ORIGINAL RESEARCH

Association of Deficiency of 25-Hydroxyvitamin D with Dyslipidemia among asymptomatic adults

[1]Dr. Rohit Mishra, [2]Dr. Ewarld Marshall, [3]Dr. Aishwarya Singh, [4]Dr. Alvin Billey

[1,3,4]Lecturer, [2]Chair and Associate Professor, Department of Pathology, St. George's University, Grenada, West Indies

Corresponding Author
Dr. Rohit Mishra
Lecturer, Department of Pathology, St. George's University, Grenada, West Indies

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ABSTRACT

Background: Vitamin D is important for maintaining bone health, immune function, and cardiovascular health. Vitamin D deficiency is prevalent worldwide and has been associated with an increased risk of several chronic diseases, including dyslipidemia, a condition characterized by an abnormal lipid profile that is a major risk factor for cardiovascular diseases. The relationship between vitamin D status and dyslipidemia is not fully understood, and previous studies have reported inconsistent results. The present study aims to investigate the correlation between 25(OH)D and serum lipid profile among asymptomatic adults to provide insights into the relationship between vitamin D status and dyslipidemia, which may aid in the development of preventive strategies and personalized treatment plans for dyslipidemia and CVD. **Methods:** This study was a cross-sectional observational study conducted on asymptomatic adults between December 2021 and November 2022. Participants were enrolled using convenient sampling, and were divided into two groups based on their level of Vitamin D. Demographic details were noted, and blood samples were collected to measure serum 25-hydroxyvitamin D [25(OH)D] and lipid profile. Descriptive statistics and statistical tests, such as the chi-square test and unpaired t-test, were used for data analysis. Pearson's correlation coefficient was used to determine the correlation between serum 25(OH)D levels and serum lipid profile. A p-value less than 0.05 was considered statistically significant. **Results:** Of the participants, 55.3% were male and 44.7% were female. The mean age of the participants was 39.12±8.91 years and the mean BMI was 26.54±5.43 kg/m².Of the 179 participants, 83 (46.4%) were deficient, 74 (41.3%) were insufficient, and 22 (12.3%) had sufficient Vitamin D levels.The mean values of total cholesterol (TC), triglycerides (TG), and very low-density lipoprotein (VLDL) were significantly higher in the deficient group compared to the insufficient and sufficient groups (p=0.03).There is a significant negative correlation between Vitamin D levels and Total Cholesterol, Triglyceride, Very Low-Density Lipoprotein, and Low-Density Lipoprotein levels among study participants. **Conclusion:** Present study provides evidence that a large proportion of adults have Vitamin D deficiency or insufficiency and that this is associated with adverse lipid profile parameters. The findings of this study highlight the importance of Vitamin D screening and supplementation for individuals with Vitamin D deficiency or insufficiency, particularly those with dyslipidemia or other risk factors for cardiovascular diseases.

Keywords: 25-Hydroxyvitamin D, Dyslipidemia, Asymptomatic, Adults, Coronary artery disease

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INTRODUCTION

Vitamin D is a fat-soluble vitamin that is essential for maintaining bone health, immune function, and cardiovascular health. Vitamin D is obtained from dietary sources or synthesized in the skin upon exposure to sunlight. The major circulating form of vitamin D is 25-hydroxy vitamin D (25(OH)D), which is considered the best indicator of vitamin D status in the body. Vitamin D deficiency is prevalent worldwide, and it is estimated that approximately one billion people are affected by it [1]. Vitamin D deficiency has been associated with an increased risk of several chronic diseases, including hypertension, diabetes, and dyslipidemia[2,3,4].

Dyslipidemia is a condition characterized by an abnormal lipid profile, which includes high levels of low-density lipoprotein cholesterol (LDL-C), triglycerides, and low levels of high-density lipoprotein cholesterol (HDL-C). Dyslipidemia is a major risk factor for the development of atherosclerosis, which can lead to cardiovascular diseases (CVD), such as coronary artery disease (CAD) and stroke [5]. Dyslipidemia is a common

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condition affecting approximately one-third of the adult population in the United States [6].

Several studies have investigated the relationship between vitamin D status and dyslipidemia, but the results have been inconsistent. Some studies have reported a significant negative correlation between vitamin D status and total cholesterol, LDL-C, and triglycerides, while others have reported no correlation [7,8,9,10]. The relationship between vitamin D status and HDL-C is also unclear, with some studies reporting a positive correlation, while others report no correlation or a negative correlation [7,8,9,10].

The mechanism underlying the association between vitamin D status and dyslipidemia is not fully understood, but it has been suggested that vitamin D may regulate lipid metabolism by modulating the expression of genes involved in lipid synthesis and metabolism [11,12,13]. Vitamin D may also improve endothelial function, reduce inflammation, and enhance insulin sensitivity, which may contribute to the beneficial effects on lipid metabolism [8,13].

Given the inconsistent results from previous studies, further investigation is needed to clarify the relationship between vitamin D status and serum lipid profile. Therefore, the present study aimed to investigate the correlation between 25(OH)D and serum lipid profile among asymptomatic adults. The findings from this study will provide valuable insights into the relationship between vitamin D status and dyslipidemia, which may aid in the development of preventive strategies and personalized treatment plans for dyslipidemia and CVD.

MATERIALS AND METHODS

STUDY DESIGN

This study was designed as a cross-sectional observational study conducted between December 2021 and November 2022. The study was conducted on asymptomatic adults who were not on any lipid-lowering medication and had no known history of dyslipidemia, liver, or kidney disease. The study was approved by the institutional ethics committee, and all participants provided written informed consent.

STUDY PARTICIPANTS

A total of 179 participants were enrolled in this study. The patients' attendees at the Department of Medicine of a tertiary care teaching hospital of North India, and were screened for eligibility and were recruited as participants using convenient sampling technique. The inclusion criteria were age between 18 and 60 years, BMI between 18.5 and 29.9 kg/m², and no history of dyslipidemia, liver, or kidney disease. The exclusion criteria were pregnancy, lactation, the use of vitamin D supplements, lipid-lowering medications, or any medication that could affect lipid metabolism. The participants were divided into two groups (I and II) based on the level of Vitamin D, i.e. Group I: Vitamin D deficient and Group II Vitamin D non deficient.

DATA COLLECTION

Participants demographic details (age, gender, height, weight) was noted. A detailed medical history was obtained, and a physical examination was performed to exclude participants with a history of dyslipidemia, liver, or kidney disease. Fasting blood samples were collected in the morning after an overnight fast of at least 12 hours. Serum 25-hydroxyvitamin D (25(OH)D) levels were measured by chemiluminescence immunoassay (CLIA).Serum lipid profile, including total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C), was measured by enzymatic colorimetric methods. The lipid panel included direct measurements of total cholesterol, VLDL cholesterol, HDL cholesterol, and triglyceride levels. LDL cholesterol levels were calculated using the Friedewald formula if plasma triglyceride levels were less than 300mg/dL. In cases where plasma triglycerides exceeded 300mg/dL, LDL cholesterol was directly assayed.

DEFINITIONS

In accordance with previous research and the laboratory manual, the defined ranges for vitamin D status are as follows: deficiency, <20 ng/mL; insufficiency, 20-30 ng/mL; and normal, >30-100 ng/mL [14].

The definition of dyslipidemia in this study was based on the laboratory's normative values for the lipid panel, where any values exceeding the upper limits were considered abnormal. Specifically, total cholesterol (TC) levels greater than 200 mg/dL, LDL cholesterol (LDL-C) levels greater than 130 mg/dL, HDL cholesterol (HDL-C) levels less than 40 mg/dL, very low-density lipoprotein cholesterol (VLDL-C) levels greater than 30 mg/dL, and triglyceride (TG) levels greater than 150 mg/dL were all considered as dyslipidemia, based on the ATP III criteria [15].

STATISTICAL ANALYSIS

All statistical analyses were performed using SPSS version 25.0 (IBM Corp, Armonk, NY, USA). Descriptive statistics were used to describe the study population. The significance of the association between tabulated data values and categorical data was tested using the chi-square test. To compare the differences between the means of quantitative measurements, a two-tailed unpaired t-test was employed.Pearson's correlation coefficient was used to determine the correlation between serum 25(OH)D levels and serum lipid profile. A p-value less than 0.05 was considered statistically significant.

RESULTS

Table 1 presents the baseline characteristics of 179 study participants. Of the participants, 55.3% were male and 44.7% were female. The mean age of the participants was 39.12±8.91 years and the mean BMI was 26.54±5.43 kg/m². About 46.4% of the

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participants were Vitamin D deficient, 41.3% were insufficient, and only 12.3% had sufficient levels of Vitamin D. The lipid profile showed that the mean Total Cholesterol was 169.41±32.23 mg/dL, mean Triglyceride was 147.67±68.32 mg/dL, mean Very Low-Density Lipoprotein was 27.42±12.19 mg/dL, mean Low Density Lipoprotein was 89.67±28.82 mg/dL, and mean High Density Lipoprotein was 52.24±7.27 mg/dL. 29.6% of the participants had dyslipidemia while 70.4% did not.

Table 1: Baseline characteristics of the study participants (N=179).

Variables	N	%
Gender		
Male	99	55.3
Female	80	44.7
Mean Age (in years)	39.12±8.91	
Mean BMI (kg/m²)	26.54±5.43	
Mean Vit D (ng/mL)	21.76±7.22	
Vit D status		
Deficient	83	46.4
Insufficient	74	41.3
Sufficient	22	12.3
Lipid profile		
Mean Total Cholesterol (mg/dL)	169.41±32.23	
Mean Triglyceride (mg/dL)	147.67±68.32	
Mean Very Low-Density Lipoprotein (mg/dL)	27.42±12.19	
Mean Low Density Lipoprotein (mg/dL)	89.67±28.82	
Mean High Density Lipoprotein (mg/dL)	52.24±7.27	
Dyslipidaemia		
Yes	53	29.6
No	126	70.4

Table 2 compares the baseline characteristics of the study participants based on their Vitamin D status. Of the 179 participants, 83 (46.4%) were deficient, 74 (41.3%) were insufficient, and 22 (12.3%) had sufficient Vitamin D levels. The p-value for gender was not significant (p=0.947), indicating that there was no significant difference in gender distribution among the Vitamin D groups. However, there was a significant difference in Vitamin D levels (p=0.000) among the groups, with the deficient group having the lowest levels (mean 11.68±6.36 ng/mL), the insufficient group having intermediate levels (mean 26.39±4.41 ng/mL), and the sufficient group having the highest levels (mean 59.80±11.37 ng/mL). There was also a trend towards higher BMI in the deficient group, but this did not reach statistical significance (p=0.071). Age did not differ significantly among the groups (p=0.291).

Table 2: Comparison of the baseline characteristics of the study participants on the basis of Vit D status.

Variables	N (%)			p-value
	Deficient (n=83)	Insufficient (n=74)	Sufficient (n=22)	
Gender				
Male (n=99)	45 (54.2)	42 (56.8)	12 (54.5)	0.947
Female (n=80)	38 (45.8)	32 (43.2)	10 (45.5)	
Mean Age (in years)	38.83±10.48	39.34±9.89	42.67±10.42	0.291
Mean BMI (kg/m²)	27.64±3.81	26.24±4.12	25.91±6.23	0.071
Mean Vit D (ng/mL)	11.68±6.36	26.39±4.41	59.80±11.37	0.000

The table shows the comparison of the lipid profile parameters of the study participants on the basis of Vit D status. The mean values of total cholesterol (TC), triglycerides (TG), and very low-density lipoprotein (VLDL) were significantly higher in the deficient group compared to the insufficient and sufficient groups (p=0.03). The mean value of low-density lipoprotein (LDL) was significantly higher in the deficient group compared to the insufficient and sufficient groups (p=0.033). The proportion of participants with dyslipidemia was significantly higher in the deficient group compared to the insufficient and sufficient groups (p=0.032). The mean value of high-density lipoprotein (HDL) was not significantly different between the groups (p=0.133).

Table 3: Comparison of the lipid profile parameters of the study participants on the basis of Vit D status.

Variables	N (%)			p-value
	Deficient (n=83)	Insufficient (n=74)	Sufficient (n=22)	
TC (mg/dL)	174.33±38.91	161.69±36.33	154.02±37.98	0.03
TG (mg/dL)	152.78±61.26	136.29±56.74	121.09±47.29	0.042

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VLDL (mg/dL)	29.62±12.87	25.82±11.23	23.06±9.27	0.03
LDL (mg/dL)	94.24±24.45	86.16±21.21	83.23±19.41	0.033
HDL (mg/dL)	49.87±6.93	51.08±10.22	54.15±10.57	0.133
Dyslipidaemia				
Yes (n=53)	32 (38.6)	18 (24.3)	3 (13.6)	0.032
No (n=126)	51 (61.4)	56 (75.7)	19 (86.4)	

The results from Table 4 show that there is a significant negative correlation between Vitamin D levels and Total Cholesterol, Triglyceride, Very Low-Density Lipoprotein, and Low-Density Lipoprotein levels among study participants. The correlation coefficients for Total Cholesterol, Triglyceride, Very Low-Density Lipoprotein, and Low-Density Lipoprotein levels are -0.317, -0.199, -0.156, and -0.326, respectively, with p-values of 0.019, 0.041, 0.045, and 0.021, respectively. However, there is no significant correlation between Vitamin D levels and High-Density Lipoprotein levels (p = 0.742).

Table 4. Correlation between Vit D levels and lipid profile parameters among study participants.

Lipid profile parameters	Pearson's correlation (R)	P value
Total Cholesterol (mg/dL)	-0.317	0.019
Triglyceride (mg/dL)	-0.199	0.041
Very Low-Density Lipoprotein (mg/dL)	-0.156	0.045
Low Density Lipoprotein (mg/dL)	-0.326	0.021
High Density Lipoprotein (mg/dL)	0.031	0.742

DISCUSSION

The present study aimed to investigate the association between Vitamin D status and lipid profile parameters in apparently healthy adults. Of the participants, 55.3% were male and 44.7% were female. The mean age of the participants was 39.12±8.91 years and the mean BMI was 26.54±5.43 kg/m². A similar age and gender distribution was observed in the study by Hinduja et al., [16].

Our study results showed that Vitamin D deficiency is highly prevalent among the study participants, with 46.4% of them being deficient, 41.3% being insufficient, and only 12.3% having sufficient Vitamin D levels. This is consistent with previous studies Chaudhuri et al., Al-Daghri et al., and Alzaheb et al., reporting high prevalence rates of Vitamin D deficiency worldwide [17,18,19]Vitamin D deficiency is a common health problem worldwide, with estimates suggesting that over a billion people have Vitamin D deficiency or insufficiency. The main sources of Vitamin D are sunlight exposure and dietary intake, but many people have insufficient exposure to sunlight and have inadequate dietary intake of Vitamin D. Vitamin D deficiency has been associated with a wide range of health problems, including osteoporosis, cancer, autoimmune diseases, and infectious diseases [1,20,21].

The lipid profile parameters, including total cholesterol, triglycerides, very low-density lipoprotein, and low-density lipoprotein, were significantly higher in the deficient group compared to the insufficient and sufficient groups. Similar findings were observed in the studies by Anantharamakrishnan et al., Tosunbayraktar et al., Alkhatatbeh et al., and Faridi et al.,[22,23,24,25]. Furthermore, the proportion of participants with dyslipidemia was also significantly higher in the deficient group compared to the other groups.The results of this study are consistent with previous research by Kim et al.,Ponda et al., and Guan et al., that has shown an association between Vitamin D deficiency and dyslipidemia [26,27,28]. Vitamin D plays a crucial role in regulating calcium metabolism and bone health, but it also has several extra-skeletal effects, including its potential to improve lipid metabolism. Vitamin D deficiency has been shown to be associated with an increase in total cholesterol, low-density lipoprotein, and triglycerides, and a decrease in high-density lipoprotein, which are all risk factors for cardiovascular diseases. Furthermore, several studies have suggested that Vitamin D supplementation can improve lipid metabolism and reduce the risk of cardiovascular diseases [29].

In our study, correlation analysis showed that there is a significant negative correlation between Vitamin D levels and Total Cholesterol, Triglyceride, Very Low-Density Lipoprotein, and Low-Density Lipoprotein levels among study participants. Similar correlation was observed in the studies by Tosunbayraktar et al., Alkhatatbeh et al., Elmi et al., Annapurna et al., and Dodda et al., [23,24,30,31,32].

Our study also showed that there was a trend towards higher BMI in the Vitamin D-deficient group, but this did not reach statistical significance. This is consistent with previous studies by Wortsman et al., and Vimaleswaran et al., that reported a positive association between Vitamin D deficiency and obesity, characterized by increased BMI [33,34]. The exact mechanisms underlying this association are not fully understood, but it is suggested that Vitamin D may play a role in adipose tissue biology and regulation of energy metabolism.

LIMITATIONS

This study has several limitations that should be acknowledged. Firstly, the study had a cross-sectional design, which limits the ability to establish causality between Vitamin D status and lipid profile parameters. Secondly, the study had a relatively small sample size,

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which limits the generalizability of the findings. Thirdly, the study did not collect data on dietary intake of Vitamin D or sunlight exposure, which could have provided additional insights into the factors contributing to Vitamin D deficiency or insufficiency.

CONCLUSION

Present study provides evidence that a large proportion of adults have Vitamin D deficiency or insufficiency and that this is associated with adverse lipid profile parameters. The findings of this study highlight the importance of Vitamin D screening and supplementation for individuals with Vitamin D deficiency or insufficiency, particularly those with dyslipidemia or other risk factors for cardiovascular diseases. Further research is needed to better understand the mechanisms underlying the association between Vitamin D and lipid metabolism and to establish the optimal strategies for preventing and treating Vitamin D deficiency.

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