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Original Research Article

A Study to Evaluate Relationship between Serum 25 (OH) Vitamin D and Insulin Resistance in Prediabetes

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Abstract

Aim: The aim of the present study was to evaluate relationship between serum 25 (OH) vitamin D and insulin resistance in prediabetes.

Methods: The present study was conducted in the Department of Medicine, Katihar Medical College and Hospital , Katihar, Bihar India for 1 year, and the sample selected was 70 diabetics, 60 pre-diabetes and 50 healthy control individuals.

Results: Maximum pre-diabetics had serum 25(OH)D >30 ng/ml, diabetes 21-30, and control >30. In diabetes, pre-diabetes, and control subjects, BMI was 24.6 kg/m2, 25.5 kg/m2, and 23.7 kg/m2, waist circumference was 91.7 cm, 88.2 cm, and 86.4 cm, waist-height ratio was 0.84, 0.52, and 0.50, waist-hip ratio was 0.94, 0.90, and 0.86, LDL-C was 97.3 mg/dl, 106.4 mg/dl, and 98.6 mg/dl, HDL-C was 46.2 mg/dl, 48.4 mg/dl, and 49.6 mg/dl HbA1C levels were 7.3%, 6.5%, and 5.6%, with HOMA2-IR values of 2.52, 1.52, and 0.82, HOMA2-β values of 63.7, 82.6, and 86.4, and 25 (OH) D levels of 25.5, 24.2, and 22.8 ng/ml. A substantial difference was found ($P<0.05$). Both 1 hour and 2 hours PG blood glucose showed a strong positive connection with FBS ($P< 0.05$).

Conclusion: Understanding the connection between vitamin D and diabetes is crucial. Insufficient levels of Vitamin-D exacerbated insulin resistance in persons diagnosed with prediabetes.

Keywords: prediabetes, insulin resistance, hypovitaminosis-D, hyperglycemia, serum vitamin D

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Introduction

Insulin resistance is acknowledged as a basic and partly modifiable factor that leads to the development of type 2 diabetes mellitus (T2DM) and several related illnesses. [1] The hyperinsulinemia-euglycemic clamp is widely regarded as the most precise technique for assessing insulin resistance. However, it is expensive, requires invasive procedures, and is time-consuming. Additionally, it needs workers who have received specialized training. Consequently, the homeostasis model of insulin resistance (HOMA-IR) is sometimes used as a more practical substitute. HOMA-IR assesses insulin resistance by analyzing levels of glucose and insulin during fasting. [2] Vitamin D is a collective word that encompasses both vitamin D3 (cholecalciferol) and vitamin D2 (ergocalciferol).3 Global studies have shown that there is a prevalent health problem of vitamin D inadequacy that affects people of all ages and ethnicities. [4,5]

Without a question, diabetes is one of the most challenging health problems in the 21st century. Prediabetes is a significant contributing factor for the development of both diabetes and cardiovascular disease. [6,7] Pre-diabetes is distinguished by the existence of impaired fasting glucose (IFG) and/or impaired glucose tolerance (IGT). Pre-diabetes is an intermediary stage that occurs between having normal glucose tolerance and becoming type 2 diabetes mellitus. Prediabetes often has a strong association with obesity and other components of metabolic syndrome. Hypovitaminosis-D is often associated with obesity due to the adipose tissue's capacity to hold 25(OH) D, rendering it physiologically unavailable. [8] Decreased blood levels of 25-hydroxyvitamin D (25(OH)D), calcitriol [1,25-dihydroxyvitamin D], and an increase in parathyroid hormone (PTH) might cause an increase in intracellular calcium levels in adipocytes. This may enhance the process of fat production (lipogenesis), making a patient more susceptible to gaining weight and thereby raising the chances of acquiring diabetes. [9] Animal studies suggest that a lack of serum 25(OH)D may impede the synthesis and secretion of insulin, thus playing a role in the onset of diabetes. [10,11]

Prediabetes is more widespread than type 2 diabetes across all age groups, genders, and race/ethnicities, in almost all areas globally. Prediabetes is an intermediary phase when preemptive interventions have been shown to effectively delay or prevent the onset of diabetes. However, there is a lack of previous studies examining the relationship between blood 25(OH) D levels and prediabetes, especially among the Indian population. The aim of this research was to evaluate the association between serum 25 (OH) vitamin D levels and insulin resistance in persons diagnosed with prediabetes.

Materials and Methods

The present study was conducted in the Department of Medicine, Katihar Medical College and Hospital, Katihar, Bihar India for one year, and the sample selected was 70 diabetics, 60 pre-diabetes and 50 healthy control individuals. Inclusion criteria used was subjects in age ranged 40-75 years of either gender with persistent IFG or IGT over 2 OGTTs.

A detailed case history file was compiled, with information on gender, waist circumference (WC), hip circumference (HC), waist-hip ratio, HbA1C, and lipid profile parameters including LDL-C, HDL-C, and triglyceride levels. Individuals with vitamin-D status measured 25(OH)D ≥30 ng/ml were categorized as having sufficient levels of vitamin-D. Individuals with a vitamin-D status of 25(OH)D: 20-30 ng/ml were categorized as having insufficient levels of vitamin-D. Individuals with a vitamin-D status of 25(OH)D: 10-20 ng/ml were categorized as having mild vitamin-D insufficiency. Finally, persons who had a vitamin-D status of 25(OH)D <10 ng/ml were categorized as controls. A chemiluminescent immunometric assay was used to quantify the blood insulin levels. This method utilized a solid phase and an enzyme label. The determination of insulin resistance in the fasting state was conducted using HOMA2-IR (homeostatic model assessment-insulin resistance), while the evaluation of beta cell activity was carried out using HOMA2-β. An elevated blood glucose level over 155 mg/dl one hour after glucose consumption serves as a dependable predictor of an augmented susceptibility to acquiring Type 2 Diabetes (T2D) in the future.

The data collected in the current research were analyzed using a chi-square test to draw statistical conclusions. A p-value below 0.05 indicated a substantial degree of significance.

Results

Table 1: Level of vitamin D in individuals

Category	Serum 25 (OH) D			
	<10	11-20	21-30	>30
Pre-diabetes (60)	10	15	20	15
Diabetes (70)	15	18	22	15
Control (50)	8	10	14	18

Maximum pre- diabetes subjects had serum 25 (OH) D >30 ng/ml, diabetes between 21-30 ng/ml and control >30 ng/ml.

Table 2: Relationship between anthropometric parameters and diabetes status

Parameters	Diabetes	Pre-diabetes	Normal	P value
BMI	24.6	25.4	23.7	>0.05
Waist circumference	91.7	88.2	86.4	<0.05
Waist- height ratio	0.84	0.52	0.50	<0.05
Waist- hip ratio	0.94	0.90	0.86	<0.05
LDL- C	97.3	106.4	98.6	<0.05
HDL- C	46.2	48.4	49.6	<0.05
TG	148.4	146.4	117.4	<0.05
HbA1C	7.3	6.5	5.6	<0.05
HOMA2-IR	2.52	1.52	0.82	<0.05
HOMA2-β	63.7	82.6	86.4	>0.05
25 (OH) D	25.5	24.2	22.8	>0.05

In diabetes, pre-diabetes and control subjects had BMI of 24.6 kg/m^2, 25.5 kg/m^2 and 23.7 kg/m^2, waist circumference of 91.7 cm, 88.2 cm and 86.4 cm, waist- height ratio of 0.84, 0.52 and 0.50, waist-hip ratio of 0.94, 0.90 and 0.86, LDL- C of 97.3 mg/dl, 106.4 mg/dl and 98.6 mg/dl, HDL- C of 46.2 mg/dl, 48.4 mg/dl and 49.6 mg/dl, TG of 148.4 mg/dl, 146.4 mg/dl and 117.4 mg/dl respectively. HbA1C found to be 7.3%, 6.5% and 5.6%, HOMA2-IR was 2.52, 1.52 and 0.82, HOMA2-β was 63.7, 82.6 and 86.4 and 25 (OH) D level was 25.5 ng/ml, 24.2 ng/ml and 22.8 ng/ml. A significant difference was observed (P< 0.05).

Table 3: Correlation between vitamin-D status and insulin resistance, systemic inflammation and dyslipidemia in prediabetes

Correlation variables		Variable adjusted	Pearson's correlation	P value
Parameter 1	Parameter 2			
25 (OH) D	HOMA2-IR	BMI,HbA1C	-0.32	<0.05
25 (OH) D	HOMA2-β	BMI, HbA1C	-0.16	>0.05
25 (OH) D	HbA1C	-	-0.07	>0.05
1 hour PG	FBS	-	0.38	<0.05
1 hour PG	2 hours PG	-	0.54	<0.05

1 hour PG blood glucose had statistically significant positive correlation with FBS and 2 hours PG blood glucose (P< 0.05).

Discussion

People with impaired fasting glucose (IFG) and/or impaired glucose tolerance (IGT) are often described as having prediabetes. [12] The Indian diabetes prevention programme-1 (IDPP-1) discovered that the annual probability of acquiring overt diabetes from impaired glucose tolerance (IGT) was around 18%. However, in the Chinese diabetes prevention study, this possibility was only 2.5% in the diabetes prevention trial (DPT). Prediabetes often coexists with obesity and other components of metabolic syndrome. [13] Hypovitaminosis-D is often associated with obesity due to the adipose tissue's capacity to store 25-hydroxy vitamin-D [25(OH)D], rendering it physiologically unattainable. [14] A decrease in blood levels of 25(OH)D, calcitriol [1,25(OH)2D], and an increase in parathyroid hormone (PTH) might raise the amount of calcium within fat cells. This may stimulate adipogenesis, resulting in adipocyte proliferation, which can contribute to weight gain and heightened vulnerability to diabetes. [15,16] Prediabetes is an initial phase in the advancement towards hyperglycemia/diabetes, characterized by an increased probability of getting diabetes. Currently, lifestyle modifications and pharmaceutical therapies have shown efficacy in avoiding or postponing the development of diabetes. [17]

Most persons who were pre-diabetic had serum 25 (OH) D levels over 30 ng/ml, whereas those with diabetes had levels ranging from 21-30 ng/ml, and the control group had levels beyond 30 ng/ml. Several studies have shown a link between lower levels of 25-hydroxyvitamin D (25[OH]D) and an increased likelihood of developing cardiovascular disease (CVD). [18-20] The body mass index (BMI) values for persons with diabetes, pre-diabetes, and control patients were 24.6 kg/m2, 25.5 kg/m2, and 23.7 kg/m2, respectively. The waist circumference measures were 91.7 cm, 88.2 cm, and 86.4 cm, respectively. The waist-height ratios were 0.84, 0.52, and 0.50, respectively. The waist-hip ratios were 0.94, 0.90, and 0.86, in that order. The LDL-C levels were quantified as 97.3 mg/dl, 106.4 mg/dl, and 98.6 mg/dl, whilst the HDL-C levels were determined as 46.2 mg/dl, 48.4 mg/dl, and 49.6 mg/dl. The triglyceride levels were quantified as 148.4 mg/dl, 146.4 mg/dl, and 117.4 mg/dl, respectively. The HbA1C readings were determined to be 7.3%, 6.5%, and 5.6%. The HOMA2-IR values were determined to be 2.52, 1.52, and 0.82, whereas the HOMA2-β values were found to be 63.7, 82.6, and 86.4. In addition, the levels of 25-hydroxyvitamin D were also tested. The concentration of vitamin D was determined to be 25.5 ng/ml, 24.2 ng/ml, and 22.8 ng/ml. Dutta et al [21] investigated the association between vitamin-D levels and insulin resistance in a cohort of 157 individuals diagnosed with prediabetes. The research found that 115 individuals (73.25%) diagnosed with prediabetes had a deficiency or insufficiency of vitamin-D. Shankar et al [22] examined a cohort of 12,719 adults (52.5% female) without diabetes. The levels of Serum 25(OH)D were categorized into four categories based on quartiles: <17.7, 17.8–24.5, 24.6–32.4, and >32.4 ng/mL. Prediabetes is defined as a 2-hour glucose concentration between 140 and 199 mg/dL, a fasting glucose concentration between 110 and 125 mg/dL, or an A1C test between 5.7 and 6.4%. After considering multiple variables including age, sex, race/ethnicity, season, geographic region, smoking, alcohol intake, BMI, outdoor physical activity, milk consumption, dietary vitamin D, blood pressure, serum cholesterol, C-reactive protein, and glomerular filtration rate, it was discovered that lower levels of serum 25(OH)D were associated with prediabetes.

A significant difference was observed (P< 0.05). The 1-hour postprandial (PG) blood glucose levels exhibited a statistically significant positive correlation with both the fasting blood sugar (FBS) levels and the 2-hour postprandial (PG) blood glucose levels (P< 0.05). Forouhi et al [23] did a research with 524 nondiabetic adults, comprising both males and females aged between 40 and 69 years. It was found that males had higher average blood 25(OH)D levels at the start of the trial (64.5 nmol/l) compared to females (57.2 nmol/l). The levels also varied according on the season, with the highest amounts seen in late summer. There was a negative relationship between the initial level of 25(OH)D and the 10-year risk of hyperglycemia,

insulin resistance, and metabolic syndrome z score. The link remained statistically significant even after controlling for variables such as age, sex, smoking, BMI, season, and the initial value of each metabolic outcome variable. The relationships between 2-h glucose, insulin, and HOMA-IR remained statistically significant even after including other covariates such as IGF-1, parathyroid hormone, calcium, physical activity, and socioeconomic class.

Conclusion

Knowing how vitamin D affects diabetes is vital. Vitamin D deficiency worsened insulin resistance in prediabetics. Vitamin D deficiency is common in prediabetics, with severe deficiencies (<10 ng/ml) resulting in the worst insulin resistance. Our data strongly supports utilizing vitamin D levels as an early diabetes indication. Our findings also imply pre-diabetic vitamin D prescription may be advantageous.

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