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Vitamin D Status and Its Association with Lifestyle and Metabolic Variables Among Adult Male in Nepal: A Cross-Sectional Study

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ABSTRACT

Background: Vitamin D plays a crucial role in various physiological processes, including metabolic regulation. This study aimed to investigate the association between vitamin D status and metabolic and lifestyle variables among adult males in Nepal.
Methods: A cross-sectional survey was conducted from May 1 to June 12, 2024, in Bharatpur Metropolitan City, Chitwan, Nepal. A sample of 131 men aged 18-70 years was selected using the Cochran formula at a 95% confidence level. Serum 25-hydroxyvitamin D [25(OH)D] levels were measured to categorize vitamin D status as deficient (<20 ng/ml), insufficient (20-30 ng/ml), or sufficient (>30 ng/ml). Metabolic variables, including body mass index (BMI), waist-to-hip ratio (WHR), cholesterol, triglycerides, and high-density lipoprotein (HDL), were collected. Lifestyle factors like age, smoking, alcohol consumption, and diet type were also assessed. Data were analyzed using SPSS version 23, with significance set at $p < 0.05$.
Results: Vitamin D deficiency was significantly associated with higher WHR (p = .000), BMI (p = .000), cholesterol (p = .007), triglycerides (p = .001), and lower HDL levels (p = .000), compared to sufficient vitamin D levels. However, no significant associations were found between vitamin D status and lifestyle factors such as age (p = .657), smoking (p = .356), alcohol consumption (p = .245), and diet type (p = .903).
Conclusion: The study highlights significant relationships between vitamin D status and metabolic markers including WHR, BMI, cholesterol, triglycerides, and HDL. Monitoring vitamin D levels in individuals with metabolic risk factors is crucial for early intervention. Further research is needed to explore the interaction between vitamin D, lifestyle, and metabolic health in diverse populations.

Keywords: Vitamin D, metabolic health, lifestyle factors, Nepal

1. INTRODUCTION

Vitamin D plays a crucial role in supporting bone health in men by enhancing bone density and reducing the risk of osteoporosis through its essential function in calcium absorption.[1] Additionally, it contributes significantly to joint health by alleviating inflammation and maintaining cartilage integrity.[2] Beyond its skeletal benefits, vitamin D is also associated with cardiovascular health, influencing the risk of conditions such as heart failure, myocardial infarction, and overall heart health.[3] In older adults, vitamin D deficiency has been linked to low bone mineral density, which can lead to secondary hyperparathyroidism and the calcification of coronary arteries, ultimately contributing to an increased risk of cardiovascular diseases.[4]

This deficiency is particularly prevalent among older adults, females, and individuals following vegetarian diets.[5] [6] Furthermore, insufficient vitamin D levels have been significantly associated with various metabolic parameters, including obesity, hypertension, diabetes, and cardiovascular diseases.[7] Research indicates that vitamin D supplementation can positively impact lipid profiles, effectively reducing total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), and glycated hemoglobin (HbA1c).[8] However, insufficient vitamin D levels are also connected to lifestyle factors such as dietary patterns, alcohol consumption, smoking habits, and sun exposure.[9] Despite these associations, conflicting results exist regarding vitamin D levels and their relationship with these lifestyle variables, largely due to differences in measurement techniques, metabolic parameters influencing vitamin D metabolism, and lifestyle differences between alcohol consumers and non-consumers.[10]

Therefore, this study aims to assess the relationship between serum vitamin D levels and metabolic parameters, as well as lifestyle factors, including diet, smoking habits, and alcohol consumption, among adult men living in Bharatpur, Nepal. By understanding these associations, the study seeks to illuminate the importance of vitamin D in this population and its potential implications for public health.

2. METHODS AND MATERIALS

Study Design, Study Site, and Participants

This cross-sectional survey was carried out in Bharatpur Metropolitan City, a sub-urban area of Chitwan District, Nepal, over the course of one month, from May 1 to june 12, 2024. Using a 95% confidence level and a 5% margin of error, the sample size was determined based on a previously published 6.3% prevalence rate of vitamin D deficiency.[11] Based on Cochran formula, 131 men between the ages of 18 and 70 who had routinely visited Chitwan Medical College were chosen for the study. The main objective was to evaluate the relationship between several metabolic parameters (body mass index, waist-to-hip ratio, blood glucose, triglycerides, cholesterol, high density lipoprotein), lifestyle factors, and serum 25(OH)D levels was assessed.

$n = Z^2 P (1-P) / d^2$

n= Sample size, Z = 95% level of confidence, P= 6.3% previous prevalence, d = 5% margin error

The recruitment of female participants was based on their routine medical follow-up at the outpatient department of Chitwan Medical College and Teaching Hospital. Before any participant was included in the study, written informed consent was obtained from them all. Men who visited the internal medicine outpatient department of Chitwan Medical College for routine checkups and who were at least eighteen years old and more meet the inclusion criteria. Men, those on vitamin D supplements, and those with any known chronic illness that may impact vitamin D metabolism are all excluded.

Outcome Variables and Criteria for Vitamin D Status

The assessment of vitamin D status was determined by serum 25(OH) D levels. Three categories were established for vitamin D levels: insufficiency (20-30ng/ml), sufficiency (≥30 ng/ml), and deficiency (<20 ng/ml).[12]

Data Collection

Data collection involved structured questionnaires to assess lifestyle factors such as age, smoking habits, alcohol consumption, and dietary patterns. Physical measurements, including height, weight, body mass index (BMI), waist circumference, and blood pressure, were taken. Blood samples were also collected to measure fasting blood glucose, serum 25-hydroxyvitamin D (25(OH)D) levels, triglycerides, cholesterol, and high-density lipoprotein (HDL). The assessments utilized various equipment, including a digital weighing scale, a stadiometer, a non-stretchable measuring tape, an Omron-5 series digital blood pressure monitor, and specific assays: hexokinase assay for blood glucose[13], chemiluminescence immunoassay (CLIA) for vitamin D,[14] glycerol phosphate oxidase/phenol aminoantipyrine peroxidase (GPO/PAP) for triglycerides,[15] cholesterol oxidase/phenol aminoantipyrine peroxidase (CHOD/PAP) for cholesterol,[16] and the direct method (dextran sulfate) for measuring high-density lipoprotein (HDL).[17]

Blood Sample Collection and Analyses

The blood samples from adult men were obtained from the left arm. The blood was collected in a yellow-stopped vacutioner tube, then stored in an ice box and transported to the Biochemistry department at Chitwan Medical College Hospital within 20 minutes. The samples were centrifuged at 3000 rpm for 10 minutes to separate the serum. The serum samples were then analyzed for glucose concentration, 25-hydroxyvitamin D (25(OH)D), triglycerides, cholesterol, and high-density lipoprotein (HDL) using the hexokinase method, chemiluminescence immunoassay (CLIA), glycerol phosphate oxidase/phenol aminoantipyrine peroxidase (GPO/PAP), cholesterol oxidase/phenol aminoantipyrine peroxidase (CHOD/PAP), and the direct method (dextran sulfate), respectively.

STATISTICAL ANALYSIS

Statistical package for the social sciences (SPSS) window version 23 was used to run statistical analyses on the data that had been collected. In this study, the status of vitamin D was examined in relation to a wide range of lifestyle and metabolic variables. The results were presented as percentages of patients with varied vitamin D status levels. Using the Chi-square test, the prevalence of vitamin D deficiency, insufficiency, and sufficiency was examined across the variables, with a significance level of $p < 0.05$. Using one-way ANOVA, the means and standard deviations of the metabolic variables were compared statically across vitamin D categories. The F value (variance) between groups was then analyzed, and the level of significant p value was set at $p < 0.05$.

Ethical Considerations

The Institutional Review Board (IRB) of Chitwan Medical College granted ethical clearance (reference code CMC-IRC/080/081/094). Written informed consent was given by each subject. The Helsinki Declaration's ethical criteria were adhered to, thus participant rights and welfare were safeguarded throughout all processes carried out in research involving human subjects.

3. RESULTS

As shown in Table 1, none of the variables showed a statistically significant association with vitamin D status among adult male in Nepal. The distribution of vitamin D deficiency (<20 ng/ml), insufficiency (20-30 ng/ml), and sufficiency (>30 ng/ml) across different age groups, smoking status, alcohol consumption and diet type was analyzed. For age, both those below 65 years (P = .657) and those 65 years and above had similar rates of deficiency, insufficiency, and sufficiency. Smoking status (P = .356), alcohol consumption (P = .245), and diet type (P = .903) did not show any significant differences in vitamin D levels.

Table 1. Vitamin D status across various lifestyles and metabolic variables

Variables	**Vitamin D Status**			**P**
	Deficiency <20 ng/ml (n %)	**Insufficiency 20-30 ng/ml (n %)**	**Sufficiency >30 ng/ml (n %)**	
Age				.657
<65 (n=95)	18(18.9 %)	27(28.4%)	50(52.6 %)	
≥65 (n=36)	9(25.0%)	8(22.2%)	19(52.8%)	
Smoking Status				.356
Smoker (n=18)	6(33.3 %)	4(22.2%)	8(44.4%)	
Non-Smoker (n=113)	21(18.6 %)	31(27.4 %)	61(54.0%)	
Alcohol Consumption				
Yes (n=13)	4(30.8%)	3(23.1%)	6(46.2%)	.245
No (n=118)	23(19.5%)	32(27.1%)	63(53.4%)	
Diet type				
Vegetarian (n= 21)	4(19.0 %)	5(23.4 %)	12(57.1%)	.903
Non-vegetarian (n=107)	23(20.9 %)	27(28.3%)	57(51.8%)	

***P < 0.05, significant association**
****P < 0.01, highly significant association**
n % = number of patient percentage

As observed in Table 2. Significant associations between Vitamin D status and several metabolic variables. Waist-to-hip ratio (WHR) was significantly higher in participants with Vitamin D deficiency compared to those with sufficiency (P = .000). Similarly, BMI showed a significant decrease from the deficiency group to the sufficiency group (P = .000). Cholesterol levels were also significantly associated with Vitamin D status, with the deficiency group having the highest mean levels (P = .007). Fasting serum triglycerides (TG) exhibited a notable decline from the deficiency group to the sufficiency group (P = .001). Additionally, serum HDL levels increased significantly across the groups, with the sufficiency group having the highest levels (P = .000).

Table 2. Metabolic variables across different Vitamin D status groups

Variable	**Deficiency <20ng/ml)**		**Insufficiency 20-30 ng/ml**		**Sufficiency >30 ng/ml**		**P**
	Mean	**±SD**	**Mean**	**±SD**	**Mean**	**±SD**	
Age (year)	56.63	10.92	52.60	16.58	55.67	11.49	.407
WHR (Waist-to-Hip Ratio)	1.08	.073	1.02	.099	0.94	0.116	.000**
BMI (kg/m²)	29.09	4.35	25.88	4.55	24.51	5.21	.000**
SBP (mmHg)	129.63	14.13	123.43	18.93	123.70	12.23	.168
DBP (mmHg)	83.52	5.34	80.23	6.99	82.61	5.72	.072
Cholesterol (mg/dL)	205.19	124.13	228.46	140.10	164.46	57.44	.007**
Fasting Serum TG (mg/dL)	189.48	103.04	183.17	122.89	127.99	43.64	.001**
Serum HDL (mg/dL)	39.52	15.33	103.86	70.85	106.41	24.03	.000**
Fasting Blood sugar (mg/dL)	91.07	15.33	103.86	70.15	106.41	24.03	.251

***P < 0.05, significant association**
****P < 0.01, highly significant association**

4. DISCUSSIONS

This cross-sectional study aimed to investigate the association between vitamin D status and various lifestyle and metabolic variables among adult males in Nepal. The findings demonstrated that several metabolic variables, including waist-to-hip ratio (WHR), body mass index (BMI), cholesterol, triglycerides (TG), and high-density lipoprotein (HDL) levels, were significantly associated with vitamin D status. However, lifestyle factors such as age, smoking status, alcohol consumption, and diet type did not show any significant association with vitamin D levels.

In the context of metabolic health, vitamin D has been increasingly recognized for its role in maintaining homeostasis.[18] One of the key findings of this present study was the significant association between WHR and vitamin D status Table 2. Individuals with vitamin D deficiency had a higher WHR compared to those with sufficient levels (P = .000). Waist-to-hip ratio (WHR) is a well-established marker of abdominal obesity and is linked to various metabolic disorders, including insulin resistance, type 2 diabetes, and cardiovascular diseases.[19] Association between increased WHR and low vitamin D levels in this study suggests that individuals with abdominal obesity are at a higher risk of vitamin D deficiency, which could contribute to an increased burden of metabolic disorders. Body mass index (BMI) another important marker of obesity, also showed a significant association with vitamin D status Table 2. Participants with vitamin D deficiency had a higher BMI than those with sufficient vitamin D levels (P = .000). This finding aligns with previous research that has shown a strong inverse relationship between BMI and vitamin D levels .[20] Obesity to affect the bioavailability of vitamin D, as the vitamin is sequestered in adipose tissue, leading to lower circulating levels in the blood.[21] This inverse relationship suggests that individuals with higher BMI may require higher doses of vitamin D supplementation to achieve sufficient levels. Given the high prevalence of obesity and overweight in many populations, including Nepal, these findings emphasize the importance of monitoring and addressing vitamin D deficiency in overweight and obese individuals. Cholesterol levels were also significantly associated with vitamin D status in our study. Participants with vitamin D deficiency had higher mean cholesterol levels compared to those with sufficient vitamin D levels (P = .007) Table 2.

Dyslipidemia, characterized by elevated cholesterol and triglyceride levels, is a known risk factor for cardiovascular diseases, and vitamin D has been implicated in lipid metabolism.[22] The findings of this results is consistent with previous research that suggests a potential role of vitamin D in improving lipid profiles by modulating cholesterol and triglyceride levels. [23] While the exact mechanisms underlying this relationship are not fully understood, vitamin D is thought to influence lipid metabolism through its effects on calcium homeostasis and parathyroid hormone regulation, which may in turn affect lipid absorption and synthesis .[24]

Fasting serum triglyceride (TG) levels also have significant association with vitamin D status (P = .001) Table 2. Participants with vitamin D deficiency had higher TG levels compared to those with sufficient levels. Elevated triglyceride levels are a key component of metabolic syndrome and are associated with an increased risk of atherosclerosis and cardiovascular disease.[25] The inverse relationship between TG levels and vitamin D observed in present study Table 2, suggests that vitamin D may play a protective role against dyslipidemia and cardiovascular disease by regulating TG levels. In addition to cholesterol and triglycerides, serum HDL levels were significantly associated with vitamin D status (P = .000) Table 2.

HDL, often referred to as good cholesterol, plays a crucial role in reverse cholesterol transport, removing excess cholesterol from peripheral tissues and reducing the risk of atherosclerosis.[26] Participants with sufficient vitamin D levels had significantly levels compared to those with vitamin D deficiency Table 2. This finding supports the hypothesis that vitamin D may improve lipid profiles by increasing HDL levels, which could contribute to a reduced risk of cardiovascular diseases in individuals with sufficient vitamin D status.

While, Table 1 lifestyle factors including age, smoking status, alcohol consumption, and diet type did not show any significant association with vitamin D levels. While previous studies have reported mixed results on the relationship between these factors and vitamin D status, the lack of significant associations in present study could be attributed to the homogeneity of the study population. As in Table 1, smoking status (P = .356), alcohol consumption (P = .245), and diet type (P = .903) did not show any significant differences in vitamin D levels. These findings suggest that, at least in this population, lifestyle factors may not be major determinants of vitamin D status compared to metabolic factors like obesity and dyslipidemia.

CONCLUSIONS

Hence, this study highlights significant associations between vitamin D status and key metabolic variables, including WHR, BMI, cholesterol, triglycerides, and HDL levels. These findings underscore the importance of monitoring vitamin D levels, particularly in individuals with metabolic risk factors such as obesity and dyslipidemia. While lifestyle factors including smoking, alcohol consumption, and diet type were not significantly associated with vitamin D levels in this study, future research with more diverse populations may provide further insights into the complex interactions between vitamin D, lifestyle, and metabolic health. Addressing vitamin D deficiency through targeted interventions could have important implications for reducing the risk of metabolic disorders and improving overall health outcomes.

Informed Consent Statement

Informed consent was obtained from all participants who were involved in the study.

Data availability statement

Raw data can be made available upon request from the corresponding author.

Declaration by Authors

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