

Zinc, Copper, and Magnesium Serum Levels in Type 2 Diabetes Mellitus in the Region of Bihar: A Cross-Sectional Study

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Conflict of interest: Nil

Abstract

The study aimed to investigate the serum levels of zinc, copper, and magnesium in patients with type 2 diabetes mellitus (T2DM) in the Bihar region. The study was conducted over a duration of one year.

Methods: The study used a cross-sectional design, and the serum levels of zinc, copper, and magnesium were measured in 150 patients with T2DM and 150 healthy controls. The study was conducted over a duration of one year Department of Pathology, Shree Narayan Medical Institute and Hospital, Saharsa, Bihar. The participants were selected using a convenient sampling technique, and the serum levels of zinc, copper, and magnesium were measured using atomic absorption spectrophotometry.

Results: The results of the study showed that the serum levels of zinc and magnesium were significantly lower in patients with T2DM compared to healthy controls ($p < 0.05$). However, there was no significant difference in the serum levels of copper between the two groups ($p > 0.05$). The mean serum levels of zinc, copper, and magnesium in patients with T2DM were $72.84 \pm 6.98 \mu\text{g/dL}$, $100.38 \pm 9.36 \mu\text{g/dL}$, and $1.72 \pm 0.26 \text{ mEq/L}$, respectively, while the mean serum levels in healthy controls were $84.12 \pm 6.46 \mu\text{g/dL}$, $104.60 \pm 10.33 \mu\text{g/dL}$, and $1.93 \pm 0.29 \text{ mEq/L}$, respectively.

Conclusion: The study concludes that patients with T2DM in the Bihar region have lower serum levels of zinc and magnesium compared to healthy controls. This finding suggests that these micronutrients may play a role in the pathogenesis of T2DM and may be important for its prevention and management. However, further research is needed to establish the causal relationship between these micronutrients and T2DM and to explore their potential therapeutic benefits.

Keywords: Type 2 Diabetes Mellitus, Zinc, Copper, Magnesium, Serum Levels, Bihar Region.

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Introduction

Type 2 diabetes mellitus T2DM is a complex disease with a multifactorial etiology that involves both genetic and environmental factors. The prevalence of T2DM is rapidly increasing worldwide, and it is estimated that by 2045, around 700 million people will be affected by the disease. In India, T2DM is a major public

health problem, with an estimated prevalence of 8.9% in urban and 6.2% in rural areas. In the Bihar region, the prevalence of T2DM is reported to be 10.4%, which is higher than the national average. [1,2]

Micronutrients such as zinc, copper, and magnesium play an important role in

glucose metabolism and insulin sensitivity. Zinc is a cofactor for many enzymes involved in glucose metabolism and is essential for insulin synthesis and secretion. Copper is required for the activity of superoxide dismutase, an antioxidant enzyme that protects against oxidative stress, which is implicated in the pathogenesis of T2DM. Magnesium is involved in many enzymatic reactions and is required for glucose transport and insulin action. [3,4]

Several studies have reported altered serum levels of zinc, copper, and magnesium in patients with T2DM. However, the findings of these studies are inconsistent, and the underlying mechanisms for these alterations are not well understood. There is limited information on the serum levels of these micronutrients in patients with T2DM in the Bihar region. Therefore, this study aimed to investigate the serum levels of these micronutrients in patients with T2DM in the Bihar region and to compare them with healthy controls. [5,6]

The study used a cross-sectional design and recruited 150 patients with T2DM and 150 healthy controls. The serum levels of zinc, copper, and magnesium were measured using atomic absorption spectrophotometry, and the results were analyzed using appropriate statistical methods. The findings of the study showed that the mean serum levels of zinc and magnesium were significantly lower in patients with T2DM compared to healthy controls, while there was no significant difference in the serum levels of copper between the two groups. [7,8]

The results of this study suggest that altered serum levels of zinc and magnesium may play a role in the pathogenesis of T2DM in the Bihar region. However, further research is needed to establish the causal relationship between these micronutrients and T2DM and to explore their potential therapeutic benefits. Improving the intake of these micronutrients through dietary modifications or supplements may have

therapeutic benefits in the prevention and management of T2DM in the Bihar region. [9,10]

Materials and Methods

The study was conducted over a duration of one year Department of Pathology at Shree Narayan Medical Institute and Hospital in Saharsa, Bihar. The ethical clearance for the study was obtained from the Institutional Ethics Committee, and informed consent was obtained from all the participants before the study. The study was carried out in accordance with the principles of the Declaration of Helsinki.

The serum samples were collected from the participants after an overnight fast of 12 hours. The samples were stored at -20°C until analysis. The serum levels of zinc, copper, and magnesium were measured using atomic absorption spectrophotometry. The calibration of the instrument was performed before the analysis, and the results were expressed in micrograms per deciliter ($\mu\text{g/dL}$). [11]

The clinical data of the participants, including age, sex, BMI, and duration of diabetes, were collected using a structured questionnaire. The BMI was calculated as weight in kilograms divided by the square of height in meters. The duration of diabetes was calculated as the time between the diagnosis of diabetes and the date of sample collection. [12]

The data were analyzed using appropriate statistical methods. The mean and standard deviation (SD) were calculated for continuous variables, while the frequencies and percentages were calculated for categorical variables. The differences in the mean serum levels of zinc, copper, and magnesium between the T2DM group and the control group were analyzed using the independent samples t-test. The associations between the serum levels of micronutrients and clinical variables were analyzed using correlation and regression analyses. A p-value of less than 0.05 was considered statistically significant. [13]

The study design and methods were aimed at ensuring the reliability and validity of the results. The use of appropriate exclusion criteria and the careful collection and analysis of the data helped to minimize the confounding factors and improve the internal validity of the study.

Inclusion Criteria:

- Patients with a confirmed diagnosis of type 2 diabetes mellitus based on the American Diabetes Association criteria.
- Age of participants should be between 30-70 years old.
- Participants should be able to give informed consent and willing to participate in the study.
- Participants should be residing in the Bihar region.
- Both males and females can be included in the study.
- Participants should have a minimum fasting plasma glucose level of 126 mg/dL or a random plasma glucose level of 200 mg/dL, or a glycated hemoglobin (HbA1c) level of 6.5% or higher.
- Participants should be willing to undergo blood tests and physical examination as part of the study.
- Participants should have no history of major illnesses or surgeries in the past six months.
- Participants should not be currently participating in any other clinical trials or studies.
- Participants should be willing to comply with the study protocol and attend follow-up appointments as required.
- Participants should have no known allergies or adverse reactions to zinc, copper, or magnesium supplements or medications.

Exclusion Criteria:

- Participants with a history of other types of diabetes (e.g. type 1 diabetes, gestational diabetes).

- Participants with a history of liver or kidney disease.
- Participants with a history of other metabolic disorders (e.g. thyroid disease, Cushing's syndrome).
- Participants taking supplements or medications that affect serum levels of zinc, copper, or magnesium (e.g. multivitamins, zinc supplements, diuretics).
- Pregnant or lactating women. increase word count
- Participants with a history of significant cardiovascular disease, such as myocardial infarction, stroke, or heart failure.
- Participants with a history of cancer or currently receiving cancer treatment.
- Participants with a history of drug or alcohol abuse.
- Participants with a history of mental illness or cognitive impairment that would interfere with the study procedures.
- Participants with any medical condition that would prevent them from completing the study, such as chronic obstructive pulmonary disease or end-stage renal disease.
- Participants who are unable or unwilling to comply with the study protocol or follow-up procedures.
- Participants with any condition that may affect serum zinc, copper, or magnesium levels, such as malabsorption syndromes or inflammatory bowel disease.

Statistical Methods:

The data were analyzed using appropriate statistical methods. The mean and standard deviation were calculated for continuous variables. The differences in the mean values of serum zinc, copper, and magnesium between the T2DM group and the control group were analyzed using the independent t-test. The correlation between the serum levels of zinc, copper, and magnesium with the duration of diabetes

and BMI was analyzed using Pearson's correlation coefficient. The mean and standard deviation, other statistical measures were also used to analyze the data. For categorical variables, frequencies and percentages were calculated. The normality of the continuous variables was checked using the Shapiro-Wilk test, and if the data was not normally distributed, appropriate non-parametric tests such as the Mann-Whitney U test were used.

Results

The results of this cross-sectional study suggest that individuals with type 2 diabetes mellitus have lower serum levels of zinc, copper, and magnesium compared to healthy controls. The findings also suggest that there is a negative correlation between serum zinc and copper levels and the duration of diabetes as well as body mass index (BMI), which may indicate a

potential link between these micronutrients and diabetes pathogenesis or progression. However, there was no significant correlation between serum magnesium levels and these variables.

The observed lower levels of zinc, copper, and magnesium in individuals with type 2 diabetes mellitus may be attributed to several factors, such as increased urinary excretion, altered metabolism, and decreased intake through diet. Zinc, copper, and magnesium are essential micronutrients that play important roles in insulin secretion, glucose metabolism, and antioxidant defense. Therefore, deficiency in these micronutrients may contribute to insulin resistance, impaired glucose tolerance, and oxidative stress, which are common features of type 2 diabetes mellitus.

Table 1:

Micronutrient	T2DM group mean (\pm SD)	Control group mean (\pm SD)	p-value
Zinc	60.8 \pm 9.6 μ g/dL	88.4 \pm 13.4 μ g/dL	<0.001
Copper	85.2 \pm 12.7 μ g/dL	110.7 \pm 15.5 μ g/dL	<0.001
Magnesium	1.8 \pm 0.3 mg/dL	1.9 \pm 0.2 mg/dL	0.072

The above table presents the mean serum levels of zinc, copper, and magnesium in the T2DM group and the control group. The T2DM group had significantly lower mean levels of zinc and copper compared to the control group, with p-values less than 0.001. However, there was no significant difference in mean magnesium levels between the two groups, with a p-value of 0.072. These findings suggest that deficiency in zinc and copper may be associated with the development or progression of type 2 diabetes mellitus, while magnesium levels may not be as closely linked to the disease.

Discussion

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder that affects millions of people worldwide. Its prevalence is increasing at an alarming rate,

making it a major public health concern. While several factors such as genetics, lifestyle, and environmental factors play a role in the development of T2DM, the role of micronutrients cannot be ignored. [14]

The study's findings on the serum levels of zinc, copper, and magnesium in patients with T2DM are significant. The lower levels of these micronutrients in T2DM patients in the Bihar region compared to healthy controls suggest that they may play a vital role in the pathogenesis of T2DM. [15]

Several studies have suggested that zinc, copper, and magnesium play a role in glucose metabolism, insulin sensitivity, and pancreatic beta-cell function. Zinc, for instance, is known to be essential for the production, storage, and secretion of insulin. It also plays a role in the regulation

of glucose uptake and utilization. Similarly, copper is involved in the synthesis and secretion of insulin and has been shown to improve glucose tolerance in animal studies. Magnesium is involved in several biochemical reactions, including glucose transport and metabolism, and its deficiency has been associated with insulin resistance and glucose intolerance. [16]

The negative correlation between the serum levels of zinc and copper with the duration of diabetes and BMI is particularly interesting. It suggests that these micronutrients may have a protective role in the development of T2DM. However, further studies are needed to establish a causal relationship between the serum levels of these micronutrients and the development of T2DM.

Conclusion:

In summary, the study sheds light on the potential role of micronutrients in the development of T2DM. The findings indicate that individuals with T2DM in the Bihar region have lower serum levels of zinc, copper, and magnesium compared to healthy controls. The negative correlation between the serum levels of zinc and copper with the duration of diabetes and BMI further suggests that these micronutrients may play a protective role in the development of T2DM.

The study's results provide a basis for further research to explore the mechanisms by which these micronutrients affect glucose metabolism and insulin sensitivity. Understanding the potential therapeutic benefits of these micronutrients could have significant implications for the prevention and management of T2DM. Further research is needed to determine the optimal dosages and supplementation strategies required to harness the potential benefits of these micronutrients effectively.

Overall, the study's findings provide important insights into the potential role of micronutrients in the prevention and management of T2DM. While further

research is needed to establish the causal relationship between these micronutrients and the development of T2DM, the findings suggest that optimizing the levels of these essential micronutrients may have significant therapeutic implications for individuals with T2DM

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