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Hypomagnesemia in Diabetic Patients and Its Correlation with Glycemic Control

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ABSTRACT

Diabetes mellitus is a growing pandemic of the modern era with a wide array of complications. Better glycemic control is linked to improved survival and quality of life in diabetes patients. Serum magnesium levels have been postulated to adversely affect glycemic targets. **Objectives:** To determine hypomagnesemia prevalence in diabetic patients and its correlation with glycemic control. **Methods:** This cross-sectional observational study was conducted over six months from January 2025 to June 2025 at the diabetic clinical Jinnah Hospital, Lahore. A total of 174 patients fulfilling the inclusion criteria were enrolled in the study following a non-probability consecutive sampling technique. Informed consent was obtained from the participant. Data were recorded on a predesigned proforma, and analysis was run using SPSS version 25.0 version. **Results:** Out of the total 174 patients, 51 patients had normal magnesium levels, and 123 patients were hypomagnesemic. Poor glycemic control (HbA1C>7.0%) was significantly more prevalent (p=0.001) in hypomagnesemic patients. Although most of the female patients were having low serum magnesium levels (n=77), this gender difference was non-significant (p-value=0.450). Age-wise distribution of hypomagnesemia showed significantly more predilection (p=0.001) for 45 to 60 years age patients. **Conclusions:** The study concluded that hypomagnesemia is significantly linked to poor glycemic control in diabetic patients. Further studies are needed to explore the relationship between serum magnesium and dysglycemia.

INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by hyperglycemia leading to a variety of acute and chronic complications. It has gained major attention of healthcare systems worldwide due to its major impact on cardiovascular and renal diseases [1]. Diabetes burden is growing worldwide, with the highest prevalence in the USA and the Chinese population [2]. Pakistan ranks number three regarding the total number of diabetic patients worldwide [3]. This high incidence of diabetes poses a difficult challenge to the health resources of our country [4]. The morbidity and mortality associated with diabetes have led to the development of a multidisciplinary approach to optimize glycemic management. A diabetes management plan includes a comprehensive patient assessment, followed by lifestyle change and then subsequent pharmacotherapy. Insulin resistance is one of the major pathogenic factors employed in the development of new diabetes as well as poor glycemic control [5]. Various genetic and environmental factors have been implicated in the development of insulin resistance. Serum magnesium, an important electrolyte of the human body, has been proposed as an important factor modulating

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insulin resistance [6]. Previous study reported that higher HbA1C values were significantly associated (p=0.0016) with hypomagnesemia as compared to controls [7]. Prevalence of hypomagnesemia is reported to be around 13 to 47 % in diabetic patients [8]. Previous studies described hypomagnesemia as an independent risk factor (odds ratio 3,64, 1.76–7.52, p=0.001) for albuminuria and inversely related (p<0.001) to glycemic control [9]. A study conducted in Pakistan reported hypomagnesemia in one among 10 diabetes patients, and it was linked (p-value=0.019) with weak glycemic control [10]. Normomagnesimia is essential in maintaining homeostasis of major electrolytes and several other immunomodulation functions [11]. Low magnesium levels occur mostly due to decreased oral intake or poor GI absorption and lead to multiple electrolyte abnormalities like refractory hypokalemia and hypocalcemia [12]. Local studies are insufficient to establish a clear relationship between serum magnesium and glycemic control. Our study was designed to determine the prevalence of hypomagnesemia in diabetes who have poor glycemic control and high insulin requirements. Its objective was to determine the prevalence of hypomagnesemia in patients with diabetes and its comparison with glycemic control.

Although hypomagnesemia has been increasingly recognized as a potential contributor to insulin resistance and poor glycemic control, its true prevalence and clinical significance among Pakistani diabetic patients remain inadequately explored. Existing international studies report variable prevalence rates, and local data are limited and inconsistent, particularly regarding its correlation with HbA1c levels. Moreover, routine assessment of serum magnesium is not commonly integrated into diabetes management protocols in resource-limited settings. This lack of context-specific evidence highlights the need for further investigation to clarify the relationship between serum magnesium levels and glycemic control in our population. Our study was designed to determine the prevalence of hypomagnesemia in diabetes who have poor glycemic control and high insulin requirements. Its objective was to determine the prevalence of hypomagnesemia in patients with diabetes and its comparison with glycemic control.

METHODS

This cross-sectional observational study was conducted over a six-month duration from January 2025 to June 2025 at the diabetic clinic of Jinnah Hospital Lahore, after obtaining approval from the hospital ethical review board (Ref. No. ERB 181/6 16-01-2025/S1 ERB). One hundred and seventy-four patients were included in this study after explaining to them the study purpose and obtaining informed consent. A sample size of 174 was calculated at a 95% confidence interval, 5% margin of error, and an anticipated frequency of hypomagnesemia of 13% [8]. Privacy and anonymity of patient data were ensured. It included patients of type 2 diabetes from 18 to 75 years and both genders with at least two oral antidiabetic drugs. Patients using insulin or GLP1 agonists were also enrolled in the study. The minimal time period of ongoing therapy was at least three months after their last follow-up. Patients with conditions like malabsorption, inflammatory bowel disease, acute gastroenteritis, and stage 3 chronic kidney disease were excluded from the study. Similarly, patients using diuretics or those receiving magnesium supplements didn't qualify inclusion criteria. Patients with poor compliance to treatment or dietary management (as judged by a dietitian) or those with a recent change in therapy were also excluded from the study. Patient demographics and clinical parameters were recorded on a proforma. Five milliliters of blood were withdrawn by nursing staff following aseptic measures and sent to the laboratory immediately for testing. Serum magnesium levels were checked, and a value less than 1.6 mg was labeled as hypomagnesemia, while 1.6 to 2.4 mg/dl was considered as normomagnesemia. HbA1C was also measured on the same sample using the HPLC technique, and a value < 7.0 % was taken as good glycemic control, and > 7.0 % was reviewed as week glycemic control. Patients were called for follow up regarding advice on glycemic management. Data were recorded on proforma for demographic, clinical, and biochemical variables. Data analysis was done using SPSS version 25.0. Demographic variables like age, gender, etc. were charted in the form of means, frequencies and percentages. Hypomagnesemia occurrence was calculated for both genders and various age groups. Glycemic control was also calculated according to the operational definition in all patients. Chi-square test was applied to observe the statistical relation between hypomagnesemia and glycemic control, with a p< 0.050 being considered significant.

RESULTS

This study comprised 174 diabetic patients (62 males and 112 females) who were reviewed for glycemic control and serum magnesium levels. Demographic characteristics of the study population (Table 1).

Table 1: Demographic Characteristics of Study Population

Variables	Category	Frequency (%)
Gender	Male	62 (35.6%)
	Female	112 (64.4%)
Age (years)	30–45	47 (27.0%)
	46–60	82 (47.1%)
	61–75	45 (25.9%)
Body weight (kg)	Mean ± S.D	82.9 ± 13.8

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Duration of diabetes (years)	Mean ± S.D	7.9 ± 4.5

Sixty-nine percent (n=120) of patients were using two drugs for their glycemic control, and 31% (n=54) were using three or more drugs. Mean values of baseline laboratory parameters, i.e., serum creatinine, alanine transferase, and LDL cholesterol, were 0.9 mg/dl, 35IU/L, and 93mg/dl, respectively. Good glycemic control (HbA1C<7% as per operational definition) was noted in 26.4% (n=46) patients, while 73.6% patients had HbA1C>7%. Fifty-one patients (29.3%) had normomagnesemia, and one hundred and twenty-three (70.7%) had serum magnesium levels less than 1.6 mg/dl (hypomagnesemia). Cross tabulation was done, which showed a statistically significant relation between glycemic control and serum magnesium levels (p-value 0.001)(Table 2).

Table 2: Cross-Tabulation of Serum Magnesium Levels and Glycemic Control

Serum Magnesium Status	Good Control (HbA1c<7)	Poor Control (HbA1c>7)	p-Value
Eumagnesemia (≥1.6 mg/dL)	37	14	0.001
Hypomagnesemia (<1.6 mg/dL)	9	114	
Total	46 (26.4%)	128 (73.6%)	

Serum magnesium level was also analyzed for gender distribution (table 2). Although hypomagnesemia was more frequent (68.8%, n=77) in females in our study as compared to males (74.2%, n=46), this difference was statistically insignificant (p=0.450). Hypomagnesemia was also checked in different age groups to assess for any effect of age on hypomagnesemia distribution. Eighty-five percent of hypomagnesemic patients were age between 46 to 60 years, while normomagnesemia was more prevalent (61.7%) in the age group 30 to 45 years. Statistical analysis for age-related distribution of magnesium levels was significant in our study (p=0.001)(Table 3).

Table 3: Serum Magnesium Levels in Different Age Groups (Cross Tabulation)

Age Group (Years)	Eumagnesemia (>1.6 mg/dL)	Hypomagnesemia (<1.6 mg/dL)	p-Value
30–45	29 (61.7%)	18 (38.3%)	0.001
46–60	12 (14.6%)	70 (85.4%)	
61–75	10 (22.2%)	35 (77.8%)	
Total	51 (29.3%)	123 (70.7%)	

DISCUSSIONS

Our study findings denoted an inverse relation between hypomagnesemia and glycemic control. Hypomagnesemia patients' glycemic control was significantly inferior to patients with normomagnesemia. Hypomagnesemia was more prevalent in female diabetes patients and subsequently reflected in their glycemic parameters. Diabetes is a growing pandemic estimated to adversely affect major health systems worldwide in future. It stands as number one cause of end stage renal disease across the globe and also an important contributor to stroke and ischemic heart diseases. Diabetes control is of paramount importance in preventing and delaying its macro- and microvascular complications. A rise in HBA1C above target is strongly linked with diabetic morbidity and mortality and imposes huge burden on health resources of a country. Vigorous efforts have been made to explore underlying factors associated with deranged glycemia. Other comorbidities like hypertension, dyslipidemias, and smoking have proven additive effects on poor cardiovascular outcomes of diabetes and need to be addressed well for overall well-being. Some studies have discussed hypomagnesemia in diabetes patients. Previous study showed hypomagnesemia was 10 times more prevalent in diabetes patients [13]. A systematic analysis conducted by previous researchers showed 32% of patients (n=4192) with diabetes had low serum magnesium levels [14]. Current study findings were quite matching with these studies. Low magnesium trend was noted in female patients in our study which was similar to a study of Hamarshih et al, in which female patients were found to be low (adjusted OR: 2.7, 95%CI: 1.2%-5.8%) in serum magnesium levels [15]. However, when statistical analysis was applied, the gender distribution of hypomagnesemia in our study was not significant. A previous study showed no significant differences in mean serum magnesium levels (2.06 ± 0.49 mg/dl) in diabetic versus nondiabetic individuals (2.22 ± 0.48 mg/dl) [16]. The etiology of hypomagnesemia in diabetic patients is not well explored. It is linked to molecular level changes in insulin secretion and altered cellular response. Drugs may contribute to low serum magnesium levels in diabetes individuals. Other factor which may cause low magnesium levels are renal and GI losses. The relationship between glycemic control and serum magnesium have been explored in a few studies. Serum magnesium alters insulin response as suggested in some studies demonstrating high insulin levels in patients with hypomagnesemia. A study conducted by Morais et al suggested that hypomagnesemia is linked to induce insulin resistance and that magnesium supplementation can improve insulin sensitivity in such patients [17]. Earlier studies showed significantly low (p<0.001) magnesium levels in diabetics as compared to healthy or prediabetic individuals. Furthermore, serum magnesium was negatively linked with glucose (R=-0.58) and HbA1C (R=-0.61) values [18]. Our study findings were in alignment with these results. Some studies also linked hypomagnesemia to the development of early diabetic kidney disease in the form of mild albuminuria. It was observed that hypomagnesemia patients (67.9%) showed more predilections for diabetic complications, especially diabetic kidney disease [19]. Another study by Bherwani *et*

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al. showed diabetic kidney disease was more prevalent (52%) in patients with decreased (1.40 ± 0.16 mg/dL) magnesium levels, and microalbuminuria was inversely related (r=-0.352, p=<0.001) to hypomagnesemia. [20]. Similarly, a study conducted by Shivakumar *et al.* showed sight-threatening diabetic retinopathy was significantly higher (p=0.031) in diabetic patients with hypomagnesemia [21]. Other factors have been postulated to affect glycemic control and thus pose therapeutic challenges in the management of diabetes. There is robust evidence about the pleiotropic effects of vitamin D in glucose metabolism. Abubaker S. *et al.* stated that low vitamin D levels were inversely related (p<0.001) to glycemic targets in the Saudi population (n=370) [22]. Serum zinc levels have been postulated to affect insulin sensitivity (p=0.020), with low zinc levels regarded as contributory to diabetes [23]. A comprehensive management of diabetes also takes into account existing cardiovascular risk factors. Dyslipidemias play a key role in the development of the atherosclerosis process and, hence, premature cardiovascular diseases. Strict LDL cholesterol targets are designed to modify this risk factor. Similarly, variability in blood pressure is linked to macrovascular pathologies like stroke, peripheral vascular disease, and myocardial infarction. Optimal blood pressure control in patients with diabetes is recommended to achieve good cardiovascular outcomes. There were certain limitations of our study, is a small sample size, being a single-center study, and a lack of a control group. Multicenter studies with an analytical approach and a large sample size can be very fruitful in establishing a causal relationship between hypomagnesemia and higher HBA1C values.

This study has several limitations, including its single-center design, relatively small sample size, and cross-sectional nature, which limits the ability to establish causality between hypomagnesemia and poor glycemic control. The absence of a non-diabetic control group and lack of dietary magnesium assessment may also have influenced the findings. Additionally, potential confounders such as micronutrient status and medication effects were not fully explored. Future large-scale, multicenter prospective studies incorporating interventional arms with magnesium supplementation are warranted to better understand causal relationships and evaluate the therapeutic role of magnesium in optimizing glycemic outcomes.

CONCLUSIONS

In conclusion, the study concluded that low serum magnesium level is strongly associated with hyperglycemia in diabetes patients. It may serve as a basis to explore the underlying mechanisms of serum magnesium and glucose metabolism.

Authors' Contribution

Conceptualization: AP, SS
Methodology: AP, SS, ZA, UP
Formal analysis: SS, UP
Writing and Drafting: AP, SS, AMB, ZJ, IU
Review and Editing: AP, SS, AMB, ZJ, IU, UP, ZA

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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