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**ORIGINAL RESEARCH**

# Association between serum zinc & magnesium levels with glycemic parameters in type 2 diabetes mellitus patients

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## ABSTRACT

**Background:** The metabolic disease known as type 2 diabetes mellitus (T2DM) is associated with poor glucose regulation. According to recent research, glycemic management may be impacted by mineral imbalances, especially those involving zinc and magnesium. The purpose of this study is to investigate the connection between serum zinc and magnesium levels and glycemic parameters in patients with type 2 diabetes. **Methods:** This cross-sectional study included 70 T2DM patients (24 females, 46 males). Zinc and magnesium levels were measured using the Calmagite and colorimetric methods, respectively. FPG, PPG, and RPG were assessed by the GOD-POD method, while HbA1c was measured using the Automated Analyser ERBA EM360 with a particle-enhanced immune turbidimetric method. **Results**: The average age of the participants was 44.49 ± 11.65 years, and their mean serum magnesium and zinc levels were 0.895 ± 0.446 mEq/L and 67.814 ± 21.044 µg/dL, respectively. HbA1c was 8.214 ± 1.965% on average. There was a positive correlation between zinc and magnesium ($r = 0.591$, $p = 0.001$). Magnesium had substantial negative connections with all glycemic markers, including RPG ($r = -0.391$, $p = 0.001$), PPG ($r = -0.352$, $p = 0.003$), and HbA1c ($r = -0.287$, $p = 0.016$). It also shown a high negative correlation with RPG ($r = -0.205$, $p = 0.008$). **Conclusion**: Serum magnesium and zinc levels in T2DM patients were found to significantly correlate positively. Serum magnesium exhibited strong negative connections with RPG, PPG, and HbA1c, but very minor correlations with diabetic indicators. According to these findings, magnesium may have an impact on HbA1c and blood glucose management, which calls for more research into its potential as a treatment.

**Keywords:** serum zinc, serum magnesium, glycated hemoglobin, glucose, diabetes mellitus.



## INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both. Diabetes mellitus is associated with abnormalities in carbohydrate, fat and protein metabolism [1]. Diabetes mellitus is a chronic disease that affects 366 million people worldwide (6.4% of the adult population) and is expected to rise to 552 million by 2030. In India this increase has been estimated to be 58%, which means increase from 51 million people in 2010 to 87 million in 2030 [2]. Type 2 DM results from the interaction of genetic, environmental and behavioral risk factors [3]. Many research studies have shown the direct association of minerals, trace elements and vitamins in the pathogenesis and natural course of 1 and 2 diabetes mellitus [4-6]. An alteration in the metabolism of these minerals and vitamins has been associated with an absolute or relative change of serum minerals level as well as insulin resistance [7]. Zinc another essential trace element, is a component of many enzymes, and plays an important role in the maintenance of several tissue functions including the synthesis, storage and release of insulin [8,9]. Zn plays an important role in glucose metabolism [10]. It has been found to enhance effectiveness of insulin in vitro and it has been postulated that its deficiency may aggravate the insulin resistance in non-insulin dependent diabetes mellitus (NIDDM)[11]. Magnesium is the fourth most abundant cation in the human body and the second most abundant intracellular cation [12]. It plays an

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important role in carbohydrate metabolism. It serves as a cofactor for all enzymatic reactions that require kinases [13]. It is also an essential enzyme activator for neuromuscular excitability and cell permeability, a regulator of ion channels and mitochondrial function, a critical element in cellular proliferation and apoptosis, and an important factor in both cellular and humoral functions [14]. Hypomagnesaemia has been associated with diabetes mellitus.31 Intracellular Mg deficiency may affect the development of insulin resistance [15,16] It has been demonstrated that low serum Mg level was strong and independent predictor of incident of type 2 diabetes. Hypomagnesaemia will impair tyrosine kinase activity at insulin receptors and further it aggravates insulin resistance which leads to micro and macrovascular complications observed in diabetes, such as cardiovascular disease, retinopathy, neuropathy. As Zinc deficiency and hypomagnesaemia causes insulin resistance and directly related to Diabetes Mellitus type II[17,19]. As there are very few studies which focus on glycemic control by HbA1c, Zinc and Magnesium levels that's why this study was conducted to determine the association between serum zinc & magnesium levels with glycemic parameters in Type 2 Diabetes Mellitus patients.

## MATERIAL AND METHODS

**Subject selection:** The study was carried out in the Department of Biochemistry and the Department of Medicine in Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh. Ethical clearance was taken from Institutional Ethical Committee. Present study includes 70 are clinically confirmed cases of diabetes mellitus of both sexes, age group ranges from 21-70 years.

**Sample collection:** 5 ml venous blood after a fasting period of 10 hours was collected from cases.

**Analysis of Sample:** Serum separated from plain vial after centrifugation was used for estimation of serum zinc by colorimetric method, serum magnesium by Calmagite method; Plasma glucose estimation by GOD-POD Method, End Point, Glycated hemoglobin by Particle enhanced immune turbidimetric method on Automated Analyser ERBA EM360.

**Statistical analysis:** Mean ± SD were calculated for all the parameters analyzed and Pearson's Correlation analyses were used to estimate the correlation between serum Zinc & Magnesium levels with glycemic parameters. P-values considered significant were as follows:- $P < 0.05$ – As Significant, $P < 0.001$ – As Highly significant.

## OBSERVATIONS AND RESULTS

The Diabetes Mellitus group consisted of 70 people, 24 of whom were female and 46 of whom were male. Table No. 1 indicates that the majority of participants were between the ages of 21 and 70, with the largest participation for both genders in the 41–50 age bracket. According to Table No. 2, the average age was 44.49 ± 11.65 years. The average age was 45.36 ± 11.13 years for females and 44.55 ± 11.73 years for males. Serum magnesium was 0.895 ± 0.446 mEq/L (range: 0.3–2.3 mEq/L), while the mean serum zinc was 67.814 ± 21.044 μg/dL (range: 42.0–121.0 μg/dL). Table No. 3 shows that the mean HbA1c was 8.214 ± 1.965% (range: 5.3–14.0%) and the average fasting plasma glucose was 257.55 ± 99.34 mg/dL (range: 70–140 mg/dL). According to Table No. 4, there was a substantial positive association between serum magnesium and zinc ($r = 0.591$, $p = 0.001$). Postprandial glucose ($r = -0.203$, $p = 0.091$), fasting plasma glucose ($r = -0.124$, $p = 0.305$), and HbA1c ($r = -0.132$, $p = 0.277$) all had weak, non-significant negative associations with it. Random plasma glucose showed a significant negative connection ($r = -0.205$, $p = 0.008$). Similarly, table no. 5 indicates that serum magnesium had a negative correlation with all glycemic indicators and a positive correlation with serum zinc ($r = 0.591$, $p = 0.001$). There were modest and non-significant connections with fasting glucose ($r = -0.159$, $p = 0.187$), but substantial negative correlations with postprandial glucose ($r = -0.352$, $p = 0.003$), random glucose ($r = -0.391$, $p = 0.001$), and HbA1c ($r = -0.287$, $p = 0.016$).

**Table No: 1 Age and Sex distribution in Diabetes Mellitus**

| Age (Years) | Diabetes Mellitus Group (n=70) | |
|---|---|---|
| | **Males** | **Females** |
| 21-30 | 10 | 5 |
| 31-40 | 10 | 5 |
| 41-50 | 12 | 7 |
| 51-60 | 10 | 6 |
| 61-70 | 4 | 1 |
| **Total** | **46** | **24** |

**Table No.: 2 Demographic characteristic of study population**

| Parameters | Diabetes Mellitus Group (mean ± SD) |
|---|---|
| Age (Yrs.) | 44.49 ± 11.65 |
| Male | 44.55 ± 11.73 |
| Female | 45.36 ± 11.13 |

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**Table No.: 3 Serum Zinc, Magnesium, plasma glucose and glycemic parameters levels in Diabetic patients.**

| Parameter | Mean ± SD | Range |
|---|---|---|
| Serum Zinc | 67.814 ± 21.044 µg/dL | 42.0 – 121.0 µg/dL |
| Serum Magnesium | 0.895 ± 0.446 mEq/L | 0.3 – 2.3 mEq/L |
| Glycated hemoglobin | 8.214 ± 1.965 % | 5.3 – 14.0 % |
| Fasting plasma Glucose | 257.55 ± 99.34 mg/dl | 70-140 mg/dl |

**Table No. 4: Correlation of Serum Zinc with glycemic parameters in Diabetes Mellitus patients**

| Parameters | Variables | Pearson Correlation (r) | 'P' Value |
|---|---|---|---|
| Serum Zinc | Serum Magnesium | 0.591 | 0.001 |
| | Fasting Plasma Glucose | -0.124 | 0.305 |
| | Postprandial Plasma Glucose | -0.203 | 0.091 |
| | Random Plasma Glucose | -0.205 | 0.008 |
| | HbA1c | -0.132 | 0.277 |

**Table No. 5: Correlation of Serum Magnesium with glycemic parameters in Diabetes Mellitus patients**

| Parameters | Variables | Pearson Correlation (r) | 'P' Value |
|---|---|---|---|
| Serum Magnesium | Serum Zinc | 0.591 | 0.001 |
| | Fasting Plasma Glucose | -0.159 | 0.187 |
| | Postprandial Plasma Glucose | -0.352 | 0.003 |
| | Random Plasma Glucose | -0.391 | 0.001 |
| | HbA1c | -0.287 | 0.016 |

## DISCUSSION

This study aimed to evaluate the association between serum zinc and magnesium levels with glycemic parameters in patients with Type 2 Diabetes Mellitus (T2DM). A total of 70 individuals were enrolled, with a male predominance (46 males and 24 females), and the majority of participants fell within the 41–50 years age group. The overall mean age was 44.49 ± 11.65 years, consistent with the middle-aged population commonly affected by T2DM.

The biochemical analysis revealed suboptimal mean levels of serum zinc (67.814 ± 21.044 µg/dL) and serum magnesium (0.895 ± 0.446 mEq/L), both of which are essential micronutrients involved in glucose metabolism and insulin function. Almost similar finding had been reported in various research studies [4, 20, 21]. The elevated mean HbA1c level (8.214 ± 1.965%) and fasting plasma glucose (257.55 ± 99.34 mg/dL) reflect poor glycemic control among the study participants.

Correlation analysis demonstrated a significant positive association between serum zinc and magnesium levels (r = 0.591, $p$ = 0.001), suggesting a potential interdependence in their metabolic roles [22]. However, serum zinc showed weak and statistically non-significant negative correlations with fasting glucose, postprandial glucose, and HbA1c. A significant negative correlation was found only with random plasma glucose (r = -0.205, $p$ = 0.008), indicating a possible, role of zinc in acute glycemic regulation [23].

Serum magnesium also showed a significant positive correlation with zinc levels and negative correlations with all glycemic parameters [22]. Notably, significant inverse relationships were observed with postprandial glucose (r = -0.352, $p$ = 0.003), random glucose (r = -0.391, $p$ = 0.001), and HbA1c (r = -0.287, $p$ = 0.016), indicating that lower magnesium levels may be associated with poorer glycemic control. The non-significant correlation with fasting glucose may reflect the influence of multiple regulatory factors on fasting glycemia [24].

## CONCLUSION

The findings suggest that while serum zinc has a limited direct association with long-term glycemic control (HbA1c), serum magnesium shows a more consistent inverse relationship, particularly with HbA1c and post-meal glucose levels. This highlights the potential importance of magnesium status in managing glycemic parameters in T2DM patients. Further studies with larger sample sizes and longitudinal follow-up are warranted to better elucidate the therapeutic implications of correcting micronutrient deficiencies in diabetes management.

**Conflict of Interest:** The authors have declared no conflicts of interest in relation to the publication of this work. The study has not been improperly influenced by financial or personal ties to other people or organizations.

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