

Biochemical Variations of Serum Zinc 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

Objective: Oxidative stress is linked to both macrovascular and microvascular problems in diabetes. Zinc prevents the consequences of diabetes since it has antioxidant properties. The goal of the current observational hospital-based cross-sectional investigation was to determine the diagnostic importance of serum zinc and link it with lipid analytes in various clinical groups of both type 1 and type 2 diabetes.

Methods: There were 150 participants in the trial, including 50 healthy normoglycemic controls and 100 individuals with T1DM and T2DM who were randomly selected. 22 T1DM and 78 T2DM clinical patients were divided into three groups based on their medical histories and clinical records: group I was recently diagnosed, group II was stabilized and under control, and group III was long-term, uncontrolled, and associated with problems. Plasma glucose, serum zinc, total cholesterol, and triacylglycerol biochemical assays were examined, contrasted, and statistically associated with each group and healthy controls.

Results: The biochemical changes of hypozincemia in overt hyperglycemic-hyperlipidemic clinical cases were clearly illustrated by the comparison and correlation of the examined analytes in the T1DM and T2DM groups of subgroups with healthy controls. With varying statistical significances in different clinical groups, hypozincemia was negatively linked with hypertriglyceridemia and hypercholesterolemia in hyperglycemic individuals with both type 1 and type 2 diabetes. In group III, the correlation was $p < 0.001$, in group I, it was $p < 0.01$, and in group II, it was $p > 0.05$. For all subgroups, there was no statistically significant difference ($p > 0.05$) between type 1 and type 2 analytes.

Conclusion: The current investigation examined biochemical alterations associated with hypozincemia in overt hyperglycemic-hyperlipidemic clinical groups of people with type 1 and type 2 diabetes. For early screening, periodic monitoring for deficiencies, and improved management of clinical cases through supplementation to prevent the development of long-term critical diabetes complications, it is advised that serum zinc be measured as part of a routine or extended diagnostic profile investigation in recognized health cases of T1DM and T2DM.

Keywords: Biochemical, Zinc, Lipid, Insulin Resistance.

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Introduction

Due to factors like population increase, age, urbanization, bad eating habits, rising obesity rates, and physical inactivity, the number of persons with diabetes and pre-diabetes is rapidly rising globally [1]. In 2011, 346 million adults were expected to have diabetes mellitus, making it a major source of illness and mortality globally [2]. Between 2005 and 2030, the frequency is predicted to quadruple, with the biggest increases occurring in low- and middle-income developing nations in South America, Asia, and Africa [2, 3]. Currently, low- and middle-income nations are home to 80% of the world's diabetic population [2, 4]. Numerous potentially fatal and incapacitating macro- and microvascular

problems are also linked to diabetes [5]. As a result, the burden of missed production due to limited daily activities is likewise much greater. Type-2 diabetes, which affects 90% of people with diabetes, is typified by insulin resistance, hyperinsulinemia, -cell dysfunction, and eventually cell failure [6]. The pancreatic cells store insulin as a hexamer with two zinc ions, which is then released into the portal venous system when the cells degranulate [7]. Co-secreted Zn(II) ions inhibit the natural amyloidogenic characteristics of monomeric insulin [8]. Video fluorescence research revealed that zinc concentrated in the islet cells was linked to the production, storage, and secretion of insulin [9],

while Zalewski et al. demonstrated that high quantities of glucose and other secretagogues reduce the islet cell labile zinc. Insulin function and the metabolism of carbohydrates both depend on zinc [10,11]. The pathophysiology of diabetes and its consequences is significantly influenced by oxidative stress. A zinc shortage hinders the formation of important antioxidant enzymes including superoxide dismutase, which increases oxidative stress [12]. Research has indicated that hypozincemia [13] and hyperzincuria [14] are associated with diabetes. Furthermore, zinc deficiency is more prevalent in emerging nations [15], where the prevalence of diabetes is also rapidly rising [2]. Pharmacological treatment with vitamin C and E, magnesium, and zinc supplementation improves the severity of neuropathy symptoms in diabetic patients with mild to moderate peripheral neuropathy, according to studies assessing the effects of micronutrient supplementation on different degrees and manifestations of diabetic neuropathy [16]. In individuals with type-2 diabetes, studies employing zinc supplements alone have also shown a notable increase in motor nerve conduction velocity after supplementation [17, 18]. Autonomic functions, however, have not changed [17].

Given the aforementioned, a cross-sectional research of care facilities based on observation was undertaken at Jawaharlal Nehru Medical College's biochemistry department in Bhagalpur. The study will compare and correlate biochemical variants of fasting blood glucose, serum zinc, and important lipid analytes, such as serum total cholesterol and triacylglycerol, in various medical groups of both type 1 and type 2 diabetes between June 2023 and November 2023.

Methods

Quantifying and correlating blood zinc with lipid analytes in different clinical groups of type 1 and type 2 diabetes, as well as confirming its diagnostic importance, were the objectives of this hospital-based cross-sectional observational investigation. The study was conducted at the Jawaharlal Nehru Medical College's biochemistry department in Bhagalpur.

The study, which involved 150 research participants and ran from June 2023 to November 2023. There were 150 participants in the trial, including 50 healthy normoglycemic controls and 100 individuals with T1DM and T2DM who were randomly selected. 50 normoglycemic control participants and 100 clinical cases of diabetes who visited outpatient and inpatient medical facilities were selected at random. With ages ranging from 10 to 60, both sexes were represented in the study. The study was started after obtaining informed consent from each participant and institutional ethics approval.

Clinical notes, the clinical state of illness documented in a thorough predesigned patient proforma filled with sociodemographic information, prior medical history of diseases, physical-clinical examinations, duration, compliance with treatment drugs, clinical and relevant diagnostic records with special reference to DM and its comorbidities, clinical and specific clinical records, and clinical and relevant diagnostic documents with special reference to DM and its comorbidities were also taken into consideration when selecting participants. Included were those without serious concurrent conditions such chronic diarrhea, diuretics, compromised renal, respiratory, or gastrointestinal systems, or persistent alcoholism. Patients without diabetes who had serious concurrent conditions, such as weakened respiratory, gastrointestinal, or renal systems, chronic diarrhea, diuretics, or persistent alcoholism, were not included in the study. In order to compare and correlate the study findings, healthy people were randomly selected as healthy controls. They had normal blood sugar levels, no diabetes symptoms, and no abnormal clinical results, especially when it came to metabolic and nutritional impairment.

Participants in the study were divided into the following groups:

- Newly diagnosed patients. Stabilized controlled patients make up the second group.
- Long-term cases with problems related to diabetes mellitus comprise the third group.

Blood collection and analysis of biochemicals. Fifty distinct subjects In order to compare and relate the study findings, healthy participants were randomly selected as control subjects. They had no abnormal clinical results, normoglycemia, and no diabetes symptoms or indicators, especially when metabolic and nutritional impairment were present. The fasting plasma glucose levels were determined using the glucose oxidase peroxidase method. Determination of serum zinc was performed using Br-PAPS method. Determination of serum total cholesterol, serum triglycerides was performed by using (GPO-PAP) enzymatic photometric method. To verify the group comparison, ANOVA was employed. Along with a mean and standard deviation, the study's findings were displayed as percentages. The results were deemed statistically significant at 0.05.

Results

Of the 150 patients in the current study, 100 had diabetes mellitus (DM), 84 (55%) were men, and 66 (45%) were women. In this study, the percentage of males with diabetes (55%) was higher than the percentage of women with diabetes (46%), which may be related to differences in lifestyle. 26 percent The most common type of diabetes was T2DM, as evidenced by the fact that 74 (74%) of the research

participants had T2DM and 26 (26%) had T1DM. Table I displays the gender distribution of the DM and control study participants. Approximately 18 (18%) of the DM individuals were between the ages of 10 and 20, and the majority of the 48 (48%)

diabetes patients were between the ages of 41 and 60. All research participants were between the ages of 10 and 60. The age and sex distribution of DM research participants in subgroups is also shown in Table I.

Table 1: Distribution of study groups by gender.

Sl No	Group	Male	Female	Total
	Total Cases	84 (56%)	66 (44%)	150
Diabetes Mellitus				
1.	DM+ Patients	55 (55%)	45 (45%)	100
	Newly Diagnosed (1 st Group)	37 (57%)	15 (15%)	52 (52%)
	Chronic stabilized cases (2nd group)	14 (14%)	11 (11%)	25 (25%)
	Chronic cases with complication (3 rd Group)	4b(4%)	19 (19%)	23 (23%)
2.	Control- non diabetic patients	27 (54%)	23 (46%)	50
3. Age group (DM + Patients)				
	10-20	6 (6%)	12 (12%)	18 (18%)
	21-40	22 (22%)	12 (12%)	34 (34%)
	41-60	36 (26%)	22(22%)	48 (48%)

The biochemical profiles of the three groups were compared using ANOVA. Three groups' plasma glucose levels were compared, and the findings were statistically significant. Additionally, the results for serum triglyceride, serum zinc, and serum total cholesterol were statistically significant (Table 2).

Table 2: Comparison of biochemical parameters

Bio-chemical parameters Mean±SD	Fasting plasma glucose (mg/dl)	Serum Zinc (mmol/L)	Serum total cholesterol (mg/dl)	Serum Triglyceride (mg/dl)
Healthy control (50)	83.51 ± 4.03	12.08 ± 1.31	130.0 ± 20.05	72.8 ± 30.87
1st group Subjects	191.123 ± 20.07	10.54 ± 1.08	250.21 ± 17.03	135.8 ± 10.402
2nd group Subjects	105.63 ± 6.98	9.82 ± 0.93	191.62 ± 30.16	85.1 ± 20.30
3rd group subjects	251.22 ± 45.52	8.35 ± 0.89	300.1 ± 13.01	230.6 ± 32.25
p-value	0.04	<0.001	0.05	<0.001

Discussion

The biochemical alterations of hypozincemia were found to be adversely associated with hyperglycemia, hypertriglyceridemia, and hypercholesterolemia in comparison to normoglycemic healthy individuals. Three groups' plasma glucose levels were compared, and the findings showed statistical significance. Serum zinc, total cholesterol, and triglyceride levels all showed statistically significant results.

According to this study, all diabetics had considerably lower mean serum zinc levels than controls. This was consistent with the results of McNairetal's investigation, which found an inverse relationship between serum zinc levels and the glycemic status of diabetes [19]. Similar results in diabetes were also observed by Gargetal [20]. When comparing the zinc content in diabetics to controls, Williams et al. found a 17% drop. Diabetes affects zinc homeostasis in a number of ways, and it is hypothesized that hyperglycemia causes increased zinc loss through the urine, which results in hypozincemia. It has been discovered that zinc regulates the structural integrity of insulin as well as its synthesis, storage, and secretion. Furthermore,

because increased insulin secretion is accompanied by increased zinc co-secretion from the islet cells, early type 2 diabetes is characterized by hyperinsulinemia (to overcome insulin resistance). Consequently, intracellular zinc depletion occurs as a result of increased insulin secretion (in the early stage of the disease). However, in the face of increasing secretion and urine excretion of zinc, islets are unable to replace the rapidly diminishing zinc reserves, compromising zinc maintenance [21]. The progressive loss of intracellular zinc impairs the islet cells' capacity to secrete insulin and exacerbates the severe impairment of islet cell function [21]. According to one study, diabetics had far lower levels of zinc, copper, and chromium than the control group [22]. The study unequivocally shows that diabetic people have zinc levels that are below optimum. Given the strong relationship between zinc action and insulin production and beta cell performance, serum zinc may be essential for beta cell functioning and may significantly correlate with beta cell function predictions.

While interventional studies could produce tangible data on the effects of zinc supplementation and correction in stopping/decelerating the progression of diabetes and at least partially reversing insulin

resistance in patients with T1DM or T2DM, large prospective cohort observational studies are needed to establish a reference range of zinc and assess the extent of zinc deficiency in diabetics and its correlation with diabetic complications.

Conclusion

The current investigation examined biochemical alterations associated with hypozincemia in overt hyperglycemic-hyperlipidemic clinical groups of people with type 1 and type 2 diabetes. For early screening, periodic monitoring for deficiencies, and improved management of clinical cases through supplementation to prevent the development of long-term critical diabetes complications, it is advised that serum zinc be measured as part of a routine or extended diagnostic profile investigation in recognized health cases of T1DM and T2DM.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

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