium and lipid analytes in diabetes mellitus: a cross-sectional study

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### ABSTRACT

**BACKGROUND & OBJECTIVE:** Hypomagnesemia has a detrimental influence on glucose homeostasis and insulin sensitivity in T1DM and T2DM patients, as seen by the progression of DM comorbidities such as arterial atherosclerosis, retinopathy, and nephropathy. The objective of this study is to make a comparison and correspond biochemical variants (to analyze the difference) of fasting blood glucose, serum magnesium, and major lipid analytes (serum total cholesterol and triacylglycerol) in diverse medical groups of both T1DM and T2DM.

**METHODOLOGY:** It was a cross-sectional observational study carried out at Sahiwal teaching hospital, Sahiwal, Pakistan, including 250 research participants. The study used a traditional time-bound sample size of 6 months starting from first March to August 2021 through a random selection approach.

**RESULTS:** Out of 250 participants, 200(80%) had diabetes mellitus (DM), The number of men with diabetes 110(55%) was greater than the percentage of women with diabetes 90(45%) in this study. 52(26%) of the research participants had T1DM, whereas 148 (74%) had T2DM. A comparison of plasma glucose levels of the three groups was made, and the difference was statistically significant. The difference in serum magnesium, serum total cholesterol, and serum triglycerol among the groups was also statistically significant  $p < 0.05$ .

**CONCLUSION:** The current study looked at hypomagnesemia biochemical changes in overt hyperglycemic-hyperlipidemic clinical groups of T1DM and T2DM. In light of the reviewed research findings, it is recommended that serum magnesium can be measured as a routine or extended diagnostic profile investigation in recognized health cases of T1DM and T2DM for early screening, periodic monitoring for deficiency, and better management of clinical cases through supplementation to prevent the development of long-term critical diabetes complications.

**KEYWORDS:** Biochemical, Magnesium, Lipid.

### INTRODUCTION

Diabetes mellitus (DM), a prolonged hormonal condition defined by overt hyperglycemia caused by insulin insufficiency or inefficiency, is now a severe pandemic with increasing morbidity and death<sup>[1-5]</sup>. Type 2 diabetes mellitus (T2DM) is more common than type 1 diabetes mellitus (T1DM)<sup>[6]</sup>. According to the World Health Organization, the global prevalence of T2DM has risen drastically to 422 million individuals as a result of the growing westernization of the population's lifestyle across all economic levels<sup>[7]</sup>.

Diabetes mellitus is regarded as a major deadly disease of the twenty-first century, with the highest numbers of people expected to be affected in India, China, and the United States by 2030, with India is already recognized as the world's "Diabetes Capital"<sup>[8]</sup>. The general metabolism of biomolecules is disrupted in DM, as are mineral and electrolyte abnormalities<sup>[9]</sup>. Magnesium is a nutritionally important macromineral that may be found in a wide variety of living organisms diets. It is a free divalent cation of cells that is intricately woven into mitochondrial function and has a role in a variety of structural and metabolic activities

Muzammil F, Abbas H, Naz S, Muzammil H, Hussain W. Biochemical variations of serum magnesium and lipid analytes in diabetes mellitus: a cross-sectional study. *Journal of University Medical & Dental College*.2022;13(3):403-407.



in the human body. Most enzyme pathways that govern different metabolic processes of carbohydrate, lipid, and protein metabolism for energy generation through oxidative phosphorylation use it as an inorganic cofactor<sup>[10]</sup>.

It is linked to the building construction of bones, DNA and RNA production, glutathione antioxidant properties, and plasma glucose and blood pressure regulation. Magnesium plays a key role in the active movement of potassium and calcium ions as a chemical signal for nerve impulse transmission, muscular action, and the generation of proper heart rhythm. Muscle spasms are a common symptom of severe hypomagnesemia, which is linked to psychological illnesses, migraine, osteoarthritis, hypertension, cardiovascular events, and infarct. Insulin resistance and magnesium have a complicated relationship. Magnesium has been shown to play a key role in the etiology of diabetes and its consequences, including heart, blood vessel, eye, kidney, and nerve damage<sup>[11]</sup>. The ability of controlled magnesium levels to enhance insulin sensitivity in diabetics with cardiovascular problems has gotten a lot of attention<sup>[12]</sup>. Magnesium deficiency exacerbated the clinical effects of persistent post-receptor insulin resistance, which decreases glucose consumption in cells and worsens T2DM insulin sensitivity<sup>[1]</sup>.

Diabetes causes hypomagnesemia, which is a risk factor for the disease's numerous consequences<sup>[2]</sup>. Hypomagnesemia has a detrimental influence on glucose homeostasis and insulin sensitivity in T2DM patients, as seen by the progression of DM comorbidities such as arterial atherosclerotic, retinopathy, and nephropathy<sup>[3]</sup>. Hypomagnesemia has been linked to Alzheimer's disease, hypertensive, cardiovascular disease, stroke, cluster headaches, and attention deficit hyperactivity disorder in people with type 2 diabetes<sup>[4]</sup>. The depletion of magnesium in myocardial cells was connected to an influx of Na<sup>+</sup> and Ca<sup>2+</sup> into mitochondria, which might lead to cardiac cell death and raise the risk of subsequent problems<sup>[5]</sup>. Another potential risk for T2DM pathogenesis is dyslipidemia, which is a common characteristic of insulin resistance syndrome. In DM, hypomagnesemia plays a role in lipid metabolism disruption<sup>[13]</sup>.

Hypertension is linked to increase in the frequency of hypercholesterolemia, diabetes mellitus, hypomagnesemia, and hypertriglyceridemia<sup>[14]</sup>. A review of prior epidemiologic research revealed that serum magnesium was linked to and connected with a variety of biochemical analytes, mostly in T2DM, with little evidence in T1DM. In light of the foregoing, an observation-based, care facility cross-sectional study was designed at biochemistry department of Sahiwal teaching hospital Sahiwal, Pakistan to make a comparison and correspond biochemical variants of fasting blood glucose, serum magnesium, and major lipid analytes, serum total cholesterol and triacylglycerol in diverse medical groups of both T1DM and T2DM.

The goal of this hospital-based cross-sectional observational study was to quantify and correlate blood magnesium with lipid analytes in distinct clinical groups of T1DM and T2DM, as well as to confirm its diagnostic relevance. The research was carried out at a biochemistry department of Sahiwal teaching Hospital Sahiwal, Pakistan (ERC# 64-B/DNE/SLMC/SWL) with a total of 250 research participants, the study used a traditional time-bound sample size of 18 months.

A random selection approach was used to choose 200 clinical cases of diabetes who visited outpatient and inpatient medical facilities, as well as 50 normoglycemic control subjects. Both genders were represented in the research, with ages ranging from 10 to 60. After receiving institutional ethical approval and informed permission from all participants in the study, the study was launched. Participants were determined based on the survey's criteria for inclusion, clinical notes, the clinical state of illness recorded in a comprehensive predesigned patient proforma filled with sociodemographic details, previous medical history of diseases, physical-clinical examinations, duration, treating drug compliances, clinical and relevant diagnostic records with special reference to DM and its comorbidities, clinical and specific clinical records, and clinical and relevant diagnostic documents with special reference to DM and its comorbidities. Patients having no severe concomitant illnesses such as impaired renal, respiratory, and gastrointestinal systems, chronic diarrhea, diuretics, and chronic alcoholics were included. The study excluded non-diabetes patients with severe concomitant illnesses such as impaired renal, respiratory, and gastrointestinal systems, chronic diarrhea, diuretics, and chronic alcoholics. Healthy subjects were chosen at random as healthy controls to compare and correlate the study findings. They were normoglycemic with no signs or symptoms of diabetes and no aberrant clinical findings, particularly in the setting of metabolic and nutrition impairment.

Grouping of study participants:

- 1st group: New diagnosed cases.
- 2nd group: Stabilized controlled patients.
- 3rd group: long course cases with DM associated complications.

Blood Collection & Biochemical Analysis:

Fifty different topics Healthy subjects were chosen at random as control subjects to contrast and relate the study findings. They were normoglycemic with no signs or symptoms of diabetes and no aberrant clinical findings, particularly in the setting of metabolic and nutrition impairment. The glucose oxidase peroxidase technique was used to calculate fasting plasma glucose levels. Specific kit techniques were used to test serum lipid analytes triacylglycerol (TAG) and total cholesterol. ANOVA was used to check the comparison of groups. The results of the study were presented in the form of percentages and also with a mean and standard deviation. The statistical significance of the results was taken at 0.05.

## METHODOLOGY

## RESULTS

The current study included 250 participants, 200 of whom had diabetes mellitus (DM), 110(55%) of whom were males, and 90(45%) of whom were females. The number of men with diabetes (55%) were greater than the percentage of women with diabetes (46%) in this study, which might be attributable to lifestyle differences. Twenty-six percent 52(26%) of the research participants had T1DM, whereas 148(74%) had T2DM, indicating that T2DM was the most frequent form of diabetes. There were 27(54%) men and 23(46%) women among the fifty healthy controls chosen at random (41.38%). "The gender distribution of DM and control study patients is shown in Table-I." All research participants were between the ages of 10 and 60 years, with about 36(18%) of DM subjects being between the ages of 10 and 20, and the largest number of 96 (48%) diabetic patients being between the ages of 41 and 60. "Table-I also depicts the age and sex distribution of DM research participants in subgroups." Through ANOVA, a comparison of biochemical profiles of three groups was made. A comparison of plasma glucose levels of three groups was done and the results were statistically significant. Results of serum magnesium, serum total cholesterol, and serum triglycerol were also statistically significant.

**Table-I: Gender distribution of all the study groups.**

SR. No	Group	Male	Female	Total
	Total Cases	140 (56)	110 (44)	250
<b>Diabetes mellitus (DM)</b>				
1	DM+ Patients	110 (55)	90 (45)	200
	Newly Diagnosed (1st group)	75 (37.5)	30 (15)	105(52.5)
	Chronic stabilized cases (2nd group)	27 (13.5)	22 (11%)	49(24.5)
	Chronic cases with complications (3rd group)	08 (4)	38 (19%)	46(23)
2	Control- non diabetic patients	27 (54)	23 (46)	50
3	Age groups (DM+ Patients)			
	10-20	12 (6)	24 (12)	36(18)
	21-40	45 (22.5)	23 (11.5)	68(34)
	41-60	53 (26.5)	43(21.5)	96(48)

**Table-II: Biochemical parameter comparison.**

Bio-chemical parameters Mean±SD	Fasting plasma glucose (mg/dl)	Serum magnesium (mmol/L)	Serum total cholesterol (mg/dl)	Serum Triglycerol (mg/dl)
Healthy control (50%)	82.55 ± 3.99	2.002 ± 0.03	129.0 ± 19.69	71.6 ± 31.47
1st group Subjects	185.16 ± 19.92	1.522 ± 0.03	248.32 ± 16.62	132.9 ± 9.49
2nd group Subjects	104.75 ± 7.10	1.846 ± 0.02	183.71 ± 31.27	84.2 ± 19.40
3rd group subjects	242.00 ± 43.49	1.346 ± 0.022	292.2 ± 12.04	220.7 ± 33.52
<b>p-value</b>	<b>0.04</b>	<b>&lt;0.001</b>	<b>0.05</b>	<b>&lt;0.001</b>

## DISCUSSION

When compared to normoglycemic healthy controls, biochemical changes of hypomagnesemia were shown to be negatively linked with hyperglycemia, hypertriglycerolemia, and hypercholesterolemia. A comparison of plasma glucose levels of three groups was made, and the results were statistically significant. Results of serum magnesium, serum total cholesterol and serum triglycerol were also statistically significant.

"Table-II depicts the distribution of diabetic research patients by type and clinical phase." Hypomagnesemia was linked to hyperglycemic and hyperlipidemic situations in both T1DM and T2DM patients, according to the study. In a case-control study of serum lipid profile and serum magnesium levels in newly diagnosed type 2 diabetes subjects and normal individuals, Hussain KSA found similar results to those found in the current study, with diabetics having lower serum magnesium and higher TAG and total cholesterol mean levels ( $p=0.001$ ) than controls<sup>[15]</sup>. Serum Mg levels in DM are affected by poor glycemic control, which impacts

both glycemic control and the incidence of complications<sup>[16]</sup>. Low serum magnesium may be a factor in the pathogenesis of poor glycemic control and abnormal lipid profile, according to an Egyptian study of children with type 1 diabetes. Hypomagnesemia was linked to poor diabetes control and higher atherogenic lipid parameters, suggesting that low serum magnesium may be a factor for the development of poor glycemic control and abnormal lipid profile<sup>[17]</sup>. Correction of hypomagnesemia in children with type 1 diabetes with oral Mg supplements was linked to improved glycemic control and a decrease in atherogenic lipid fraction with an increase in protective lipid fraction<sup>[15]</sup>. Another study noted that hypomagnesemia was associated with poor DM type 2 management and that blood magnesium depletion increased exponentially with illness duration. Hypomagnesemia and elevated serum cholesterol and triglyceride levels were responsible for micro- and macrovascular problems in diabetes, according to Khubchandani and Sanghani's research<sup>[18]</sup>. Manonmani and Manimekalai found hypomagnesemia in type 2 diabetes and an inverse relationship with diabetes duration in a study with a south Indian population<sup>[19]</sup>.

In Nepalese diabetic patients, old age, poor glycemic control, and a low eGFR were all significant predictors of low serum magnesium<sup>[20]</sup>. Low magnesium, high TAG, and increased HbA1c % might be used as biochemical markers of insulin sensitivity and resistance in the state and action of insulin<sup>[21]</sup>. When comparing DM patients to healthy controls, Sendhav et al. found a strong negative relationship between hypomagnesemia and dyslipidemia and increased fasting plasma glucose in DM patients<sup>[22]</sup>. Researchers found that hypomagnesemia in T2DM was linked to a variety of problems and that magnesium might be used as a dietary supplement to help diabetic patients avoid vascular issues<sup>[23]</sup>.

Subjects with type 2 diabetes had a significant link between reduced serum magnesium and foot ulcers<sup>[24]</sup>. Diabetic foot ulcers (grades I and II) lasted longer when diabetes duration and blood magnesium levels dropped<sup>[25]</sup>. T2DM was often linked with extracellular and intracellular chronic latent magnesium insufficiency in overt clinical hypomagnesemia, especially in individuals with poorly managed glycemic profiles. Rodríguez et al. recently published a comprehensive review and meta-analysis that accurately illustrated a link between low magnesium levels and poor glycemic control in T1DM patients<sup>[12]</sup>.

Various treatment modalities can reverse diabetes related complications<sup>[26]</sup>. It would be interesting to see if magnesium can have such effect on other complications of diabetes.

## CONCLUSION

The current study looked at hypomagnesemia biochemical changes in overt hyperglycemic-hyperlipidemic clinical groups of T1DM and T2DM. In light of the reviewed research findings, it is recommended that serum magnesium can be measured as a routine or extended diagnostic profile investigation in recognized health cases of T1DM and T2DM for early screening, periodic monitoring for deficiency, and better management of clinical cases through supplementation to prevent the development of long-term critical diabetes complications. Prospects for conducting population-based prospective cohort studies to clarify facts and achieve a holistic approach with both extracellular, intracellular, total, and ionized magnesium concentrations in various kinds, clinical states, and complications of DM may remain.

**ACKNOWLEDGEMENT:** None.

**CONFLICT OF INTEREST:** All authors disclose no conflict of interest.

**GRANT SUPPORT & FINANCIAL DISCLOSURE:** None.

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**Author's Contribution:**

**Fariha Muzammil:** Substantial contributions to the conception or design of the work.

**Huda Abbas:** Acquisition, analysis, or interpretation of data for the work.

**Shazia Naz:** Interpretation of data for the work.

**Hamza Muzammil:** Drafting of the work.

**Wajahat Hussain:** Drafting the work or revising it critically for important intellectual content.

Submitted for publication: 15-09-2021

Accepted after revision: 08-06-2022