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Original Article

Association between Dyslipidemia and Vitamin D Deficiency: a Cross-Sectional Study

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Abstract

Introduction: Dyslipidemia is one of the most common metabolic disorders. Vitamin D is one of the essential fat soluble vitamins which has many functions in the human body.

Aim: The aim of this study was to evaluate the association between dyslipidemia and vitamin D deficiency.

Materials and methods: This is a cross-sectional study which included 130 participants (58 males and 72 females) aged between 20-70 years and conducted between June 1 and October 30, 2020. The level of vitamin D was determined for each participant; we also measured the serum levels of cholesterol, triglyceride, high density lipoprotein, and low density lipoprotein.

Results: There were 79 persons with vitamin D deficiency, 21 persons were vitamin D insufficient, and 10 - vitamin D sufficient. There were significant differences in the level of cholesterol, triglycerides, high-density and low-density lipoproteins according to the level of vitamin D.

Conclusions: Deficiency of vitamin D has a negative impact on the levels of cholesterol, triglycerides, high-density and low-density lipoproteins.

Keywords

cholesterol, dyslipidemia, high-density lipoproteins, low-density lipoprotein, triglyceride, vitamin D

INTRODUCTION

Dyslipidemia is defined as an abnormal metabolic condition resulting in a high concentration of lipids. There are three types of dyslipidemia: hypercholesterolemia, hypertriglyceridemia, and mixed hyperlipidemia.[1] Dyslipidemia is also considered a key factor or independent risk factor for many diseases such as the cardiovascular disease and cerebrovascular disease.[2,3] It can be caused by enetic factors, lifestyle habits, diabetes mellitus, hypothyroidism, Cushing syndrome, and inflammatory bowel disease.[4]

Vitamin D is a fat soluble vitamin which acts as a steroid hormone. It can be obtained from different sources like diet, and exposure to ultraviolet B light. It can be synthesized endogenously and photo chemically from dehydrocholesterol by the skin[5] and as a supplement form[6]. It plays an important role in the homeostasis of calcium and phosphorous, and is known to have an impact on bone mineral density.[7] Deficiency of vitamin D is considered a common disorder affecting people of all ages.[8] The deficiency of vitamin D is multifactorial and results from many factors such as increasing in fiber diet, malabsorption, limited intake of fish, reduction in

synthesis of vitamin D due to restricted exposure to sunlight as in indoor occupation, dark skin, obesity, and others.[9]

AIM

We conducted this study to evaluate the association between dyslipidemia and 25-hydroxyvitamin D deficiency.

MATERIALS AND METHODS

Study design and setting

This was a cross-sectional study involving 130 subjects (58 males and 72 females) that visited the Internal Medicine Clinic for a routine follow-up, with data collected between June and October 2020.

Data collection

Much information was taken from each subject concerning their age, sex, and body mass index. Blood samples were collected to estimate the total cholesterol, triglyceride (TG), high-density (HDL) and low density (LDL) lipoprotein levels by the spectrophotometric method, and to test vitamin D by the MINI VIDAS method. The study subjects were categorized into 3 groups by the serum level of vitamin D: <10 ng/ml - vitamin D deficient, 10-30 ng/ml - vitamin D insufficient, and 30-100 ng/ml - vitamin D sufficient.

Statistical analysis

Statistical analysis was performed using SPSS version 18. The correlation coefficient of Spearman was used to evaluate the strength of the association. P value less than 0.05 was considered statistically significant.

RESULTS

We found a highly significant difference in the distribution of gender according to the categories of vitamin D in the study population (p<0.001) **(Table 1)**. In males, the insufficient vitamin D group was the most common (50%) followed by the deficient (37.9%) and then the sufficient groups (12.1%). In females, the deficient vitamin D group was the most common (79.2%) followed by the insufficient (16.7%) and the sufficient groups (4.2%). According to the levels of vitamin D, the deficient group was the most common (79, 60.8%), followed by the insufficient group (41, 31.5%), and the sufficient D vitamin group (10, 7.7%).

The results **(Table 2)** showed that there was a highly significant difference in the distribution of lipid status between the categories of vitamin D (p<0.0001) while there were no significant differences in the distribution of age and BMI between the categories of vitamin D (p>0.05).

Fig. 1 showed a highly significant negative correlation between the levels of cholesterol, TG, and LDL and vitamin D level in the study (p<0.001), while there was a highly significant positive correlation between the levels of HDL and the level of vitamin D (p<0.001).

DISCUSSION

One of the major risk factors for cardiovascular diseases is dyslipidemia described as elevation of the serum levels of cholesterol, LDL, and TG, and reduction of the level of HDL. Deficiency of vitamin D is one of the factors that is related to dyslipidemia.[10]

In this study, the deficiency of vitamin D was very high, these findings being compatible with the results of other studies.[11,12] The results showed a significant difference in the serum level of lipids with deficiency of vitamin D compared with sufficient vitamin D. These findings agree with the results of many other studies.[13-15]

Also, the study showed that there was a significant negative correlation between the levels of cholesterol and vitamin D. The relation between hypercholesterolemia and vitamin D deficiency we found in this study may be attributed to the following: a defect in the cholesterol uptake may lead to the increase of its blood level due to a defect in the LDL receptors which leads to a reduction in the level of vitamin D at the same time because the LDL cholesterol is a precursor for vitamin D synthesis.[12,16]

The TG serum level was inversely related to the serum level of vitamin D. Subjects with deficient or insufficient vitamin D have a significant increase in the level of triglyceride and this finding is supported by many other studies, noted the same negative correlation and in both sexes.[17-20]

The first mechanism that explained this relationship between triglyceride and vitamin D is that vitamin D en-

Table 1. Gender distribution of the categories of vitamin D in the study

		Vitamin D status			Total	*P* value
		Sufficient	Insufficient	Deficient		
		N (%)				
Gender	Males	7 (12.1)	29 (50)	22 (37.9)	58 (100)	<0.001
	Females	3 (4.2)	12 (16.7)	57 (79.2)	72 (100)	
Total		10 (7.7)	41 (31.5)	79 (60.8)	130 (100)	

Table 2. Distribution by age, body mass index, and lipid status of the study population

Variables	Vitamin D status	N	Mean±SD	95% CI	*P* value
Age (years)	Sufficient	10	54±7	50-59	0.811
	Insufficient	41	57±12	53-60	
	Deficient	79	56±10	53-58	
BMI (m^2/kg)	Sufficient	10	30±5	26-33	0.665
	Insufficient	41	28±4	27-30	
	Deficient	79	29±3	28-30	
Cholesterol (mg/dL)	Sufficient	10	185±8	180-190	<0.001
	Insufficient	41	193±17	188-198	
	Deficient	79	266±44	256-276	
TG (mg/dL)	Sufficient	10	142±20	127-156	<0.001
	Insufficient	41	172±49	156-187	
	Deficient	79	259±33	251-266	
HDL (mg/dL)	Sufficient	10	73±10	66-80	<0.001
	Insufficient	41	67±12	64-71	
	Deficient	79	51±13	48-54	
LDL (mg/dL)	Sufficient	10	89±12	80-97	<0.001
	Insufficient	41	98±21	92-105	
	Deficient	79	201±55	189-213	

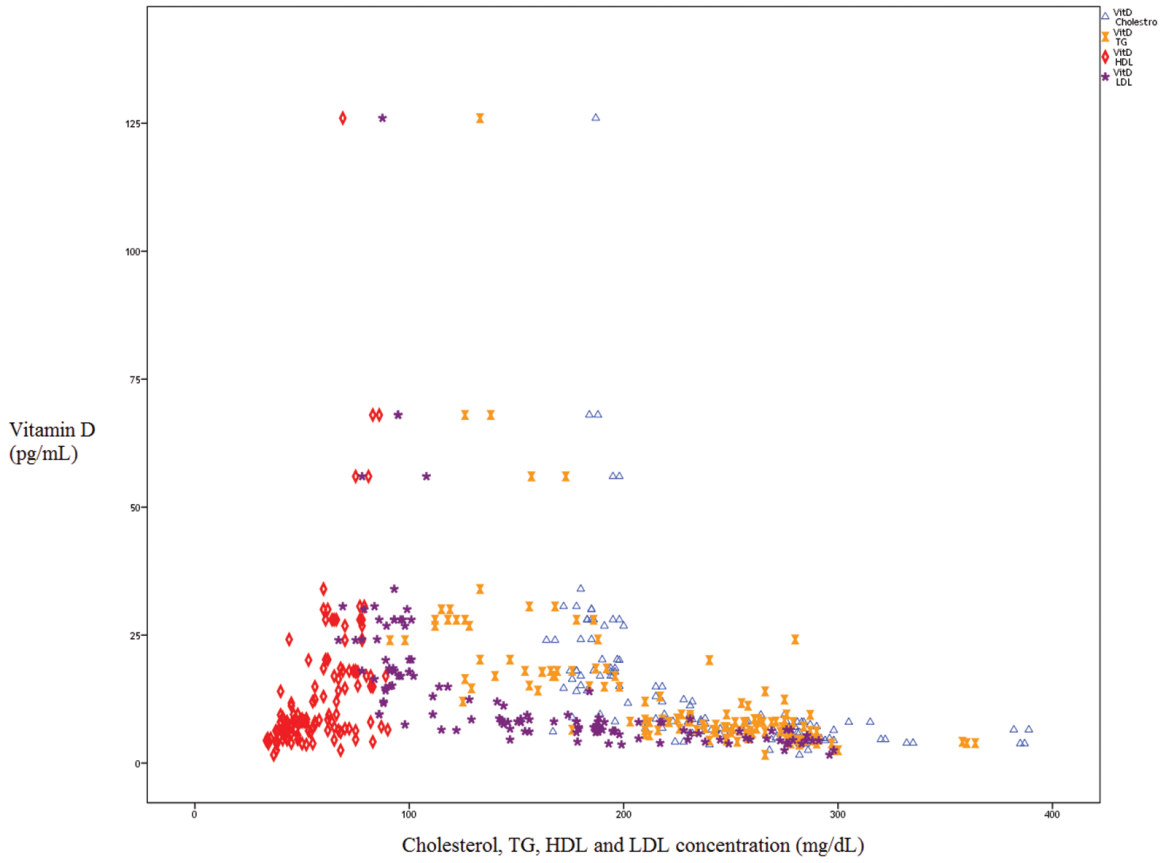

Figure 1. Scatter plot showing the correlation between cholesterol, TG, HDL, and LDL and vitamin D.

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hance the absorption of calcium in the intestine and results in elevated serum level of calcium. Elevated level of calcium results in reduction of the hepatic synthesis and secretion of triglyceride.[16] Another mechanism involves the effect of vitamin D on parathyroid hormone (PTH). The deficiency of vitamin D can lead to an increase of the concentration of PTH which results in the reduction of the plasma activity of post heparin lipolysis, so the triglyceride level can decline by enhancement of the peripheral removal.[21]

In addition to the above mechanisms, there are other mechanisms that can demonstrate the association between vitamin D deficiency and hypertriglyceridemia. The metabolism of triglyceride is regulated by vitamin D through the expression of the receptors of VLDL in specific types of cell as one of the possible mechanism.[20] Another mechanism involves the increasing of insulin resistance which is caused by the vitamin D deficiency and this leads to elevation of the levels of triglyceride and very low density lipoprotein.[22]

The LDL cholesterol level was significantly increased with vitamin D deficiency as found in this study and this finding was consistent with that reported by Auwerx et al.[23] The mechanism that explains this correlation is unclear: it may be due to photo metabolism in which the squalene in the skin is converted to vitamin D and 7-dehydrocholesterol during exposure to sunlight; so in the absence of effective sunlight, its metabolic pathway is diverted into the formation of cholesterol, and its level increases due to the defect in vitamin D level.[23,24]

On the other hand, the level of HDL cholesterol is significantly reduced when subjects have vitamin D deficiency or insufficiency, a finding which is in agreement with those reported by other studies.[16,25] This relationship between vitamin D and HDL levels can be seen to begin in the early stages of life as in the Spanish children in the study by Rodríguez-Rodríguez et al.[26]

In addition to common synthesis pathways of both cholesterol and vitamin D in the liver, there is an extra-hepatic link between 1,25 dihydroxyvitamin D3 (cholecalciferol) and HDL levels. Cholecalciferol is likely influencing the different stages of metabolism of cholesterol in or out of the liver.[27]

CONCLUSIONS

Vitamin D deficiency has a negative impact on the level of cholesterol, triglyceride, high density lipoprotein, and low density lipoprotein.

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Competing interests

The authors have declared that no competing interests exist.

Data Availability

Zahraa Fathi. Association between dyslipidemia and vitamin D deficiency. 2021; http://doi.org/10.5281/zenodo.4618630.

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Связь между дислипидемией и дефицитом витамина D: кросс-секционное исследование

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Резюме

Введение: Дислипидемия - одно из наиболее частых нарушений обмена веществ. Витамин D - один из важнейших жирорастворимых витаминов, который выполняет множество функций в организме человека.

Цель: Целью этого исследования было оценить связь между дислипидемией и дефицитом витамина D.

Материалы и методы: Это кросс-секционное исследование с участием 130 участников (58 мужчин и 72 женщин) в возрасте от 20 до 70 лет, проведённое с 1 июня по 30 октября 2020 года. Уровни витамина D измерялись у каждого участника, мы также измеряли уровни холестерина сыворотки, триглицеридов, липопротеинов высокой и низкой плотности в соответствии с уровнями витамина D.

Результаты: 79 человек с дефицитом витамина D, 21 с дефицитом витамина D и 10 с достаточным уровнем витамина D. Наблюдались значительные различия в уровнях холестерина, триглицеридов и липопротеинов низкой плотности в зависимости от уровня витамина D.

Заключение: Дефицит витамина D отрицательно влияет на холестерин, триглицериды, липопротеины высокой и низкой плотности.

Ключевые слова

холестерин, дислипидемия, липопротеины высокой плотности, липопротеины низкой плотности, триглицериды, витамин D