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Short Report

Relationship between Vitamin D level and Insulin Resistance According to Obesity Level

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Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2). In adults, WHO defines overweight as a BMI greater than or equal to 25 kg/m^2; and obesity as a BMI greater than or equal to 30 kg/m^2. BMI over 40 kg/m^2 is classified as morbid obesity, and over 50 kg/m^2 as super obesity. BMI is the same for both sexes and for all ages of adults. Overall, about 13% of the world's adult population (11% of men and 15% of women) were obese in 2016.[1]

Insulin resistance (IR) is defined as a defective metabolic response of insulin to stimulate glucose uptake into skeletal muscle and adipose tissue and/or to suppress hepatic gluconeogenesis and glucose release into circulation.[2,3] The metabolic response of IR and subsequent hyperinsulinemia is attributed to the development of serious health consequences such as for overweight, hypertension, hyperlipidemia, cardiovascular disease, and type 2 diabetes. IR is considered a common mechanism underlying derangements associated with the syndrome.[4] Metabolic syndrome (MetS) is a cluster of metabolic disorders and diagnosed on the following criteria and if the individual is positive for three or more of the following measurements5: Abdominal obesity/waist circumference (≥94-102 cm in men or ≥80-88 cm in women), high blood pressure (≥130/85 mmHg), abnormal fasting glucose (≥100 mg/dL), elevated triglycerides (TG: ≥150 mg/dL) and low HDL (males <40 mg/dL, female <50 mg/dL). These metabolic disorders collectively or independently increase the risk of an individual developing cardiovascular disease (CVD), diabetes mellitus, and vascular or neurological complications.

It has been proposed 25-OH-vitamin D concentration affects insulin sensitivity and beta-cell function.[6,7] Numerous clinical studies showed that vitamin D supplementation reduces the level of metabolic parameters such as total cholesterol (T-chol), low-density lipoprotein (LDL), TG, glycated hemoglobin (HbA1c), as well as decreases IR indicator (HOMA-IR) in type 2 diabetic patients.[8-10] However, the underlying mechanism not fully understood how vitamin

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D may reduce the risk of metabolic disorders development. Besides, the effect of vitamin D on beta-cell dysfunction is more apparent in patients without metabolic syndrome or obvious beta-cell dysfunction.[11,12] In this study, we aimed to investigate the relationship between vitamin D level and IR in obese patients without diabetes mellitus, hypertension, and hyperlipidemia in the light of previous studies.

The study enrolled 95 obese adult patients without a history of hypertension, diabetes mellitus, and hyperlipidemia who applied to our clinic were included in the study. None of the patients were using antihypertensive drugs, oral antidiabetic drugs and/or insulin, statin and/or fibrate derivatives, calcium and/or vitamin D supplements. Insulin, vitamin D, parathyroid hormone, total calcium, ionized calcium, T-chol, HDL, LDL, TG levels were measured from venous blood samples taken after 12 hours of fasting. IR was calculated using fasting glucose (FBG) and insulin levels (HOMA-IR = FBG x insulin/405). IR was considered as HOMA-IR level above 2.5. 25-hydroxyvitamin D level was measured, vitamin D level above 20 ng/mL was normal, and below it was accepted as a deficiency. Patients were classified according to BMI level, between 30-39.9 kg/m^2 were classified as mild-moderate obese, 40-49.9 kg/m^2 as morbid obese, and 50 kg/m^2 and above as super obesity. The diagnosis of the MetS was made when three or more were present according to NCEP/ATP III criteria.

Seventeen (17.9%) of the patients were male and 78 (82.1%) were female. The mean age of the patients was 40.4 (18-75) years. The mean BMI of all patients was 43.42±7.74 kg/m². 39 (41.1%) of all patients had MetS. The baseline demographic characteristics and laboratory findings of the

Table 1. Demographic characteristics and laboratory findings of patients (n=95)

Age (years)	40.44±12.54 (18-75)
Sex (female)	78 (82.1%)
BMI (kg/m²)	43.42±7.74 (30-62)
Fasting blood glucose (mg/dL)	89.82±13.07 (65-125)
Insulin (mg/dL)	18.17±12.19 (2.6-80)
HOMA-IR	3.99±2.68 (0.45-15.8)
Total cholesterol (mg/dL)	200.62±36.92 (104-275)
HDL (mg/dL)	41.49±10.16 (23-88)
LDL (mg/dL)	127.61±32.33 (58-209)
Triglyceride (mg/dL)	163.93±91.41 (56-512)
Vitamin D (ng/mL)	14.89±11.9 (4-54.9)
Calcium (mg/dL)	9.56±0.41 (8.5-10.5)
Parathormone	6.11±2.27 (1.9-14.88)
Metabolic syndrome (n, %)	39 (41.1%)

Table 2. Characteristics of patients according to vitamin D levels

Vitamin D level	<20 (n=75)	≥20 (n=20)	p value
Sex Female	64 (82.1%)	14 (17.9%)	0.185
Male	11 (64.7%)	6 (35.3%)	
Age (years)	37	37.5	0.862
BMI (kg/m²)	43	40.5	0.156
HOMA-IR	3.57	2.39	0.029

Table 3. Relation between Vitamin D level and insulin resistance

Vitamin D level		<20 (n=75)	≥20 (n=20)	p value
HOMA-IR	<2.5	16 (59.3%)	11 (40.7%)	0.005
	≥2.5	59 (86.8%)	9 (20%)	

Table 4. Characteristics of patients according to insulin resistance

HOMA-IR	<2.5 (n=27)	≥2.5 (n=68)	p value
Age (years)	47	36	0.003
Sex Female	24 (30.8%)	54 (69.2%)	0.277
Male	3 (17.6%)	14 (82.4%)	
BMI (kg/m²)	40.4	43.5	0.202
Vitamin D	8.7	11.6	0.461
Metabolic syndrome (n, %)	6 (15.4%)	33 (84.6%)	0.034
Insulin	8	18.7	<0.001
Parathormone	5.1	6	0.328

Frequency n (%), mean ± standard deviation, median (Q1-Q3).

patients are shown in Table 1. The average HOMA-IR level of women was 3.84 and 4.68 for men. There was no statistically significant difference in terms of HOMA-IR levels between both sexes (p=0.283). Vitamin D deficiency was found in 77.9% of the patients. When the groups with and without vitamin D deficiency were compared, no difference was found in terms of age, gender, and BMI. The median HOMA-IR level of the group with vitamin D deficiency (<20 ng/mL) was 3.57, and the HOMA-IR median level of the group without vitamin deficiency (>20 ng/mL) was 2.39. The median HOMA-IR level of the vitamin D deficiency group was statistically significantly higher than the group without vitamin D deficiency (p=0.029) (Table 2). Vitamin D deficiency was statistically significantly more common in the group with IR (p=0.005) (Table 3). The mean age of the group with IR (HOMA-IR >2.5) was statistically significantly lower than the group without IR (HOMA-IR <2.5) (p=0.003). There was no significant difference between the groups according to gender, BMI, and vitamin D levels (Table 4).

The patients were divided into 3 groups according to their BMI (obese, morbid obese, and super-obese). No difference was found between these groups in terms of age, gender, and vitamin D level (Table 5). However, while insulin level and IR level are significantly higher in morbid obese patients compared to obese patients, this relationship could not be demonstrated in super-obese patients (p=0.03 and p=0.019, respectively).

This study is the first study investigating the relationship between vitamin D-HOMA-IR in morbid and super-obese patients. No statistically significant linear correlation was found between vitamin D and HOMA-IR level, but vitamin D deficiency was more common in the group with IR. Karatas et al.[13] demonstrated that vitamin D deficiency was more common in overweight/obese patients regardless of the presence of MetS.

Table 5. Characteristics of patients according to obesity level

BMI level (kg/m²)	30-39.9 (n=33)	40-49.9 (n=44)	≥50 (n=18)	p value
Age (years)	37	37	39.5	0.894
Sex Female	27 (34.6%)	36 (46.2%)	15 (19.2%)	0.989
Male	6 (36.3%)	8 (47.1%)	3 (17.6%)	
HOMA-IR	2.79	3.65	3.89	0.019
Metabolic syndrome	11 (28.2%)	23 (59%)	5 (12.8%)	0.110
Vitamin D	13.4	10.45	11.45	0.278
Glucose (mg/dL)	86	90	92	0.175
Insulin	12	17	16.3	0.030

Frequency n (%), median (Q1-Q3).

Clemente-Postigo et al. and Ferreira et al. showed a negative correlation between vitamin D levels and IR.[14] There is increasing evidence that vitamin D level is inversely related to BMI and IR. It is thought that factors such as improper food intake, decreased sun exposure due to lack of mobility, and decreased bioavailability of the vitamin. However, the effect of vitamin D supplementation on IR is limited and insufficient. Additional studies are needed to explain the relationship between the level of obesity and the effect of vitamin D on IR.

Conflict of Interests

Authors declare that there are none.

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