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RESEARCH ARTICLE

Associations of vitamin D with metabolic syndrome components in Indian urban middle-aged women

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ABSTRACT

Background: The prevalence of metabolic syndrome is increasing in developing countries and the prevalence is reported to be higher in Indian urban women and vitamin D deficiency is documented as a common health problem. However, little is known regarding whether vitamin D deficiency plays an important role in the heightened prevalence of metabolic syndrome. **Aims and Objectives:** This study was planned to assess the levels of vitamin D and their association with components of metabolic syndrome in middle-aged women. **Materials and Methods:** A total of 300 women volunteers who were in the age group of 35-64 years were included in the study. We used the criteria of metabolic syndrome defined by A joint interim statement of the International Diabetes Federation task force. Plasma levels of 25-hydroxyvitamin D [25(OH)D] was assessed by chemiluminescence method. Pearson**'s** correlation was used for associations. **Results:** Vitamin D levels are significantly lower in women with metabolic syndrome. Waist circumference (WC), systolic blood pressure (BP), and triglyceride concentrations were inversely associated with vitamin D concentrations. 84% are with deficient levels of vitamin D. **Conclusion:** Vitamin D deficiency was found to be common in Indian women. Elevated WC, BP, and triglycerides were found to inversely associate with low serum levels of 25(OH)D. Improving vitamin D status would be useful in improving the health in middle-aged urban women.

KEY WORDS: Vitamin D; Metabolic Syndrome; Middle-aged Women

INTRODUCTION

The prevalence of metabolic syndrome is increasing in developing countries with rapid nutrition and lifestyle transitions in the last 20 years.[1,2] Recent data indicates that about one third of the Indian urban population has metabolic syndrome.[3] Furthermore, the prevalence is reported to be higher in Indian urban women and has been shown to be associated with older age, changes in life style, dietary patterns, and socioeconomic status.[3-7] Vitamin D deficiency is documented as a common health problem in the world. Limited data have been found on the prevalence of vitamin D deficiency in urban population[8] and specially middle-aged women in India.[9] Moreover, little is known regarding whether vitamin D deficiency plays an important role in the heightened prevalence of metabolic syndrome and other metabolic disorders among Asian individuals.

Metabolic syndrome components include abdominal obesity measured by waist circumference (WC), along with elevated triglycerides (TG), reduced high-density lipoprotein-cholesterol (HDL-C), elevated blood pressure (BP), and elevated fasting glucose.[10] Vitamin D deficiency has been shown to be associated with higher insulin resistance (IR).[11-13]

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Since the serum levels of vitamin D and the prevalence of metabolic syndrome vary by ethnicity.[7] Hence, it is an important to study this association in urban Indian middle-aged women. Very few studies have been done in India in this context.

MATERIALS AND METHODS

Study Design

This study was an observational cross-sectional study. A written informed consent was taken after Ethical Committee approval from Institutional Ethics Committee (BVDU/MC/42). The study was conducted in the Department of Obstetrics and Gynecology, Pune. Volunteers were those women who were attending free camps organized by Department of Obstetrics & Gynaecology, Bharati Hospital, Pune, for measurement of bone mineral density, detection of anemia and also those women who are attending women wellness clinic conducted by them. Those who were in the age group of 35-64 years and were willing to participate were enrolled consecutively in the study.

We anticipated the prevalence of metabolic syndrome as 46.5%.[3] Based on this with a relative precision of 9% with 95% confidence level and power of 80%, we arrived at the sample size of 241. Anticipating for refusals and dropouts we enrolled 300 women. Patients with conditions such as diabetes, hypertension, ischemic heart disease, renal, thyroid and bone diseases or any current infectious condition, vitamin D supplements were excluded from the study.

We used the criteria of metabolic syndrome defined by A joint interim statement of the International Diabetes Federation (IDF) task force on epidemiology and prevention[14] that suggested using the IDF global consensus definition, but without having central obesity as an obligatory parameter. It was suggested that the presence of three or more of the five parameters could be considered as diagnostic of MS that includes abdominal obesity measured by WC for men ≥90 cm and women >80 cm, elevated TG ≥150 mg/dL, reduced HDL-C men ≤40 mg/dL, women <50 mg/dL, elevated BP ≥130/85 mm Hg, and fasting glucose ≥100 mg/dL.

WC was obtained as the minimum value between the iliac crest and the lateral costal margin. Systolic and diastolic BP was measured in the right arm in supine position using mercury - column sphygmomanometer positioned near heart level after 5 min rest. Two readings of SBP and DBP were recorded and the mean of each was used.

Sample Collection and Processing

All women were asked to come to the hospital for blood sample collection in the morning (7:00-8:00 A.M.) Fasting venous blood sample (10 ml) was taken after an overnight fast. Blood was collected by venipuncture of median cubital vein in the antecubital fossa with aseptic precautions. The plasma and serum were separated and stored at −80°C.

Biochemical Analysis

Plasma levels of 25-hydroxyvitamin D [25(OH)D] was assessed by chemiluminescence method.[15] Fasting plasma glucose was assessed by glucose oxidase per oxidase (mg/dl).[16] IR was measured using homeostasis model assessment ratio-IR (HOMA-IR). Serum lipids were measured using commercially available kit. Low-density lipoprotein cholesterol was estimated using the Friedewald's formula.

Statistical Analysis

Data are represented as mean (standard deviation). SPSS version 17.0 for Windows (SPSS Inc., Chicago) was used for the statistical analysis. Variables with skewed distribution were log transformed to satisfy the assumptions of normality. In such cases, the data have been represented as median (interquartile range, IQR). Analysis of variance and Chi-square test were used for comparison between groups. Pearson's correlation was used for associations. $P < 0.05$ was considered as significant difference.

RESULTS

Table 1 shows that 61% subjects obese, 56% having elevated BP, 58% impaired fasting glucose, 97% low HDL, 14% high TGs, and 53% prevalence of metabolic syndrome.

Table 2 shows vitamin D levels are significantly lower in women with metabolic syndrome than without metabolic syndrome.

Table 3 shows that WC, systolic BP, and triglyceride concentrations were inversely associated with vitamin D concentrations. There was no correlation between fasting glucose, HDL, and HOMA-IR with vitamin D.

DISCUSSION

In this study, we investigated whether serum levels of 25(OH)D have associations with the prevalence of metabolic syndrome along with its risk factors in middle-aged urban women.

Table 1 showed that 61% subjects obese, 56% having elevated BP, 58% IFG, 97% low HDL, 14% high TGs, and 53% prevalence of metabolic syndrome. Mean vitamin D levels are - 14.6 (5.7) ng/mL and 84% were with deficient vitamin D levels (<20 ng/mL).

Table 1: Mean values of components of metabolic syndrome and vitamin D

Mean values of components	All (*n*=300)
Waist (cm)	82.2 (10.7)
Obese (≥80)	185 (61.7%)
BP (mmHg)	
Systolic	130 (16)
≥130	153 (51%)
Diastolic	80 (11)
≥85	103 (34.3%)
Systolic≥130 or diastolic≥85	169 (56.3%)
Fasting glucose (mg%)*	90 (104, 115%)
≥100%	176 (58.7)
HDL cholesterol (mg%)	44 (2.5%)
<50	291 (97)
TG (mg%)	105.7 (38.6%)
≥150	43 (14.3%)
Metabolic syndrome	159 (53)
Vitamin D	14.6 (5.7)
Vitamin D deficiency (<20 ng/mL)	254 (84%)

BP: Blood pressure, HDL: High-density lipoprotein, TG: Triglycerides

Table 2: Comparison of vitamin D levels according to presence or absence of metabolic syndrome in all study group

Parameter	Metabolic syndrome		*t* value	*P* value
	Mean±standard deviation			
	Absent (*n*=137)	Present (*n*=163)		
Vitamin D	16.36±5.58	13.16±5.34	5.07	<0.0001

Table 3: Correlation of vitamin D with metabolic syndrome components and HOMA-IR

Metabolic syndrome components (*n*=300)	*R* value
WC	−0.28***
Fasting glucose	−0.11
BP	
Systolic	−0.23***
Diastolic	−0.08
HDL cholesterol	−0.045
Triglyceride	−0.13*
HOMA-IR	−0.06

*P<0.05, **P<0.01, ***P<0.001, HOMA-IR: Homeostasis model assessment ratio-insulin resistance, HDL: High-density lipoprotein, WC: Waist circumference, BP: Blood pressure

In our study, comparison of vitamin D levels according to presence or absence of metabolic syndrome in all subjects. Vitamin D levels are significantly lower in women with metabolic syndrome as compared to women without metabolic syndrome.

We have found a high prevalence of vitamin D deficiency in urban middle-aged women, which could be explained by decreased indoor activity and the use of sunscreens and other sun protectors.[16] Since cutaneous vitamin D production in elderly individuals is known to diminish.[17] It is easy to assume that the prevalence of vitamin D deficiency in this study is due to inclusion of older women.

In Table 3, we found that WC, systolic BP, and TG were inversely associated with vitamin D concentrations whereas there was no correlation between fasting glucose, HDL and HOMA-IR with vitamin D.

Our study is in accordance with the previous study that reported negative association of vitamin D levels and WC.[13,18-20] Vitamin D being fat soluble is readily stored in adipose tissue and gets sequestered in the fat depot of obese individuals, thereby possibly reflected as low serum levels.[21]

In our finding elevated BP was statistically significantly related with vitamin D status in women. Similar results have been found in many clinical studies.[19,20] Vitamin D receptors are distributed on vascular smooth muscle, endothelium, and cardiomyocytes. 1, 25(OH)D suppresses renin gene expression, regulating the growth and proliferation of vascular smooth muscle cells and cardiomyocytes. Therefore, the absence of vitamin D receptor activation leads to tonic upregulation of the renin-angiotensin system, eventually leading to hypertension.[22]

Perhaps low levels of vitamin D were attributed to obesity. Due to sequestration in visceral fat vitamin D was not available for BP regulation.

Our finding of association between vitamin D and triglyceride is in accordance with Lu et al. although the exact mechanism is not well understood this may be due to modifications of gene expression by vitamin D receptors.[23]

In our study**,** we found no correlation between fasting glucose and vitamin D but a study significantly associated with increased IR, especially among those who were overweight or obese whereas in our study the subject included both obese and nonobese.

This study has several strengths, this study was performed using a representative sample of the general population. However, we could not consider factors such as amounts of sunlight exposure, which could have affected the serum levels of 25(OH)D because of the limited data. Further, measurements were performed only once for each participant, and serial measurements over a year would be required for more accurate studies.

CONCLUSION

In summary, vitamin D deficiency was found to be common in Indian women. Elevated WC, BP, TGs were found to inversely associate with low serum levels of 25(OH)D but no correlation between FBG and HOMA-IR. Improving vitamin D status by reducing obesity would be useful in improving the health in middle-aged urban women.

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