Original Article

Vitamin D status of overweight and obese Bangladeshi adults

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Abstract

Background: Both obesity and vitamin D deficiency are pandemics and both have influences on cardiovascular parameters. The reported prevalence of vitamin D deficiency in obesity is high. Data relating to vitamin D status in obese is currently lacking in Bangladesh. **Objective:** To discover the vitamin D status in Bangladeshi overweight and obese adults. **Subjects and Methods:** This cross-sectional study, conducted in a specialized endocrine center of Bangladesh, evaluated 500 consecutive overweight or obese subjects, diagnosed according to body mass index (BMI) categories applicable to the south Asian population. Serum 25(OH)D was measured by using the enzyme-linked fluorescent assay (ELFA) method, and the cutoffs described by the Endocrine Society were used to define vitamin D status. **Results:** The mean age of the study subjects was 45.85 (±11.41) years; most (59.6%) of them were in the age group 40–59 years; almost three-fourth (72.4%) were females; an almost equal number of them came from urban (33.8%), semi-urban (29.6%), and rural (36.6%) areas; three-fourth (74.2%) were homemaker. Their mean BMI was 29.54 (±3.11) kg/m^2; the frequencies of overweight, class I obesity, class II obesity, and class III obesity were 27.6%, 57.4%, 12.2%, and 2.8%, respectively. The mean serum 25(OH)D level was 25.25 (±11.97) ng/mL. 27.4% were sufficient, and 33.4% were insufficient for vitamin D, whereas 39.2% had vitamin D deficiency. The 25(OH)D level did not differ across different age groups, gender, residence, education status, occupation, and income status. The 25(OH)D levels were also indifferent in overweight, obese class I, obese class II, and obese class III subjects. None of the demographic, anthropometric, and biochemical variables (except low-density lipoprotein cholesterol) correlated with 25(OH)D levels. **Conclusions:** The prevalence of vitamin D deficiency in overweight and obese Bangladeshi adults is very high.

Keywords: Body mass index, blood pressure, obesity, overweight, vitamin D

Introduction

Obesity is a global pandemic; overall, about 13% of the adult population (11% of men and 15% of women) of the world were obese in 2016. Moreover, 39% of adults (39% of men and 40% of women) were overweight in 2016.[1] In the last 40 years (between 1975 and 2016), the prevalence of obesity nearly tripled worldwide.[2] Once associated with high-income countries, obesity is now also prevalent in low- and middle-income countries.[1] In a study conducted in 2011, the prevalence of overweight and obesity in adults aged 35–70 years in different cities of Bangladesh found was 18.9% (male 17.4% and female 18.4%) and 4.6% (male 3.0% and female 6.0%), respectively.[3] Another population-based, cross-sectional survey conducted in 2009 reported that the prevalence of overweight and obesity was 17.7% and 26.2%, respectively, in rural Bangladeshi adults.[4] Obesity is associated with several comorbidities such as cardiovascular (CV) disease, hypertension (HTN), stroke, type 2 diabetes mellitus (T2DM), dyslipidemia, osteoarthritis, and some cancers.[5] Around 2.8 million people are dying each year as a result of being overweight or obese.[2]

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The fat-soluble vitamin D is a prohormone and needs to convert to its active form 1,25-dihydroxyvitamin D for its biological effect. Vitamin D has important roles in the development and maintenance of bone tissue, as well as for normal homeostasis of calcium and phosphorus. Moreover, it is related to differentiation, cell proliferation, and hormone secretion.[6] Nowadays, vitamin D deficiency is a pandemic and has been implicated in several diseases, including CV morbidity and mortality, metabolic syndrome, and T2DM.[7]

Serum concentrations of 25-hydroxyvitamin D [25(OH)D] are considered as the best indicator of total body vitamin D stores.[8] The association between reduced 25(OH)D concentrations and obesity is well known, but the mechanisms are not fully understood.[7] Many clinical and epidemiological studies reported that obese subjects have lower serum concentrations of 25(OH)D and higher prevalence of vitamin D deficiency with a negative correlation of vitamin D concentrations with waist circumference (WC) and body mass index (BMI).[9-16] In a meta-analysis, the prevalence of vitamin D deficiency was 35% higher in obese subjects compared to the eutrophic group and 24% higher than in the overweight group.[6] One "superfluous" BMI unit is known to induce a 1.15% reduction in the 25(OH)D concentration.[17] Evidence also supports the inverse association of fat mass with 25(OH)D levels.[18]

In Bangladesh, previous studies have reported a high prevalence of vitamin D deficiency in various subsets of the population.[19-21] Obesity is also a common problem here encountered by both primary care physicians and specialists. Data relating to vitamin D status in obese are currently lacking in this country; we conducted this study was to fill this knowledge gap.

Subjects and Methods

Study area

This cross-sectional study was conducted in the endocrinology outpatient department of Cumilla Diabetic Hospital located at Cumilla, a district town located in the South-East part of Bangladesh, from January 2017 to December 2018.

Study subjects

All consecutive subjects having overweight or obesity attending the endocrine center were included in the study sample. The subjects who had an acute illness, hepatic or renal dysfunction, malabsorption, debilitating chronic disease, and those who got vitamin D or a calcium supplement in the previous 3 months, vegans, pregnant and lactating women were excluded. Finally, 500 overweight or obese subjects fulfilling the inclusion and exclusion criteria were investigated.

Clinical assessment

A semi-structured questionnaire-based interview on a one-to-one basis was conducted to collect data. Socio-demographic data were collected, and anthropometric measurements were done for all. Height (to ± 0.1 cm) was measured in all the individuals using wall-mounted stadiometers, and body weight (to ± 0.1 kg) measured using electronic calibrated scales; BMI was calculated from height and weight using the formula: height/weight^2 and BMI categories applicable to the south Asian population was used to define obesity status.[22] Blood pressure was measured two times in every study subject by the auscultatory method using standard validated aneroid sphygmomanometer after at least 5 min of rest; two separate readings were taken at an interval of a minimum of 3 min, and the average of the two readings was used.

Biochemical assay

Venous blood was collected from each subject. Serum 25(OH)D was measured by the auto analyzer VIDAS (Marcy l'Étoile, France) using the enzyme-linked fluorescent assay (ELFA) method. 25(OH)D levels were considered normal (≥30 ng/mL), insufficient (>20 to 29.9 ng/mL), and deficient (≤20 ng/mL) as per Clinical Practice Guidelines, 2011 of the Endocrine Society.[23] Lipid profile was measured in all in fasting states using fully automatic biochemistry analyzers.

Ethical issues

The institutional review board of the hospital approved the study protocol on 26 December, 2016. Informed written consent was taken from all of the study participants before clinical and laboratory assessments. The privacy of the study subjects was maintained throughout the study procedure. Data were anonymous, and only a number was expressed against each subject.

Statistical analysis

Data were analyzed using Statistical Packages for Social Sciences (SPSS) for Windows, version 23.0 software (SPSS Inc; Chicago, IL, USA). The categorical variables were represented as percentages and measurable variables as mean ± SD or median. Student's *t*-test and one-way analysis of variance (ANOVA) were performed for comparing the variables between different groups as appropriate. Pearson's correlation test was used to observe the correlation of vitamin D levels with other variables. P value ≤0.05 was considered to be statistically significant.

Results

The demographic, clinical, and biochemical parameters of the study subjects are given in Table 1. Their mean age was 45.85 (±11.41) years; most (59.6%) of them were in the age group 40–59 years; almost three-fourth (72.4%) were females; an almost equal number of them came from urban (33.8%), semi-urban (29.6%), and rural (36.6%) areas; more than half (59.2%) got education up to the primary level; three-fourth (74.2%) were homemaker; less than half had a monthly income ≥20,000 BDT. Their mean BMI was 29.54 (±3.11) kg/m^2; the frequency of overweight, class I obesity, class II obesity, and class III obesity were 27.6%, 57.4%, 12.2%,

Table 1: General characteristics of the study participants (*n*=500)

Variables	Subgroups	Mean±SD or *n* (%)
Age (years)		45.85±11.41
Age group (years)	20-39	140 (28.0)
	40-59	298 (59.6)
	60 & above	62 (12.4)
Gender	Male	138 (27.6)
	Female	362 (72.4)
Residence	Urban	169 (33.8)
	Suburban	148 (29.6)
	Rural	183 (36.6)
Education	Primary level or less	296 (59.2)
	Secondary level	85 (17.0)
	Higher secondary level	66 (13.2)
	Graduate and higher level	53 (10.6)
Occupation	Homemaker	371 (74.2)
	Office job	93 (18.6)
	Business	36 (7.2)
Monthly income (BDT)	Up to 10,000	122 (24.4)
	>10,000 to <20,000	139 (27.8)
	20,000 & above	239 (47.8)
Weight (Kg)		71.19±9.74
Height (Meter)		1.55±0.07
BMI (kg/m2)		29.54±3.11
Obesity category	Overweight	138 (27.6)
	Obese class I	287 (57.4)
	Obese class II	61 (12.2)
	Obese class III	14 (2.8)
Systolic BP (mmHg)		125±14
Diastolic BP (mmHg)		80±6
Triglyceride (mg/dL)		144±53
Total cholesterol (mg/dL)		167±73
LDL cholesterol (mg/dL)		130±54
HDL cholesterol (mg/dL)		60±15
Serum 25(OH)D (ng/mL)		25.25±11.97

and 2.8%, respectively. The mean serum 25(OH) D level was 25.25 (±11.97) ng/mL.

Figure 1 depicts the vitamin D status of the study participants; 27.4% were sufficient, and 33.4% were insufficient of vitamin D, whereas 39.2% of them had vitamin D deficiency.

The comparison of 25(OH)D level in various subgroups of the study subjects are given in Table 2. The study subjects in the different age groups, gender, residence, education status, occupation, and income status, had similar 25(OH)D levels. 25(OH)D levels were also indifferent in overweight, obese class I, obese class II, and obese class III subjects.

Correlations of 25(OH)D level with other variables are shown in Table 3. Only LDL cholesterol (LDL-C) showed a significant positive correlation with vitamin D level.

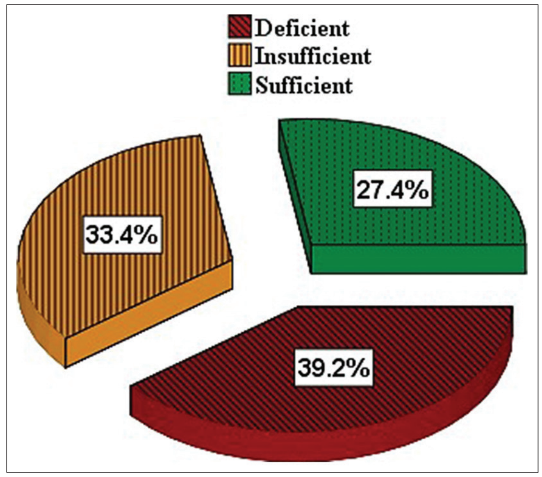

Figure 1: Vitamin D status of the study subjects

Discussion

In this study conducted among the overweight and obese patients attending a specialized endocrine center of Bangladesh, we observed that their mean BMI was 29.54 (±3.11) kg/m^2; the frequency of overweight, class I obesity, class II obesity, and class III obesity were 27.6%, 57.4%, 12.2%, and 2.8%, respectively. The mean serum 25(OH)D level was 25.25 (±11.97) ng/mL in them; 27.4% were sufficient, and 33.4% were insufficient of vitamin D, whereas 39.2% of them had vitamin D deficiency.

Both obesity and vitamin D deficiency are pandemic conditions, and both of them are related to some common adverse outcomes, most importantly, adverse cardio-metabolic outcomes.[24]

Moreover, obese people have lower serum 25(OH)D than normal-weight people, and serum 25(OH)D is inversely correlated with body weight, BMI, and fat mass. This has been shown in many clinical and epidemiological studies conducted in different countries of the world. The prevalence of 25(OH)D deficiency is greater in obese people, reported at between 40 and 80%.[9-16] Studies reported that, serum 25(OH)D is about 20% lower in obese people than normal weight.[24] Low serum 25(OH)D is more likely a consequence of obesity, rather than the cause of obesity. A large genetic study found that high BMI and genes that predispose to obesity decrease serum 25(OH)D. In contrast, low 25(OH)D and genes associated with low 25(OH)D have minimal effect on obesity.[17] The underlying mechanisms of hypovitaminosis D in obesity is not clear. There could be lower vitamin D input because of lower dietary intake, lower sunlight exposure, or impaired skin synthesis of vitamin D. Alterations in protein binding or faster metabolic clearance in obesity could lead to lower serum 25(OH)D. The lower serum 25(OH)D could be because of the distribution of 25(OH)D into a larger whole-body tissue volume, particularly if 25(OH)D were actively sequestered in other tissues.[24]

The vitamin D status of the general population is not well studied in Bangladesh. Few small scale studies had observed

Table 2: Comparison of 25(OH)D level in various subgroups of the study subjects

Variables	Subgroups	Serum 25(OH)D level (ng/mL, mean±SD)	*P*
Age group (years)	20-39	24.89±11.99	
	40-59	25.58±12.02	0.742
	60 & above	24.49±11.81	
Gender	Male	25.51±12.68	0.770
	Female	25.16±11.71	
Residence	Urban	25.62±12.87	
	Suburban	25.30±11.54	0.841
	Rural	24.87±11.50	
Education	Primary level or less	25.45±11.76	
	Secondary level	26.53±13.78	0.453
	Higher secondary level	23.84±11.29	
	Graduate and higher level	23.90±10.82	
Occupation	Homemaker	25.16±11.68	
	Office job	25.07±13.27	0.738
	Business	26.75±11.67	
Monthly income (BDT)	Up to 10,000	24.70±12.19	
	>10,000 to <20,000	26.17±10.97	0.555
	20,000 & above	25.00±11.97	
Obesity category	Overweight	26.08±13.48	
	Obese class I	24.97±11.67	0.820
	Obese class II	24.73±10.54	
	Obese class III	25.25±11.97	

P-value by student's t-test or one-way ANOVA, as applicable

Table 3: Correlations of 25(OH)D level with other variables

	r	*P*
25(OH)D and age	0.010	0.825
25(OH)D and height	0.000	0.999
25(OH)D and weight	-0.027	0.547
25(OH)D and BMI	-0.025	0.573
25(OH)D and systolic BP	0.043	0.339
25(OH)D and diastolic BP	0.014	0.750
25(OH)D and LDL-C	0.100	0.025
25(OH)D and HDL-C	-0.073	0.103
25(OH)D and TG	-0.015	0.740
25(OH)D and TC	0.034	0.445

by Pearson correlation test

a high prevalence of hypovitaminosis D in this country. In a study, Kamrul-Hasan *et al.* found all of the healthy women of reproductive age to have hypovitaminosis D (12% insufficient and 88% deficient).[19] Among the 212 study populations of different age groups, all were found to be vitamin D deficient in another study conducted by Hossain *et al.*[20] Islam *et al.*, in a laboratory-based study of 793 samples, found that 61.4% had vitamin D deficiency, and 24.1% had insufficiency, vitamin D level was found sufficient in 13.1% subjects.[25] In the current study, the frequency of hypovitaminosis D (72.6%, insufficiency 33.4%, and deficiency 39.2%) was lower than the previous observations. In the absence of vitamin D status of the general population of the country and lack of an otherwise healthy normal-weight control group in the current study, it is tough to comment on the relative status of vitamin D in our study subjects. In this context, the frequency of vitamin D deficiency, insufficiency, and sufficiency among Turkish obese patients without metabolic syndrome observed by Karatas *et al.* were 69.2%, 17.5%, and 13.3%, respectively.[12] Taheri *et al.* found that 79% of Iranian obese otherwise healthy subjects to suffer from vitamin D deficiency or insufficiency.[9]

A negative correlation between serum 25(OH)D levels and BMI has been observed by many researchers.[9-15,26] We also observed a negative correlation between serum 25(OH)D levels and BMI, though it was not statistically significant. The 25(OH)D levels were also similar in different obesity categories in this study. Palazhy *et al.* noticed no direct correlations between BMI and 25(OH)D level.[26] We found no correlations of 25(OH)D levels with body weight and height. In a study on 250 overweight and obese adults of different ethnicities, McGill *et al.* demonstrated that the serum level of vitamin D3 was inversely related to weight.[27]

Age is an important factor affecting 25(OH)D levels, and a decline in 25(OH)D levels has been reported with advancing age.[28] We observed no differences in 25(OH)D levels among the different age groups, and 25(OH)D levels did not correlate with age. Similarly, another study in Bangladesh found no significant difference of 25(OH)D levels between age groups <40 years and ≥40 years.[21] On the contrary, Palazhy *et al.* and Al Zarooni *et al.* found 25(OH)D levels to be increased with increasing age.[26,29]

Our study observed no significant difference of 25(OH)D level between males and females; this is in agreement with the observations of Alam *et al.* and Palazhy *et al.*[21,26] On the contrary, women had higher vitamin D compared to men in an Indian study conducted among the general population.[30] Serum vitamin D levels were similar among subjects residing in rural, suburban, and urban areas in this study. Al Zarooni *et al.* also found no difference in mean vitamin D level concentration between the urban and suburban areas.[29] The urban residents had the highest levels of 25(OH)D, followed by rural residents and the lowest for large metro residents in the American population in a study done by Bailey *et al.*[31] The community in which the participants belonged did not have any significant influence on the vitamin D level, according to Tangoh *et al.*, indicating that the level of urbanization may not affect vitamin D status.[32] 25(OH)D levels were indifferent across different levels of educational qualification and income status in the current study. Subjects with a higher level of education had lower 25(OH)D levels in a study done by Al Zarooni *et al.*[29] There was no significant difference in vitamin D levels between levels of education and income levels in another study by Tangoh *et al.*[32]

In this study, 25(OH)D levels did not correlate with either systolic or diastolic BP. Karatus *et al.* had similar observations in obese subjects, Alam *et al.* also found no differences in vitamin D level among the among normotensive, borderline hypertensive, and hypertensive subjects with DM.[12,21] On the other hand, Kota *et al.* demonstrated that systolic blood pressure, diastolic blood pressure, and mean arterial pressure was increased among individuals experiencing inadequacy of vitamin D.[33] Most of the observational studies demonstrated the association of lower circulating 25(OH)D levels with higher blood pressures or a higher prevalence of hypertension.[34]

In this study, 25(OH)D levels did not correlate with either total cholesterol, HDL cholesterol, or triglyceride levels; only LDL cholesterol showed a significant positive correlation with vitamin D level. Karatus *et al.* also observed no correlations of vitamin D with triglyceride and HDL cholesterol levels in obese subjects.[12] In the Indian population, Chaudhuri *et al.* reported that 25(OH)D deficiency was independently associated with dyslipidemia.[35] The serum 25(OH)D levels were inversely associated with TG and LDL-C and positively associated with TC in Chinese adults.[36]

Limitations of the study

Our study had several limitations. It was a single-center study, and the sample size was small, which may not reflect the scenario of the whole country. No control group was evaluated, so comparison with the vitamin D status of the normal-weight healthy population could not be made. The seasonal variations in vitamin D levels and the extent of sun exposure of the study subjects were not taken into account. WC was not measured, limiting the influence of abdominal obesity on vitamin D status. We did not measure plasma glucose, glycated hemoglobin, and the markers of insulin resistance like fasting insulin level and HOMA-IR. Due to a lack of availability, it was not possible to measure 25(OH)D using the reference standard methods, e.g., liquid chromatography-mass spectrometry (LC-MS) and mass spectrometry (MS). Serum calcium, inorganic phosphate, parathormone, and other markers of calcium metabolism were also not assessed. Therefore the result of the study may not be conclusive.

Conclusion

The prevalence of vitamin D deficiency in overweight and obese Bangladeshi adults is very high (72.6%; 33.4% insufficient, 39.2% deficient) according to this study result. No correlations were observed between vitamin D levels and age, BMI, blood pressure, and serum lipids except LDL cholesterol, which had a positive correlation with vitamin D level. However, a large-scale population-based study, including the normal weight otherwise healthy comparison group, should be conducted to explore the vitamin D status in our population.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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