Original Article

Association of Metabolic Syndrome with Vitamin D Deficiency: A Cross-Sectional Study from a Tertiary Care Hospital in Eastern India

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Abstract

Background: In India, metabolic syndrome (MetS) and vitamin D insufficiency are both very common. This study aimed to evaluate the association between metabolic syndrome and serum 25-hydroxyvitamin D levels in patients attending a tertiary care hospital in eastern India. **Material and Methods:** At Raiganj Government Medical College and Hospital, a cross-sectional study was carried out between September 2022 and September 2023. 102 patients who satisfied the IDF criteria for metabolic syndrome (cases) and 102 age- and sex-matched, seemingly healthy persons (controls) made up the 204 subjects, ages 18 to 80. Electrochemiluminescence immunoassay (ECLIA, Roche e411) was used to measure serum 25(OH)D. Less than 20 ng/mL was considered a vitamin D insufficiency. **Results:** The metabolic syndrome group had a substantially lower mean serum 25(OH)D level (11.99 ± 6.20 ng/mL) than the controls (13.74 ± 6.37 ng/mL) ($p = 0.048$). Vitamin D deficiency (<20 ng/mL) was present in 92.2% of MetS patients versus 85.3% of controls ($p = 0.038$). 50% of MetS sufferers and 36.3% of controls had severe vitamin D insufficiency (<10 ng/mL) ($p = 0.042$). BMI, waist circumference, fasting blood sugar, triglycerides, systolic and diastolic blood pressure, and HDL were all significantly higher in MetS patients than in controls ($p < 0.001$ for all but FBS, $p = 0.043$). **Conclusion:** Metabolic syndrome is strongly associated with lower serum 25-hydroxyvitamin D levels. Patients with metabolic syndrome are far more likely to have severe vitamin D insufficiency. Patients with MetS may benefit from routine screening for vitamin D levels.

Keywords: Metabolic syndrome · Vitamin D deficiency · 25-hydroxyvitamin D · Insulin resistance · Obesity · Eastern India.

Received: 19 June 2026 **Revised: 01 July 2026** **Accepted: 14 July 2026** **Published: 17 August 2026**

Introduction

Type 2 diabetes and cardiovascular disease are largely caused by the cluster of cardiometabolic risk factors known as metabolic syndrome (MetS), which is rapidly rising in India and includes central obesity, dyslipidemia, hyperglycemia, and hypertension.[1,2] Despite abundant sunshine, vitamin D deficiency remains paradoxically widespread in India, with prevalence rates exceeding 70–90% in various studies.[3,4]

Serum levels of 25-hydroxyvitamin D [25(OH)D] appear to be inversely correlated with both the metabolic syndrome and its separate components.[5-7] Multiple mechanisms have been proposed, including vitamin D's role in insulin secretion/sensitivity, Renin-angiotensin system modulation and anti-inflammatory properties.[8,9]

However, data from eastern India remain limited, and results across Indian studies have been inconsistent. Therefore, the current study was conducted in a tertiary care hospital environment in West Bengal to ascertain the frequency of vitamin D deficiency in patients with metabolic syndrome and to investigate the relationship between serum 25(OH)D levels and metabolic syndrome.

Materials and Methods

Study Design and Setting: After receiving institutional ethics committee approval, this cross-sectional study was carried out from September 2022 to August 2023 in cooperation with the Departments of General Medicine and Biochemistry at Raiganj Government Medical College and Hospital in Raiganj, Uttar Dinajpur, West Bengal.

Study Population: Patients who were willing to give written informed consent and who were between the ages of 18 and less than 80 and who visited the outpatient department of Raiganj Government Medical College and Hospital in Raiganj, Uttar Dinajpur, West Bengal, were included in the study.

Exclusion Criteria

- Known chronic renal, hepatic, cardiac, gastrointestinal, skeletal, or endocrine disease (except diabetes)
- Acute critical illness
- Cushing's syndrome

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DOI:
10.21276/amit.2026.v13.i2.946

How to cite this article: Gochipatala S, Saha S, Mandal N, Biswas P. Association of Metabolic Syndrome with Vitamin D Deficiency: A Cross-Sectional Study from a Tertiary Care Hospital in Eastern India. Acta Med Int. 2026;13(2):1728-1731.

- Vitamin D or calcium supplementation in the past 6 months
- Pregnancy
- Psychiatric disorders

Sample Size and Selection: The required sample size was calculated assuming mean 25(OH)D levels of 21.34 ± 12 ng/mL in MetS and 26.94 ± 12 ng/mL in Non-MetS (from Maria Aziz et al),[10] with 90% power and α = 0.05, yielding 97 subjects per group. Considering a 5% non-response, 102 subjects per group were enrolled (total n = 204).

The patients attending the OPD of RGMCH were selected as every alternate patient for this study through systematic random sampling (considering 200 average patients per day patient & sampling interval of 2), where the initial patient was identified from the first two patients through lottery. Recruited patients were assessed for fulfilling IDF criteria for metabolic syndrome,[11] and were selected under the MetS group if they fulfilled the criteria. Those who did not fulfill the criteria were selected under the Non-MetS group. This selection process was continued until the sample size of two groups was achieved.

Data collection: After receiving informed consent, the patients were interviewed in-person using a pretested, predesigned interview schedule to gather sociodemographic and behavioral data. A standard operating procedure was used to carry out the clinical, anthropometric, and biochemical evaluation.

Age (in years), gender (male/female), history of diabetes and dyslipidemia (present/absent), tobacco use (present/absent), alcohol use (present/absent), and physical activity (no activity/physically active) were among the sociodemographic factors.

A standardized weighing machine and a non-stretchable measuring tape were used to measure anthropometric variables like weight (in kg), height (in cm), waist circumference (in cm), and BMI (Kg/m2). Standard formulas were used to calculate indicators like body mass index, conicity index, and body fat percentage.

As per usual procedure, an aneroid sphygmomanometer was used to measure and record the patients' systolic and diastolic blood pressure twice over their left arm while they were at rest.

Venous blood samples were obtained aseptically by a certified phlebotomist, and after the proper disposal of biomedical waste, biochemical parameters were assessed using standard reagents and kits with assistance from the hospital's biochemistry department.[16] Serum hemoglobin (Hb), total cholesterol, HDL cholesterol, and fasting sugar were measured in the biochemical samples. The CHOD-PAP method was used to assess total cholesterol,[17] whereas the PEG-precipitation method was used to measure HDL cholesterol.[19] These blood parameters were measured using a semi-automated analyzer (Erba-Mannheim Chen 5X).

Clinical and Biochemical Assessment: Anthropometric measurements (height, weight, waist circumference) and blood pressure (after 15 min rest, mercury sphygmomanometer) were recorded. Fasting venous blood was collected and analyzed for glucose, lipid profile (enzymatic methods, Bio systems, Spain), and 25(OH)D (ECLIA, Roche e411, CV <8%).

Metabolic syndrome was defined per IDF criteria: Central obesity (waist circumference ≥90 cm for men and ≥80 cm for women who are South Asian) plus any two of the following: triglycerides ≥150 mg/dL, HDL <40 mg/dL for men or <50 mg/dL for women, blood pressure ≥130/85 mmHg, and fasting glucose ≥100 mg/dL.[11]

The state of vitamin D was categorized as: ≥30 ng/mL is sufficient. 20–29.9 ng/mL is insufficient. <20 ng/mL is deficient, and severe deficiency: <10 ng/mL, where sufficient and insufficient were clubbed as Optimal Level (>=20).

Statistical Analysis: IBM SPSS version 22 was used to analyze the data. An independent t-test was used to compare continuous variables, while the Chi-square/Fisher's exact test was used to analyze categorical variables. Significance was defined as $p < 0.05$.

Results

102 patients with MetS and 102 patients without MetS were recruited into the MetS and Non-MetS groups. On estimating their serum vitamin D levels, 58(57%), 32(31%) & 12(12%) of the patients had severe vitamin D deficiency, vitamin D deficiency & optimal level in the MetS group, respectively. In the non-mets group, 40(39%), 45(44%) & 17(17%) of the patients had severe vitamin D deficiency, vitamin D deficiency & optimal level respectively [Figure 1]. The vitamin D status of the patients was found significantly different between MetS & Non-MetS groups [$\chi2(1) =6.363$, P=0.042]. Even the mean±SD of the serum vitamin D level of these two groups is significantly different [t (202) =(-1.99), P=0.048] [Table 1].

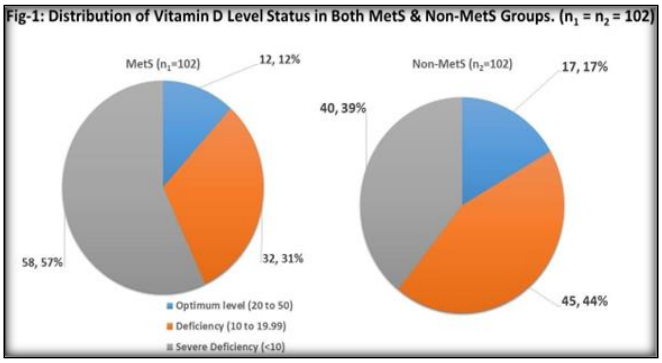

Fig-1: Distribution of Vitamin D Level Status in Both MetS & Non-MetS Groups. ($n_1 = n_2 = 102$)

Age [t (202) =0.45, P=0.658] and gender [2(1) =0.41, P=0.483] did not differ significantly between the MetS and Non-MetS groups. But presence of habit of smoking [$\chi2(1) =4.3$, P=0.038] and alchoholism [$\chi2(1) =8.114$, P=0.004] were significantly different in these two groups. No physical activity [$\chi2(1) =5.568$, P=0.018] was significantly more associated with the MetS group. On assessment of comorbidity status, h/o T2DM [$\chi2(1) =5.68$, P=0.017] and h/o dyslipidemia [$\chi2(1) =7.805$, P=0.005] more significantly associated with the MetS group. [Table 1]

On anthropometric assessment, the mean±SD of weight [t (202) =2.99, P=0.003], BMI [t (202) =35.6, P<0.001] & waist circumference [t (202) =19.16, P<0.001] were significantly different and more in the MetS group than the Non-MetS group, whereas, there was no significant difference of mean±SD of height [t (202) =1.66, P=0.099] between these groups. The

mean±SD of SBP [t (202) =5.23, P<0.001] & DBP [t (202) =4.27, P<0.001] were also significantly different and more in the MetS group than the non-mets group. On biochemical evaluation of blood samples, the mean±SD of serum Hb level [t (202) =0.33, P=0.745] was not significantly different between MetS & Non-MetS groups. But mean±SD of serum total cholesterol [t (202) =3.79, P=0.0002], TG [t (202) =7.56, P<0.001], HDL [t (202) =(-4.2), P<0.001] & FBS [t (202) =2.03, P=0.044] were significantly different in these two groups. [Table 1]

Table 1: Relationship of Metabolic syndrome with Vitamin-D Deficiency & other different independent variables. (N=204; n1 = n2 = 102)

Variables	MetS Group (n1=102)	Non-MetS Group (n2=102)	Test of Significance
Vitamin D3 Status Optimum level Deficiency Severe Deficiency	12 (11.76%) 32 (31.37%) 58 (56.86%)	17 (16.67%) 45 (44.12%) 40 (39.22%)	$\chi2(1)=6.363$, P=0.042
Age (in years)	43.71 ± 11.11	42.94 ± 13.39	t(202)=0.45, P=0.658
Gender Male Female	46 (45.1%) 56 (54.9%)	51 (50%) 51 (50%)	$\chi2(1)=0.41$, P=0.483
Smoking Present Absent	15 (14.7%) 87 (85.3%)	6 (5.9%) 96 (94.1%)	$\chi2(1)=4.3$, P=0.038
Alcoholism Present Absent	21 (20.6%) 81 (79.4%)	7 (6.9%) 95 (93.1%)	$\chi2(1)=8.114$, P=0.004
Physical Activity No activity Physically active	75 (73.5%) 27 (26.5%)	59 (57.8%) 43 (42.2%)	$\chi2(1)=5.568$, P=0.018
H/O T2DM Present Absent	62 (60.8%) 40 (39.2%)	45 (44.1%) 57 (55.9%)	$\chi2(1)=5.68$, P=0.017
H/O Dyslipidaemia Present Absent	38 (37.3%) 64 (62.7%)	20 (19.6%) 82 (80.4%)	$\chi2(1)=7.805$, P=0.005
Height (cm)	160.96 ± 8.39	159.06 ± 7.99	t(202)=1.66, P=0.099
Weight (Kg)	84.53 ± 8.59	66.67 ± 59.77	t(202)=2.99, P=0.003
BMI (Kg/m2)	32.57 ± 1.23	24.06 ± 2.08	t(202)=35.6, P<0.001
Waist Circumference (cm)	97.06 ± 6.94	75.17 ± 9.23	t(202)=19.16, P<0.001
SBP (mmHg)	135.73 ± 15.1	125.11 ± 13.93	t(202)=5.23, P<0.001
DBP (mmHg)	87.25 ± 10.68	81.21 ± 9.49	t(202)=4.27, P<0.001
Hb (mg/dl)	12.9 ± 0.89	12.86 ± 0.83	t(202)=0.33, P=0.745
FBS (mg/dl)	135.56 ± 42.3	122.75 ± 47.61	t(202)=2.03, P=0.044
Total Cholesterol (mg/dl)	225.87 ± 49.86	200.18 ± 47.05	t(202)=3.79, P=0.0002
TG (mg/dl)	194.85 ± 59.1	144.26 ± 32.44	t(202)=7.56, P<0.001
HDL (mg/dl)	37.33 ± 6.59	42.37 ± 10.18	t(202)=(-4.2), P<0.001
Serum Vitamin D3 (ng/mL)	11.99 ± 6.2	13.74 ± 6.37	t(202)=(-1.99), P=0.048

All parenthesis shows column percentages except test of significance column where parenthesis showing degree of freedom. * Results of Prearson Chisquare test and Independent t test were expressed as [$\chi2$(df)=chi-square value, P=p-value] and [t(df)=t-statistic value, P=p-value] respectively.

Discussion

The present study demonstrates a significant association between metabolic syndrome and lower serum 25(OH)D levels in an eastern Indian population. Mean 25(OH)D was approximately 1.75 ng/mL lower in MetS patients (p = 0.048), with severe vitamin D deficiency being 38% more common in the MetS group.

These findings are consistent with previous Indian studies. Utmani et al,[12] reported a mean 25(OH)D of 16.5 ng/mL in MetS versus 20.75 ng/mL in controls (p = 0.004). Pathania et al,[13] from North India also found significantly lower vitamin D levels in MetS patients and negative correlations with waist circumference, blood pressure, and triglycerides.

Due to food habits, indoor lifestyles, air pollution, and skin pigmentation, vitamin D deficiency is quite prevalent in both categories (92.2% and 85.3%), reflecting the pervasive hypovitaminosis D in India despite sufficient sunshine.[14]

Possible mechanisms include sequestration of vitamin D in adipose tissue, volumetric dilution, reduced sun exposure due to an obesity-related lifestyle, and chronic low-grade inflammation suppressing 1-α-hydroxylase activity.[15]

The concordance with several other research clearly suggests that vitamin D deficiency may contribute to the development or severity of metabolic syndrome, even if the cross-sectional design excludes causality. To find out if vitamin D treatment can enhance metabolic parameters in patients with inadequate MetS, interventional trials are required.

Conclusion

In this eastern Indian community, metabolic syndrome is strongly linked to lower serum 25-hydroxyvitamin D levels and a greater incidence of severe vitamin D deficiency. Patients with metabolic syndrome seem to benefit from routine screening for vitamin D levels.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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