

# Correlation of Serum Magnesium Levels in Type 2 Diabetes Mellitus: An Institutional Study

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## ABSTRACT

**Introduction:** In developing nations, the increased prevalence of type 2 diabetes mellitus (T2DM) has resulted in significant morbidity and socioeconomic consequences. Hypomagnesemia has been associated with insulin resistance and related micro-vascular consequences due to its ability to trigger hyperglycemia. Although many research articles on glycemic control have been published in recent years, the latest therapeutic approaches may not be feasible to all. As a result, prioritising preventative and primary care research becomes critical.

**Aim and objective:** The study is aimed at estimating serum magnesium concentration and glycated hemoglobin (HbA1c) levels in patients with Type 2 Diabetes mellitus. This will help us evaluate how glycemic control in Diabetes can influence serum Magnesium levels.

**Method:** The study consists of 50 consenting patients who came for routine blood investigations. Those patients having high random blood sugar were selected and divided into two groups based on their age. i.e. 25-50, 51-75. Other parameters considered were age, gender and diet. After an overnight fasting, blood of the consenting patient was collected. Magnesium was measured by Cobas 6000 using the calorimeter end-point method. The other blood sample was transferred into an EDTA test tube which was used to estimate HbA1c level.

**Result:** Participants were divided into two groups based on their age. i.e. 25-50, 51-75. The mean serum magnesium levels were 1.46 mg/dL for group 1 and 1.3 mg/dL for group 2. The mean HbA1c levels for group 1 were 7.65 and 8.36 for group 2 respectively. According to Pearson's correlation coefficient, inverse correlation was found between HbA1c levels and Serum magnesium levels.

**Conclusion:** Magnesium insufficiency has been linked to a higher incidence of diabetic due to poor glycemic management in people with diabetes. To avoid such problems and maintain glycemic control, dietary supplements may be recommended. Large-scale clinical research is also required.

**Keywords:** Hypomagnesaemia, diabetes mellitus, hyperglycemia, epidemic, research, HbA1c.

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## INTRODUCTION

Diabetes mellitus (DM) is attributed to a group of common metabolic disorders that share the phenotype of hyperglycemia.<sup>1</sup> The worldwide prevalence of DM has risen dramatically over the past two decades, from an estimated 366 million cases in 2011 and by 2030 this will have risen to 552 million. According to the International Diabetes Federation (IDF), there were an estimated 65.1 million cases of diabetes in India in 2013, which was more than double of the 2000 statistics. By 2030, DM is likely to afflict up to 79.4 million individuals in India.<sup>2,3</sup> Internationally, huge morbidity and socioeconomic impact has been observed due to the advancing burden of Type 2 Diabetes mellitus (T2DM).<sup>4</sup>

Magnesium (Mg) being the fourth most abundant cation and an established central electrolyte in the human body is instrumental in many fundamental biological processes.<sup>4</sup> It also has a crucial role to play in the phosphorylation reactions of glucose and its metabolism by activating various enzyme systems and helping insulin in its action.<sup>4,5</sup> It is claimed that there is an

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inverse relationship between Mg intake and glycemic control.<sup>6</sup>

Hypomagnesemia is associated with poor control of T2DM, and its deficiency occurs exponentially along the course of the disease.<sup>7</sup> It is now entrenched that diabetes can procure

hypomagnesaemia which in turn worsens DM.<sup>8</sup>

Determination of HbA1c helps in monitoring the response to treatment in diabetic patients since it's free of day to day glucose variation and unaffected by recent physical activity and food intake.<sup>9</sup>

This study is a genuine endeavour to estimate the incidence of hypomagnesaemia in patients with Type 2 Diabetes Mellitus which will help us in better management of DM in future.

## OBJECTIVE

The study is aimed at estimating serum magnesium concentration and glycated hemoglobin (HbA1c) levels in patients with T2DM. This will help us evaluate how glycemic control in Diabetes can influence serum Magnesium levels.

## METHODOLOGY

### Geographical extent of the study-

The present study was conducted at D.Y. Patil University, School of Dentistry, Navi Mumbai, India. All individuals belong to the same geographical population of Western India to be specific Navi Mumbai.

### Materials -

The study consisted of 50 consenting patients who came for routine blood investigations. Those patients having high random blood sugar were selected and divided into two groups based on their age. i.e. 25-50, 51-75.

### Inclusion criteria -

T2DM patients of either sex with age more than 18 years were included.

### Exclusion criteria -

Critically ill patients, Patients with T2DM, patients with age less than 18 years of age, patients on drugs known to affect magnesium levels and patients taking supplements containing magnesium were included.

### Method -

After an overnight fasting, 5 ml of peripheral venous blood of the consenting patient was collected from the antecubital fossa using an 18 gauge needle attached to a 5ml syringe. The procedure was conducted under aseptic conditions. 2.5 ml of the sample was placed in a lithium heparin tube. Serum is obtained by low-speed centrifugation and was stored at 2-8°C which was then used for magnesium analysis. Magnesium was measured by Cobas 6000 using the calorimeter end-point method. The other 2.5

ml sample was transferred into an EDTA test tube which was then used to estimate HbA1c level. This was measured by enzyme-linked immunosorbent assay (ELISA) test.

### Ethical clearance -

Ethical clearance was obtained from Institutional Research and Ethical Board D Y Patil University, School of Dentistry, Navi Mumbai.

### Statistical analysis -

In this study, descriptive and inferential statistical analyses were performed. Results on continuous measurements were presented on Mean  $\pm$  SD and results on categorical measurement were presented in number (%). Level of significance was fixed at  $p=0.05$  and any value less than or equal to 0.05 was considered to be statistically significant.

Student t tests (two tailed, unpaired) were used to find the significance of study parameters on continuous scale between two groups.

Pearson's Correlation coefficient was computed to measure correlation between HbA1C & serum magnesium levels.

The data was analysed using IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA), and graphs, tables, and other graphics were created using Microsoft Word and Excel.

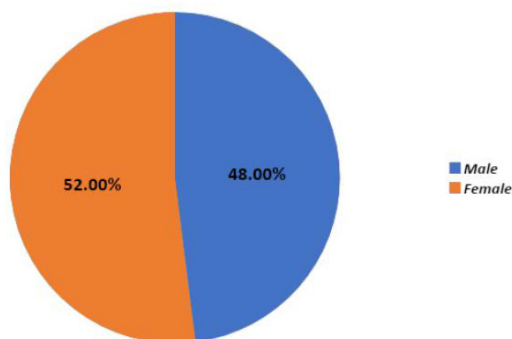
## RESULTS

A comparative study consisting of 50 patients was undertaken to investigate the correlation of serum magnesium levels in T2DM. Description of the participants according to the gender and age group is depicted in Table 1. (Figure 1)

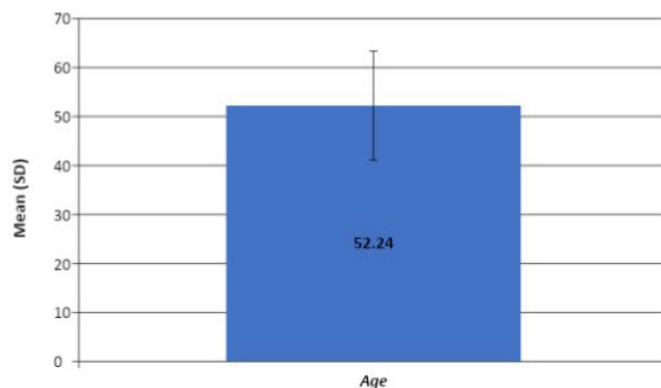
Participants were divided into two groups based on their age. i.e. 25-50, 51-75. Group 1 consisted of the age group 25-50 and Group 2 consisted of the age group 51-75. The mean age was 52.24  $\pm$  11.113. (Figure 2)

The mean serum magnesium levels were 1.46 mg/dL for group 1 and 1.3 mg/dL for group 2. The normal range for serum magnesium level is 1.7 to 2.2 mg/dL. Prevalence of hypomagnesaemia was observed among 40 patients out of 50 of type 2 diabetes mellitus patients. (Figure 3)

The mean HbA1c levels for group 1 were 7.65 and 8.36 for group 2 respectively. Normal ranges for HbA1c in people without diabetes is about 4% to 5.9%. People with diabetes with poor glucose control have HbA1c levels above 7%. Comparison of HbA1c levels and Serum magnesium levels among different age groups using unpaired t test is depicted in Table 2. (Figure 4)

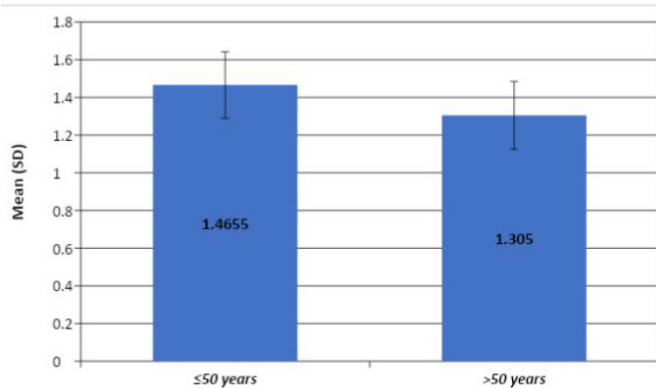


**Fig. 1:** Shows that 52% of the participants are male and 48% of the participants are female.

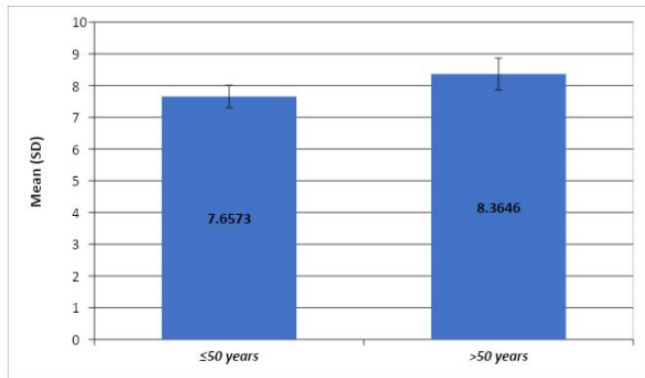


**Fig. 2:** Depicts that the standard deviation for the mean age calculated for all the participants is about 52.24.

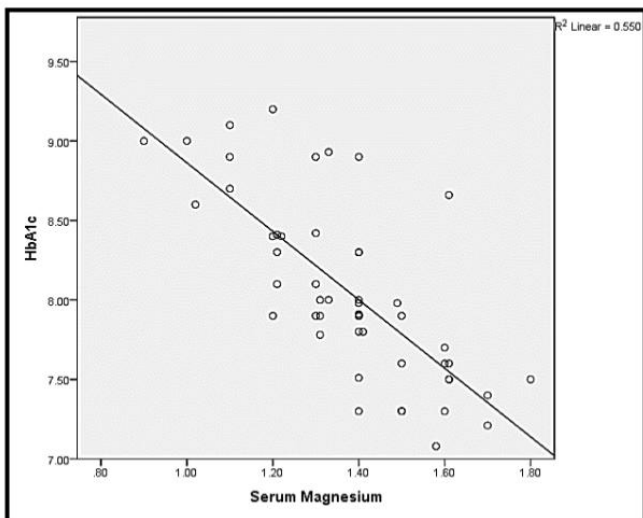
According to Pearson's correlation coefficient, inverse correlation was found between HbA1c levels and Serum magnesium levels (Table 3, Figure 5).



**Fig. 3:** Shows that the mean standard deviation calculated for the participants aged below 50 years is 1.30mg/dL% and the mean standard deviation calculated for the participants aged above 50 years is 1.46mg/dL% for prevalence of hypomagnesaemia in participants.



**Fig. 4:** Shows mean HbA1c levels for group 1 were 7.65 and and 8.36 for group 2 respectively. Normal ranges for HbA1c in people without diabetes is about 4% to 5.9%. People with diabetes with poor glucose control have HbA1c levels above 7%.



**Fig. 5:** depicts the graph showing the inverse correlation between serum magnesium and the HbA1c levels of the participants.

## DISCUSSION

T2DM is a chronic condition caused by a complicated genetic environmental interplay, as well as additional risk factors like obesity and an inactive lifestyle.<sup>10</sup> Despite the use of cutting-edge diabetes management techniques, morbidity and mortality ratios remain high. Diet is commonly implicated in the development of type 2 diabetes and the comorbidities that come with it.

Patients with Type 2 diabetes have been reported to have low magnesium levels repeatedly. Magnesium insufficiency appears to have a deleterious influence on glucose homeostasis and insulin resistance.<sup>11</sup>

The present study was conducted on 50 patients to understand how hyperglycemia management affects blood magnesium levels in diabetic patients. The findings of this study provides a clear insight into the correlation of serum magnesium levels in Type 2 Diabetes mellitus.

Hypomagnesaemia associated with raised HbA1c levels were present in 80% of the participants in the current study. The mean serum magnesium levels were 1.46 mg/dL for group 1 and 1.3 mg/dL for group 2. Similar results were observed in 75.5% of patients with type II diabetes mellitus in a study conducted by NH Rekha et al.<sup>12</sup> These results are also consistent with other studies done by Shaikh and Viktorinova et al.<sup>13,14</sup> This could be due to decreased dietary consumption, poorer intestinal absorption, autonomic

**Table 1:** Demographic characteristics of the study participants (N=50)

Variables	Sub-groups	n	%
Gender	Male	24	48.0
	Female	26	52.0
Age groups	≤50 years	22	44.0
	>50 years	28	56.0
Age (Mean ± SD)		52.24 ± 11.113	

**Table 2:** Comparison of HbA1c levels and Serum magnesium levels in terms of {Mean (SD)} among different age groups using unpaired t test

Variables	Group	N	Mean	Std. Deviation	t value	P value
HbA1c	≤50 years	22	7.6573	0.35491	5.603	<0.001**
	>50 years	28	8.3646	0.50113		
Serum magnesium	≤50 years	22	1.4655	0.17690	3.155	0.003*
	>50 years	28	1.3050	0.17972		

**Table 3:** Correlation between HbA1c levels and Serum magnesium levels using Pearson's correlation coefficient

Variable	R (correlation coefficient)	P value
Overall	-0.742	<0.001**

dysfunction, higher urine magnesium loss coupled with glucose, or reduced magnesium intake by cells in contrast to non-diabetic healthy individuals.<sup>15</sup>

Prevalence of hypomagnesaemia associated with gender was not found in our study. This is in contrast to a study conducted by Ghafour et al wherein prevalence of hypomagnesemia was reported more in males than females.<sup>16</sup>

As per the findings of this study, an inverse correlation was found between serum magnesium level and HbA1c level. Studies conducted by Siddique et al and Al-Osali et al also demonstrated the negative correlation between the same.<sup>17,18</sup> Hypomagnesemia disrupts glycemic control through altering cellular glucose transfer, lowering pancreatic insulin release, disrupting post-receptor signalling, and changing the insulin-insulin receptor contact.<sup>5</sup> It also plays a part in the pathogenesis of microvascular complications of diabetes like advanced retinopathy, foot ulcers and nephropathy. According to a study conducted by Marhelle et al, dylipidemia and hypertension were also inversely related with serum magnesium levels.<sup>19</sup> Although a large number of potential cohort research and meta-analyses have indicated that magnesium consumption lowers the incidence of diabetes, the findings are still mixed, and additional research is needed to confirm this.<sup>20</sup>

Patients must be closely monitored using a multi-dimensional technique that includes full investigation and plan of care. Despite its obvious connection with glycemic values, serum magnesium levels are not routinely tested in clinical settings as part of diabetes care. To avoid and eliminate consequences of T2DM, dietary recommendations for increased intake of key magnesium-rich food should be made at the time of diagnosis. According to the findings of our investigation, serum magnesium should be integrated as a routine electrolyte test for improved Type 2 diabetes mellitus treatment and to avoid complications such as diabetic retinopathy.

Despite the fact that type 2 diabetes is a multifactorial disease, our findings suggest that improved magnesium consumption, together with changes in other type 2 diabetes risk variables, could be a novel way to avoid the condition.

The limitations of this study were its small sample size and unequal distribution of patients in the two groups. Being a cross sectional study, no follow-ups were conducted. Furthermore, in the present study magnesium test was limited to serum, a fairly minor category for magnesium that may not yield precise amounts. To establish the link between magnesium deficiency and type 2 diabetes, large-scale clinical research is required.

## CONCLUSION

In the current study, we aimed to understand the relation between serum magnesium levels and T2DM. The main implication for our research is that hypomagnesemia has been linked to a lack of glycemic regulation which can lead to diabetic complications. Early detection with oral magnesium supplementation as a therapeutic approach can avoid this; nonetheless, the prospective effect of magnesium therapy in avoiding the emergence of diabetes complications deserves further research.

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