How to Cite:
Samad, A., Shahid, T., Khurshid, A., Shah, F. U., Tayyab, K., & Khizar, S. H. (2023). The impact of zinc supplementation and serum zinc levels on glycemic control in type 2 diabetes mellitus. *International Journal of Health Sciences*, *7*(S1), 567–574.
https://doi.org/10.53730/ijhs.v7nS1.14239

The impact of zinc supplementation and serum zinc levels on glycemic control in type 2 diabetes mellitus

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***Abstract*---**Introduction: Diabetes mellitus (DM) is a chronic metabolic disorder that requires a multifaceted approach to manage the disease, including lifestyle changes, medication, and monitoring blood glucose levels. Zinc is an essential micronutrient that plays a critical role in regulating insulin secretion, glucose metabolism, and immune function. Zinc supplementation may improve glycemic control and reduce oxidative stress in people with type 2 DM. Objectives: To determine whether zinc supplementation can enhance glycemic control in type 2 diabetic patients by investigating the relationship between serum zinc levels and glycemic control. Methodology: 100 participants with type 2 DM were recruited from local DM clinics and hospitals to participate in the study. Fifty participants were assigned

to the zinc supplementation group and fifty to the placebo group. At the beginning and conclusion of the 12-week study period, serum zinc, HbA1c, and fasting plasma glucose levels were measured using blood samples. Using the t-test and regression analysis, SPSS (version 23.0) was used to conduct statistical analysis. Results: The mean age of the participants was 58.2 years, and the majority had a BMI greater than 25. There were no significant differences between the two categories in terms of participant characteristics. At baseline, there were no significant differences between the zinc supplementation and placebo groups in serum zinc levels, HbA1c levels, or fasting plasma glucose levels. Compared to the placebo group, the zinc supplementation group demonstrated a significant increase in serum zinc levels and an improvement in glycemic control as measured by HbA1c levels and fasting plasma glucose levels after 12 weeks. There were no significant differences between the two groups in terms of zinc intake, which averaged 10.2 mg per day. Conclusion: Zinc supplementation may be an effective adjunct therapy for the management of type 2 DM, as it increases serum zinc levels and improves glycemic control. These findings emphasize the necessity of sufficient zinc intake in the management of type 2 DM; however, additional research is required to determine the optimal dosage and duration of zinc supplementation.

***Keywords*---**zinc supplementation, serum zinc levels, glycemic control, type 2 diabetes mellitus.

Introduction

Hyperglycemia due to abnormalities in insulin production, insulin action, or both characterizes type 2 diabetes mellitus, a chronic metabolic illness (American Diabetes Association, 2022). An estimated 463 million individuals have DM in 2019, and this figure is expected to rise to 700 million by 2045, demonstrating the global trend of rising DM prevalence (International DM Federation, 2019). The management of DM requires a multifaceted approach, including lifestyle modifications, pharmacotherapy, and monitoring of blood glucose levels. However, despite these efforts, many people with DM continue to experience poor glycemic control, which can lead to complications such as cardiovascular disease, neuropathy, and retinopathy (American DM Association, 2022).

In many of the body's biochemical reactions, zinc plays a crucial function, including the regulation of insulin secretion, glucose metabolism, and immune function (Wessells & Brown, 2012). Several studies have suggested that people with DM may be at higher risk of zinc deficiency, and low serum zinc levels have been associated with poor glycemic control and increased risk of complications (Jayawardena et al., 2020; Wang et al., 2020).

A systematic review and meta-analysis of 13 randomized controlled trials (RCTs) with a total of 666 participants investigated the effect of zinc supplementation on glycemic control in type 2 DM (Jayawardena et al., 2020). The meta-analysis

found that compared to a placebo, the use of zinc substantially lowered fasting blood glucose levels, HbA1c, and insulin resistance. They found that zinc supplementation could help persons with type 2 DM better regulate their blood sugar levels.

Low blood zinc levels were also related with an elevated risk of type 2 DM in a meta-analysis of 20 observational studies including a total of 14,934 people (Wang et al., 2020). The authors argued that regular zinc status testing for diabetics was warranted and that therapies to boost zinc status might aid in the prevention or management of diabetes and its consequences.

Serum zinc levels were substantially lower in individuals with poor glycemic control (HbA1c 8%) compared to those with excellent glycemic control (HbA1c 8%) in a cross-sectional study of 323 persons with type 2 DM in Iran (Ghasemi et al., 2019). Those with low blood zinc levels may benefit from zinc supplementation to enhance glycemic management, according to the authors.

Zinc supplementation was tested in a double-blind, randomised, placebo-controlled experiment on glycemic control and indicators of oxidative stress in 70 Egyptian people with type 2 diabetes (Martin et al., 2022). In comparison to the placebo group, those using zinc supplements had considerably lower levels of fasting blood glucose and HbA1c, as well as lower levels of oxidative stress indicators. The authors hypothesised that zinc supplementation may be an effective supplementary treatment for persons with type 2 DM, helping to better regulate their blood sugar levels and lessen the effects of oxidative stress.

Objective

The objectives of this study were (1) to examine whether zinc supplementation may enhance glycemic control in people with type 2 diabetes, and (2) to assess the link between blood zinc levels and glycemic control in this group.

Materials and Methods

Ethical considerations

The Declaration of Helsinki was followed throughout this investigation, and permission from an institutional review board was sought and granted. Before someone is enrolled in the research, their informed permission was requested.

Participants

Inclusion criteria: Adults (age > 18 years) diagnosed with type 2 DM for at least 1 year, who are not pregnant or breastfeeding, and who have not taken zinc supplements in the past 6 months
Exclusion criteria: Individuals with other types of DM (e.g. type 1), those with a history of zinc allergy or intolerance, those with renal or liver disease, and those taking medications that may interfere with zinc metabolism (e.g. thiazide diuretics, penicillamine).

Sample size

Based on a power calculation, a sample size of 100 participants were required to detect a significant difference in HbA1c levels between the zinc supplementation group and the placebo group, assuming a power of 80% and alpha of 0.05.

Study design

This was a cross-sectional study design, with two groups: a zinc supplementation group and a placebo group.
The study was conducted in a clinical setting, and participants were recruited from local DM clinics and hospitals.
Participants in the zinc supplementation group received a daily dose of 30mg elemental zinc (as zinc gluconate or zinc sulfate), while participants in the placebo group received a daily dose of a placebo tablet containing no zinc.
Everyone who participated was instructed to maintain their current treatment for DM.
Blood samples were taken at baseline and at the end of the 12-week study period to measure serum zinc levels, HbA1c levels, and fasting plasma glucose levels.
Participants also complete a food frequency questionnaire to assess dietary zinc intake.

Statistical Analysis

Using the right t-tests and regression analysis, the link between blood zinc levels and glycemic control, as well as the effect of zinc intake on glycemic control, were found.

Results

Participant Characteristics

- 100 participants were recruited (50 in the zinc supplementation group, 50 in the placebo group).
- The participants' average age was 58.2 years old (SD = 9.3).
- Most of the individuals had a body mass index that was more than 25 (76%) and were female (60%).
- There were no statistically significant variations in the demographics of the participants between the two groups ($p > 0.05$).

Serum Zinc Levels

- At baseline, there were no significant differences in serum zinc levels between the zinc supplementation group (mean = 90.2 ug/dL, SD = 11.7) and the placebo group (mean = 92.1 ug/dL, SD = 10.3; $p = 0.26$).
- At the end of the 12-week study period, serum zinc levels had significantly increased in the zinc supplementation group (mean = 102.4 ug/dL, SD = 14.1) compared to the placebo group (mean = 91.9 ug/dL, SD = 11.5; $p < 0.001$).

Glycemic Control

- At baseline, there were no significant differences in HbA1c levels between the zinc supplementation group (mean = 8.3%, SD = 1.2) and the placebo group (mean = 8.4%, SD = 1.1; p = 0.72).
- At the end of the 12-week study period, HbA1c levels had significantly decreased in the zinc supplementation group (mean = 7.6%, SD = 1.1) compared to the placebo group (mean = 8.2%, SD = 1.2; p < 0.001).
- Fasting plasma glucose levels also showed a significant decrease in the zinc supplementation group (mean = 147.3 mg/dL, SD = 22.1) compared to the placebo group (mean = 166.2 mg/dL, SD = 21.6; p < 0.001).

Dietary Zinc Intake

- The subjects' daily intake of zinc from food was, on average, 10.2 milligrammes (SD = 2.5).
- There were no significant differences in dietary zinc intake between the zinc supplementation group (mean = 10.5 mg/day, SD = 2.6) and the placebo group (mean = 9.9 mg/day, SD = 2.3; p = 0.12).

Table 1: Participant Characteristics

Characteristic	Zinc Supplementation Group (n=50)	Placebo Group (n=50)	p-value
Mean age (years)	58.6 (SD = 9.5)	57.8 (SD = 9.2)	0.54
Female (%)	58	62	0.69
BMI > 25 (%)	74	78	0.63

Table 2: Serum Zinc Levels (ug/dL)

Time Point	Zinc Supplementation Group (n=50)	Placebo Group (n=50)	p-value
Baseline	90.2 (SD = 11.7)	92.1 (SD = 10.3)	0.26
12 weeks	102.4 (SD = 14.1)	91.9 (SD = 11.5)	<0.001

Table 3: Glycemic Control

Time Point	Zinc Supplementation Group (n=50)	Placebo Group (n=50)	p-value
Baseline	8.3% (SD = 1.2)	8.4% (SD = 1.1)	0.72
12 weeks	7.6% (SD = 1.1)	8.2% (SD = 1.2)	<0.001

Table 4: Fasting Plasma Glucose

Time Point	Zinc Supplementation Group (n=50)	Placebo Group (n=50)	p-value
Baseline	155.2 (SD = 24.5)	163.8 (SD = 22.1)	0.11
12 weeks	147.3 (SD = 22.1)	166.2 (SD = 21.6)	<0.001

Overall, the results indicate that 12 weeks of zinc supplementation in type 2 diabetic patients resulted in a significant increase in serum zinc levels and significant improvement in glycemic control. These findings suggest that zinc supplementation may be a useful adjunct therapy for managing type 2 DM.

Discussion

Based on the findings of current study, zinc supplementation for 12 weeks resulted in a significant increase in serum zinc levels in diabetic patients, as compared to the placebo group. Furthermore, the zinc-supplemented group showed a significant improvement in glycemic control as measured by HbA1c and fasting plasma glucose levels, as compared to the placebo group. The study found that zinc supplementation for 12 weeks resulted in a significant increase in serum zinc levels in diabetic patients (Table 2; $p<0.001$), as compared to the placebo group. (Jayawardena et al., 2020). These findings suggest that zinc supplementation may be a useful adjunct therapy for managing type 2 DM.

Furthermore, the zinc-supplemented group showed a significant improvement in glycemic control as measured by HbA1c (Table 3; $p<0.001$) and fasting plasma glucose levels (Table 4; $p<0.001$), as compared to the placebo group. These findings suggest that zinc supplementation may be a useful adjunct therapy for managing type 2 DM. (Jayawardena et al., 2020; Ranasinghe et al., 2015)

Zinc is known to play a role in insulin synthesis, secretion, and signaling, and it also has antioxidant properties that can protect pancreatic beta cells from damage (Huang et al., 2018). Zinc deficiency has been associated with impaired glucose tolerance and insulin resistance, and supplementation has been shown to improve these parameters in animal models and human studies (Ranasinghe et al., 2015).

The findings of this study are in line with other investigations on the impact of zinc supplementation on glycemic control in type 2 diabetes. In type 2 DM patients, zinc supplementation substantially reduced HbA1c and fasting plasma glucose levels, according to a comprehensive review and meta-analysis by Jayawardena et al. (2020). Similar results were obtained by Ranasinghe et al. (2015), who discovered that zinc supplementation dramatically improved glycemic control in diabetic individuals.

Furthermore, the results of the current study are also supported by the proposed mechanisms of action of zinc in DM. Zinc is known to play a role in insulin synthesis, secretion, and signaling, and it also has antioxidant properties that can protect pancreatic beta cells from damage (Huang et al., 2018). Zinc deficiency has been associated with impaired glucose tolerance and insulin resistance, and supplementation has been shown to improve these parameters in animal models and human studies (Huang et al., 2018).

Overall, the findings of the current study are consistent with the existing literature on the potential benefits of zinc supplementation for managing type 2 DM. However, further studies are needed to confirm these findings and to

determine the optimal dosage and duration of zinc supplementation for achieving maximum benefits.

Conclusion

In conclusion, 100 people with type 2 diabetes were included in the trial, 50 of them received zinc supplements and 50 received a placebo. The majority of individuals were female with a BMI > 25, and the mean age was 58.2 years. Between the two groups, there were no discernible variations in the participant characteristics. Between the zinc supplementation and placebo groups, there were no discernible variations in baseline serum zinc levels, HbA1c levels, or fasting plasma glucose levels. Comparing the zinc supplementation group to the placebo group after 12 weeks revealed that the zinc supplementation group had significantly higher blood zinc levels and significantly better glycemic control as shown by HbA1c levels and fasting plasma glucose levels. Participants' average daily dietary intake of zinc was 10.2 mg, with no discernible variations between the two groups.

Based on the results, zinc supplementation may be a useful adjunct therapy for managing type 2 DM, as it leads to an increase in serum zinc levels and improvement in glycemic control. The study's findings are consistent with previous studies that showed the beneficial effects of zinc supplementation on glycemic control in type 2 DM. These findings highlight the importance of adequate zinc intake in the management of type 2 DM, and further research is needed to explore the optimal dosage and duration of zinc supplementation.

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