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College of Health Technology
Department of Community Health

The Association between Triglyceride Level and Vitamin D3 Deficiency

A Graduation Project Submitted to
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In

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بِسْمِ اللهِ الرَّحْمَنِ الرَّحِيم

ٱقۡرَأۡ وَرَبُّكَ ٱلۡأَكۡرَمُ (٣) ٱلَّذِي عَلَّمَ بِٱلۡقَلَمِ (٤)

صدق الله العظيم

سورة العلق

Dedication

To our loving parents and caring friends and professors who have mentored us and whose words of encouragement and push for tenacity ring in our ears.

Acknowledgements

We would like to express our sincere gratitude to A.L Aram Mohammed Bra for his efforts and patience during the period of writing this research and for all the guidance and advice he gave us and to all school principals who cooperated with us in obtaining the results of this study.

Abstract

Background: Vitamin D is a group of structurally related, fat-soluble compounds responsible for increasing intestinal absorption of calcium, magnesium, and phosphate, along with numerous other biological functions. The link between triglycerides and vitamin D3 has received a lot of attention in the scientific community due to its importance in human metabolism and general health. The main aim of present investigation to study association among Vitamin D3 and Lipid profile in Erbil, Kurdistan, Iraq. This research explores how serum Vitamin D3 concentrations correlate with lipid profiles and specifically triglyceride levels.

Methods: This descriptive cross-sectional study collected data from 100 patients who had either low or high Vitamin D3 levels along with lipid profiles during January and February 2025.

Results: Research results demonstrated that higher Vitamin D3 levels correspond with lower triglyceride levels especially in overweight subjects pointing towards Vitamin D's role in controlling lipid metabolism. Researchers have identified various biochemical pathways that Vitamin D deficiency utilizes to induce dyslipidemia through inflammation-related mechanisms and insulin resistance alongside calcium-PTH homeostasis.

Conclusion: The research emphasizes the need for screening and health education about Vitamin D status even though it faces methodological challenges such as its observational design and urban-focused sample. The findings demonstrate the necessity for public health measures and prospective longitudinal and interventional research which considers genetic variations and stratifies participants based on their deficiency levels to advance our comprehension and management of hypovitaminosis D's metabolic effects.

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1 Chapter One: Introduction

1.1 Introduction

Cholecalciferol, another name for vitamin D3, is a kind of vitamin D. Ergocalciferol (vitamin D2) and cholecalciferol (vitamin D3) are the two primary constituents of vitamin D, a pleiotropic hormone. Vitamin D from food or the skin must first be hydroxylated into 25-hydroxyvitamin D [25(OH)D] before it can be transformed into 1, 25-dihydroxyvitamin D [1,25(OH)2D]. In addition to controlling calcium homeostasis, vitamin D plays a number of other functions that support human health [1, 2]. Vitamin D insufficiency has been on the rise in recent years. Sunlight exposure is the main source of vitamin D, while some meals high in protein also contain it. It should be mentioned, nevertheless, that food consumption might not be sufficient to satisfy a person's vitamin D requirements[1]. Low blood vitamin D levels are an independent risk factor for cardiovascular illnesses and hypertension, according to observational studies[3]. The body naturally produces vitamin D, a fat-soluble hormone, through subcutaneous synthesis when exposed to sunshine. This vitamin is essential for preserving the health of muscles and bones as well as preventing a number of illnesses, including diabetes, cancer, heart disease, and autoimmune disorders[4]. Lipid profiles and blood vitamin D levels have been found to be significantly correlated. It is currently unclear how vitamin D affects blood lipid levels, despite the fact that several theories have been put out to explain its effects on lipid profiles[5]. By increasing the generation of bile salts and lowering lecithin-cholesterol acyltransferase activity, vitamin D may directly affect blood lipid profiles, including triglycerides, total cholesterol, and LDL cholesterol, according to hypothesized mechanisms. It may also have an indirect effect by influencing calcium absorption, which lowers fat absorption and increases the synthesis of hepatic bile acids from cholesterol[6].It is well established that vitamin D plays a key biological role in maintaining calcium and phosphorus homeostasis. Furthermore, the discovery of the vitamin D receptor (VDR) in a range of tissues has increased awareness of its role in angiogenesis, terminal differentiation, cell proliferation, inflammation, and immunological response[7]. VD3 is a precursor of hormones, which have been linked to various regulatory responses in the body[8]. Vitamin D is an important fat-soluble vitamin that serves several roles. Humans get their vitamin D mostly from sunshine exposure. After being exposed to solar ultraviolet B radiation, 7-dehydrocholesterol in the skin is transformed to provitamin D3, which is subsequently hydroxylated into 25(OH)D and 1,25-dihydroxyvitamin D3 (an active form) by hydroxylases in the liver and kidneys[9]. Vitamin D can also be consumed in the food or through oral supplements[10]. VD3 affects bone metabolism, insulin resistance, poor glucose tolerance, and diabetes[8]. It is believed that between 30 and 60 percent of people worldwide, including adults and children, suffer from vitamin D deficiency (VDD), which has become a serious public health concern[11]. According to a recent study, vitamin D deficiency clearly contributes to the development of non-Hodgkin's lymphoma, esophageal, renal, lung, gastric, and endometrial cancers[12]. Numerous studies have shown that VDD affects more than only the musculoskeletal system. Interestingly, it is linked to a higher risk of a number of illnesses, such as diabetes, autoimmune disorders, cancer, heart disease, depression [6], and acute respiratory infections. Together, these results demonstrate how important it is to treat VDD in order to potentially reduce a wide range of health issues. This importance is further highlighted by the critical function of vitamin D in controlling lipid metabolism, which affects the total lipid profile in addition to triglyceride levels[13]. The variables linked to IR, IGT, and DM include D3 and triglycerides/high-density lipoprotein (TG/HDL) (14–17). Few studies have examined whether varying VD3 levels have an impact on the association between impaired glucose metabolism and the TG/HDL ratio[14]. The American National Health and Nutrition Examination Survey (NHANES) database served as the basis for this retrospective research, which sought to identify any differences (or supporting evidence) in the relationships between the TG/HDL ratio and IR, IGT, and DM at various VD3 levels[8]. The link between triglycerides and vitamin D3 has received a lot of attention in the scientific community due to its importance in human metabolism and general health. The most common type of fat stored in the human body, triglycerides are crucial for energy metabolism. They are a crucial part of lipoproteins, particularly chylomicrons and very low-density lipoproteins (VLDL), and are composed of three fatty acids esterified to a glycerol backbone. Elevated triglyceride levels, frequently related with dyslipidemia, obesity, metabolic syndrome, and cardiovascular disease (CVD), have been intensively investigated because of their consequences for health[15]. Recent studies have found intricate relationships between triglycerides and vitamin D3. Vitamin D3 is fat-soluble, hence its absorption, transport, and storage are all tied to lipid metabolism. Vitamin D3 bioavailability is affected by dietary fat consumption and the efficacy of chylomicron-mediated absorption in the intestines [16, 17]. Furthermore, vitamin D3 is mostly carried in the bloodstream via vitamin D-binding protein (DBP) and lipoproteins, namely chylomicrons and VLDL. As a result, alterations in lipid profiles, particularly triglycerides, may influence vitamin D3 status and metabolism[18]. Several epidemiological and interventional research have looked at the relationship between blood triglyceride levels and vitamin D3 concentrations. Some studies imply an inverse association, where greater triglyceride levels correspond with lower blood 25(OH)D concentrations, perhaps due to sequestration in adipose tissue or abnormalities in lipid metabolism that impact vitamin D3 transport and absorption[19]. Other studies have indicated a positive correlation, possibly owing to improved vitamin D3 transport via triglyceride-rich lipoproteins[20]. Obesity, a disease defined by excessive triglyceride accumulation in adipose tissue, has been linked to vitamin D3 insufficiency. It is hypothesized that increased adipose tissue mass works as a reservoir for vitamin D3, limiting its bioavailability in the bloodstream. Obesity-related chronic inflammation and metabolic dysregulation may also affect vitamin D3 production and metabolism[21]. On the other side, vitamin D3 levels may affect lipid metabolism, especially triglyceride levels. Vitamin D3 has been reported to regulate lipid metabolism via interacting with nuclear receptors such as the vitamin D receptor (VDR) and peroxisome proliferator-activated receptors (PPARs)[22]. These interactions can alter gene expression associated with lipid metabolism, such as fatty acid oxidation, lipogenesis, and triglyceride production[5]. Some studies have suggested that vitamin D3 supplementation may contribute to changes in lipid profiles, including decreases in triglyceride levels. However, data remain inconsistent across different populations and research designs[23]. Since triglycerides and vitamin D3 have a complex interaction, it is essential to comprehend the underlying mechanisms in order to create tailored therapy techniques that reduce the risk of cardiovascular and metabolic diseases. This paper aims to critically analyse the existing literature on the relationship between triglycerides and vitamin D3, elucidating potential mechanisms, clinical implications, and future research directions[24, 25]. The aim of the present study was to determine the association between vitamin D3 and triglyceride. The results of this investigation will significantly advance our understanding about relationship between vitamin D3 and triglyceride.

2 Chapter Two: Literature Review

2.1 Literature review

Numerous researches have looked at the connections between triglycerides and vitamin D3, showing their complex roles in metabolic processes. Vitamin D3 is fat-soluble, hence its absorption, transport, and storage are all tied to lipid metabolism.

In order to better understand how vitamin D status impacts metabolic health and to provide evidence for the early detection of vitamin D deficiency (VDD) using the TyG index, one of the investigations sought to determine the relationship between the triglyceride-glucose (TyG) index and vitamin D status. The meta-analysis included nine research. Patients with vitamin D deficiency (VDD) had a substantially higher TyG index compared to those without (no-VDD), with a mean difference (MD) of 0.16 (95% CI: 0.10 to 0.23, I2 = 93%). Patients with type 2 diabetes (T2DM) had the strongest connection, with an MD of 0.15 (95% CI: 0.05 to 0.26, I2=55%). A negative association was found between the TyG index and vitamin D levels, with a correlation value (r) of -0.236 (95% CI: -0.310 to -0.159, I2=91%). The results were not materially altered when each study was excluded sequentially in the sensitivity analysis. The data reveal a substantial relationship between the TyG index and vitamin D status across varied groups, including individuals with T2DM, subclinical hypothyroidism (SCH), and metabolic related fatty liver disease (NAFLD)[13, 26].

Investigating the relationships between TG/HDL and insulin resistance (IR), impaired glucose tolerance (IGT), and diabetes mellitus at different VD3 levels was the aim of the subsequent investigation. According to their VD3 levels, 2,929 males and 3,031 females were divided into four groups using information from five National Health and Nutrition Examination Survey (NHANES) cycles. Logistic regression was used to investigate the connections between TG/HDL ratio and IR, IGT, and DM in various groups. The correlations between TG/HDL and IR, IGT, and DM demonstrated a threshold effect, with cutoff values of 1.094, 1.51, and 1.11, respectively. The association deteriorated on both sides of the cutoff values before improving when VD3 levels increased. TG/HDL is a risk factor for IR, IGT, and Diabetes. Both low and high levels of VD3 can exacerbate this link, whereas keeping VD3 at a moderate level helps to minimize the correlations between TG/HDL and IR, IGT, and DM[8].

1475 volunteers from Beijing, China's 306 Hospital of PLA's Centre for Physical Examination participated in the studySerum levels of 25(OH)D, total cholesterol (TC), triglycerides (TG), and high density lipoprotein cholesterol (HDL-C) were measured from fasting blood samples. and [10]low-density lipoprotein cholesterol (LDL-C) were determined. AIP was determined using the formula log [TG/HDL-C]. Multiple linear regression analysis was utilized to determine the relationships between serum 25(OH)D and lipids. Multiple logistic regression analysis was used to investigate the relationship between dyslipidemia and vitamin D levels. The adjustment took into account confounding variables such as age and BMI. The median serum 25(OH)D concentration was 47 (27-92.25) nmol/L in all individuals. The total proportion of 25(OH)D $\leq$ 50 nmol/L was 58.5% (males 54.4%, females 63.7%). In males, blood 25(OH)D levels were inversely linked with TG (β coefficient = -0.24, $p < 0.001$) and LDL-C (β coefficient = -0.34, $p < 0.001$), but positively associated with TC (β coefficient = 0.35, $p < 0.002$). In females, serum 25(OH)D levels were linked to TC (β coefficient = 0.39, $p = 0.001$) and LDL-C (β coefficient = -0.25, $p = 0.01$). Serum 25(OH)D levels were linked to AIP in men but not in women ($r = -0.111$, $p < 0.01$). Additionally, males with vitamin D deficiency had higher AIP values than those with adequate vitamin D.[10].

The cross-sectional research included 592 participants with type 2 diabetes. The participants were separated into two groups: non-vitamin D deficiency [25(OH)D≥20ng/mL] and vitamin D deficiency [25(OH)D<20ng/mL]. The triglyceride glucose (TyG) index is derived using the following equation: ln[fasting triglycerides (mg/dL)*fasting blood glucose (mg/dL)/2]. Participants were separated into two groups: high TyG and low TyG, with the median TyG serving as the border. All participants were classified into male and female groups, as well as normal and high BMI groups, and then further divided into high and low TyG groups. We discovered that TyG levels are independently and inversely linked with vitamin D levels in male T2DM patients. There was no significant association between TyG and vitamin D levels in the female group, whether adjusted or uncorrected for confounding factors. A subgroup analysis revealed that the connection between TyG and the risk of vitamin D insufficiency in the normal BMI group was much larger than in the high BMI group. This study found that vitamin D insufficiency is associated with a high TyG level in male T2DM patients, whereas this association is not significant for female patients[13].

Recent research has suggested a possible link between vitamin D deficiency and cardiovascular risk factors, including dyslipidaemia. This study sought to evaluate the relationship between serum 25(OH)D levels and atherogenic lipid profiles, especially small dense low-density lipoprotein cholesterol (sdLDL-C). From 2009 to 2011, 715 people aged 35 to 65 without obvious cardiovascular disease (CVD) were included. Their serum 25(OH)D and lipid profiles were assessed. Vitamin D insufficiency was shown to be more common among females, smokers, alcohol users, those of a younger age, and those who do not exercise frequently. The lipid profile study found that high sdLDL-C levels were related with low blood vitamin D levels and were more prevalent among cigarette smokers; alcohol drinkers; individuals with hypertension; individuals with high BMI; and those with high levels of fasting blood glucose, triglycerides, LDL-C, and VLDL-C. The use of multivariate logistic regression verified a strong negative correlation between low vitamin D status (serum 25(OH)D < 15 ng/mL) and the three identified biomarkers of atherogenic dyslipidemia: high serum levels of sdLDL-C, triglycerides, and VLDL-C. This study provides strong evidence that vitamin D deficiency is associated with atherogenic dyslipidemia, and in particular, high sdLDL-C levels in middle-aged adults without CVD[27, 28].

It is yet unknown how vitamin D and lipid levels relate to one another in terms of sex and age. During physical examinations, this retrospective study examined the relationships between blood 25-hydroxyvitamin D levels and many biomarkers, as well as the variations in these relationships by age and sex in 573 men and 436 women. The study population's mean age was 51.4 years, and 66% of participants had serum 25(OH)D levels less than 30 ng/mL. Women's 25(OH)D levels were lower than men's, and those over 65 had greater levels than those under that age. Independent risk variables for vitamin D insufficiency included being younger (odds ratio (OR) per year = 1.044, 95% CI, 1.029–1.059, p < 0.0001), female (OR = 1.779, 95% CI, 1.149–2.755, p = 0.0097), and having higher serum triglyceride (TG) levels (OR per 1 mg/dL = 1.005, 95% CI, 1.002–1.007, p = 0.0002). TG levels were negatively correlated with serum 25(OH)D levels. Hypertriglyceridemia and vitamin D insufficiency were significantly positively correlated in males (but not in women) and in those between the ages of 50 and 65. In conclusion, vitamin D insufficiency is more likely to occur in middle-aged men, women, and younger people with hypertriglyceridemia[12].

3 Chapter Three: Material and Methods

3.1 Material and Methods

A descriptive study conducted on the patients with Vitamin D3 and Lipide profile in the Erbil city, Data collected from January and February of 2025.

Preparatory phase

This phase was carried out in December 2024. The following activities including preparation of study tools, literature review and pilot study were done. Review of the literatures related to the study. Literature review was done for additional references, to help in preparation of the study tools**.**

Operational phase

This phase was carried out in January and February 2025. The following activities including preparation of study tools, literature review and pilot study were done:

Study setting:

The study was conducted in Erbil, Kurdistan, Iraq.

Study design:

A descriptive study was used for the implementation of the study.

Target population:

Patients presenting to (100) people and diagnosed as High or low Vitamin D3 and Lipid profile and the result of collected data presented in form of tables and graphs.

4 Chapter Four: Results

4.1 Results

4.1.1 Demographic Information

The table provides a breakdown of the respondents by age. The largest proportion of participants fell within the 35-44 age group (23.0%), followed by the 45-54 age group (20.0%). The 25-34 and 55-64 age groups represented 17.0% and 13.0% of respondents, respectively. Smaller proportions were observed in the 18-24 age group (15.0%) and those aged 65 or over (12.0%).

Table 4-1 : Age Distribution

Age	Frequency	Percent
18-24	15	15.0
25-34	17	17.0
35-44	23	23.0
45-54	20	20.0
55-64	13	13.0
65 or over	12	12.0
Total	100	100.0

The table outlines the gender distribution of the respondents. More than half of the participants were female (54.0%), while 46.0% were male. This indicates a slightly higher representation of females in the sample.

Table 4- 2: Gender Distribution

Gender	Frequency	Percent
Male	46	46.0
Female	54	54.0
Total	100	100.0

The figure provides a breakdown of the respondents’ body mass index (BMI). Over half of the participants were classified as overweight (54.0%), while 42.0% had a normal BMI. A small proportion of respondents were underweight (4.0%). This highlights a significant prevalence of overweight individuals in the sample.

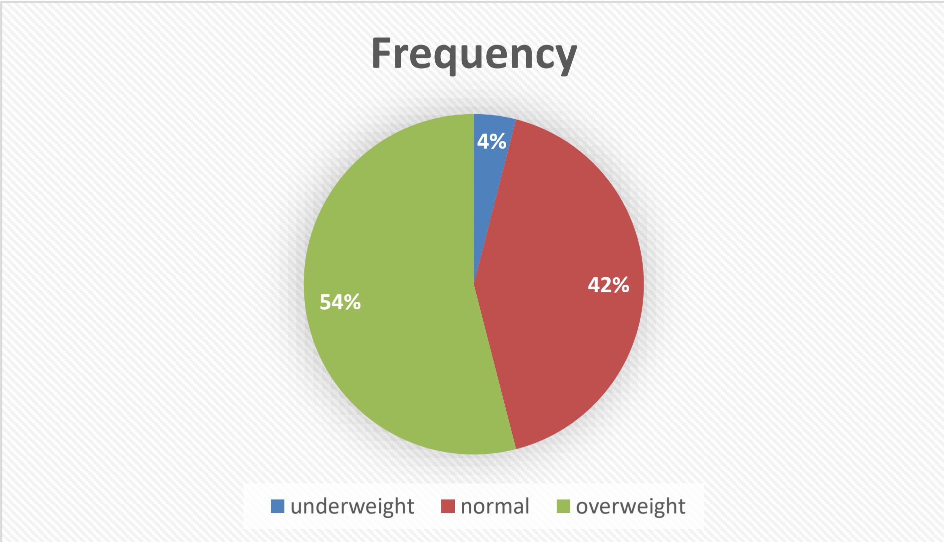

Figure 4- 1: BMI Distribution

The figure shows the distribution of respondents based on their place of living. The vast majority of participants resided in urban areas (83.0%), while a smaller proportion lived in rural areas (17.0%). This indicates a significant urban concentration in the sample.

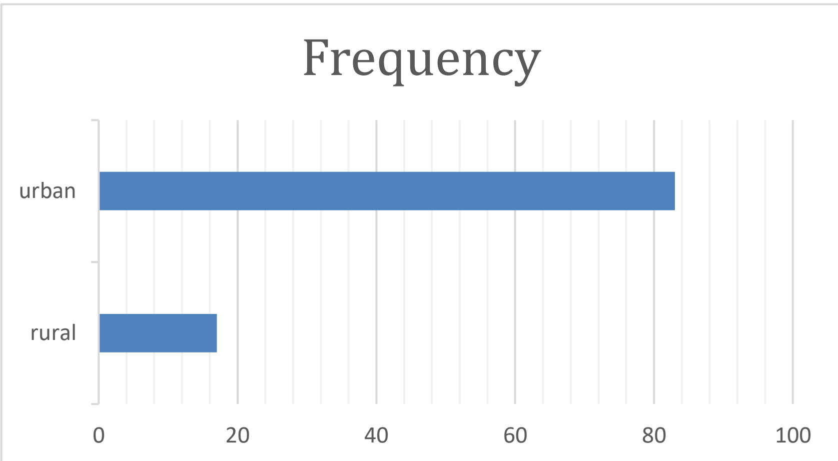

Figure 4- 2: Place of Living

The table details the current occupations of the respondents. The largest group of participants fell under the "others" category (41.0%), indicating a diverse range of occupations not explicitly listed. Employees and teachers each represented 12.0% of the sample, followed by doctors (8.0%), students and Peshmarga (7.0% each), police (5.0%), drivers (3.0%), chefs and managers (2.0% each), and lawyers (1.0%). This distribution reflects a varied occupational background among respondents.

Table 4- 3: Current Occupation

Current occupation	Frequency	Percent
Employee	12	12.0
Teacher	12	12.0
Doctor	8	8.0
Student	7	7.0
Peshmarga	7	7.0
Driver	3	3.0
Chef	2	2.0
Police	5	5.0
Lawyer	1	1.0
Manager	2	2.0
Others	41	41.0
Total	100	100.0

4.1.2 Medical History

The table provides a breakdown of respondents based on diagnosed health conditions. A significant proportion of participants reported no diagnosed health conditions (42.0%). Among those with conditions, the most common was blood pressure (22.0%), followed by hypertension (15.0%), heart disease (11.0%), diabetes (7.0%), and stroke (3.0%). This indicates that blood pressure and hypertension are the most prevalent health issues in the sample.

Table 4- 4: Diagnosed Health Conditions

Do you have any diagnosed health conditions?	Frequency	Percent
No	42	42.0
Hypertension	15	15.0
Heart disease	11	11.0
Stroke	3	3.0
Blood pressure	22	22.0
Diabetic	7	7.0
Total	100	100.0

The figure outlines whether respondents are currently taking any medications. Half of the participants reported taking medications (50.0%), while the other half were not (50.0%). This suggests an equal split in medication use among the respondents.

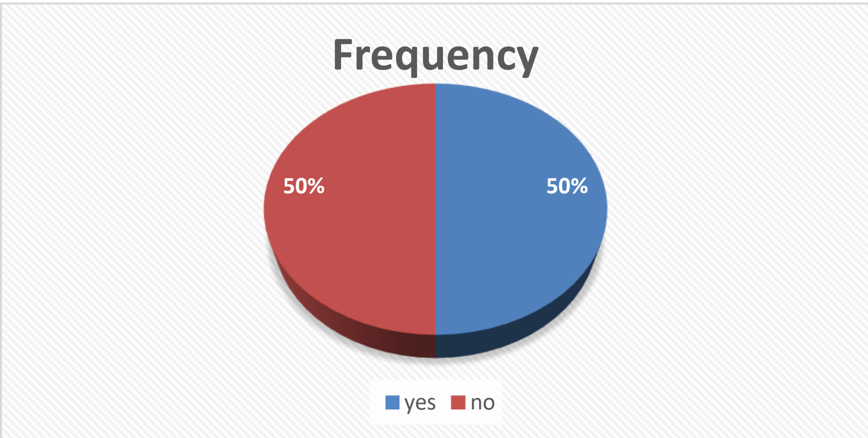

Figure 4- 3: Current Medication Use

The table shows the distribution of respondents diagnosed with high triglycerides. Slightly more than half of the participants reported a diagnosis of high triglycerides (52.0%), while 48.0% did not. This indicates a relatively high prevalence of high triglycerides in the sample.

Table 4- 5: Diagnosis of High Triglycerides

Have you been diagnosed with high triglycerides?	Frequency	Percent
Yes	52	52.0
No	48	48.0
Total	100	100.0

The table details the prevalence of vitamin D deficiency among respondents. A significant majority of participants reported being diagnosed with vitamin D deficiency in the past (66.0%), while 34.0% had no such diagnosis. This highlights a high prevalence of vitamin D deficiency in the sample.

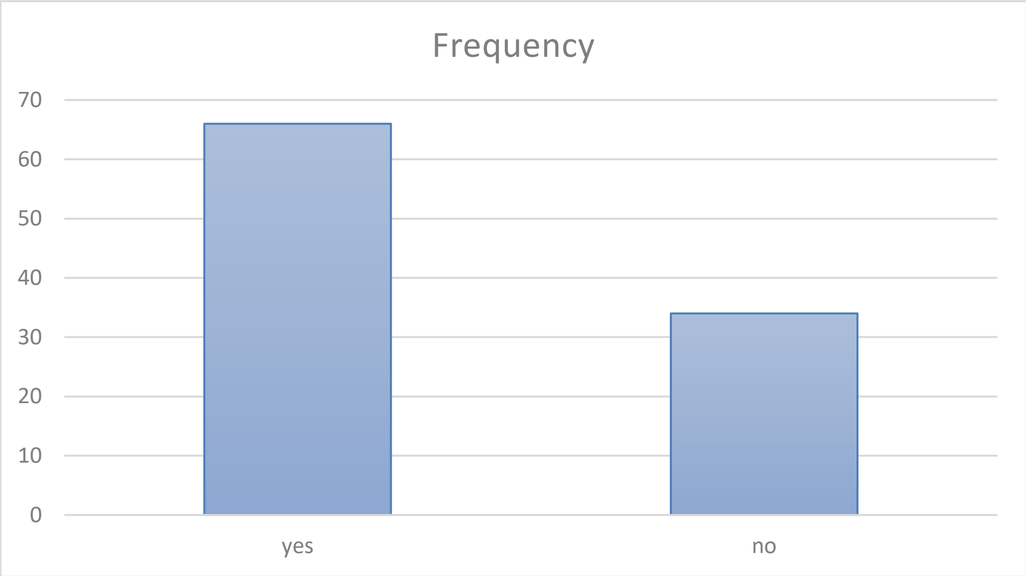

Figure 4- 4: Diagnosis of Vitamin D Deficiency

The table provides information on respondents’ family history of cardiovascular diseases. The majority of participants reported no family history of cardiovascular diseases (71.0%), while 29.0% indicated a positive family history. This suggests that most respondents do not have a familial predisposition to cardiovascular diseases.

Table 4- 6: Family History of Cardiovascular Diseases

Do you have a family history of cardiovascular diseases?	Frequency	Percent
yes	29	29.0
no	71	71.0
Total	100	100.0

4.1.3 Dietary Habits

The table provides a breakdown of how often respondents consume foods high in fats, such as fried foods, fatty meats, and fast foods. The majority of participants reported consuming such foods either daily (43.0%) or weekly (45.0%). A smaller proportion consumed them monthly (9.0%), rarely (2.0%), or never (1.0%). This indicates a high frequency of fatty food consumption among respondents.

Table 4- 7: Consumption of Foods High in Fats

How often do you consume foods with highly Fats (e.g., fried foods, fatty meats, fast foods)?	Frequency	Percent
Daily	43	43.0
Weekly	45	45.0
Monthly	9	9.0
Rarely	2	2.0
Never	1	1.0
Total	100	100.0

The table outlines how often respondents consume foods rich in vitamin D, such as fatty fish, egg yolks, and fortified foods. Nearly half of the participants reported consuming these foods daily (45.0%), while 36.0% consumed them weekly. A smaller proportion consumed them monthly (16.0%), rarely (1.0%), or never (2.0%). This suggests that vitamin D-rich foods are a regular part of the diet for most respondents.

Table 4- 8: Consumption of Foods Rich in Vitamin D

How often do you consume foods rich in vitamin D (e.g., fatty fish, egg yolks, fortified foods)?	Frequency	Percent
Daily	45	45.0
Weekly	36	36.0
Monthly	16	16.0
Rarely	1	1.0
Never	2	2.0
Total	100	100.0

The table details the use of vitamin D supplements among respondents. The largest proportion reported taking vitamin D supplements via injection (38.0%), followed closely by tablets (37.0%). A smaller group reported not taking any supplements (25.0%). This indicates that a significant majority of respondents rely on vitamin D supplementation in some form.

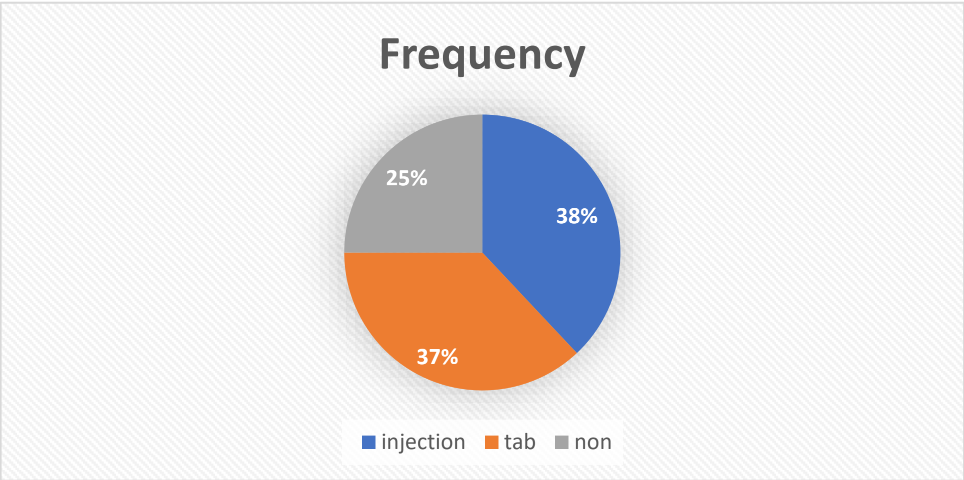

Figure 4- 5: Use of Vitamin D Supplements

The table shows how often respondents consume foods high in added sugars. A significant proportion reported consuming such foods daily (41.0%) or weekly (40.0%). A smaller group consumed them monthly (11.0%), rarely (4.0%), or never (4.0%). This highlights a frequent intake of sugary foods among respondents.

Table 4- 9: Consumption of Foods High in Added Sugar

How often do you consume foods high in added sugars?	Frequency	Percent
daily	41	41.0
weekly	40	40.0
monthly	11	11.0
rarely	4	4.0
never	4	4.0
Total	100	100.0

4.1.4 Lifestyle Factors

The table provides a breakdown of how often respondents engage in physical activity or exercise. The largest proportion of participants reported rarely engaging in physical activity (29.0%), followed by weekly (26.0%) and monthly (17.0%) engagement. A smaller group reported daily exercise (19.0%), while 9.0% never engaged in physical activity. This indicates that a significant portion of respondents have a sedentary lifestyle.

Table 4- 10: Frequency of Physical Activity or Exercise

How often do you engage in physical activity or exercise?	Frequency	Percent
daily	19	19.0
weekly	26	26.0
monthly	17	17.0
rarely	29	29.0
never	9	9.0
Total	100	100.0

The figure outlines the smoking habits of respondents. The majority of participants reported not smoking (73.0%), while 27.0% indicated that they smoke. This suggests that smoking is relatively common among a minority of respondents.

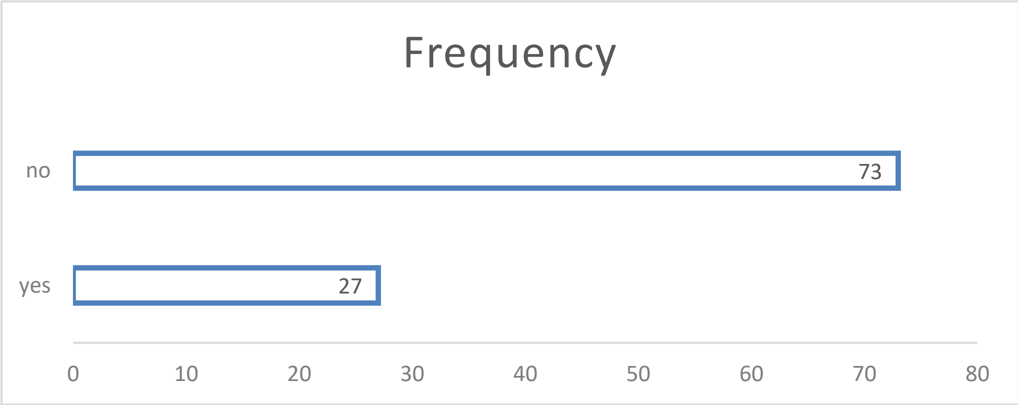

Figure 4- 6: Smoking Habits

The table details the alcohol consumption habits of respondents. The vast majority of participants reported not consuming alcohol (92.0%). A small proportion reported consuming alcohol once per week (5.0%), three times per week (2.0%), or rarely (1.0%). This indicates that alcohol consumption is uncommon among most respondents.

Table 4- 11: Alcohol Consumption

Do you consume alcohol?	Frequency	Percent
3 per week	2	2.0
1 per week	5	5.0
rarely	1	1.0
non	92	92.0
Total	100	100.0

The figure shows how many hours per day respondents typically spend outdoors. The largest group reported spending 1-2 hours outdoors daily (31.0%), followed by 2-3 hours (22.0%) and more than 6 hours (20.0%). Smaller proportions reported spending 3-4 hours (15.0%) or 5-6 hours (12.0%) outdoors. This suggests that most respondents spend a moderate amount of time outdoors each day.

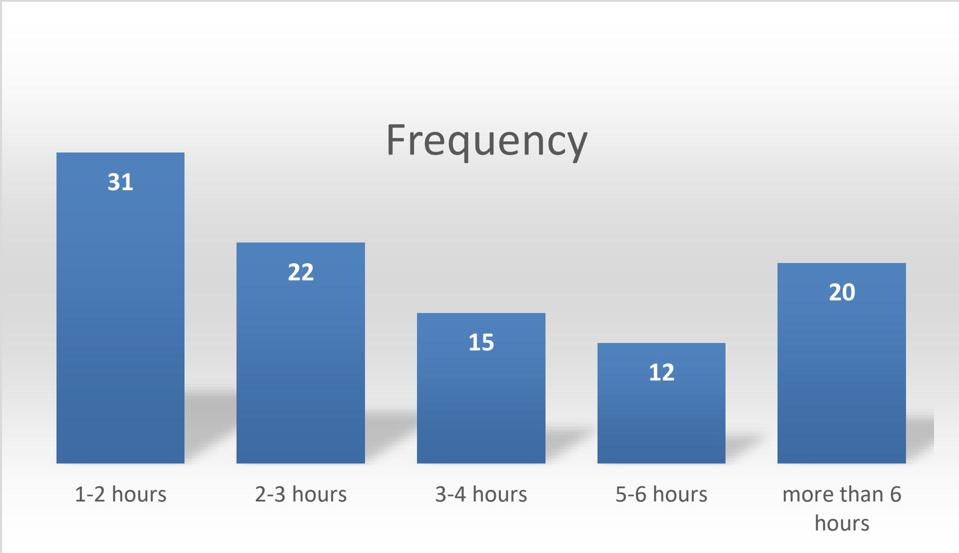

Figure 4-7: Time Spent Outdoors

4.1.5 Sun Exposure and Vitamin D

The table provides a breakdown of how many hours per week respondents spend in direct sunlight. The largest proportion of participants reported spending 1-2 hours in direct sunlight weekly (45.0%), followed by 2-3 hours (24.0%) and 3-4 hours (15.0%). Smaller groups reported spending 5-6 hours (10.0%) or more than 6 hours (6.0%) in direct sunlight. This indicates that most respondents have limited sun exposure.

Table 4- 12: Hours Spent in Direct Sunlight per Week

On average, how many hours per week do you spend in direct sunlight?	Frequency	Percent
1-2 hours	45	45.0
2-3 hours	24	24.0
3-4 hours	15	15.0
5-6 hours	10	10.0
more than 6 hours	6	6.0
Total	100	100.0

The table outlines how often respondents use sunscreen when outdoors. The majority of participants reported never using sunscreen (41.0%), while 20.0% reported using it sometimes, 18.0% often, and 16.0% rarely. Only 5.0% reported always using sunscreen. This suggests that sunscreen use is inconsistent or uncommon among most respondents.

Table 4-13: Use of Sunscreen When Outdoors

How often do you use sunscreen when outdoors?	Frequency	Percent
Always	5	5.0
Often	18	18.0
Sometimes	20	20.0
Rarely	16	16.0
Never	41	41.0
Total	100	100.0

The figure details during which seasons respondents spend the most time outdoors. The majority of participants reported spending the most time outdoors during spring (60.0%), followed by summer (18.0%), winter (16.0%), and fall (6.0%). This indicates a strong preference for outdoor activities during the spring season.

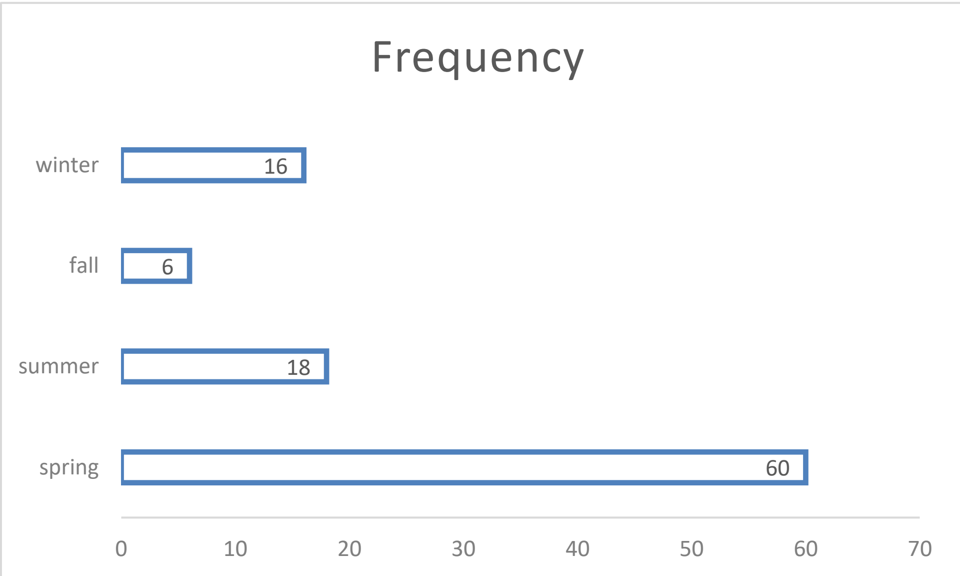

Figure 4-8: Seasons Spent Outdoors

The table shows how respondents describe the climate where they live. The largest proportion described the climate as cloudy (40.0%), followed by cold and warm (22.0% each). A smaller group described it as sunny (15.0%), and 1.0% selected "other." This suggests that cloudy and temperate climates are most common among respondents.

Table 4-14: Description of Climate

How would you describe the climate where you live?	Frequency	Percent
sunny	15	15.0
cloudy	40	40.0
cold	22	22.0
warm	22	22.0
other	1	1.0
Total	100	100.0

4.1.6 Blood Tests and Biomarkers

The table provides a breakdown of respondents' latest vitamin D levels. The largest proportion of participants had insufficient vitamin D levels (43.0%), followed by sufficient levels (29.0%) and deficient levels (26.0%). A very small group had levels indicating potential intoxication (2.0%). This highlights a significant prevalence of vitamin D insufficiency and deficiency among respondents.

Table 4-15: Latest Vitamin D Level (ng/mL)

What is your latest vitamin D level? (ng/mL)	Frequency	Percent
Deficient (<10)	26	26.0
Insufficient (10 - 29)	43	43.0
Sufficient (30 - 70)	29	29.0
Potential Intoxication (> 70)	2	2.0
Total	100	100.0

The figure outlines respondents' latest triglyceride levels. The largest proportion of participants had triglyceride levels within the 50–150 mg/dL range (37.0%), followed by those with levels higher than 150 mg/dL (36.0%). A smaller group had levels lower than 50 mg/dL (27.0%). This indicates a relatively even distribution of triglyceride levels, with a notable proportion having elevated levels.

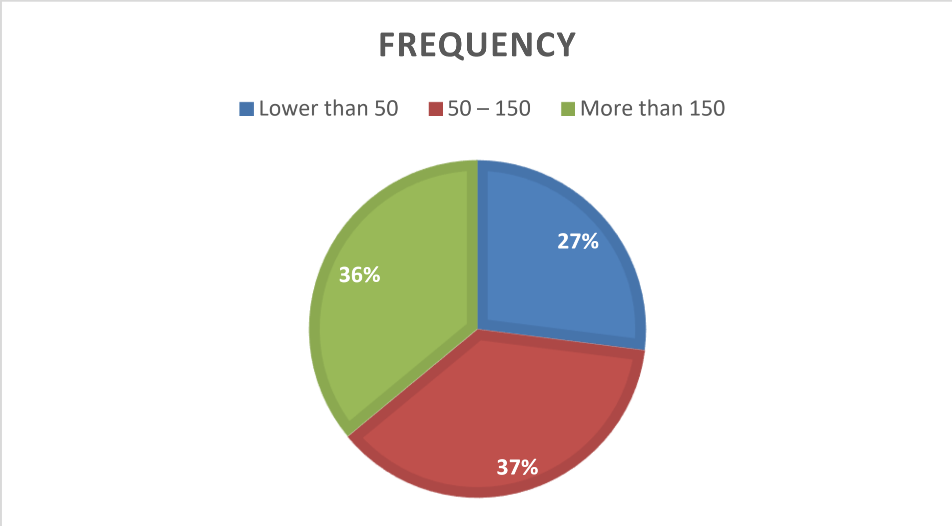

Figure 4- 9: Latest Triglyceride Level (mg/dL)

4.1.7 Perceived Health and Awareness

The table provides a breakdown of respondents' beliefs about the impact of vitamin D levels on heart health or triglyceride levels. The majority of participants did not believe that vitamin D levels impact heart health or triglyceride levels (53.0%), while 31.0% believed they do. A smaller group was unsure (16.0%). This indicates a lack of awareness or agreement among most respondents regarding this relationship.

Table 4- 16:Belief in the Impact of Vitamin D on Heart Health or Triglyceride Levels

Do you believe that vitamin D levels impact heart health or triglyceride levels?	**Frequency**	**Percent**
Yes	31	31.0
No	53	53.0
Ensure	16	16.0
Total	100	100.0

The figure outlines how respondents rate their overall health. The largest proportion of participants rated their health as good (65.0%), followed by fair (20.0%). Smaller groups rated their health as poor (9.0%) or excellent (6.0%). This suggests that most respondents perceive their health to be good, though a notable proportion report fair or poor health.

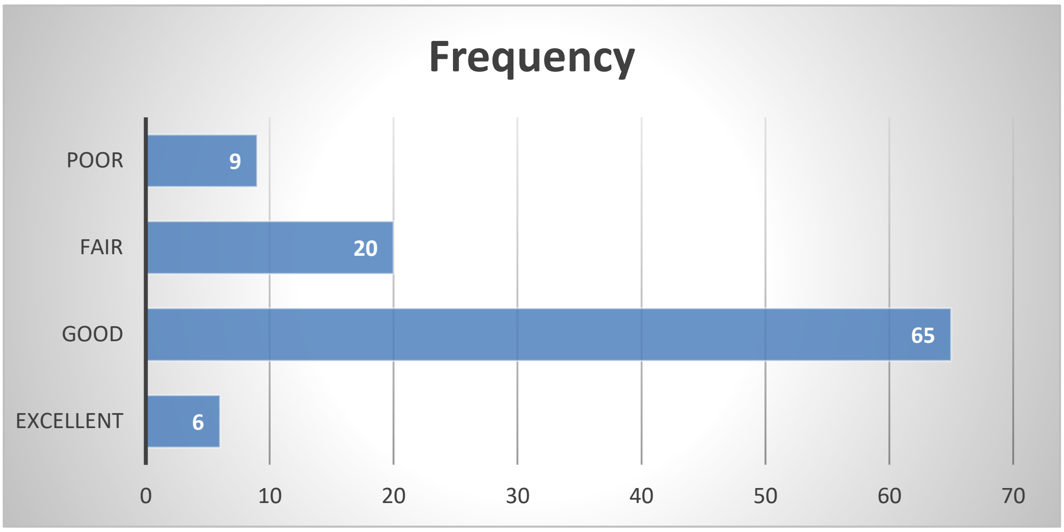

Figure 4-10: Self-Rated Overall Health

The figure details respondents' awareness of any link between vitamin D and lipid levels. The vast majority of participants were not aware of such a link (81.0%), while only 19.0% were aware. This highlights a significant lack of awareness about the connection between vitamin D and lipid levels among respondents.

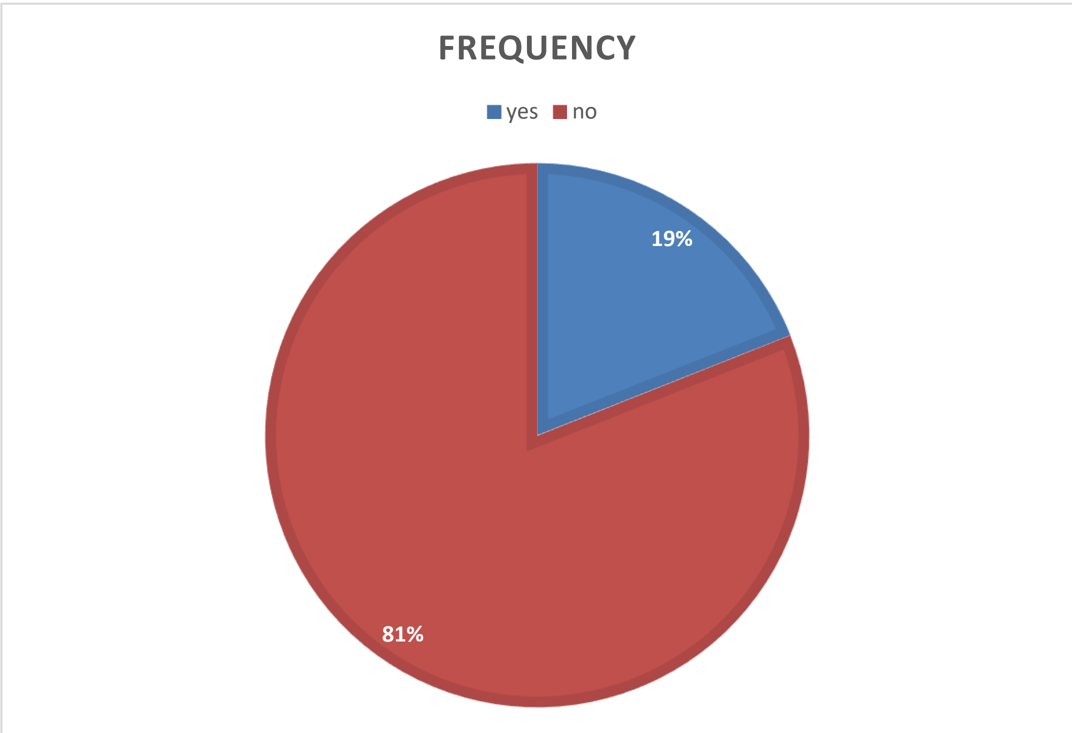

Figure 4-11: Awareness of the Link Between Vitamin D and Lipid Levels

5 Chapter Five: Discussion and Conclusion

5.1 Discussion

The connection of vitamin D deficiency with raised triglycerides was similar to previous observational studies, indicating that the relationship may be a feature in different populations. In this study, however, most of the subjects had increased triglyceride levels as well as low serum 25(OH)D levels. This finding was consistent with the research by [29] who have found a significant inverse relationship between vitamin D levels and triglycerides, indicating that decreasing serum 25(OH)D concentrations would lead to elevated triglyceride levels. The inverse correlation indicates a likely regulatory effect of vitamin D on lipid metabolism. In fact, [30]linked hypovitaminosis D to insulin resistance-hepatically synthesized triglycerides are positively regulated. More than half of the participant subjects (54%) were classified as overweight. Overweight, typically, is accompanied by insulin resistance. This condition has potentially added fuel to both vitamin D deficiency and lipid derangement, thereby reinforcing the stated relationship. In line with this, [31] showed that increased dietary intake of vitamin D was associated with reduced triglyceride levels and lower BMI, findings which match demographic characteristics in the present study where overweight people were found with a significantly higher prevalence of vitamin D deficiency as well as dyslipidemia. Such observations by themselves from many observational studies could support the theory that low vitamin D status may contribute significantly to poor lipid profiles, particularly in people with pre-existing metabolic vulnerabilities.

The core rationale for this general lack of consensus is probably to be found in some key methodological differences one might draw between observational studies versus interventional trials. First, the baseline vitamin D status of participants enrolled in many RCTs is often higher than the vitamin D status observed in this study. In this study, a significant number of participants were severely vitamin D-deficient, having serum 25(OH)D concentrations that were less than 10 ng/mL, while many RCTs had participants with levels in the range of 20-30 ng/mL. This difference in the status at baseline would tend to dilute the observed effect of supplementation, as mild vitamin D insufficiency cases may not respond dramatically to treatment. Second, most intervention trials have had relatively short durations-of often restricted to 6 months or less-in which to observe potentially meaningful changes in triglyceride levels. The third difference lies with the characteristics of the subjects recruited in this study, which are quite different than the common characteristics of subjects enrolled in RCTs. Presently, the sample in this study was predominantly overweight (54%), almost fully residing in an urban environment (83%)-conditions associated with an increased metabolic risk. In other studies, or clinical trials, participants with relatively higher health status have been recruited, allowing the masking of putative effects of vitamin D on lipid metabolism in the at-risk group. Complicating these findings, [32]recorded that vitamin D supplementation could not decrease triglycerides in patients with type 2 diabetes. Thereby indicating that in cases with extreme metabolic disturbances such as T2DM, alterations in lipid levels may occur with far more than just vitamin D. Not stratifying the groups in this study by diabetes status could also have contributed to discrepancies seen in triglyceride levels among the study participants with differing levels of vitamin D deficiency.

Several mechanisms have been proposed that could explain why vitamin D deficiency might lead to increased triglycerides. The discussion of such mechanisms in this paper provides a rationale to interpret the observed associations. One major pathway relates to vitamin D's anti-inflammatory properties. These immunomodulatory activities may arise from inhibition of nuclear factor-kappa B (NF-kB) and the downregulation of proinflammatory cytokines, including interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), as per [33]. Chronic low-grade inflammation, seen predominantly among the obese, is known to upregulate hepatic triglyceride production while downregulating lipid clearance. One-third of the subjects (29%) in the present study indicated low levels of physical activity—a behavior that is commonly associated with systemic inflammation. The combination of such inactivity and vitamin D deficiency may further induce inflammatory processes, aggravating triglyceride profiles. Another mechanism could involve alteration of calcium-PTH homeostasis. Vitamin D stimulates intestinal calcium absorption, but if the levels are low, calcium deficiency may be compensated by increasing PTH secretion. High levels of PTH can stimulate lipogenesis via increased intracellular calcium in adipocytes, thereby also enhancing fatty acid synthase expression [34].In this study, PTH was not directly measured, but the high prevalence of overweight subjects, who commonly experience impaired calcium metabolism, indicates that this pathway could have contributed to the lipid derangements observed. Vitamin D also enhances insulin sensitivity by increasing insulin receptor expression and stimulating pancreatic β-cell function [30].In the context of insulin resistance, a common finding in overweight subjects, this increased hepatic production of very-low-density lipoprotein (VLDL) while decreasing lipoprotein lipase activity, thus raising circulating triglyceride levels. The large proportion of overweight subjects in the present study provides a stronger link toward the possibility of insulin resistance being an intermediate pathway through which low vitamin D levels could lead to hypertriglyceridemia. Furthermore, evidence is emerging that genetic and epigenetic plays a role here. mentioned that polymorphisms in the vitamin D receptor (VDR) gene, particularly the FokI variant, may influence vitamin D effects on lipid metabolism. Although genetic data were not collected in this study, future studies should consider including genetic screening to allow for examinations into whether individual differences in VDR expression may modulate responses to vitamin D and its role in regulating triglyceride levels.

The study has some merits, making it noteworthy and relatable. One strength is that it reflects real-life circumstances. The very high vitamin D deficiency (66%) and elevated triglyceride levels (52%) observed in this study simulate conditions often witnessed in an urban setting with less sunshine, sedentary lifestyle patterns, and dietary insufficiencies being rampant. In this study, 83% of the participants lived in an urban environment, and almost half spent less than two hours in the sun. This finding points to the environmental circumstances in which hypovitaminosis D becomes established. In addition, the fact that overweight participants represent 54% of the sample could also strengthen the results considerably, as this group tends to suffer more from both vitamin D deficiency and lipid abnormalities. In contrast, the considerable proportion (81%) of participants who did not know about the connection between vitamin D and lipid metabolism illustrates a serious deficiency in health education and literacy, giving great urgency to targeted public health messaging. This study has its limitations. Because of its cross-sectional design, it cannot estimate causality; that is, it is still not clear whether low vitamin D causes elevation in triglycerides or vice versa or whether a third variable might affect both at the same time. The lack of the evaluation of key mechanistic end-point indicators such as PTH levels, inflammation status, or even genetic profiles does not allow for conclusions on the exact biological mechanisms. Heavy urban representation may inadvertently lead to selection bias, making worse generalizability for rural populations, who might have other lifestyle behaviors, sun-exposure patterns, and dietary habits.

To conclude from such findings, we have a whole lot of recommendations for the clinic and public health. First comes the consideration of targeted screening for vitamin D deficiency in adults who are overweight and have elevated triglyceride levels, as they seem to be at increased risk. Second, therapy must not be vitamin D-based alone, but should take a more global approach. For example, vitamin D is very much likely to have synergistic effects when given together with omega-3 fatty acids concerning anti-inflammation and improvement of lipid regulation [33]. Interventions for weight loss also should be highly encouraged, as these may enhance insulin sensitivity and the bioavailability of vitamin D by reducing fat tissue. Public health-wise, campaigns should be run to create awareness among the masses about the metabolic importance of vitamin D. This study illustrated that the majority of study participants had no knowledge of vitamin D and its relationship to lipid health, an important hindrance to prevention and early intervention. Health education must encompass support for sources of vitamin D in diets such as fatty fish and fortified foods as well as safe sun exposure and regular physical activity.

Future research may pursue a number of avenues to build on the findings of this study. Longitudinal studies will be required to clarify whether a temporal or potentially causal relationship exists between vitamin D status and triglyceride levels. Moreover, stratified RCTs should be carried out to determine, if, in severe deficiency (for example, <10 ng/mL), greater lipid-related benefits may proffer from vitamin D supplementation compared to those with milder forms of insufficiency. Finally, if genetic analyses are incorporated in future studies, it might shed light on whether specific VDR polymorphisms or other genetic markers possibly alter lipid metabolism-related individual responsiveness to vitamin D therapy.

5.2 Conclusion

- The study provides good evidence that vitamin D deficiency is strongly correlated with high triglyceride levels, especially in overweight with urban lifestyle individuals.
- Regarding to marital status there was no highly difference between male and female.
- The majority of the cases were between (35 to 54) years according to age group.
- According to this study the most of cases consuming foods with Hight fats daily and weekly
- Statistically there was association between Vitamin D and triglyceride.
- According to body mass index (BMI) the majority of the cases were overweight.
- Most of the cases were not doing physical activity regularly.
- This study detected that most of cases were consuming vitamin D daily and weekly.
- According to this study the majority of cases were spent outdoor between 1-2 hours daily which is 31% comparing to 5-6 hours were 12%

5.3 Recommendation

1. Increase awareness for lifestyle modification for balanced diet, moderate physical activity practice, healthy body weight, and avoidance of smoking and alcohol.
2. Establish an integrated ongoing public information program for health education about Taking Vitamin D supplements
3. Foods containing carbohydrate from whole grains, fruits, vegetables, and low-fat milk should be included in a healthy diet.
4. Construct suitable guidelines in the light of the available international guidelines and training to increase the skills of the health care providers.
5. Appropriate referrals and diagnostic follow up to avoid delay in diagnosis with Vitamin D deficiency.
6. Encouraging people to expose to the sun more than1-2 hours daily.
7. Education the people to reduce of consuming foods with low fat and eating foods which contain vitamin D.

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ملخص

الخلفية: فيتامين د هو مجموعة من المركبات القابلة للذوبان في الدهون والمرتبطة هيكليًا، وهي مسؤولة عن زيادة امتصاص الكالسيوم والمغنيسيوم والفوسفات في الأمعاء، إلى جانب العديد من الوظائف البيولوجية الأخرى .وقد حظيت العلاقة بين الدهون الثلاثية وفيتامين د3 باهتمام كبير في الأوساط العلمية نظرًا لأهميتها في عملية التمثيل الغذائي البشري والصحة العامة .يستكشف هذا البحث كيفية ارتباط تركيزات فيتامين د3 في المصل بملفات الدهون، وتحديدًا مستويات الدهون الثلاثية لدى أشخاص من أربيل، كردستان، العراق .

المنهجية: جمعت هذه الدراسة الوصفية المقطعية بيانات من 100 مريض عانوا من مستويات منخفضة أو مرتفعة من فيتامين د3، بالإضافة إلى ملفات الدهون، خلال شهري يناير وفبراير 2025 .

النتائج: أظهرت نتائج البحث أن ارتفاع مستويات فيتامين د3 يتوافق مع انخفاض مستويات الدهون الثلاثية، خاصةً لدى الأشخاص الذين يعانون من زيادة الوزن، مما يشير إلى دور فيتامين د في التحكم في عملية التمثيل الغذائي للدهون .وقد حدد الباحثون مسارات كيميائية حيوية مختلفة يستخدمها نقص فيتامين د لإحداث اضطراب شحميات الدم من خلال آليات مرتبطة بالالتهاب ومقاومة الأنسولين، إلى جانب توازن الكالسيوم مع هرمون الغدة جار الدرقية .

الخلاصة: يُشدد البحث على ضرورة إجراء فحص وتثقيف صحي حول حالة فيتامين د، على الرغم من التحديات المنهجية التي تواجهه، مثل تصميمه الرصدي وعينته التي تركز على المناطق الحضرية .وتُظهر النتائج ضرورة اتخاذ تدابير الصحة العامة وإجراء بحوث طولية وتدخلية مستقبلية، تأخذ في الاعتبار الاختلافات الجينية وتُصنف المشاركين بناءً على مستويات نقص فيتامين د لديهم، وذلك لتعزيز فهمنا للآثار الأيضية لنقص فيتامين د وإدارتها.

پوختە

پێشینە: ڤیتامین D کۆمەڵێک پێکهاتەی پەیوەندیدارە لە ڕووی پێکهاتەوە و لە چەوریدا دەتوێتەوە کە بەرپرسن لە زیادکردنی مژینی ڕیخۆڵەی کالیسیۆم، مەگنیسیۆم و فۆسفات، لەگەڵ چەندین ئەرکی بایۆلۆژی دیکە. پەیوەندی نێوان ترایگلیسیرید و ڤیتامین D3 لە کۆمەڵگەی زانستیدا گرنگییەکی زۆری پێدراوە بەهۆی گرنگییەکەی لە میتابۆلیزمی مرۆڤ و تەندروستی گشتیدا. ئەم توێژینەوەیە لێکۆڵینەوە لەوە دەکات کە چۆن چڕیی ڤیتامین D3 لە سیرۆمدا پەیوەندی بە پرۆفایلی چەوری و بە تایبەتی ئاستی ترایگلیسیرید لە کەسانی هەولێر، کوردستان، عێراقدا هەیە.

شێوازەکان: ئەم توێژینەوەیە وەسفکەرەی بڕبڕەیی زانیارییەکانی لە 100 نەخۆش کۆکردەوە کە ئاستی ڤیتامین D3 یان نزم یان بەرزیان هەبوو لەگەڵ پرۆفایلی چەوری لە ماوەی مانگەکانی یەکەم و شوباتی 2025.

دەرەنجامەکان: ئەنجامەکانی توێژینەوەکان دەریانخست کە ئاستی بەرزی ڤیتامین D3 هاوتایە لەگەڵ ئاستی نزمبوونەوەی ترایگلیسیرید بەتایبەتی لە کەسانی کێشی زیادەدا کە ئاماژە بە ڕۆڵی ڤیتامین D دەکات لە کۆنترۆڵکردنی میتابۆلیزمی چەوریدا. توێژەران ڕێڕەوی بایۆکیمیایی جۆراوجۆریان دەستنیشان کردووە کە کەمی ڤیتامین D بەکاریدەهێنێت بۆ هاندانی نارێکی چەوری خوێن لە ڕێگەی میکانیزمەکانی پەیوەست بە هەوکردن و بەرگری ئەنسۆلین شانبەشانی هێمۆستاسیس کالیسیۆم-PTH.

دەرەنجام: توێژینەوەکە جەخت لەسەر پێویستی سکرینکردن و پەروەردەی تەندروستی دەکاتەوە سەبارەت بە دۆخی ڤیتامین D هەرچەندە ڕووبەڕووی ئاستەنگی میتۆدۆلۆژی دەبێتەوە وەک دیزاینی چاودێری و نمونەی سەرنجڕاکێشی شارەکان. دۆزینەوەکان پێویستی ڕێوشوێنی تەندروستی گشتی و لێکۆڵینەوە درێژخایەن و دەستێوەردانەکانی ئایندەیی نیشان دەدەن کە گۆڕانکارییە بۆماوەییەکان لەبەرچاو دەگرێت و بەشداربووان چینبەندی دەکات بە پشتبەستن بە ئاستی کەمییان بۆ پێشخستنی تێگەیشتن و بەڕێوەبردنی ئێمە لە کاریگەرییەکانی گۆڕانکارییەکانی کەمی ڤیتامین D.