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**Research Article**

# Biochemical Variations of Serum Magnesium with Lipid Analytes in Different Clinical Groups of Type 1 and Type 2 Diabetes Mellitus: A Hospital-Based Cross-Sectional Study

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## ABSTRACT

**Background**: Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia due to defects in insulin secretion, insulin action, or both. Electrolyte disturbances, particularly hypomagnesemia, are frequently observed in diabetic patients and may contribute to insulin resistance, dyslipidemia, and increased cardiovascular risk. Serum magnesium plays a vital role in carbohydrate metabolism, insulin activity, and lipid regulation.
**Objective**: To evaluate the biochemical variations of serum magnesium and its association with lipid profile parameters in different clinical groups of Type 1 and Type 2 diabetes mellitus.
**Materials and Methods**: This hospital-based cross-sectional study included 100 participants comprising 30 patients with Type 1 diabetes mellitus, 50 patients with Type 2 diabetes mellitus, and 20 healthy controls. Serum magnesium levels and lipid profile parameters including total cholesterol, triglycerides, HDL-cholesterol, and LDL-cholesterol were measured using standard biochemical methods. Statistical analysis was performed to compare the biochemical parameters among the groups and to determine correlations between magnesium and lipid analytes.
**Results**: Serum magnesium levels were significantly lower in diabetic patients compared to healthy controls. Patients with Type 2 diabetes exhibited relatively lower magnesium levels than Type 1 diabetes patients. Lipid profile parameters including total cholesterol, triglycerides, and LDL-cholesterol were elevated in diabetic groups, while HDL-cholesterol was reduced. A negative correlation was observed between serum magnesium and total cholesterol, triglycerides, and LDL levels, whereas a positive correlation was observed with HDL levels.
**Conclusion**: Hypomagnesemia is commonly associated with diabetes mellitus and is significantly correlated with dyslipidemia. Monitoring serum magnesium levels in diabetic patients may help in early identification of metabolic disturbances and reduce the risk of cardiovascular complications.

***Keywords***: *Diabetes mellitus, Serum magnesium, Dyslipidemia, Lipid profile, Type 1 diabetes, Type 2 diabetes.*

## INTRODUCTION

Diabetes mellitus is one of the most prevalent metabolic disorders worldwide and represents a major public health concern due to its rapidly increasing incidence and associated complications. It is characterized by chronic hyperglycemia resulting from impaired insulin secretion, insulin resistance, or both. Persistent hyperglycemia leads to disturbances in carbohydrate, lipid, and protein metabolism and contributes to the development of microvascular and macrovascular complications such as neuropathy, nephropathy, retinopathy, and cardiovascular disease (1).

Magnesium is the fourth most abundant cation in the human body and plays an essential role in numerous physiological processes, including glucose metabolism, insulin secretion, and insulin receptor activity (2). It acts as a cofactor for more than 300 enzymatic reactions involved in energy metabolism and cellular homeostasis. Adequate magnesium levels are necessary for proper insulin signaling and glucose uptake by peripheral tissues (3).

Several studies have demonstrated that hypomagnesemia is commonly observed in patients with diabetes mellitus. Reduced serum magnesium levels in diabetic patients may result from increased urinary loss, poor dietary intake, and impaired intestinal absorption. Diabetic patients exhibited lower levels of serum calcium, phosphorus, and vitamin D. These biochemical markers may serve as early indicators of metabolic dysfunction in T2DM and could have implications for clinical management (4). Chronic hyperglycemia and osmotic diuresis further contribute to magnesium depletion in these patients (5).

Magnesium deficiency has been associated with insulin resistance, impaired glucose tolerance, and poor glycemic control. Low magnesium levels may also influence lipid metabolism and contribute to the development of dyslipidemia, which is a major risk factor for cardiovascular disease in diabetic individuals (6). Dyslipidemia in diabetes is characterized by elevated triglycerides, increased LDL cholesterol, and reduced HDL cholesterol levels (7).

Both Type 1 and Type 2 diabetes mellitus may exhibit alterations in magnesium metabolism; however, the mechanisms involved may differ between these clinical groups. In Type 1 diabetes mellitus, insulin deficiency may influence intracellular magnesium transport, whereas in Type 2 diabetes mellitus, insulin resistance may lead to increased urinary magnesium excretion (8).

Numerous clinical studies have reported an inverse relationship between serum magnesium levels and lipid parameters, suggesting that magnesium deficiency may contribute to the development of atherogenic lipid profiles (9). Hypomagnesemia has also been linked to endothelial dysfunction, inflammation, and increased risk of cardiovascular complications in diabetic patients (10).

Understanding the relationship between serum magnesium levels and lipid metabolism in diabetic patients may provide valuable insights into the pathophysiology of metabolic disturbances and help identify potential therapeutic targets (11). Early detection and correction of magnesium deficiency may improve glycemic control and reduce the risk of cardiovascular complications (12).

Despite growing evidence regarding the role of magnesium in diabetes, limited studies have evaluated its association with lipid profile parameters in different clinical groups of diabetes mellitus, particularly in hospital-based populations (13). Therefore, the present study was undertaken to evaluate the biochemical variations of serum magnesium and its correlation with lipid analytes in patients with Type 1 and Type 2 diabetes mellitus.

## MATERIALS AND METHODS

### Study Design

This was a hospital-based cross-sectional study conducted in the Department of Biochemistry in collaboration with the Department of Medicine at a tertiary care hospital.

### Study Population

A total of 100 participants were included in the study and divided into three groups:

- **Type 1 Diabetes Mellitus:** 30 patients
- **Type 2 Diabetes Mellitus:** 50 patients
- **Healthy Controls:** 20 individuals

### Sample Collection

After obtaining informed consent**,** 5 ml of venous blood was collected under aseptic conditions from each participant following overnight fasting.

### Biochemical Analysis

The following parameters were estimated:

- **Serum Magnesium:** Colorimetric method
- **Total Cholesterol:** Enzymatic CHOD-PAP method
- **Triglycerides:** Enzymatic GPO-PAP method
- **HDL Cholesterol:** Precipitation method
- **LDL Cholesterol:** Calculated using Friedewald formula

**INCLUSION CRITERIA**

1. Patients diagnosed with Type 1 or Type 2 diabetes mellitus.
2. Age 18 years and above.
3. Patients willing to participate in the study and providing informed consent.

**EXCLUSION CRITERIA**

1. Patients with chronic kidney disease.
2. Patients taking magnesium supplements.
3. Patients with thyroid disorders or liver disease.
4. Pregnant women.
5. Patients with other metabolic disorders affecting magnesium levels.

**Statistical Analysis**

Data were analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation. Comparisons between groups were performed using ANOVA and Student's t-test, and correlation analysis was done using Pearson correlation coefficient.

**RESULTS**

Out of the total 100 subjects included in the study, the majority were patients with Type 2 Diabetes Mellitus (50%), followed by Type 1 Diabetes Mellitus (30%), while 20% of the participants served as healthy controls. This distribution allowed comparison of biochemical parameters between diabetic patients and non-diabetic individuals.

**Table 1: Distribution of Study Participants According to Clinical Groups**

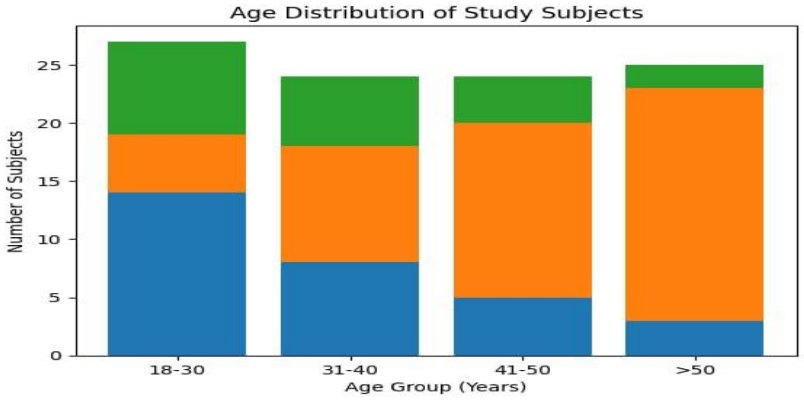
| Clinical Group | Number of Participants (n) | Percentage (%) |
|---|---|---|
| Type 1 Diabetes Mellitus | 30 | 30% |
| Type 2 Diabetes Mellitus | 50 | 50% |
| Healthy Controls | 20 | 20% |
| **Total** | **100** | **100%** |

Explanation

**Table 2: Age Distribution of Study Subjects**

| Age Group (Years) | Type 1 DM (n=30) | Type 2 DM (n=50) | Controls (n=20) |
|---|---|---|---|
| 18–30 | 14 | 5 | 8 |
| 31–40 | 8 | 10 | 6 |
| 41–50 | 5 | 15 | 4 |
| >50 | 3 | 20 | 2 |

Table 2 demonstrates the age distribution of participants in the study groups. Type 1 diabetes patients were predominantly observed in the younger age group of 18–30 years. In contrast, Type 2 diabetes patients were more commonly found in older age groups, particularly above 40 years. Healthy controls were mostly distributed in the younger and middle age groups. This distribution reflects the typical epidemiological pattern of Type 1 diabetes occurring in younger individuals and Type 2 diabetes in middle-aged or elderly populations.




**Graph 1: Age Distribution of Study Subjects**

**Table 3: Gender Distribution of Study Participants**

| Gender | Type 1 DM (n=30) | Type 2 DM (n=50) | Controls (n=20) |
|---|---|---|---|
| Male | 18 | 28 | 11 |
| Female | 12 | 22 | 9 |

Table 3 presents the gender distribution among the study participants. Among patients with Type 1 diabetes, males constituted a slightly higher proportion compared to females. Similarly, in Type 2 diabetes patients, males were more prevalent than females. The control group also showed a similar trend with a slight male predominance. Overall, the gender distribution in this study indicated a marginally higher prevalence of diabetes among males.

**Table 4: Comparison of Serum Magnesium Levels in Study Groups**

| Group | Mean Serum Magnesium (mg/dL) | Standard Deviation |
|---|---|---|
| Type 1 DM | 1.65 | ±0.20 |
| Type 2 DM | 1.50 | ±0.25 |
| Controls | 2.05 | ±0.18 |

Table 4 compares the mean serum magnesium levels among the different study groups. The results show that diabetic patients had significantly lower serum magnesium levels compared to healthy controls. Among the diabetic groups, Type 2 diabetes patients demonstrated slightly lower magnesium levels than Type 1 diabetes patients. The findings suggest that hypomagnesemia may be associated with diabetes mellitus and could play a role in metabolic disturbances.

**Table 5: Lipid Profile Parameters in Study Groups**

| Parameter | Type 1 DM (Mean ± SD) | Type 2 DM (Mean ± SD) | Controls (Mean ± SD) |
|---|---|---|---|
| Total Cholesterol (mg/dL) | 198 ± 32 | 218 ± 40 | 165 ± 28 |
| Triglycerides (mg/dL) | 160 ± 35 | 210 ± 45 | 130 ± 30 |
| HDL (mg/dL) | 40 ± 6 | 36 ± 5 | 52 ± 7 |
| LDL (mg/dL) | 120 ± 25 | 140 ± 30 | 95 ± 20 |

Table 5 illustrates the comparison of lipid profile parameters among the study groups. Diabetic patients showed higher levels of total cholesterol, triglycerides, and LDL cholesterol compared to the control group. HDL cholesterol levels were lower in both Type 1 and Type 2 diabetic patients. Type 2 diabetes patients exhibited more pronounced dyslipidemia compared to Type 1 diabetes patients. These findings highlight the presence of lipid abnormalities in diabetic individuals, which may contribute to increased cardiovascular risk.

**Table 6: Correlation of Serum Magnesium with Lipid Profile**

| Parameter | Correlation with Magnesium (r value) |
|---|---|
| Total Cholesterol | -0.42 |
| Triglycerides | -0.48 |
| LDL Cholesterol | -0.45 |
| HDL Cholesterol | +0.36 |

Table 6 shows the correlation between serum magnesium levels and lipid parameters. A negative correlation was observed between serum magnesium and total cholesterol, triglycerides, and LDL cholesterol, indicating that lower magnesium levels were associated with higher lipid concentrations. Conversely, a positive correlation was found between serum magnesium and HDL cholesterol levels. These results suggest that serum magnesium may influence lipid metabolism and play a role in the development of dyslipidemia in diabetic patients.

## DISCUSSION

The present study evaluated the relationship between serum magnesium levels and lipid profile parameters among patients with Type 1 and Type 2 diabetes mellitus. The findings demonstrated that diabetic patients exhibited significantly lower serum magnesium levels compared to healthy controls. These results are consistent with previous studies that have reported hypomagnesemia as a common biochemical abnormality in diabetic individuals (14).

Magnesium plays an important role in glucose metabolism and insulin signaling. Reduced magnesium levels may impair insulin-mediated glucose uptake and contribute to insulin resistance. Several studies have suggested that magnesium deficiency may worsen glycemic control and increase the risk of diabetic complications (15).

In the present study, serum magnesium levels were found to be lower in patients with Type 2 diabetes mellitus compared to those with Type 1 diabetes mellitus. This finding may be explained by increased urinary magnesium loss associated with insulin resistance and hyperglycemia in Type 2 diabetes (16).

The lipid profile analysis in this study revealed elevated levels of total cholesterol, triglycerides, and LDL cholesterol in diabetic patients, while HDL cholesterol levels were reduced. Similar findings have been reported in previous studies that described dyslipidemia as a common metabolic abnormality in diabetes mellitus (17).

An inverse relationship between serum magnesium levels and lipid parameters was observed in this study. Lower magnesium levels were associated with higher total cholesterol, triglycerides, and LDL cholesterol levels. This negative correlation suggests that magnesium deficiency may contribute to the development of atherogenic lipid profiles in diabetic patients (18).

Magnesium deficiency may influence lipid metabolism by altering enzymatic activity involved in lipid synthesis and degradation. It has been proposed that magnesium plays a role in regulating lipoprotein lipase activity and cholesterol metabolism (19). Therefore, decreased magnesium levels may lead to accumulation of circulating lipids and increased cardiovascular risk.

The positive correlation observed between serum magnesium and HDL cholesterol in this study further supports the protective role of magnesium in lipid metabolism. Higher magnesium levels may contribute to improved lipid profiles and reduced risk of cardiovascular complications in diabetic patients (20).

Overall, the findings of the present study highlight the importance of monitoring serum magnesium levels in diabetic patients as part of routine biochemical evaluation.

## CONCLUSION

The present study demonstrated that serum magnesium levels are significantly reduced in patients with diabetes mellitus, particularly in those with Type 2 diabetes. Hypomagnesemia was associated with adverse lipid profile changes, including elevated cholesterol, triglycerides, and LDL cholesterol levels, along with reduced HDL cholesterol. These findings suggest that magnesium deficiency may contribute to dyslipidemia and increased cardiovascular risk in diabetic patients. Regular monitoring of serum magnesium levels may help in early detection and management of metabolic abnormalities associated with diabetes.

## DECLARATIONS:

- **Conflicts of interest:** There is no any conflict of interest associated with this study
- **Consent to participate:** There is consent to participate.
- **Consent for publication:** There is consent for the publication of this paper.
- **Authors' contributions:** Author equally contributed the work.

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