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ORIGINAL RESEARCH article

Correlational study of vitamin D deficiency and dyslipidemia among adult Libyan population

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Abstract: Vitamin D deficiency is a public health concern affecting many individuals as it is highly prevalent in all parts of the world. Recent studies have reported an association of vitamin D deficiency with cardiometabolic alterations such as dyslipidemia. The study aimed to evaluate vitamin D and lipid profile levels among the Libyan adult population and investigate the correlation of vitamin D deficiency with the alteration of lipid profile levels. A cross-sectional study was conducted at Janzour Hospital among 193 subjects (107 males and 86 females) whose ages ranged between 20 and 50 years over three months from Sept to Dec 2023. Vitamin D, cholesterol, triglyceride, low-density lipoprotein, and high-density lipoprotein levels were estimated. The total mean vitamin D levels were 8.31±4.74, 23.83±2.78, and 42.67±7.95 ng/dl for deficiency, insufficiency, and sufficiency, respectively. The findings revealed significant alterations in cholesterol (increase), triglyceride (increase), LDL-cholesterol (increase), and HDL-cholesterol (decrease) among subjects who had vitamin D deficiency or insufficiency as compared to subjects having vitamin D sufficiency. Vitamin D levels were negatively correlated with cholesterol, triglyceride, and LDL cholesterol, and they were positively associated with HDL cholesterol. The incidence of dyslipidemia is higher in the vitamin D deficiency group than in the insufficiency and sufficiency groups. It is essential to frequently monitor lipid profiles among vitamin D-deficient individuals to avoid subsequent disorders or damages associated with the alterations of lipid profile patterns.

Introduction

Vitamin D is a fat-soluble vitamin synthesized from 7-dehydrocholesterol in the skin upon exposure to ultraviolet B rays of sunlight. 1,25-dihydroxycholecalciferol, the active form of vitamin D, is important in maintaining calcium homeostasis by binding its receptors on its target tissues, including bone, kidney, and intestine [1]. In addition to maintaining bone health, vitamin D has several essential extra skeletal biochemical functions in the body, including regulating immune, cardiovascular diseases (CVDs), and neuroendocrine systems [2] and has

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autocrine function on the intracellular level, facilitating gene expression [3, 4]. In the last decade, vitamin D deficiency (VDD) has been recognized as a pandemic worldwide [5]. Recent reports have shown higher rates of hypovitaminosis in the sunniest areas of the world, including the Middle East and Asian countries [6, 7]. Recent studies have reported higher rates of vitamin D deficiency in Libya [8, 9].

There is a growing concern about the health consequences of the high prevalence of vitamin D deficiency worldwide. Several factors can contribute to vitamin D deficiency, including high-fiber diets, conditions causing malabsorption, limited seafood consumption, and insufficient exposure to sunlight [10-12]. The increased mortality in subjects with a low serum vitamin D concentration appears to be mainly related to CVDs [13, 14], which could be explained by the association between low serum vitamin D concentrations and increased blood pressure [13], blood glucose, and body mass index [15, 16]. However, the relationship between serum vitamin D and serum lipid levels, among the major risk factors for CVDs, is less clear [16]. Dyslipidemia is characterized by abnormal blood lipid levels, including elevated total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C), as well as reduced high-density lipoprotein cholesterol (HDL-C); these conditions can occur singly or in combination and are a significant global health concern [16, 17]. The global prevalence of dyslipidemia is increasing, particularly in developing nations and among aging populations [17]. While high LDL-C is a primary risk factor for CVD, other forms of dyslipidemia, such as hypertriglyceridemia, are associated with conditions like acute pancreatitis and non-alcoholic fatty liver disease [17]. The prevalence of dyslipidemia has risen substantially over the past three decades, posing an increasing burden on global health [18, 19]. According to the WHO, globally, a third of ischemic heart disease is attributable to high TC [20]. Many studies have found that individuals with vitamin D deficiency tend to have poor lipid profiles [21, 22]. In a recent meta-analysis, higher vitamin D status was associated with an improved lipid profile in children and adolescents [22]. Studies have argued that there may exist a relationship between vitamin D concentration and lipid profile in adults [21, 22]. Although the burden of dyslipidemia is increasing in developing countries, there are currently few epidemiological studies on vitamin D status and its relationship with dyslipidemia in Libya. Therefore, the study aims to assess the relationship between vitamin D status and lipid profile patterns among the adult population in Libya.

Materials and methods

Study population: This study, conducted between September and December 2023 at Janzor Hospital in Tripoli, Libya, included 193 participants (107 males and 86 females) aged 20 to 50 years. The Ethics Committee at Tripoli College of Medical Sciences approved the study protocol (8/2023). The purpose of the study was clearly explained to all participants, and they requested to complete the structured questionnaire after signing the written consent form. A structured questionnaire included demographic characteristics (age, gender, residence, and occupation), medical history, current medications or supplementations taken, physical activity, and lifestyle habits. The questionnaire was self-designed and reviewed by Tripoli College of Medical Sciences experts for its validity and relevance.

Inclusion criteria: All healthy Libyan adults without apparent illness who consented to the study were included for both sexes (males and females).

Exclusion criteria: Subjects whose ages are less than 20 years or above 50 years were excluded. Subjects suffering from osteoporosis, bone, and skin diseases; pregnant or lactating women; subjects with diabetes history; subjects with hepatic, renal, and heart diseases; subjects suffering from thyroid and parathyroid dysfunction; subjects

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suffering from diarrhea and who recently took medications or any supplementations that act on or modify vitamin D and lipid metabolism were all excluded.

Sample collection: Peripheral venous blood samples were collected after 8-12 hours of overnight fasting. 5.0 ml of blood was collected from individuals at Janzor Hospital to measure vitamin D and lipid profile levels (TC, TG, HDL, and LDL). A blood sample was allowed to clot at room temperature, and the serum was separated by centrifugation at 4000 rpm for 15 min.

Biochemical analysis: Serum vitamin D levels were estimated by direct ELISA kit method using vitamin D ELISA Kit (ORGENTEC Diagnostika GmbH Company - Germany). The reference value of the used kit: vitamin D deficiency: <20 ng/ml, vitamin D insufficiency: 20-30 ng/ml, and vitamin D sufficiency: >30-100 ng/ml. Serum total TC and HDL were estimated using the cholesterol oxidase method, and serum TG using the glycerol peroxidase method via auto analyzer. Serum LDL-Cholesterol was calculated value by Fried wald's equation (LDL cholesterol (mg/dL) = Total cholesterol- HDL cholesterol - (Triglycerides/5).

Statistical analysis: The analysis was performed using SPSS version 25. Participants were categorized into three groups based on their vitamin D status: deficient, insufficient, and sufficient. Data are presented as mea±standard deviation. One-way ANOVA was used to compare group means of age, vitamin D, TC, TG, LDL-cholesterol, and HDL-cholesterol between males and females. A p-value of less than 0.01 was considered highly statistically significant. Pearson's correlation coefficient was used to assess the relationship between vitamin D levels and lipid profile parameters (TC, TG, LDL, and HDL).

Results

The results of the current study included 193 subjects, with an age range of 20-50 years. Of these, 55.44% were males 44.55% were females. **Table 1** shows the distribution of participants according to vitamin D and lipid profile status among participants. The total number of participants with deficient vitamin D was 70, accounting for 36.26%. Insufficient was 50, accounting for 25.90%, while sufficient was 73 accounting for 37.82%. Additionally, the total number of participants who had normal lipids was 104, accounting for 53.88%, whereas dyslipidemia was 89, accounting for 46.11%.

Table 1: Participants' vitamin D and lipid profile status

Gender	Vitamin D status				Lipid profile status		
	Deficiency < 20 ng/dl	Insufficiency (20-30) ng/dl	Sufficiency ≥ 30 ng/dl	Total	Normal lipids	Dyslipidemia	Total
Male	22 (20.56%)	20 (18.69%)	65 (60.74%)	**107**	80 (74.76%)	27 (25.23%)	**107**
Female	48 (55.81%)	30 (34.88%)	08 (9.30%)	**86**	24 (27.90%)	62 (72.09%)	**86**
Total	**70**	**50**	**73**	**193**	**104**	**89**	**193**

Table 2 presents means and standard deviations of age and biochemical parameters of blood vitamin D, TC, TG, LDL-cholesterol, and HDL-cholesterol levels in males and females. Total mean ages were 44.55±2.31 and 43.52±3.21 in males and females, respectively. The total mean vitamin D levels were 33.4±14.78 and 15.52±11.14 in males and females, respectively. The total mean of TC levels was 174.73±34.20 and 212.89±33.42 in males and females, respectively, while, TG levels were 171.01±29.04 and 211.11±20.02 in males and females,

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respectively. Total means of LDL-cholesterol were 129.60±27.86 and 159.86±22.69 in males and females, respectively, whereas HDL cholesterol was 34.41±9.50 and 17.56±5.79 in males and females, respectively. An analysis of the data by using one-way ANOVA revealed a statistically significant difference in biochemical variables such as vitamin D, TC, TG, LDL-cholesterol, and HDL-cholesterol.

Table 2: Levels of biochemical parameters according to gender

Parameters	Male n=107	Female n=86	P Value
Age in years	44.55±02.31	43.52±03.21	0.2
Vitamin D: ng/dl	33.40±14.78	15.52±11.14	< 0.01
TC: mg/dl	174.73±34.20	212.89±33.42	< 0.01
TG: mg/dl	171.01±29.04	211.11±20.02	< 0.01
LDL-Cholesterol: mg/dl	129.60±27.86	159.86±22.69	< 0.01
HDL-Cholesterol: mg/dl	34.41±09.50	17.56±05.79	< 0.01

Table 3 shows the means of age and lipid profile patterns (TC, TG, LDL-cholesterol, HDL-cholesterol) according to vitamin D levels. The subjects were classified according to vitamin D levels into deficiency <20 ng/dl, insufficiency (20-30) n/dl, and Sufficiency ≥30 ng/dl. Total mean ages were 32.68±10.31, 35.44±7.52, and 33.43±8.31 in deficiency, insufficiency, and sufficiency vitamin D, respectively. The total mean of TC levels was 231.69±15.96, 188.54±30.67, and 155.61±15.43, respectively, while TG levels were 204.51±26.87, 215.52±4.60, and 155.64±14.93, respectively. The means of LDL-cholesterol levels were 238.52±26.79, 173.78±17.83, and 126.38±22.16, respectively, whereas HDL-cholesterol were 19.11±7.70, 26.63±12.24, and 34.55±9.12. An analysis of the data using one-way-ANOVA revealed a statistically significant difference in biochemical variables such as vitamin D, TC, TG, LDL-cholesterol, and HDL-cholesterol.

Table 3: The biochemical parameters according to vitamin D status

Parameters	Vitamin D levels ng/dl			
	Deficiency < 20 ng/dl 8.31±4.74, n=70	**Insufficiency (20-30) ng/dl** 23.83±2.78, n=50	**Sufficiency ≥ 30 ng/dl** 42.677.95, n=73	**P Value**
Age in years	32.68±10.31	35.44±7.52	33.43±8.31	0.2
TC: mg/dl	231.69±15.96	188.54±30.67	155.61±15.43	<0.01
TG: mg/dl	204.51±26.87	215.52±4.60	155.64±14.93	<0.01
LDL-Cholesterol: mg/dl	238.52±26.79	173.78±17.83	126.38±22.16	<0.01
HDL-Cholesterol: mg/dl	19.11±7.70	26.63±12.24	34.55±9.12	<0.01

Table 4 reveals the correlation of vitamin D levels with lipid profile patterns (TC, TG, LDL-cholesterol, HDL-cholesterol). By applying Pearson's correlation coefficient, it was found that vitamin D was inversely correlated with serum TC, TG, and LDL-cholesterol (- 0.5, - 0.4, and - 0.6, respectively), whereas vitamin D was positively correlated with HDL-cholesterol (+ 0.5).

Table 4: Correlation of vitamin D status with lipid profile pattern

Parameters	TC (mg/dl)	TG (mg/dl)	HDL-cholesterol (mg/dl)	LDL- cholesterol (mg/dl)
Vitamin D (ng/dl)	**-0.5**	**-0.4**	**0.5**	**-0.6**

Pearson correlation coefficients (r) evaluating the correlation between vitamin D levels and lipid profile pattern.

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Discussion

The study investigates the correlation of vitamin D deficiency with the alterations of lipid profile patterns among the Libyan population. As mentioned above, the study investigated a small size sample of 193 participants (107 males and 89 females) whose ages ranged between 19 and 48 years. Vitamin D possesses numerous biological functions, and its deficiency is not confined to specific geographical locations and can occur due to several factors. It is now considered a worldwide concern [23]. Accumulating evidence suggests that vitamin D plays a role in maintaining health and preventing diseases [24-26]. Low circulating vitamin D levels and dyslipidemia have been linked to increased CVD risk [20]. In 2019, 17.9 million deaths worldwide, which accounted for 32.0% of all global deaths, were caused by CVDs [27-29]. Dyslipidemia is defined as an increasing concentration of lipids and lipoproteins in the blood, either individually or in combination [30]. These include increased TC plasma, LDL-cholesterol, TGs, and reduced HDL-cholesterol levels [31]. The current study revealed that 62.17% of the participants had abnormal vitamin D levels (36.26% deficiency and 25.90% insufficiency), whereas 37.82% of the participants had sufficient vitamin D levels. Vitamin D deficiency and insufficiency were more prevalent in females than males. The study revealed that females had significantly lower vitamin D concentrations 15.52±11.14 ng/dl, than males 33.4±14.78 ng/dl. The results agreed with several studies demonstrating a high prevalence of vitamin D insufficiency among Libyans, particularly females [8, 9, 32]. Moreover, 46.11% of the participants had dyslipidemia, while 53.88% had normal lipid profile levels. Furthermore, females had significant changes in lipid profile patterns (increase in TC, TG, LDL cholesterol, and decrease in HDL cholesterol) compared to males. It was observed from the study that there were significant alterations in the serum lipid profile pattern among the three classified groups (deficient, insufficient, and sufficient vitamin D), and dyslipidemia was more evident in the two groups (deficient and insufficient vitamin D). The findings were aligned with prior studies, which demonstrated that the risk of dyslipidemia increases with low vitamin D levels [33, 34].

Vitamin D levels were negatively correlated with TC, TG, LDL-Cholesterol and positively with HDL-cholesterol. The present study's findings corroborate previous investigations, all indicating a negative association between vitamin D levels and serum TC, TG, and LDL cholesterol [35]. Additionally, vitamin D deficiency contributes to impaired islet function and insulin resistance, leading to impaired lipid profile levels [36]. Increased serum levels of TC, LDL-cholesterol, and TG and reduced levels of HDL-cholesterol are known to be major risk factors for developing CVDs [37]. Similarly, many studies showed that subjects with dyslipidemia have a 2-fold higher risk of developing CVDs than those with normal lipid levels [28-29, 38]. A study demonstrated that vitamin D acts as a protective factor against CVDs as it is inversely correlated with LDL-cholesterol, and TG and positively with HDL-cholesterol in patients with dyslipidemia [39]. Vitamin D is known to be one of the leading causes of death worldwide, as it is related to atherosclerotic CVD by altered lipid profile status, including levels of TC, TG, LDL-cholesterol, and HDL-cholesterol [26]. The association between vitamin D and lipid profile levels could be because vitamin D increases intestinal calcium absorption. This elevated serum calcium could reduce TG by reducing hepatic formation and secretion [40]. Moreover, lipolysis and lipid deposition are inhibited by higher serum fatty acid synthase, which is contributed by increased calcium ions in fat cells [41].

Conclusion: There is a relationship between abnormal vitamin D levels and alterations in lipid profile patterns among Libyan adults. Moreover, our findings demonstrated a negative correlation between vitamin D levels and cholesterol, triglyceride, and LDL cholesterol, and a positive correlation with HDL cholesterol. It is essential to frequently monitor lipid profile status among vitamin D deficient or insufficient individuals to avoid subsequent disorders or damages associated with the alterations of lipid profile patterns.

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