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Original Research Article

A study of serum magnesium level and its association with glycemic control in patients with type 2 diabetes mellitus

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a major public health problem associated with chronic hyperglycemia and multiple metabolic disturbances. Magnesium plays an important role in insulin action and glucose metabolism and hypomagnesemia is frequently observed in diabetic patients, potentially contributing to poor glycemic control. To estimate serum magnesium levels in patients with T2DM and to assess their association with glycemic control measured by HbA1c.
Methods: This hospital-based, single-centre, cross-sectional observational study was conducted in the General Medicine inpatient ward of a tertiary care hospital over 12 months. A total of 200 adults with T2DM were included after applying the inclusion and exclusion criteria. Clinical details and laboratory parameters, including fasting and postprandial blood glucose, serum magnesium, HbA1c, urea and creatinine, were measured. Data were analysed using SPSS. Chi-square test and correlation analysis were applied, with $p<0.05$ considered significant.
Results: Hypomagnesemia (<1.8 mg/dl) was present in 68.0% of participants. The mean serum magnesium level was 1.46±0.58 mg/dL and mean HbA1c was 7.52±1.21%. A significant association was found between serum magnesium category and HbA1c group (Chi-square=7.85, p=0.010). Serum magnesium showed a significant negative correlation with HbA1c (r=−0.262, p=0.001).
Conclusions: Hypomagnesemia is common in T2DM and is significantly associated with poorer glycemic control. Routine monitoring and correction of magnesium deficiency may support better diabetes management.

Keywords: Glycemic control, HbA1c, Hypomagnesemia, Serum magnesium, Type 2 diabetes mellitus

INTRODUCTION

Diabetes mellitus is a syndrome characterised by impaired carbohydrate, protein and fat metabolism due to insufficient insulin secretion. Although diabetic patients can maintain a normal lifestyle, the late complications of diabetes can lead to reduced life expectancy and substantial healthcare costs.

It is a growing public health burden worldwide, especially in developing countries. India is particularly affected by the diabetes epidemic, requiring immediate corrective measures.[1] Indians have a high ethnic and genetic susceptibility to diabetes and lower threshold limits for environmental risk factors. A major concern is that Indians develop type 2 diabetes mellitus (T2DM) at a younger age compared to Western populations and with minor weight gain. Magnesium metabolism disorders are common in hospital patients and often go unrecognized. Low magnesium intake may contribute to diseases such as diabetes, cardiovascular disease and osteoporosis.

Common complications of hypomagnesemia include cardiac arrhythmias and hypocalcemia. Although less frequent, hypermagnesemia can also lead to cardiovascular and neuromuscular issues.[1,2] Early

recognition and correction of magnesium imbalances are necessary to avoid these complications. The International Diabetes Federation's Sixth Diabetes Atlas revealed that there were an estimated 65.1 million diabetes cases in India in 2013, more than double previous estimates. It is predicted that by 2030, diabetes may affect up to 79.4 million individuals in India, with significant increases also expected in China and the United States.[3-5]

However, these statistics mainly reflect the urban profile and may not be fully representative of India's rural-dominated population. Some short-term metabolic studies have found that magnesium supplementation has a beneficial effect on insulin action and glucose metabolism.[1] The causes of hypomagnesemia include osmotic renal loss from glycosuria, decreased intestinal absorption of magnesium and a specific tubular magnesium defect in diabetic patients. Hypermagnesuria results from reduced tubular magnesium absorption, suggesting that magnesium supplementation benefits insulin action and glucose metabolism.[6,7]

Recent research highlights the importance of various micronutrients in managing T2DM, with magnesium emerging as a key player.[8] Magnesium deficiency is common among individuals with diabetes and may worsen glycemic dysregulation.[9] This study aims to investigate the association between serum magnesium levels and glycemic control in T2DM patients by evaluating serum magnesium concentrations in relation to HbA1c levels.

METHODS

This hospital-based, single-centre, cross-sectional observational study was conducted at KMCT Medical College Hospital, Calicut, in the General Medicine inpatient ward. The study was carried out over a duration of 12 months (January 31st 2025-February 1st 2026), after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants in both English and their mother tongue before enrollment.

The study population comprised patients admitted to the General Medicine inpatient ward at KMCT Medical College, Mukkam, Kozhikode, during the study period. A total of 200 patients were included after applying predefined inclusion and exclusion criteria.

Adult patients of both sexes with a confirmed history of diabetes mellitus who were willing to participate were considered eligible. Patients were excluded if they had coexisting hypertension, gastrointestinal disorders, impaired renal function, alcoholic pancreatitis, endocrine disorders, heart disease or if they were receiving therapy with diuretics or aminoglycosides.

Eligible participants were recruited consecutively from the inpatient medical wards. The purpose and methodology of the study were explained in detail to each participant and written informed consent was obtained before data collection. Detailed clinical history was recorded and a comprehensive clinical examination was performed for all included patients using a structured proforma. All participants underwent relevant laboratory investigations, including fasting blood glucose, postprandial blood glucose, serum magnesium levels, glycated haemoglobin (HbA1c), serum urea, serum creatinine and routine urine analysis. All biochemical measurements were performed using standard laboratory methods as per institutional protocols.

Data collected were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) software, version 26. Quantitative variables were expressed as mean and standard deviation, while qualitative variables were summarised as frequencies and percentages. Appropriate statistical tests, including Pearson and Spearman correlation analyses, were used to assess associations between variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 200 participants were included in the study. The majority of subjects belonged to the 41–50 years and ≥61 years age groups (33.5% each), followed by 51–60 years (25.0%), while only 8.0% were aged 31–40 years. The mean study population was predominantly male, with 124 participants (62.0%), whereas females constituted 76 participants (38.0%) (Table 1).

Assessment of serum magnesium levels showed that hypomagnesemia (<1.8 mg/dl) was present in 136 participants (68.0%), while 56 (28.0%) had values within the normal range (1.8–2.6 mg/dl) and only 8 (4.0%) had levels above 2.6 mg/dl. With respect to glycemic control, HbA1c values between 7% and 8% were observed in 74 participants (37.0%), whereas equal proportions of subjects had HbA1c <7% and >8% (31.5% each). The mean serum magnesium level among the study participants was 1.46±0.58 mg/dl. The mean HbA1c level was 7.52±1.21% (Table 2).

In the current study, the majority of participants across all HbA1c categories had serum magnesium levels <1.8 mg/dl, accounting for 54.0% in the HbA1c <7% group, 68.9% in the HbA1c 7–8% group and 81.0% in the HbA1c >8% group. Normal serum magnesium levels (1.8–2.6 mg/dl) were observed in 39.7%, 27.0% and 17.5% of participants in the respective HbA1c categories, while serum magnesium >2.6 mg/dl was seen only in a small proportion of subjects. The association between serum magnesium category and HbA1c group was statistically significant (Chi-square=7.85, p=0.010) (Table 3). Correlation analysis demonstrated a statistically significant negative correlation between serum magnesium and HbA1c levels (r=−0.262, p=0.001), indicating that higher HbA1c values were associated with lower serum magnesium concentrations (Table 4).

Table 1: Sociodemographic profile of study participants (n=200).

Variable	Category	Frequency	(%)
Age group (in years)	31–40	16	8.0
	41–50	67	33.5
	51–60	50	25.0
	≥61	67	33.5
Sex	Male	124	62.0
	Female	76	38.0

Table 2: Distribution of serum magnesium and HbA1c levels (n=200).

Parameter	Category	Frequency	(%)
Serum magnesium (mg/dl)	<1.8	136	68.0
	1.8–2.6	56	28.0
	>2.6	8	4.0
HbA1c (%)	<7	63	31.5
	7–8	74	37.0
	>8	63	31.5

Table 3: Association Between Serum Magnesium Level and HbA1c Level (Chi-square Test) (n=200).

Serum magnesium level	HbA1c			Chi-square	P value
	<7	7–8	>8		
<1.8 mg/dl	34 (54.0%)	51 (68.9%)	51 (81.0%)		
1.8–2.6 mg/dl	25 (39.7%)	20 (27.0%)	11 (17.5%)	7.85	0.010
>2.6 mg/dl	4 (6.3%)	3 (4.1%)	1 (1.6%)		

Table 4: Correlation between HbA1c and serum magnesium levels.

Factors	Serum magnesium	
	Correlation coefficient	P value
HbA1C	-0.262	0.001

DISCUSSION

The present study assessed the association between serum magnesium levels and glycemic control in 200 patients with type 2 diabetes mellitus. The findings revealed a significant prevalence of hypomagnesemia (68.0%) among the study population, with a mean serum magnesium level of 1.46±0.58 mg/dl. Furthermore, a statistically significant negative correlation was demonstrated between serum magnesium and HbA1c levels (r=−0.262, p=0.001), indicating that patients with poorer glycemic control exhibited lower magnesium concentrations.

These results align with several previous investigations. A large retrospective study by Wang et al involving 1,694 type 2 diabetes patients demonstrated similar findings, reporting negative correlations between serum magnesium and HbA1c (r=-0.29, p<0.05), fasting plasma glucose and HOMA-IR.[10] The authors concluded that serum magnesium was significantly associated with reduced odds of achieving glycemic control, supporting magnesium's critical role in diabetes management. Similarly, a study from Yemen by Abdo et al found that hypomagnesemia was present in 37.2% of type 2 diabetes patients and was independently associated with poor glycemic control (HbA1c ≥7%) with an adjusted odds ratio of 2.85.[11] These findings are consistent with our observation that 81.0% of patients with HbA1c >8% had hypomagnesemia. The prevalence of hypomagnesemia varies considerably across different populations. While our study documented 68.0% prevalence, Ramadass et al reported that patients with poor glycemic control had significantly lower serum magnesium levels, with hypomagnesemia occurring exponentially with disease duration.[12]

Their findings emphasized that serum magnesium depletion serves as an indicator of diabetes status and control. In contrast, Pham et al found a lower prevalence of 11.33% among hospitalized diabetic patients, though they similarly observed that mean HbA1c was significantly higher in hypomagnesemic patients (11.9%) compared to controls (9.8%, p=0.0016).[13] This variation in prevalence may be attributed to differences in study

populations, diagnostic criteria for hypomagnesemia, dietary patterns and the severity of diabetic control among participants.

The pathophysiological mechanisms underlying the relationship between magnesium deficiency and poor glycemic control are multifactorial. Gommers et al comprehensively reviewed that hypomagnesemia is 10-fold more common in individuals with type 2 diabetes than in the healthy population.[14] They described that magnesium deficiency is associated with insulin resistance, which subsequently deteriorates glycemic control in existing diabetes through impaired cellular glucose transport, defective tyrosine kinase activity and reduced pancreatic insulin secretion. Furthermore, chronic magnesium deficiency contributes to oxidative stress and low-grade systemic inflammation, both of which are recognized risk factors for cardiovascular complications in diabetes. The study was limited by its single-centre cross-sectional design, which precludes the establishment of causality and may limit generalizability to broader populations.

Additionally, the study did not evaluate dietary magnesium intake, duration of diabetes, types of antidiabetic medications used or the presence of diabetic complications, all of which could influence both magnesium status and glycemic control. Furthermore, a single measurement of serum magnesium may not accurately reflect total body magnesium stores and the lack of follow-up data prevented assessment of whether magnesium supplementation could improve glycemic outcomes in hypomagnesemic patients.

This study has certain limitations. The cross-sectional design also limits the ability to establish a causal relationship between serum magnesium levels and glycemic control. Potential confounding factors such as dietary magnesium intake, duration and severity of diabetes, use of different antidiabetic medications and presence of microvascular or macrovascular complications were not evaluated. In addition, serum magnesium was measured only once, which may not accurately reflect total-body magnesium status or long-term variation. Finally, the study did not assess the effect of magnesium supplementation or longitudinal changes in glycemic parameters, which could provide stronger clinical implications.

CONCLUSION

The current study concludes that among the 200 study participants, 68.0% had low serum magnesium levels, with a mean serum magnesium of 1.46±0.58 mg/dl, while the mean HbA1c was 7.52±1.21%. A statistically significant association was observed between serum magnesium categories and HbA1c groups (Chi-square=7.85, p=0.010) and there was a significant negative correlation between serum magnesium and HbA1c levels (r=−0.262, p=0.001), indicating that lower magnesium levels were associated with higher HbA1c values.

These findings highlight the clinical importance of magnesium in glucose metabolism and diabetes control. Routine monitoring of serum magnesium in patients with type 2 diabetes, particularly those with poor glycemic control, is recommended and timely correction through dietary measures and supplementation may be beneficial. Further longitudinal and interventional studies are recommended to establish causality and evaluate the impact of magnesium supplementation on long-term glycemic outcomes.

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