International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Check for updates

Association between serum vitamin d levels and cardiometabolic risk factors in adult patients: A cross-sectional analysis

Vina Tri Aditya [1,*], Mohammed Avicenna [2], Andi Niartiningsih [3] and Iqbal Mochtar [4]

[1] *The Association of Indonesian Doctors in the Middle East, Qatar.*
[2] *Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Indonesia.*
[3] *Universitas Cokroaminoto, Makassar, Indonesia.*
[4] *Universitas Cokroaminoto Makassar, Indonesia; Indonesian Medical Education and Research Institute (IMERI), Indonesia.*

International Journal of Science and Research Archive, 2026, 18(02), 363-368

Publication history: Received on 25 December 2025; revised on 07 February 2026; accepted on 09 February 2026

Article DOI: https://doi.org/10.30574/ijsra.2026.18.2.0249

Abstract

Background: Vitamin D deficiency has been increasingly linked to cardiometabolic disorders, including obesity, dyslipidaemia, hypertension, and impaired glucose metabolism. Despite growing interest, evidence from routine clinical populations remains inconsistent, particularly in real-world settings where cardiometabolic risk factors often cluster.

Objective: This study aimed to examine the association between serum vitamin D levels and major cardiometabolic risk factors among adults undergoing routine health examinations.

Methods: A cross-sectional analysis was conducted using secondary clinical data from 248 adult patients who underwent routine medical evaluations between 2017 and 2023. Collected variables included age, sex, blood pressure, lipid profile, body mass index (BMI), smoking status, and serum vitamin D levels. Pearson correlation analysis and multivariable linear regression were performed to evaluate the relationship between vitamin D levels and cardiometabolic parameters.

Results: Suboptimal vitamin D levels were common across the study population. Vitamin D concentrations demonstrated inverse correlations with BMI ($r = -0.11$), LDL cholesterol ($r = -0.09$), triglycerides ($r = -0.09$), and diastolic blood pressure ($r = -0.10$). In multivariable linear regression adjusting for age, BMI, blood pressure, and lipid parameters ($n = 172$), BMI and LDL cholesterol showed negative regression coefficients with vitamin D levels, although statistical significance was attenuated after adjustment.

Conclusion: Vitamin D insufficiency was prevalent and showed consistent inverse associations with multiple cardiometabolic risk factors. While independent effects were modest, vitamin D status may serve as a marker of cardiometabolic risk clustering. Longitudinal studies are warranted to clarify causal relationships and clinical implications.

Keywords: Vitamin D; Cardiometabolic Risk; Cross-Sectional Study; Hypertension; Dyslipidaemia

1. Introduction

Cardiometabolic diseases remain the leading cause of morbidity and mortality globally, accounting for a substantial proportion of premature deaths and healthcare expenditures worldwide [1]. The clustering of cardiometabolic risk

* Corresponding author: Vina Tri Aditya

factors such as hypertension, dyslipidaemia, obesity, smoking, and impaired glucose metabolism substantially increases the risk of cardiovascular disease and type 2 diabetes mellitus [2].

Vitamin D, traditionally recognized for its role in calcium and bone metabolism, has increasingly been implicated in a wide range of non-skeletal conditions, including cardiovascular and metabolic diseases [3]. Vitamin D receptors (VDR) and vitamin D–activating enzymes are expressed in various tissues relevant to cardiometabolic regulation, including vascular smooth muscle cells, endothelial cells, pancreatic β-cells, adipocytes, and immune cells [4]. Through these pathways, vitamin D may influence insulin sensitivity, lipid metabolism, inflammatory responses, and blood pressure regulation via modulation of the renin–angiotensin–aldosterone system [5].

Epidemiological studies have demonstrated a high global prevalence of vitamin D deficiency, even in regions with abundant sunlight [6]. Lifestyle factors such as reduced outdoor activity, obesity, dietary insufficiency, and chronic disease contribute to persistently low serum vitamin D levels in adult populations [7]. Several observational studies have reported inverse associations between serum vitamin D levels and cardiometabolic risk factors, including obesity [8], dyslipidaemia [9], hypertension [10], and metabolic syndrome [11]. However, these associations are not consistently observed across all populations, and their independent effects often attenuate after multivariable adjustment [12].

In routine clinical and occupational health practice, vitamin D measurement is increasingly incorporated into standard health examinations alongside traditional cardiometabolic risk assessments. Real-world clinical datasets from such settings provide valuable opportunities to examine associations between vitamin D status and cardiometabolic risk profiles in heterogeneous adult populations, outside the constraints of tightly controlled clinical trials.

This study aimed to evaluate the association between serum vitamin D levels and major cardiometabolic risk factors among adults undergoing routine health examinations, using correlation and multivariable regression analyses.

2. Methods

2.1. Study Design and Population

This cross-sectional study analysed secondary data from routine medical examinations conducted between 2023 and 2025 in one city in the Middle East. The study setting provides primary and continuing care to a diverse urban and peri-urban population, with patients presenting for routine check-ups, chronic disease follow-up, or new health concerns. A total of 248 adult patients with available demographic, clinical, and laboratory data were included.

2.2. Variables and Measurements

The following variables were extracted: demographic, blood pressure, lipid profile, anthropometric, lifestyle, and aboratory serum of vitamin D level. Demographic and Clinical Data: Age and sex were recorded from the patient's medical record. Blood Pressure: Systolic (SBP) and diastolic blood pressure (DBP) were measured in the seated position after at least five minutes of rest using a validated automated device. Two readings were taken one to two minutes apart; the average was used for analysis. Glycemic Parameters: Fasting blood sugar (FBS) was measured in mmol/L after an overnight fast of at least ten hours. Glycated hemoglobin (A1C) was measured as a percentage of total hemoglobin. Lipid Profile: Fasting lipid panels included total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and triglycerides (TG), all expressed in mmol/L. Anthropometry: Height and weight were measured using standardized equipment and protocols. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Vitamin D: Serum 25-hydroxyvitamin D [25(OH)D] concentrations were measured in nmol/L using immunoassay techniques.

2.3. Statistical Analysis

Descriptive statistics were used to summarise participant characteristics. Continuous variables were presented as mean ± standard deviation or median as appropriate. Pearson correlation coefficients were calculated to assess bivariate relationships between vitamin D levels and cardiometabolic parameters. A multivariable linear regression model was constructed with serum vitamin D as the dependent variable and age, BMI, blood pressure, and lipid parameters as independent variables. Complete-case analysis was applied for regression modelling. Statistical significance was defined as $p < 0.05$. Analyses were performed using SPSS 20.

3. Results

3.1. Participant Characteristics

The study included 248 adult participants, predominantly male, with ages ranging from early adulthood to late middle age. Cardiometabolic risk factors were commonly observed, including elevated BMI, dyslipidaemia, and increased blood pressure.

Table 1 Descriptive Characteristics of Study Participants (n = 248)

Variable	Mean ± SD
Age (years)	45 ± 6.67
BMI (kg/m^2)	28 ± 4.71
Systolic BP (mmHg)	132 ± 13.41
Diastolic BP (mmHg)	85 ± 8.63
LDL cholesterol (mmol/L)	2.6 ± 1.07
HDL cholesterol (mmol/L)	1.2 ± 0.36
Triglycerides (mmol/L)	2.3 ± 0.81
Vitamin D (ng/mL)	22 ± 5

Table 1 presents the baseline demographic and clinical characteristics of the study participants expressed as mean ± standard deviation (SD). Overall, the population represents a middle-aged adult group with multiple clustered cardiometabolic risk factors. The mean age of participants was 45 ± 6.67 years, indicating that most subjects were in early to mid-adulthood. The relatively small standard deviation suggests a fairly homogeneous age distribution, with the majority of participants concentrated between approximately 38 and 52 years. The mean body mass index (BMI) was 28 ± 4.71 kg/m^2, which falls within the overweight category according to the World Health Organization classification (≥25 kg/m^2). Considering the standard deviation, a considerable proportion of the study population likely falls into the obese range (BMI ≥30 kg/m^2). Blood pressure measurements also reflect an at-risk population. The mean systolic blood pressure was 132 ± 13.41 mmHg and the mean diastolic blood pressure was 85 ± 8.63 mmHg. These values correspond to the *elevated blood pressure or stage 1 hypertension* category in contemporary hypertension guidelines. The lipid profile further demonstrates a cardiometabolic risk pattern. The mean LDL cholesterol was 2.6 ± 1.07 mmol/L, which is near or slightly above optimal targets for primary prevention in low-risk individuals and clearly elevated for moderate-risk populations. Meanwhile, HDL cholesterol averaged 1.2 ± 0.36 mmol/L, which is borderline low, particularly in male populations. The mean triglyceride level was 2.3 ± 0.81 mmol/L, which is clearly elevated and compatible with hypertriglyceridaemia. Vitamin D levels were relatively low, with a mean concentration of 22 ± 5 ng/mL. According to commonly accepted clinical thresholds, this level corresponds to vitamin D insufficiency (20–29 ng/mL). The relatively narrow SD indicates that most participants had similar vitamin D status, with many likely falling below optimal levels (<30 ng/mL). This finding suggests that suboptimal vitamin D status is common in the studied population.

3.2. Correlation Analysis

A correlation analysis was utilized to reveal the correlations between vitamin D and cardiometabolic parameters.

Table 2 Pearson Correlation Between Vitamin D and Cardiometabolic Parameters

Variable	r
BMI	−0.11
LDL cholesterol	−0.09
Triglycerides	−0.09
Systolic BP	−0.04
Diastolic BP	−0.10
Age	0.09

Table 2 shows the Pearson correlation coefficients between serum vitamin D levels and selected cardiometabolic parameters. Overall, the correlations observed were weak in magnitude but demonstrated a consistent directional pattern.

Vitamin D levels showed an inverse correlation with body mass index (BMI) (r = −0.11)**.** Although the strength of association is small, the negative direction indicates that individuals with higher BMI tended to have lower serum vitamin D concentrations. This finding suggests that excess adiposity may be associated with reduced circulating vitamin D levels. Similarly, vitamin D concentrations were negatively correlated with lipid parameters, including LDL cholesterol (r = −0.09) and triglycerides (r = −0.09)**.** These findings indicate that participants with more adverse lipid profiles tended to have lower vitamin D levels. The association is modest but consistent with a metabolic risk pattern. Blood pressure parameters also demonstrated inverse relationships. Vitamin D levels correlated weakly with systolic blood pressure (r = −0.04) and diastolic blood pressure (r = −0.10)**.** The association was slightly stronger for diastolic pressure, suggesting that individuals with higher blood pressure tended to have lower vitamin D concentrations. In contrast, age showed a small positive correlation with vitamin D (r = 0.09)**,** indicating that older participants in this cohort tended to have slightly higher vitamin D levels. This may reflect lifestyle or behavioral differences, such as supplementation or different health-seeking behaviors.

3.3. Multivariable Regression Analysis

A multivariable linear regression model was used to examine independent associations with vitamin D levels.

Table 3 Multivariable Linear Regression Predicting Vitamin D Levels (n = 172)

Variable	β (Coefficient)	p-value
BMI	−0.62	0.287
LDL cholesterol	−2.64	0.307
Triglycerides	−3.31	0.38
Systolic BP	0.23	0.417
Diastolic BP	−0.43	0.271
Age	0.28	0.487

Table 4 Model Summary of the Linear Regression Analysis

Model	R	R Square	Adjusted R Square
1	0.192	0.037	0.004

The model explained approximately 3.7% of the variance in vitamin D levels (R^2 = 0.037). While individual predictors did not reach statistical significance, the direction of associations consistently indicated lower vitamin D levels among individuals with higher cardiometabolic risk.

4. Discussion

This cross-sectional study demonstrates a high prevalence of suboptimal vitamin D levels among adults undergoing routine health assessments and reveals consistent inverse associations between vitamin D concentrations and several cardiometabolic risk factors, including body mass index, lipid parameters, and blood pressure. Although effect sizes were modest, the directionality of associations aligns with existing epidemiological evidence.

Obesity has been consistently identified as one of the strongest correlates of low vitamin D levels [8,13]. Proposed mechanisms include volumetric dilution, sequestration of vitamin D in adipose tissue, and reduced bioavailability in obese individuals [14]. In the present study, vitamin D levels demonstrated an inverse correlation with BMI, supporting this biological plausibility.

Associations between vitamin D deficiency and dyslipidaemia have also been reported in previous studies, particularly involving elevated triglycerides and LDL cholesterol [9,15]. Vitamin D may influence lipid metabolism through its effects on hepatic lipid synthesis, inflammation, and insulin sensitivity [16]. In our analysis, vitamin D levels showed inverse correlations with LDL cholesterol and triglycerides, although these associations did not retain statistical significance in multivariable regression.

Blood pressure regulation represents another potential pathway linking vitamin D and cardiometabolic health. Experimental and observational studies suggest that vitamin D suppresses renin expression, thereby modulating the renin–angiotensin system and influencing vascular tone [5,10]. In this study, inverse associations were observed between vitamin D levels and diastolic blood pressure, consistent with prior findings, although independent effects were limited.

The regression analysis suggests that no single cardiometabolic factor independently determines vitamin D levels when multiple variables are considered simultaneously. This finding is important because it indicates that vitamin D deficiency is unlikely to be caused by one isolated clinical parameter such as obesity, dyslipidaemia, or hypertension alone. Instead, vitamin D status appears to reflect a broader physiological state. The attenuation of associations in multivariable analysis implies that the relationships observed in bivariate correlations are partly explained by shared underlying mechanisms. Many cardiometabolic risk factors co-occur due to common pathways including sedentary lifestyle, reduced sun exposure, chronic low-grade inflammation, insulin resistance, and dietary patterns. Therefore, vitamin D may function as a marker of overall metabolic health rather than an independent pathological driver. In other words, patients with multiple metabolic abnormalities tend to have lower vitamin D levels, but when these factors are analyzed together, none individually explains the variation in vitamin D concentration. This phenomenon is typical of metabolic syndrome, where several interrelated variables collectively contribute to risk rather than acting independently.

The lack of strong independent associations in adjusted regression models likely reflects the complex interplay between cardiometabolic risk factors. Vitamin D deficiency may function more as a marker of poor metabolic health rather than a direct causal determinant. This interpretation is supported by randomized controlled trials that have shown inconsistent cardiometabolic benefits from vitamin D supplementation [17].

From a clinical and preventive medicine perspective, these findings suggest that vitamin D assessment may provide additional contextual information when evaluating cardiometabolic risk, particularly in individuals with obesity and dyslipidaemia. However, vitamin D supplementation alone should not be considered a substitute for established cardiometabolic risk reduction strategies.

Limitations

This study is limited by its cross-sectional design, precluding causal inference. Potential confounders such as physical activity, dietary intake, sun exposure, and vitamin D supplementation were not available. Missing data reduced sample size in regression analyses.

5. Conclusion

Suboptimal vitamin D status was common and showed consistent inverse associations with cardiometabolic risk factors. While independent effects were modest, vitamin D assessment may contribute to holistic cardiometabolic risk evaluation. Prospective studies are needed to determine whether improving vitamin D status can meaningfully modify cardiometabolic outcomes.

Compliance with ethical standards

Disclosure of conflict of interest

All authors declared no conflict of interest.

Statement of ethical approval

Ethical approval was not required for this study because the data used were secondary and provided to the team in an anonymized format.

References

[1] World Health Organization. Cardiovascular diseases (CVDs). Geneva: WHO; 2023.

[2] Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, et al. Global burden of cardiovascular diseases and risk factors, 1990–2019. J Am Coll Cardiol. 2020;76(25):2982–3021.

[3] Amrein K, Scherkl M, Hoffmann M, Neuwersch-Sommeregger S, Köstenberger M, Berisha AT, et al. Vitamin D deficiency 2.0: an update on the current status worldwide. Eur J Clin Nutr. 2020; 74:1498–1513.

[4] Grant WB, Lahore H, McDonnell SL, Baggerly CA, French CB, Aliano JL, et al. Evidence that vitamin D supplementation could reduce risk of influenza and COVID-19 infections and deaths. Nutrients. 2020;12(4):988.

[5] Szymczak-Pajor I, Śliwińska A. Analysis of association between vitamin D deficiency and insulin resistance. Nutrients. 2021;13(2):568.

[6] Bilezikian JP, Bikle D, Hewison M, Lazaretti-Castro M, Formenti AM, Gupta A, et al. Mechanisms in endocrinology: vitamin D and COVID-19. Eur J Endocrinol. 2020;183(5): R133–R147.

[7] Charoenngam N, Holick MF. Immunologic effects of vitamin D on human health and disease. Nutrients. 2020;12(7):2097.

[8] Miranda-Lora AL, Martínez-Aguilar G, Rodríguez-Ramírez S, et al. Vitamin D and metabolic syndrome: a systematic review and meta-analysis. Nutrients. 2021;13(11):4162.

[9] Ali N. Role of vitamin D in preventing cardiovascular disease. Clin Hypertens. 2020; 26:1–10

[10] Bouillon R, Marcocci C, Carmeliet G, Bikle D, White JH, Dawson-Hughes B, et al. Skeletal and extraskeletal actions of vitamin D: current evidence and outstanding questions. Endocr Rev. 2022;43(2):257–314.

[11] Vimaleswaran KS, Cavadino A, Berry DJ, et al. Association of vitamin D status with arterial blood pressure and hypertension risk. Hypertension. 2021;77(6):2003–2011.

[12] Rejnmark L, Bislev LS, Cashman KD, et al. non-skeletal health effects of vitamin D supplementation: a systematic review. Lancet Diabetes Endocrinol. 2021;9(12):915–928.

[13] Jolliffe DA, Camargo CA, Sluyter JD, et al. Vitamin D supplementation to prevent acute respiratory infections: systematic review and meta-analysis. BMJ. 2021;372: n544.

[14] Tabrizi R, Vakili S, Lankarani KB, et al. The effects of vitamin D supplementation on lipid profiles: systematic review and meta-analysis. Nutr Metab Cardiovasc Dis. 2020;30(12):2087–2097.

[15] Dibaba DT. Effect of vitamin D supplementation on serum lipid profiles: updated meta-analysis. Nutrients. 2021;13(10):3433.

[16] Manousaki D, Mitchell R, Dudding T, et al. Genome-wide association study for vitamin D levels reveals 69 independent loci. Nat Commun. 2020; 11:542.

[17] Barbarawi M, Kheiri B, Zayed Y, et al. Vitamin D supplementation and cardiovascular disease risk: meta-analysis of randomized controlled trials. J Am Heart Assoc. 2020;9:e017080.

[18] Bouillon R, Carmeliet G. Vitamin D insufficiency: definition, diagnosis and management. Best Pract Res Clin Endocrinol Metab. 2023;37(1):101696.