

## A COMPARATIVE STUDY OF SERUM MAGNESIUM AND ZINC LEVELS IN TYPE-2 DIABETES MELLITUS

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### Abstract

**Background:**Type 2 Diabetes Mellitus(DM) is a metabolic disease. Several trace elements such as zinc (Zn) and magnesium (Mg) have been seen to be altered in Type 2 DM. The deficiency of these minerals have been seen to be associated with various microvascular and macrovascular complications. Our study aimed to see the changes in serum levels of magnesium and zinc in T2DM. Objectives of the study: To estimate and compare the levels of magnesium and zinc in cases of type 2 DM and healthy controls.**Material and Methods:**A case control study was conducted on 75 cases of clinically diagnosed type 2 DM and 75 matched healthy controls. Ethical clearance was obtained from Institute's ethical clearance committee. Informed consent was taken from both cases and controls after explaining the procedure. Serum levels of fasting blood sugar(FBS), post prandial blood sugar(PPBS),glycosylated hemoglobin(HbA1c),zinc and magnesium levels were measured in both cases and controls using analyser.Statistical analysis was done using students 't' test.**Results:**There was significantly decreased levels of serum magnesium and zinc in cases of type 2 DM as compared to controls( $p<0.05$ ).**Conclusion:**Hypomagnesemia and hypozincemia may arise as a diabetes related complications and supplementation with these minerals may have a role in correcting deficiencies.

**Keywords:**T2DM, Magnesium(Mg), Zinc(Zn), Fasting blood sugar (FBS), Post prandial blood sugar (PPBS).

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### Introduction

Diabetes mellitus (DM) is a metabolic disorder of carbohydrate, lipid and protein metabolism. It is characterized by hyperglycemia due to defects of insulin secretion or of insulin action, or both.<sup>[1]</sup> Being a major public health problem it is characterized by chronic hyperglycemia which produces microvascular complications such as retinopathy,nephropathy, coronary artery disease , stroke etc.

Magnesium is involved in the synthesis of glutathione, a major antioxidant, through ensuring the proper functioning of the enzyme gamma glutamyltranspeptidase (GGT).<sup>[2]</sup>It has an important role in glucose metabolism and its deficiency is associated with diabetes mellitus withits involvement in development of insulin resistance, dyslipidemia and carbohydrate intolerance.<sup>[3]</sup> Magnesium is a cofactor in the glucose transporting mechanisms of the cell membrane and various enzymes in carbohydrate oxidation. It is also involved at multiple levels of insulin secretion, binding and enhancing the ability of insulin to activate tyrosine kinase.<sup>[4]</sup>

Zinc (Zn) is required for synthesis, storage and secretion of insulin.<sup>[5]</sup> Diabetes and poor glycemic control alters the metabolism of Zn by increasing urinary excretion and lowering serum Zn levels.<sup>[6]</sup> In type 2 diabetic patients, insufficient dietary Zn intake increases the risk of coronary heart disease, hypertension, retinopathy, thrombosis.<sup>[7,8]</sup> Studies on these parameters have been done but very few in our locality. Hence we conducted this study to estimate the levels of serum magnesium and zinc in type 2 DM and to compare with healthy controls.

### Objectives

The objectives of this study are:

1. To estimate levels of serum zinc and magnesium in cases of type 2 DM
2. To estimate levels of serum zinc and magnesium in matched healthy controls and to correlate these values with glycemic status.

### Material and Methods

A case control study was conducted on a total of 150 subjects attending the Medicine outpatient department (OPD) at Koppal Institute of Medical Sciences, Koppal.

Seventy-five (75) subjects of clinically diagnosed and confirmed type 2 diabetes mellitus were taken as cases. Seventy-five (75) matched healthy subjects were taken as controls. The study was conducted over a period of 1 year 6 months from January 2020 to June 2021.

Ethical clearance was obtained from Institute's ethical clearance committee. Informed consent was taken from both cases and controls after explaining the procedure.

Type 2 Diabetes Mellitus was diagnosed as per the WHO diagnostic criteria.<sup>[9]</sup>

**Exclusion criteria:** Subjects of DM with other microvascular complications, those with history of severe inflammatory diseases, chronic infections, those with hepatic, renal, cardiac diseases were excluded from the study.

Patients on diuretics, those receiving magnesium and zinc supplements, those on medicines causing hyperglycemia were excluded from the study. Pregnant and lactating women were also excluded from the study.

Based on medical history, clinical examination and laboratory investigations results, subjects were grouped into type 2 DM cases and matched healthy controls.

**Biochemical analysis:** A venous blood sample of 3 ml was collected in both fasting and post prandial states under all aseptic precautions. It was allowed to clot and serum was separated by centrifugation.

#### The following parameters were studied

- FBS and PPBS – Glucose oxidase Peroxidase method.<sup>[10,11]</sup> (kits by Erba)
- Serum Magnesium-Xylidyl Blue method.<sup>[12,13]</sup> (Kit by Raichem Diagnostics).
- Serum Zinc-NITRO-PAPS method.<sup>[14]</sup> (kit supplied by Tulip diagnostics).
- HbA1c was estimated by Nycocard reader II.<sup>[15]</sup>

#### Statistical analysis:

Data was expressed in terms of mean  $\pm$  SD. Chi-square test was applied to estimate the difference between the two groups of population. Unpaired 't'-test was used to study the changes in serum magnesium and zinc in between cases and controls. Pearson correlation was performed to establish the relationship between study variables. p value  $<0.05$  was considered statistically significant.

## Results

This was a comparative casecontrol study conducted on 75 cases of type 2 DM and 75 healthy controls. Serum magnesium and zinc levels were estimated, analysed and correlated with HbA1c. The results were expressed as mean  $\pm$  SD. [Table 1] shows the age distribution in between cases and controls. [Table 2] shows the various biochemical parameters in both cases and controls. The mean age of cases was  $55.40 \pm 10.02$  and that of controls was  $56.00 \pm 9.35$ . There was no statistically significant difference in age between cases and controls.

The FBS, PPBS and HbA1c levels in the study groups is shown in [Table 3]. The FBS, PPBS, and HbA1c levels showed statistically significant elevations in cases as compared to controls. ( $p < 0.001$ ).

**Table 1: Mean age of cases and controls**

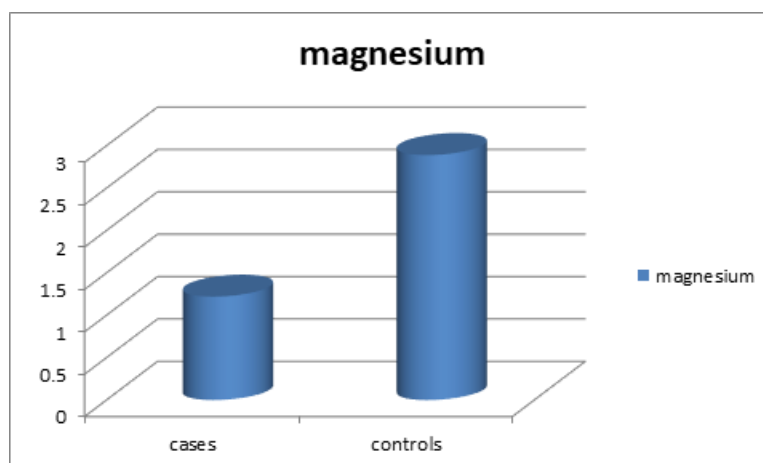
	Cases	Controls	p value
Mean age (years)	$55.40 \pm 10.02$	$56.00 \pm 9.35$	0.01

**Table 2: Various biochemical parameters incases and controls**

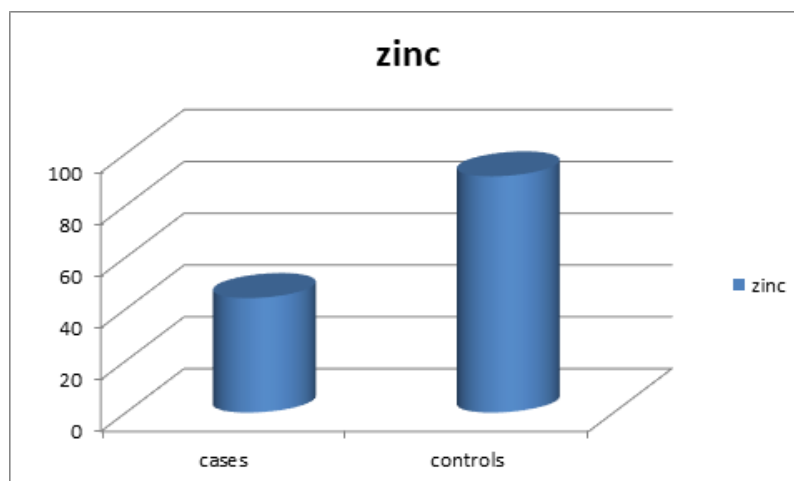
	Cases of T2DM	Controls	p value
Mean serum magnesium levels(mg/dl)	$1.570 \pm 0.8$	$2.44 \pm 0.7$	0.001
Mean serum zinc levels( $\mu$ g/dl)	$62.5 \pm 10.6$	$94.18 \pm 13.2$	0.001

**Table 3: Comparision of FBS, PPBS and HbA1c in study groups**

	Cases of T2DM	Controls	p value
FBS(mg/dl)	$186.44 \pm 64.1$	$94.66 \pm 12.02$	0.001
PPBS(mg/dl)	$254.33 \pm 84.33$	$123.44 \pm 12.11$	0.001
HbA1c(%)	$8.4 \pm 1.2$	$4.12 \pm 0.88$	0.001



**Figure 1: Comparision of serum magnesium between cases and controls**



**Figure 2: Comparison of serum zinc in cases and controls**

The mean serum magnesium (mg/dL) in cases was  $1.570 \pm 0.8$ , and in controls was  $2.44 \pm 0.7$  and was highly significant ( $p < 0.001$ ).

The mean serum zinc levels ( $\mu\text{g/dL}$ ) in cases were  $62.5 \pm 10.6$  and in controls were  $94.18 \pm 13.2$  respectively and it was highly significant. ( $p < 0.001$ ).

The comparison of serum magnesium and serum zinc levels with those of controls is shown in [Figure 1 and Figure 2] respectively.

Correlation between serum magnesium, zinc and HbA1c. There was negative correlation between serum magnesium and HbA1c as well as there was negative correlation between serum zinc and HbA1c and was statistically significant ( $p < 0.001$ ).

## Discussion

Diabetes mellitus is an endocrinological disease having high metabolic stress as well as high oxidative stress.

Many trace elements and minerals are important for normal functioning of our body. Studies have already mentioned the importance of serum magnesium and zinc in pathogenesis and development of magnesium levels in diabetes and carbohydrate metabolism.<sup>[16]</sup>

Very few studies have been done in our locality. So we conducted the study to see for role of trace elements in pathogenesis and prognosis of diabetes mellitus.

In our study we have compared serum magnesium and zinc levels in 75 diagnosed cases of diabetes mellitus with 75 matched healthy controls. The significance of these parameters in diabetes mellitus, their correlation with glycemic status is analysed and discussed.

In our study the serum magnesium levels were significantly reduced in cases as compared to controls. We also found statistically significant reduction in serum zinc levels in cases as compared to controls.

In various literature review, it has been suggested that hyperglycemia of prolonged duration in uncontrolled diabetes mellitus leads to polyuria because of osmotic diuresis. This causes increased excretion of minerals such as magnesium and zinc.<sup>[17,18]</sup>

In our study serum levels of zinc was significantly low. The hypozincemia seen in diabetics may be possibly due to increased excretion of zinc and also due to decreased gastrointestinal absorption of zinc.<sup>[19]</sup>

We also found decreased levels of serum magnesium in our study. The exact cause of hypomagnesium is still not known but an exaggerated urinary loss of magnesium may contribute to hypomagnesemia. Mainly two factors have been found to work together in this aspect, the osmotic action of glucosuria and chronic hyperglycemia- which is found to depress the net tubular reabsorption of magnesium in normal man. It has also been seen in

some other studies that oral supplementation of magnesium improves insulin sensitivity and also causes metabolic control in type 2 Diabetes mellitus.

Future experimental studies are needed to establish the underlying mechanisms of the present cross-sectional study results.

#### **Limitations of the study:**

Small number of the sample.

#### **Conclusion**

Our study showed decreased levels of serum magnesium and serum zinc in cases of type 2 diabetes mellitus suggesting the role of inflammation and oxidative stress in diabetes. Hypomagnesemia and hypozincemia may arise as a diabetes related complications and supplementation with these minerals may have a role in preventing the deleterious effects of oxidative stress and prevent future complications.

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