Section: Physiology

Original Research Article

LEVEL OF ZINC AND FACTORS ASSOCIATED IN DIABETES MELLITUS

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Abstract

Background: Zinc is a key element in numerous proteins and plays an important role in essential cell functions such as the defence of the human immune system. The number of people with diabetes in India is increasing. Level of Zinc is associated with blood glucose levels and various factors affect the zinc levels. Hence there is a need to estimate the level of zinc among the patients with Type 1 and Type 2 Diabetes Mellitus and to determine the factors associated with the abnormal Zinc levels. **Materials and Methods:** This cross-sectional study was conducted among 103 diabetes mellitus patients in Government Villupuram Medical College Hospital among the diabetes mellitus patients attending the NCD clinic. Data were collected using semi structured questionnaire. Blood samples were collected to estimate the Zinc levels. Data were entered in MS Excel and analysed using SPSS software. Appropriate descriptive and inferential statistics were done, considering p value of <0.05 as statistically significant. **Result:** About 36 (35%) were having type 1 diabetes and 67 (65%) were having type 2 diabetes mellitus. Most of the participants belong to age group of 56 to 65 years (35%). About 87.4% were taking metformin alone and others taking metformin and glimepride. The median Zinc level is 207.8 with range of 128.7 to 367.2. Zinc was significantly high in those who had exercised and morning walk (p=0.0213), and checked blood sugar regularly to keep it controlled (p=0.0337) and zinc dropped significantly high (p=0.0357) in the patients who had urinated frequently due to uncontrolled sugar. **Conclusion:** The study addressed that zinc deficiency may be one of the factors to cause severity of the diabetes mellitus in old age patients, which may lead to complications. Diabetes mellitus patients were progressing with heart, kidney, and nerve ailments while lowering zinc levels even with low HbA1c levels while losing their weight significantly. Those who had habituated to smoking and alcoholism as well as anaemic status had low zinc levels.

INTRODUCTION

Diabetes is a common endocrine disease that is affected by abnormally high levels of sugar in the blood. The sugar level in the blood is controlled by a hormone called insulin which is secreted by the pancreas and endocrine gland. If the production of insulin is low in the body then it causes diabetes. It is the leading cause of morbidity and mortality worldwide. There are three types of diabetes: Type 1 Diabetes: Pancreas fails to secrete enough insulin due to the destruction of β cells which secretes insulin. It is also called juvenile diabetes and insulin-dependent diabetes mellitus. Type 2 Diabetes: It is also called non-insulin-dependent diabetes mellitus. In which the secretion of insulin is less, and cells fail to respond to insulin. Gestational Diabetes: It occurs in pregnancy due to high sugar levels in the blood. Symptoms of diabetes include excessive urination, increased thirst, and hunger, weight loss, slow wound healing, skin problems, and numbness in the feet. It may cause many severe health complications if not treated on time including cardiovascular disease, stroke, severe kidney diseases, eye damage, and diabetic ketoacidosis.[1]

Diabetes and Zinc levels in serum are decreased in Type 1 and Type 2 diabetes because of zinc loss owing to excessive urination. It has been shown that supplementation of zinc to Type 2 diabetes patients improves the symptoms of diabetes because it decreases the level of cholesterol and HbA1c levels

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in blood.[2-5] Around 10 to 20 µM of zinc is concentrated in β cells of the pancreas within the dense core insulin-secreting granules. Zinc is vital for the storage of insulin and dispensation of insulin in the body. In diabetic patients, the content of zinc is greatly decreased in the pancreas.[6,7] Low levels of zinc in the blood plasma affect the islets of Langerhans to secrete and produce insulin. Zinc also plays an important role in the formation of insulin crystals, the release of insulin, and the transport of insulin.[8-9]

Many studies have also shown a significant reduction in systolic and diastolic blood pressures after Zinc supplementation. A comprehensive systematic review and meta- analysis on the effects of Zinc supplementation in patients with diabetes demonstrate that Zinc supplementation has beneficial effects on glycaemic control and promotes healthy lipid parameters. Zinc supplements may improve lipid metabolism and glucose homeostasis in patients with type 2 diabetes. It is found that changes are more noticeable for FBG, LDL- c, and HDL-c. duration of zinc supplementation to induce maximal positive effects.[10] Zinc has beneficial effects in both type-1 and type-2 diabetes. It is evident from the findings of the present systematic review, that Zinc plays an important role in β-cell function, insulin action, glucose homeostasis, and the pathogenesis of diabetes and its complications.[11]

Zinc deficiency is defined either as insufficient zinc to meet the needs of the body or as a serum zinc level below the normal range. However, since a decrease in the serum concentration is only detectable after long-term or severe depletion, serum zinc is not a reliable biomarker for zinc status. Common symptoms include increased rates of diarrhea. Zinc deficiency affects the skin and gastrointestinal tract; brain and central nervous system, immune, skeletal, and reproductive systems. Zinc deficiency in humans is caused by reduced dietary intake, inadequate absorption, increased loss, or increased body system utilization. The most common cause is reduced dietary intake. In the U.S., the Recommended Dietary Allowance (RDA) is 8 mg/day for women and 11 mg/day for men. The highest concentration of dietary zinc is found in oysters, meat, beans, and nuts. Increasing the amount of zinc in the soil and thus in crops and animals is an effective preventive measure. Zinc deficiency may affect up to 2 billion people worldwide.[12,13]

The number of people with diabetes and pre-diabetes is exponentially increasing worldwide due to population growth, aging, urbanization, unhealthy eating habits, increasing prevalence of obesity, and physical inactivity.[14] Diabetes mellitus is a leading cause of morbidity and mortality worldwide, with an estimated 346 million adults being affected in the year 2011.[15] Approximately 9% of the population worldwide is affected by diabetes.[16] The prevalence of diabetes has risen from 108 million to 422 million from 1980 to 2014.[17] The prevalence is expected to double between the years 2005–2030, with the greatest increases expected in low- and middle-income developing countries of the African, Asian, and South American regions. At present, 80% of the worlds' population with diabetes live in low- and middle-income countries.[18,19]

The number of people with diabetes in India increased from 26 million in 1990 to 65 million in 2016. The prevalence of diabetes in adults aged 20 years or older in India increased from 5·5% in 1990 to 7·7% in 2016. The prevalence in 2016 was highest in Tamil Nadu and Kerala (high extract, transform, load (ETL)) and Delhi (higher-middle ETL), followed by Punjab and Goa (high ETL) and Karnataka (higher-middle ETL). The age-standardized DALY rate for diabetes increased in India by 39·6% from 1990 to 2016, which was the highest increase among major non- communicable diseases. The age-standardized diabetes prevalence.[20]

The prevalence of diabetes in India has remained at 11.8% in the last four years, according to the National Diabetes and Diabetic Retinopathy Survey report released by the Health and Family Welfare Ministry. The survey conducted during 2015-2019 by Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi also showed that the prevalence of known diabetes cases was 8.0% and new diabetes cases were 3.8%. "Males showed a similar prevalence of diabetes (12%) as females (11.7%). Known diabetics comprised 67.3% of participants, while 32.7% were new diabetics. The highest prevalence of diabetes was observed in the 70-79 years age group at 13.2%. Nearly 40% of known diabetes were diagnosed 1-4 years back while 5.3% of known diabetes cases reported diagnosis within past one year," the report said.[21]

Zinc level is affected by various factors like patient characteristics, risk factors and illness among patients, adherence to diabetes management and few others. Hence this study aimed to assess the level of Zinc and the factors associated with Zinc level among the diabetes mellitus patients.

Objectives

1. To estimate the level of Zinc among the patients with Type 1 and Type 2 Diabetes Mellitus.
2. To determine the factors associated with the abnormal Zinc levels.

MATERIALS AND METHODS

This cross-sectional study was conducted among 103 diabetes mellitus patients in Government Villupuram Medical College Hospital among the diabetes mellitus patients attending the NCD clinic. Blood samples of 36 adult patients with type 1 diabetes mellitus and 67 adult patients with type 2 Diabetes mellitus age group of 30 to 80 yrs were selected from NCD Clinic, Government Villupuram Medical College, and Hospital setting for the study respectively. The Hba1c levels had been assessed by laboratory confirmation separately for type 1 and type 2 diabetes patients. Each patient was

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interviewed and confirmed eligibility, basic demographic status, and clinical symptoms, including a rapid assessment of patient eligibility for blood collection, smoking status, alcohol consumption status, characteristics, food habits, and treatment history. Information was collected on four pages of standardized proforma during covid19s second wave on April to June 2021, which was accomplished even though highly challenging. Pregnant women, HIV patients, renal disease patients, and pulmonary disease patients were not included in this study. Institutional Human Ethics committee approval was obtained. Patients were informed about the study and consent was obtained. Confidentiality were maintained.

The sample size was estimated to present 19% of zinc deficiency for diabetic patients in the state of Qatar,[22] the sample size was originally 60, and 10% assumed was refused. This study aimed to investigate the type-1 and type-2 diabetics, a total of 120 with 10% refusal were planned. The aimed study collected samples were 103(86%), which is 86% of the sample achieved. The estimated sample size was assuming 80% power, but the aimed study had no zinc-deficient patients, i.e., 56-286 mg as per the reference range of the report. The average zinc was 207.9 (min -134.7- max-349.1; n=36) and 208.3 (min -128.7- max-367.6; n=67) among type-1 and type-2 diabetic patients respectively in the study of the hospital setting. In the COVID-19 second wave, lockdown period tracing type-1 diabetic patients was very challenging, however, the diabetic prevalence in India is 120/1000, and the type- 1 adult diabetic is 2/1000, comparing the ratio 60:1 of type-1 vs type-2 diabetic patients in India. The result could be generalized and comparable scientifically.

A standardized procedure was followed to collect blood samples from the selected patients by qualified technicians, at Villupuram Government Medical College. 6ml blood was collected in the 6-mL Plain, royal blue-top vacutainer plastic trace element blood collection tube from each diabetic patient in the Department of Non-communicable Diseases, medical college hospital, where they come for routine checkups and treatment.

Zinc detection

Nitro-PAPS is a highly sensitive colorimetric reagent for Fe(II) detection that forms a water-soluble complex at pH 3.0-8.0 (λmax=582 nm, λ=107,000). This reagent is suitable for the determination of Cu, Zn, Ni, and Co in serum. Zn in serum can be determined by Nitro-PAPS using CN- as a masking reagent of Fe and Cu.

Application: Heavy metal ion detection, colorimetric

Chemical Name: 2-(5-Nitro-2-pyridylazo)-5-[N-n-propyl-N-(3-sulfopropyl)amino] phenol, disodium salt, dihydrate

CAS: 143205-66-7 (anhydrous)

Appearance: Dark green or dark greenish-brown powder

Purity: ≥90.0% (anhydrous)

MW: 503.45, C17H19N5Na2O6S, 2H2O

Storage Condition: ambient temperature, protect from light and moisture.

Normal range: 56 – 286 mg/dl Zinc, below 56mg/dl is deficiency and above 286mg/dl is abnormal.

Data were collected on the 4 pages of the pre-designed proforma and entered into Excel after creating tables and data dictionaries. The data entry was independently verified by two data entry operators for its accuracy. The patient's income, weight, and height were missing the maximum due to the patient's refusal. The data set was imported to SPSS statistical software and analyzed following data-driven methodology.

Data were cleaned and mined by using exploratory preliminary data analysis box-plot, the measure of central tendency, and the measure of dispersion to know the data validation, missing information, and an outlier. Data were analyzed by the non-parametric method Mann-Whitney U test for differences in two groups' medians and The Kruskal-Wallis test was used for comparing more than two groups because data were in non-normal distribution for HbA1c of patient's characteristic comparisons. The probability value was (<0.05) considered a 95% level of significance.

RESULTS

The study was conducted among 103 diabetes mellitus patients, among whom 36 (35%) were having type 1 diabetes and 67 (65%) were having type 2 diabetes mellitus. The results are explained below.

[Table 1] depicts the sociodemographic characteristics of the participants. Most of the participants belong to age group of 56 to 65 years (35%), followed by 46 to 55 years (26.2%) and then others. The median (range) age of the participants was 56 years (30-80). About 51.5% were females and 48.5% were males. About 90.3% were Hindu by religion, 96.1% were married and 68.9% were employed.

[Table 2] depicts the lifestyle factors among the participants. About 10.7% and 1.9% were past and current smokers respectively. About 9.7% each were past alcoholic and current alcoholics. About 90.3% takes mixed diet and 85.4% takes vegetables regularly. About 73.8% were involved in exercise regularly.

[Table 3] depicts the illness among the participants. About 68% had reported hypertension and 62.1%were taking hypertension medications. Nearly 28.2% of the participants had diabetic family members. About 42.7% reported eye problems, 17.5% reported heart problems, 17.5% reported nerve problems, 11.7% reported tooth problems, 24.3% reported foot problems, 14.6% reported skin problems and 2.9% reported kidney problems. About 54.4% reported extreme hunger, 62.1% reported having thirsty feel frequently, 53.4% were urinating frequently. About 61.2% had weight loss, 61.2% had

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reported fatigue and 19.4% reported slow healing sores. About 39.8% were anemic and 68% reported extreme tiredness.

[Table 4] depicts the diabetes management details among the participants. About 87.4% were taking metformin alone and others taking metformin and glimepride. About 75.7% had checked their blood glucose levels. About 81.6% had received their diet counselling. About 83.5% were following the diet. About 99% were receiving the diabetes treatment from government institutions. The median Zinc level is 207.8 with range of 128.7 to 367.2.

[Table 5] depicts the association between Zinc levels and various factors. Those doing exercise regularly have higher zinc than those who doesn't (p 0.02). Those having frequent urination has low zinc levels than those who doesn't (p 0.03). Those checked the blood sugar has high zinc levels that those who doesn't have (p 0.03). Those having metformin and glimepride has high zinc levels than those who ~~have~~ take metformin alone (p 0.004). Those following diet advice has high zinc levels that those who doesn't have (p 0.002).

Table 1: Sociodemographic details (N=103).

S. No	Variable	Category	n	%
1	Age in years	Median (Range)	56	30-80
2	Age group	30 to 45 years	23	22.3%
		46 to 55 years	27	26.2%
		56 to 65 years	36	35%
		66 to 80 years	17	16.5%
2	Gender	Male	50	48.5%
		Female	53	51.5%
3	Religion	Hindu	93	90.3%
		Christian	7	6.8%
		Muslim	3	2.9%
4	Marital status	Married	99	96.1%
		Widowed	4	3.4%
5	Occupation	Employed	71	68.9%
		Not gainfully employed	32	31.1%

Table 2: Lifestyle factors (N=103)

S. No	Variable	Category	n	%
1	Smoking	Past smoker	11	10.7%
		Current smoker	2	1.9%
		Non-smoker	90	87.4%
2	Alcohol status	Past alcoholic	10	9.7%
		Current alcoholic	10	9.7%
		Non-alcoholic	83	80.6%
3	Diet	Mixed diet	93	90.3%
		Vegetarian	10	9.7%
4	Eat vegetables regularly	Yes	88	85.4%
		No	13	12.6%
		Not known	2	1.9%
5	Exercise regularly	Yes	76	73.8%
		No	24	23.3%
		Not known	3	2.9%

Table 3: Illness (N=103)

S. No	Variable	Category	n	%
1	Having Hypertension	Yes	70	68%
		No	23	22.3%
		Not known	10	9.7%
2	Taking medicine for hypertension	Yes	64	62.1%
		No	26	25.3%
		Not known	13	12.6%
3	Having diabetic family members	Yes	29	28.2%
		No	49	47.6%
		Not known	25	24.3%
4	Have eye problems	Yes	44	42.7%
		No	50	48.5%
		Not known	9	8.7%
5	Have heart problems	Yes	18	17.5%
		No	76	73.8%
		Not known	9	8.7%
6	Have nerve problems	Yes	18	17.5%
		No	72	69.9%
		Not known	13	12.6%
7	Have tooth problems	Yes	12	11.7%
		No	78	75.7%

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		Not known	13	12.6%
8	Have foot problems	Yes	25	24.3%
		No	65	63.1%
		Not known	13	12.6%
9	Have skin problems	Yes	15	14.6%
		No	74	71.8%
		Not known	14	13.6%
10	Have kidney problems	Yes	3	2.9%
		No	77	74.8%
		Not known	23	22.3%
11	Have extreme hunger	Yes	56	54.4%
		No	47	45.6%
12	Have frequent thirst	Yes	64	62.1%
		No	39	37.9%
13	Feel extreme tiredness	Yes	70	68%
		No	32	31.1%
		Not known	1	1%
14	Frequently urinating	Yes	55	53.4%
		No	47	45.6%
		Not known	1	1%
15	Have weight loss	Yes	63	61.2%
		No	37	35.9%
		Not known	3	2.9%
16	Have fatigue	Yes	63	61.2%
		No	37	35.9%
		Not known	3	2.9%
17	Have slow healing sores	Yes	20	19.4%
		No	79	76.7%
		Not known	4	3.9%
18	Anemia	Normal	49	47.6%
		Anemic	41	39.8%
		Non known	13	12.6%

Table 4: Diabetes management details (N=103)

S. No	Variable	Category	n	%
1	Diabetes treatment	Metformin	90	87.4%
		Metformin and Glimepride	13	12.6%
2	Checked your blood sugar	Yes	78	75.7%
		No	14	13.6%
		Not known	11	10.7%
3	Ever received diet counselling	Yes	84	81.6%
		No	15	14.6%
		Not known	4	3.9%
4	Follow that diet	Yes	86	83.5%
		No	2	1.9%
		Not known	15	14.6%
5	Institution for diabetes treatment	Government	102	99%
		Private	1	1%
6	Zinc level	Median (range)	207.8	128.7-367.6

Table 5: Association between Zinc levels and various factors (N=103)

S. No	Variable	Category	n	Median	Min-Max	p value
1	Age group	30 to 45 years	23	214.9	128.7-367.6	0.374
		46 to 55 years	27	206.6	134.9-349.1	
		56 to 65 years	36	222	133.5-326.5	
		66 to 80 years	17	188.5	138.9-285	
2	Gender	Male	50	206.3	128.7-367.6	0.984
		Female	53	208.3	138.9-349.1	
3	Smoking	Past/ Current smoker	13	176.2	145.4-285	0.544
		Non-smoker	90	209	128.7-367.6	
4	Alcohol status	Past/ Current alcoholic	20	203.2	133.5-367.6	0.946
		Non-alcoholic	83	207.9	128.7-349.1	
5	Diet	Mixed diet	93	232.7	163.9-283.4	0.118
		Vegetarian	10	207	128.7-367.6	
6	Eat vegetables regularly	Yes	88	206.8	128.7-367.6	0.851
		No/ Not known	15	211.5	133.5-338.5	
7	Exercise regularly	Yes	76	214.4	128.7-367.6	0.021*
		No/ Not known	27	183.2	134.7-296.3	
8	Having Hypertension	Yes	70	214.4	134.7-367.6	0.074
		No/ Not known	33	177.4	128.7-349.1	
9		Yes	64	214.9	134.7-367.6	0.113

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	Having medicine for hypertension	No/ Not known	39	199.1	128.7-349.1	
10	Having diabetic family members	Yes	29	225.8	133.5-367.6	0.189
		No/ Not known	74	201.4	128.7-349.1	
11	Have eye problems	Yes	44	209.1	133.5-301.2	0.650
		No/ Not known	59	207.9	128.7-367.6	
12	Have heart problems	Yes	18	184.5	133.5-284.9	0.492
		No/ Not known	85	208.3	128.7-367.6	
13	Have nerve problems	Yes	18	193.9	138.9-283.4	0.543
		No/ Not known	85	108.3	128.7-367.6	
14	Have tooth problems	Yes	12	225.3	153-285	0.285
		No/ Not known	91	204.8	128.7-367.6	
15	Have foot problems	Yes	25	213.8	138.9-284.9	0.595
		No/ Not known	78	205.7	128.7-367.6	
16	Have skin problems	Yes	15	215	134.7-367.6	0.800
		No/ Not known	88	207.4	128.7-349.1	
17	Have kidney problems	Yes	3	163.9	139.8-218.1	0.195
		No/ Not known	100	208.1	128.7-367.6	
18	Have extreme hunger	Yes	56	205.9	134.9-349.1	0.438
		No/ Not known	47	214.9	128.7-367.6	
19	Have frequent thirst	Yes	64	207.4	134.7-349.1	0.549
		No/ Not known	39	208.3	128.7-367.6	
20	Feel extreme tiredness	Yes	70	209	133.5-367.6	0.666
		No/ Not known	33	206.6	128.7-349.1	
21	Frequently urinating	Yes	25	184.3	138.9-270	0.035*
		No/ Not known	78	212.7	128.7-367.6	
22	Have weight loss	Yes	63	207.9	134.9-338.5	0.464
		No/ Not known	40	207.7	128.7-367.6	
23	Have fatigue	Yes	63	207	133.5-338.5	0.903
		No/ Not known	40	209.7	128.7-367.6	
24	Have slow healing sores	Yes	20	180.5	133.5-270	0.133
		No/ Not known	83	209.6	128.7-367.6	
25	Anemia	Normal	49	207.9	128.7-367.6	0.233
		Anemic	40	212.7	138.9-349.1	
		Severely anemic	1	134.7	134.7-134.7	
26	Diabetes treatment	Metformin	90	203.5	128.7-367.6	0.004*
		Metformin and Glimepride	13	255.7	183.2-367.6	
27	Checked your blood sugar	Yes	78	214.4	133.5-367.6	0.033*
		No/ Not known	25	176.9	128.7-349.1	
28	Ever received diet counselling	Yes	84	206.8	128.7=367.7	0.604
		No/ Not known	19	214.9	139.8-338.5	
29	Follow that diet	Yes	86	214.4	128.7-349.1	0.002*
		No/ Not known	17	165.8	134.9-270	
30	Institution for diabetes treatment	Government	102	207.4	128.7-349.1	0.813
		Private	1	215	215-215	
31	Diabetes type	Type 1	36	207.3	134.7-349.1	0.900
		Type 2	67	208.3	128.7-367.6	
*p <0.05 – Statistically significant						

DISCUSSION

Zinc is a key element in numerous proteins and plays an important role in essential cell functions such as defense against free radicals and DNA damage repair. Chronic pancreatitis (CP) is chronic inflammation with progressive fibrosis of the pancreas ultimately resulting in pancreatic exocrine insufficiency (PEI), which is associated with malnutrition. Studies analyzing zinc levels in patients with CP are sparse and lead to conflicting results. The etiology of CP was determined according to the M-ANNHEIM classification system into the following etiological subcategories: alcohol consumption, nicotine consumption, hereditary factors, Efferent pancreatic duct factors, and immunological factors. Pancreatic exocrine function was defined as normal (fecal elastase 1 > 200 μg/g), mildly reduced (100-200 μg/g), and severely reduced (fecal elastase 1 < 100 μg/g).[23]This research has explored low zinc levels among diabetic patients who had habituated to smoking and alcoholism as well as anemic status compared to those who did not have this habit.

A review of 111 published studies reporting mechanisms of action of Zinc in diabetes revealed that Zinc has various favorable effects in both type-1 and type-2 diabetes and concluded that further randomized double-blinded placebo-controlled clinical trials are essential to establish therapeutic care in humans.[24] The present study also has suggested that clinical trials are to be conducted to justify the direct relation. A meta-analysis that included 14 cohorts, adding up to 45,821 participants has revealed that zinc intake modifies the cross-sectional association between fasting glucose levels and genetic variants known to be related to glycemia

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and zinc metabolism in individuals of European descent without T2D.[25]

The first wide-ranging systematic review and meta-analysis on the effects of Zinc supplementation review article that included 25 studies, of 3 on type-1 diabetes and 22 on type-2 diabetes. Out of these 12 studies compared the effects of Zinc supplementation on fasting blood glucose in patients with type-2 diabetes and showed a significant reduction in systolic and diastolic blood pressures after Zinc supplementation.[26]

The present study explores that regular exercise and morning walks will maintain zinc in the body mechanism, other complications like heart, kidney, and nerve anemic are related to zinc reduction in the old age of the patients. The patients are taking non-vegetarian having sufficient zinc even though the HbA1c is moderately high. HbA1c level has increased while zinc level also has increased in type-1 diabetic patients rather not in type- 2 diabetic patients with consistent HbA1c level, which recommends that micro-level clinical trials is required to address this issue. Diabetic patients in this hospital region did not have zinc deficiency, which is the added strength of this research because zinc deficiency leads to complications. Patient food habits are helping them to improve their diabetic health status.

The patients come to this medical college hospital from villages surrounding the hospital, and most people are under the poverty category. they need still awareness about diabetic mellitus because when interviewed the patients, they told their many diabetic serious symptoms but do not know the cause which was due to diabetes. Many of them had hypertension, eye problems, foot wounds, extreme hunger, extreme tiredness, thirst frequently, frequent urination, Weight Loss, and Fatigue, which had not been addressed causes, virtually it was not known to them. also, the patients did not know their family history which means that more diabetic patients were unknowingly present there. Each patient was interviewed for more than hours, a patient had a foot sore whose Hba1c level was 16 but the patient said that the wound was related to a local hit, but the reality was inverse. In the villages, self-caring is lacking behind due to minimal awareness. This would have been the reason the diabetic mellitus has been increasing every year.

The study was conducted among 103 diabetes mellitus patients, among whom 36 (35%) were having type 1 diabetes and 67 (65%) were having type 2 diabetes mellitus. Most of the participants belong to age group of 56 to 65 years (35%), followed by 46 to 55 years (26.2%) and then others. The median (range) age of the participants was 56 years (30-80). About 51.5% were females and 48.5% were males. About 90.3% were Hindu by religion, 96.1% were married and 68.9% were employed.

About 10.7% and 1.9% were past and current smokers respectively. About 9.7% each were past alcoholic and current alcoholics. About 90.3% takes mixed diet and 85.4% takes vegetables regularly. About 73.8% were involved in exercise regularly. About 68% had reported hypertension and 62.1%were taking hypertension medications. Nearly 28.2% of the participants had diabetic family members. About 42.7% reported eye problems, 17.5% reported heart problems, 17.5% reported nerve problems, 11.7% reported tooth problems, 24.3% reported foot problems, 14.6% reported skin problems and 2.9% reported kidney problems. About 54.4% reported extreme hunger, 62.1% reported having thirsty feel frequently, 53.4% were urinating frequently. About 61.2% had weight loss, 61.2% had reported fatigue and 19.4% reported slow healing sores. About 39.8% were anemic and 68% reported extreme tiredness.

About 87.4% were taking metformin alone and others taking metformin and glimepride. About 75.7% had checked their blood glucose levels. About 81.6% had received their diet counselling. About 83.5% were following the diet. About 99% were receiving the diabetes treatment from government institutions. The median Zinc level is 207.8 with range of 128.7 to 367.2.

Those doing exercise regularly have higher zinc than those who doesn't (p 0.02). Those having frequent urination has low zinc levels that those who doesn't (p 0.03). Those checked the blood sugar has high zinc levels that those who doesn't have (p 0.03). Those having metformin and glimepride has high zinc levels that those who have metformin alone (p 0.004). Those following diet advice has high zinc levels that those who doesn't follow (p 0.002).

This study showed that regular body activity reduced sugar levels like exercise, and actively involved physical work, apart from that smoking, and alcoholism may worsen the diabetic severity. Only 7% of them were in Agricultural Labour and the highest was in Non-Agricultural Labour even though all of them were from village base. It was observed the diabetic treatment started within a year only which shows that all the patients went for the treatment when they got the critical sign of diabetes of their own. Now diabetes has become a chronic disease, which has to be prevented in the community. Unusually, junk food and a lethargic lifestyle have been perverted to the village community. Environmental pollution and climate changes also influence the human lifestyle which leads to some health-related issues. COVID-19 played a crucial role in many of them becoming a diabetic patient. Investigators in the Smidt Heart Institute at Cedars-Sinai have confirmed that people who have had COVID-19 have an increased risk for new-onset diabetes. A half-century ago, have faith only through genetic diabetes which has been changed due to human food habits and lifestyle changes. It has to be given the most importance in rural health.

This study exhibited that type-1 diabetic has more zinc levels compared to type-2 diabetic patients which needs further community-based research. Elderly diabetic patients need to be administered zinc

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supplementation for their better health. the well-versed awareness program is very essential for rural diabetics' better health to elevate restored knowledge of the rural patient's role in improving their health.

CONCLUSION

Zinc is a key element in numerous proteins and plays an important role in essential cell functions such as the defense of the human immune system. The study addressed that zinc deficiency may be one of the factors to cause severity of the diabetes mellitus in old age patients, which may lead to complications. Diabetes mellitus patients were progressing with heart, kidney, and nerve ailments while lowering zinc levels even with low HbA1c levels while losing their weight significantly. Those who had habituated to smoking and alcoholism as well as anaemic status had low zinc levels.

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