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Original Research Article

Vitamin D Levels & Metabolic Syndrome Correlation

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Abstract:

Background: Over the past few years, the prevalence of MetS has increased, which has been linked to both population aging and rising obesity rates brought on by changes in lifestyle, such as reduced physical activity and unhealthy eating habits. In affluent nations, MetS is currently regarded as a pandemic and a serious public health concern.

Objectives: In order to ascertain if metabolic syndrome in persons enrolled in a tertiary care facility was related to serum vitamin D levels, the study was conducted.

Materials and Methods: It was a retrospective, observational study. The study was carried out at a tertiary care centre. The study data that was retrieved was for one year. Data from 186 participants were retrieved for the study. Adults 40 years of age and older who gave their informed consent and went to the hospital for either a normal checkup or because they had risk factors that suggested metabolic syndrome were included in the study.

Results: With p-values less than 0.01, participants with deficiency of vitamin D had a substantially larger waist circumference (98.4 ± 11.2 cm) than those with insufficiency (94.3 ± 10.8 cm) and sufficiency (91.6 ± 10.4 cm). The deficiency group had the greatest mean fasting glucose level (118.6 mg/dL), while the sufficiency group had the lowest (108.8 mg/dL).

Conclusion: Among the study participants, vitamin D deficiency was shown to be very common. It also demonstrated a substantial correlation with the metabolic syndrome and its constituent parts, such as central obesity, hyperglycemia, dyslipidemia, and hypertension.

Recommendations: It is recommended that people at risk for metabolic syndrome have their vitamin D levels regularly checked.

Keywords: Vitamin D, Metabolic Syndrome, Diabetes Mellitus, MetS, Obesity.

Introduction

The fat-soluble prohormone vitamin D was previously thought to be solely linked to bone health, but as evidence of vitamin D receptors in the kidney, pancreas, prostate, and immune system has grown, its role in health and disease has broadened and it is now associated with the activities of the hormones, including endocrine, autocrine, and paracrine functions [1].

Although vitamin D insufficiency is common, the part that vitamin D plays in metabolic syndrome is not entirely understood because of inconsistent findings and large variations in serum vitamin D levels across different regions and ethnic groups [2].

The combination of obesity that is intraabdominal, hypertension, hyperglycemia, raised blood triglyceride and cholesterol levels, decreased levels of HDLs, and IR is known as metabolic syndrome (MetS). Nonetheless, there is ongoing debate on the diagnosis and management of this illness [3, 4, 5]. IR is one of the factors that clinicians most frequently point to in order to explain the etiopathology of MetS, which combines the association of both cardiovascular risk along with high blood sugar.

Over the past few years, increase in the prevalence of MetS has been observed, which has been linked to both population aging and rising obesity rates brought on by changes in lifestyle, such as reduced physical activity and unhealthy eating habits. In affluent nations, MetS is currently regarded as a pandemic and a serious public health concern. Even in a country like India that receives a lot of tropical sunlight, vitamin D insufficiency is a widespread epidemic, but the prevalence varies by location. Deficiency of vitamin D (<20 ng/ml) was 70% in a study of 1150 patients in Western India, and it was somewhat higher in females (76%) [6, 7, 8].

According to research, a higher risk of MetS is either associated levels of vitamin D to be lower [9]. Northern India had a greater frequency; research conducted in Delhi with 1346 participants revealed a 92% prevalence [10]. Prevalence was found to be 56% in urban elderly population research conducted in South India and 53% in a comparable study conducted in West Bengal [11, 12].

The association was found among MetS and serum vitamin D levels has been the subject of numerous studies in the Western population. However, research on the Indian population has yielded contradictory findings. Deficiency of vitamin D was not linked to MetS or IR in Asian Indians among 441 individuals with age 39.7±12.8 years [13].

The purpose of this study was to ascertain if MetS in persons enrolled in a tertiary care facility was related to serum vitamin D levels. Additionally, it sought to determine whether vitamin D status was associated with any of the following components of metabolic syndrome: central obesity, hypertension, hyperglycemia, and dyslipidemia.

Methodology

Study Design: It was a retrospective, observational study.

Study Settings: The study was carried out at a tertiary care centre. The study data that was retrieved was for one year.

Study Population: Data of 186 participants were retrieved for the study. Adults 40 years of age and older who gave their informed consent and went to the hospital for either a normal checkup or because they had risk factors that suggested metabolic syndrome were included in the study. Eligibility was decided as per if they met at least one of the NCEP-ATP III criteria, which include central obesity, hyperglycemia, dyslipidemia, or high blood pressure. Individuals with chronic liver illness, renal failure, malabsorption syndromes, endocrine diseases that impact vitamin D metabolism, or those who have taken calcium or vitamin D supplements in the previous six months were not included.

Data Collection: Blood pressure, waist circumference, sex, age, BMI, and medical history, including diabetes, hypertension, and dyslipidemia, were all documented. These samples included levels of vitamin D, profiles of lipid, including triglycerides and HDL cholesterol, and fasting blood glucose, which were assessed using a conventional chemiluminescent immunoassay.

Study Procedure: In accordance with suggested protocols, blood pressure was monitored using a standardized sphygmomanometer. Levels of serum vitamin D, profiles of lipid, and fasting glucose were measured from fasting blood samples. Deficient (<20 ng/mL), insufficient (20–30 ng/mL), and sufficient (>30 ng/mL) vitamin D levels were identified. The NCEP-ATP III criteria were used to diagnose metabolic syndrome.

Statistical Analysis: SPSS version 26.0 was used for statistical analysis. Data were initially entered in Microsoft Excel. The data have been presented as either the number of participants (n) with percentages (%), or mean±SD.

The independent t-test was used for statistical analysis. Statistical significance was defined as a p-value of less than 0.05. Other than this, univariate and multivariate logistic regression analysis model were used for further analysis.

Results

The study population's mean age was 54.2 ± 11.6 years, and there was a slight male predominance (55.9%) over females (44.1%). The level of vitamin D in the blood was 21.6 ± 7.8 ng/mL. 42.5% of subjects had metabolic syndrome. The study participants' baseline demographics are shown in Table 1.

Table 1: Baseline Characteristics of Study Participants

Parameters	Value
Age (in years)	54.2 ± 11.6
Male Participants	104 (55.9%)
Female Participants	82 (44.1%)
Serum 25(OH)D (ng/mL)	21.6 ± 7.8
Vitamin D Deficiency (<20 ng/mL)	112 (60.2%)
Vitamin D Insufficiency (20–30 ng/mL)	48 (25.8%)
Vitamin D Sufficiency (>30 ng/mL)	26 (14.0%)
Metabolic Syndrome	79 (42.5%)

The 50–59 age group was the most represented, with 54 participants. The age groups of 60–69 years old had 38 individuals and 40–49 years old had 42 participants. While there were only 28 participants in the <40 age category, there were 24 in the over 70 age groups, respectively. Figure 1 shows the age-group distribution of research participants.

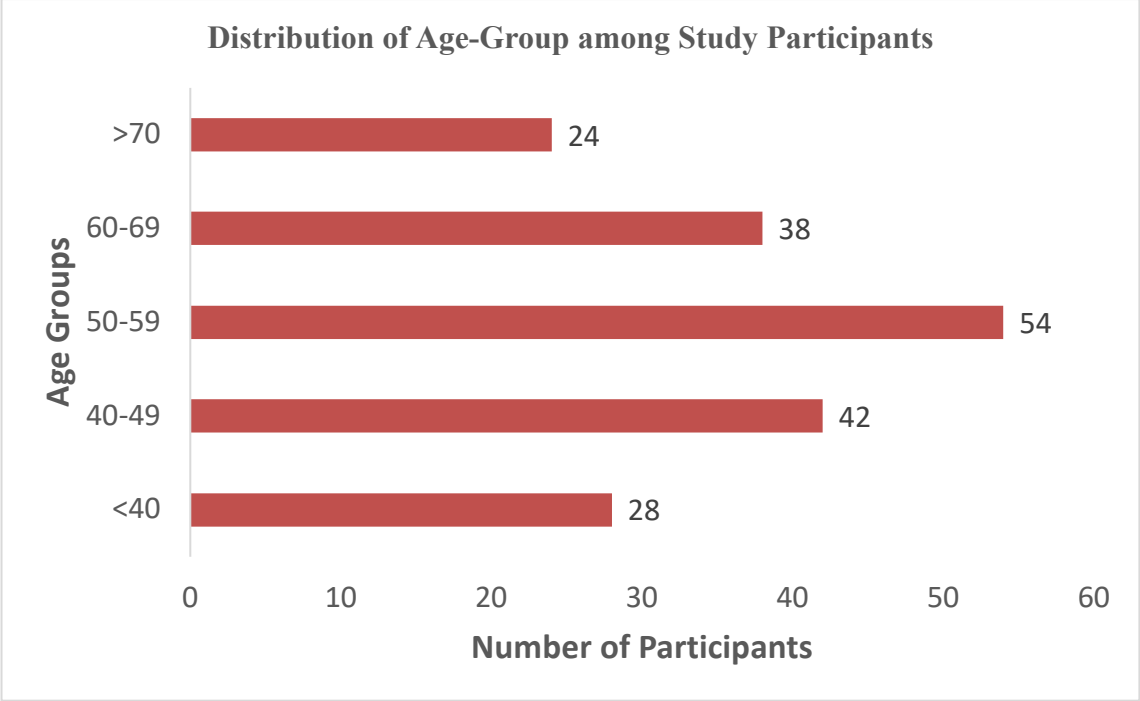

Figure 1: Distribution of Age-Groups among Study Participants

There were 112 participants with insufficient vitamin D, defined as <20 ng/mL. Forty-eight participants had vitamin D inadequately, defined as 20–30 ng/mL, while 26 people had adequate vitamin D, defined as >30 ng/mL. The levels of vitamin D among research participants is displayed in Figure 2.

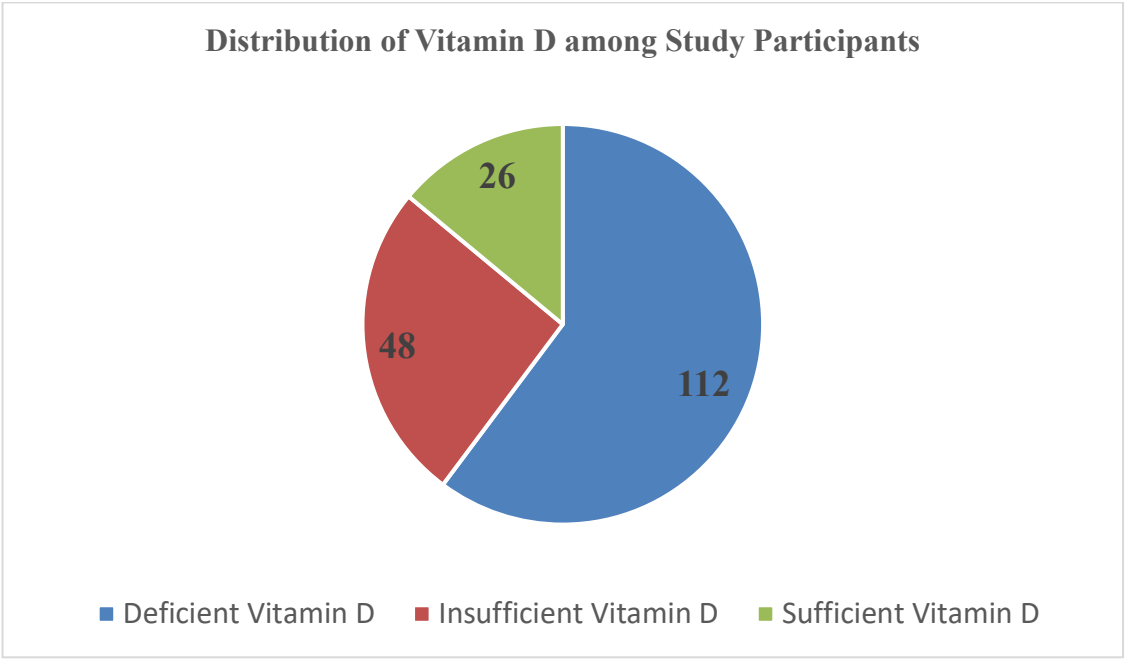

Figure 2: Distribution of Vitamin D among Study Participants

With p-values less than 0.01, participants with vitamin D deficiency had a substantially larger waist circumference (98.4 ± 11.2 cm) than those with insufficiency (94.3 ± 10.8 cm) and sufficiency (91.6 ± 10.4 cm). The deficiency group had the greatest mean fasting glucose level (118.6 mg/dL), while the sufficiency group had the lowest (108.8 mg/dL). Table 2 depicted correlation among both levels of vitamin D and MetS.

Table 2: Association between the Status of Vitamin D and Metabolic Syndrome

Parameter	Vitamin D Deficiency (n=112)	Vitamin D Insufficiency (n=48)	Vitamin D Sufficiency (n=26)	p-value
Waist circumference (in cm)	98.4 ± 11.2	94.3 ± 10.8	91.6 ± 10.4	**<0.01**
Fasting glucose (in mg/dL)	118.6 ± 22.4	110.3 ± 20.6	104.8 ± 18.2	**<0.01**
Triglycerides (in mg/dL)	176.3 ± 42.5	165.7 ± 40.2	152.7 ± 39.1	**0.02**
HDL-C (in mg/dL)	39.4 ± 7.8	42.1 ± 7.5	44.6 ± 8.2	**<0.01**
Systolic BP (in mmHg)	134.6 ± 12.4	128.3 ± 11.2	125.8 ± 10.7	**0.03**
Diastolic BP (in mmHg)	86.2 ± 8.7	83.5 ± 7.9	81.9 ± 7.5	**0.04**
Metabolic Syndrome	59 (52.7%)	16 (33.3%)	6 (23.1%)	**0.002**

Higher waist circumference is linked to decreased vitamin D levels, according to a substantial negative connection. Fasting glucose and vitamin D levels showed an inverse relationship, indicating that poorer glycemic management is linked to lower vitamin D levels. The relationship between vitamin D and metabolic syndrome is displayed in Table 3.

Table 3: Correlation of Vitamin D with Metabolic Syndrome

Parameters	Coefficient Correlation (r)	p-value
Circumference of Waist	–0.30	<0.01
Fasting glucose	–0.29	<0.01
Triglycerides	–0.26	0.02
HDL-C	+0.24	0.03
Systolic BP	–0.28	0.02

Discussion

According to the study, metabolic syndrome (42.5%) and vitamin D deficiency (60.2%) are quite prevalent. Both the metabolic syndrome and its constituent parts—central obesity, hyperglycemia, dyslipidemia, and increased blood pressure—were substantially linked to vitamin D insufficiency. These results add credence to the mounting evidence that vitamin D is important for metabolic health in addition to its traditional effects on bone metabolism.

The population's mean level of vitamin D was 21.6 ± 7.8 ng/mL, which is consistent with recent Indian studies that found widespread hypovitaminosis D despite plenty of sunlight [10, 11, 12]. Those with vitamin D deficiency exhibited greater systolic/diastolic blood pressure, lipids, fasting glucose, and waist circumference and lower HDL-C compared to those with adequate vitamin D. A possible mechanistic connection through insulin resistance, chronic inflammation, and adipocyte function is supported by relationship that was found to be inverse between vitamin D and metabolic syndrome components that has been reported in a number of Western and Asian populations [1, 9, 13].

Levels of serum vitamin D were found to be significantly correlated negatively with waist circumference ($r = –0.30$, $p<0.01$), fasting glucose ($r = –0.29$, $p<0.01$), triglycerides ($r = –0.26$, $p=0.02$), and systolic blood pressure ($r = –0.28$, $p=0.02$), while being positively correlated with HDL-C ($r = +0.24$, $p=0.03$). This generally aligns with earlier research suggesting that inadequate vitamin D may influence insulin production, glucose balance, and inflammatory pathways, hence contributing to the pathophysiology of metabolic syndrome [1, 9].

Similar correlations have been found in a number of Indian research. For example, low vitamin D levels were common in adults and linked to an increased risk of cardiometabolic disease, according to research by Marwaha et al. [10] and Suryanarayana et al. [11]. On the other hand, Majumdar et al. [13] found no evidence of a significant correlation between Asian Indians' metabolic syndrome and deficiency of vitamin D. This could be due to variations in age, lifestyle, food habits, or genetic predisposition. These discrepancies emphasize the necessity of conducting research in particular regions and giving careful thought to population factors when interpreting findings.

There are several different processes that connect vitamin D deficiency to metabolic syndrome. It is believed that secretion of levels of vitamin D affects secretion of insulin and sensitivity by modifying calcium flow and pancreatic β-cell activity. Furthermore, vitamin D has anti-inflammatory qualities that could lessen inflammation in adipose tissue, which is a major cause of insulin resistance [1, 9].

Conclusion

Among the study participants, vitamin D deficiency was shown to be very common. It also demonstrated a substantial correlation with the metabolic

syndrome and its constituent parts, such as central obesity, hyperglycemia, dyslipidemia, and hypertension. Further, it was found that levels of vitamin D seen to reduced were positively associated with HDL cholesterol and negatively associated with hypertension, triglycerides, sugar, and waist circumference.

Limitations

Since this study was conducted in a single urban tertiary care facility, it may not be feasible to extrapolate the findings to the broader population. Additionally, the study's sample size was too small to draw conclusions and extrapolate findings.

Recommendations

It is recommended that people at risk for metabolic syndrome have their vitamin D levels regularly checked. Emphasis should be placed on public health initiatives that support safe exposure to sunshine, dietary consumption, and supplementation.

List of Abbreviations

MetS- Metabolic Syndrome

NCEP-ATP III- National Cholesterol Education Program–Adult Treatment Panel III

IR- Insulin resistance

HDLs- High-Density Lipoproteins

BMI- Body Mass Index

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