

Hypovitaminosis D and Its Relationship with Diabetes Mellitus among the Postmenopausal Women in Jashore, Bangladesh

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Abstract

Background and Objectives: Vitamin D has diversity of functions including diabetes mellitus by its anti-inflammatory and immuno-modulatory effects. With the scarcity of the regarding data in Bangladesh, the aim of this study was to assess the relationship between hypovitaminosis D and diabetes mellitus among the postmenopausal women. **Methods:** An observational study conducted from 1st July to 31st December, 2018 in Jashore, Bangladesh that recruited 152 eligible apparently healthy natural postmenopausal women above 45 years without having any chronic diseases and drugs interfering vitamin D metabolism. Data was taken by face to face interview through self-administered questionnaires. Independent *t*-test, one-way analysis of variance (ANOVA) were used to extract *P* value and Hochberg's post-hoc test used as equal variance assumed in homogeneous sample to evaluate deference between different groups. **Results:** Among 152 study subjects, the frequency of diabetes and prediabetes were 28.3% and 31.6%, respectively, among the postmenopausal women by fasting blood sugar level according to the ADA guideline. The study revealed 86 (52.58%) deficient, 56 (36.84%) insufficient, and only 10 (6.58%) sufficient Vitamin D level. Illiterate subjects had less hypovitaminosis D than literate subjects. Urban subjects had more in deficiency state of Vitamin D than rural subjects' on the other hand rural subjects had more insufficiency of Vitamin D. Obese individuals suffered more in hypovitaminosis D than others. There was no significant statically relationship found between FBS and 25(OH)D Level in this study. **Conclusion:** With high frequency of diabetes and hypovitaminosis D among the postmenopausal women but there is no statically significant relationship found between diabetes and hypovitaminosis D in this study.

Keywords: Diabetes mellitus, postmenopausal woman, skeletal and non-skeletal functions, vitamin D

BACKGROUND

As the life expectancy increases in Bangladesh, women are enjoying more time in the postmenopausal phase of their life. Diabetes is most common chronic disease in the world and its incidence and prevalence are increasing day by day. Globally, an estimated 422 million adults were living with diabetes in 2014, compared to 108 million in 1980. The global prevalence (age-standardized) of diabetes has nearly doubled since 1980, rising from 4.7% to 8.5% in the adult population. Over the past decade, diabetes prevalence has risen faster in low and middle-income countries than in high-income countries. Type 2 diabetes mellitus is more common than type 1 and is commonly present in obese person over the age of 40 years.^[1] Over the last two decades, a number of reports show that various non-skeletal chronic diseases including diabetes mellitus has been associated with hypovitaminosis D.^[2,3] Though the

exact mechanism of relationship between hypovitaminosis D and diabetes mellitus is not well known but both share the common risk factors including African-American, Asian, or Hispanic ethnicity, increased adiposity, age, and physical inactivity.^[4] Hypovitaminosis D influences insulin secretion and sensitivity through its effects on intracellular calcium.^[5] Vitamin D status plays an important role on IGF system, subsequently glucose homeostasis.^[6,7] Epidemiological study shows that vitamin D seems to enhance the expression of

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insulin receptor and subsequently affect insulin sensitivity.^[8-10] With this view, we have designed the study to assess the status of hypovitaminosis D among the postmenopausal women in Bangladesh and search for any relation with diabetes mellitus. The study will immensely help to treat the diabetic patients and detect the exact scenario of hypovitaminosis D in Bangladesh. As there is no recent vitamin D supplementation program, the health policy maker may help the following decision by the means of the recent study.

METHODS

Study design and area

This is an observational study conducted in Jashore Medical College and Hospital. The study period was from 1st July to 31st December, 2018.

Study population

It recruited 152 clinically apparent healthy postmenopausal women after the age of 45 years where menopause in women had been ceased spontaneously. Women having surgical menopause, known cases of diabetes, hypertension, any organ failure or chronic diseases and drugs or nutrients that may interfere vitamin D metabolism were excluded from our study.

Data collection and data quality control

A structured questionnaire was prepared to collect the data from our participants. Institutional approval has been taken from the superintendent of Jashore Medical College and Hospital. We have explained the aim and purpose of the study to each participant before collecting the data. After getting the informed written consent, a detailed history and physical examinations were carried out among the index participants. Data has been collected by face to face interview using non-probability purposive sampling method. The structured questionnaire was used to collect demographic and socioeconomic information including age, religion, area of residence, educational attainments, occupation, skin complexion, dressing habit, age of last menstruation period, and daily time spent in the sunny environment. In our study, we have stratified area of residency by rural and urban, educational attainment by no education, primary (up to class 5), secondary (class 6--11) and graduation or above (above class 11), occupation by housewife and service, skin complexion by fair, brown and black, dressing habit by veil and no veil, daily sun exposure by <1/2 h, <1/2--1 h, >1--2h, and >2 h.

Data was collected by the trained data collectors and its quality was maintained and supervised by every author arranging a weekend group meeting. Beyond this, the corresponding author checked the collected data for their completeness and clarity on the daily basis.

Anthropometric and clinical measurement

Body weight was measured to the nearest 0.1 kg by using an Electronic Weighing Scale (Sinbe Model No, SBS 4414, and made in People's Republic of China) in light clothing without having footwears. Standing height of

the participants without footwear was measured by the stadiometer scale to its nearest millimeter. Body mass index (BMI) was calculated as weight in kilogram divided by the square of body height in meter. The participants were classified by BMI (weight in kg/height in meter²) groups as obesity (BMI = >30), overweight (BMI = 25--29.9), healthy weight (BMI = 18.5--24.9) according to the Partial update of CG43 London: National Institute for Health and Care Excellence (UK), National Clinical Guideline Centre, 2014.^[11]

Serum collection and biochemical analysis

The participants who had given informed written consents were asked to come with overnight fasting condition. Blood samples were collected under basal condition and taking precaution to avoid venostasis. A total of 05 ml of venous blood was collected from each participant into Vacutainers (Becton Dickinson Diagnostics). Blood samples were separated by centrifugation at 3,000 rpm for 10 min at room temperature within 2 h of being drawn and aliquots were stored at 2--4°C until analysis. The estimation of Vitamin D was carried out by Advia Centaur CP/Vitros Eci/Architect-2000Isr/Immulate 2000 Random Access Immunoassay Analyzer/Beckman Coulter Access 2, made in USA. Kit was used for estimation of Vitamin D Beckman Coulter made in USA. Fasting blood sugar was measured by maintaining the standard protocol. The test result was informed to every participant, respectively.

Case definition of diabetes mellitus

Due to the limitation of resources, we have taken fasting blood sugar level as a diagnostic criterion of diabetes mellitus. According to American Diabetes Association on Classification and Diagnosis of Diabetes Mellitus, fasting glucose level 5.6--6.9 mmol/l has defined as prediabetes and fasting glucose level ≥ 7.0 mmol/l as diabetes.^[12]

Case definition of vitamin D deficiency

Vitamin D status have interpreted in this study as US Endocrine Society, serum level ≤ 20 ng/ml has taken as vitamin D deficient, 21--30 ng/ml as insufficient and ≥ 30 ng/ml has taken as normal or sufficient vitamin D level.^[13]

Ethics approval and consent to participate

Ethics approval of this study is not applicable because of unavailability of institutional Review Board (IRB) in this area but Institutional approval has been taken from principal of Jashore Medical College. We have explained the aim and purpose of the study to each participant before collecting the data and an informed written consent was taken from of each of the participants after that. All the information has been kept confidential to the corresponding author and will be applicable only for the research purpose. The study participant has also been assured that their personal information would not be handed over to the third-part at any quest. The participant has been provided the right to withdraw from the study at any time without any condition.

Statistical analysis

Preformed structured data collection sheets were used in every selected case. Analysis carried out using SPSS

version 23. Categorical data was grouped as percentage and numbers, continuous data categorized as mean with standard deviation (SD). Independent *t*-test, one-way analysis of variance (ANOVA) used to extract *P* value and Hochberg's post-hoc test used as equal variance assumed in homogeneous sample to evaluate deference between groups.

RESULTS

Total 152 study subjects were recruited for this study who met the inclusion criteria. The present study had shown 28.3% diabetes and 31.6% prediabetes among the postmenopausal women by measuring the fasting blood sugar. Among the total 152 cases, 86 (52.58%) were deficient of vitamin D, 56 (36.84%) cases were insufficient of vitamin D level and only 10 (6.58%) had sufficient vitamin D level. Mean age of the study cases were 54 years with a standard deviation (SD) of 7 years and there was no significant difference observed in age between different groups. Mean age of the last menstrual period of the study participants was 46 years with a SD of 5 years and there were no significant difference observed between different groups in age of last menstrual period as well. Most of the study subjects 130 (85.5%) were house wife. Illiterate subjects had been suffered less hypovitaminosis D than that of literate subjects. No significant difference was observed between study groups with different skin complexion. Urban subjects had been suffered more deficiency state of hypovitaminosis D than rural subjects; on the other hand, rural subjects suffered more insufficiency of vitamin D. No significant difference was observed between different study subjects using different dressing [Table 1].

As sun exposure playing the vital role in vitamin D synthesis, we had divided our study subjects into four different groups according to history of sun exposure and we found more sun exposed subjects had less hypovitaminosis D. More than 2 h sun exposure needed to reduce vitamin D deficiency [Table 2].

In our study, we also subdivided our study subjects into different BMI groups and we found obese individuals suffer more than others in hypovitaminosis D [Table 3].

Finally, we grouped our study subjects into different diabetic groups with fasting blood sugar and correlate fasting blood sugar and 25(OH)D level of study subjects to find out any association between diabetes and hypovitaminosis D and we found no significant association [Table 4].

DISCUSSION

This small scale study have designed to assess the correlation between vitamin D and fasting blood sugar level among the postmenopausal women who are previously known as non-diabetic. We have also assessed the effects of age, occupation, residence, education, skin complexion, dressing practice, BMI, and sun exposure on the vitamin status among them. This recent study has found that there is high frequency of vitamin deficiency or insufficiency as high as

93.42% which have supported some other studies in both home and abroad.^[14-16] The mean level of serum vitamin D is 19.31 ± 6.37 ng/ml and this level is nearer to our previous study conducted in the same region.^[14] This is an interesting issue of hypovitaminosis D among postmenopausal women because of its relationship with increased risk of osteoporosis and fracture.

The mean age of our study cohort is 54 ± 7 years with their mean age of the last menstrual period is 46 ± 5 years. Most of the study population has come from the housewife group which has constituted 85.5%, whereas 14.5% are engaged in the service. According to the educational status we have divided the total participants into illiterate (no education), primary (up to class five), secondary (from class six to 12), and graduate (above class 12). A hypothesis related to education found that higher the education, the lower would be the vitamins D as the more educated person are engaged indoor activities. The educated people are literally devoid of sun exposure and finally develop hypovitaminosis D. The recent study found that there is relationship between education and hypovitaminosis D. The educated people are prone to hypovitaminosis D than non-educated person in our study that supports other study.^[15]

Skin complexion plays a vital role for determination of vitamin D level; the darker skin complexion prevents the penetration of UV-B from the sun beam needed for its synthesis. UV-B from the sunlight helps in the synthesis of cholecalciferol in the skin from 7-dehydrocholesterol which is transformed into the active form 25-hydroxyvitamin D in the liver and finally metabolized in the physiologically active form 1,25-dihydroxyvitamin D in the kidney. Fair complexioned individual may enjoy higher level of vitamin D than the darker people in the same regime of sun light.^[3] As the Bangladeshi people are having mostly Fitzpatrick type V skin, we have not found any significant difference of vitamin D level even after dividing the participant into the fair, brown, and black skin complexioned groups. This finding is supported by our previous study but other study has reported that the darker women have significantly lower level of vitamin D which is inconsistent with our study.^[14,17] For the religious belief most of the Muslim women use veil as their curtain which hinder to penetrate the UV-B in the skin required for vitamin D synthesis. So, the women using veil may have more vitamin D deficiency than that of the non-veil women. But the recent study has failed to show any significant difference between the veiled and non-veiled women. This is probably because of the small sample size in our study.

Locality is an important variable of vitamin D status because the rural populations are engaged mostly in the sunny environment which helps in synthesis of more vitamin D. On the other hand, the urban women are engaged in the indoor activities, many of them use sunscreen and umbrella to protect them from the sunlight. Literally they won't get enough sun exposure to synthesize adequate vitamin D and for this reason the urbanized women are more prone to hypovitaminosis D. A recent study conducted in Indonesia has been reported that

Table 1: Demographic characteristic and mean 25(OH)D levels of study subject (n=152)

Characteristics	Demographic Characteristics of study patients			
	25(OH)D Level of study subjects			
	Total	Deficient (≤ 20 ngm/dl)	Insufficient (> 20 ngm/dl-30 ng/dl)	Sufficient (> 30 ngm/dl)
n (%)	152 (100)	86 (56.58)	56 (36.84)	10 (6.58)
Mean \pm SD	19.31 \pm 6.37	14.75 \pm 3.24	23.94 \pm 2.86	32.66 \pm 1.58
Age in years (Mean \pm SD)	54 \pm 7	55 \pm 7	55 \pm 8	52 \pm 5
P			0.563 ^{ns}	
Age of last menstrual period (Mean \pm SD)	46 \pm 5	46 \pm 6	46 \pm 5	46 \pm 4
P			0.990 ^{ns}	
Occupation; n (%)				
Service	22 (14.5)	13 (8.6)	7 (4.6)	2 (1.3)
House wife	130 (85.5)	73 (48.0)	49 (32.2)	8 (5.3)
P			0.798 ^{ns}	
Education; n (%)				
Illiterate	25 (16.4)	10 (6.6)	13 (8.6)	2 (1.3)
Primary	41 (27.0)	22 (14.5)	19 (12.5)	0 (0.0)
Secondary	66 (43.3)	37 (24.3)	22 (14.5)	7 (4.6)
Graduate	20 (13.2)	17 (11.2)	2 (1.3)	1 (0.7)
P			0.018 ^s	
Skin complexion; n (%)				
Fair	63 (41.4)	44 (28.9)	15 (9.9)	4 (2.6)
Brown	70 (46.1)	33 (21.7)	33 (21.7)	4 (2.6)
Black	19 (12.5)	9 (5.9)	8 (5.3)	2 (1.3)
P			0.063 ^{ns}	
Residence				
Urban	66 (43.4)	47 (30.9)	14 (9.2)	5 (3.3)
Rural	86 (56.6)	39 (25.7)	42 (27.6)	5 (3.3)
P			0.002 ^s	
Dressing				
Use veil	101 (66.4)	59 (38.8)	33 (21.7)	9 (5.9)
Not use veil	51 (33.6)	27 (17.8)	23 (15.1)	1 (0.7)
P			0.130 ^{ns}	

Table 2: Relation of vitamin D level with sun exposure (n=152)

Sun Exposure		Relation with Sun Exposure			
		25(OH)D Level of study subjects			
		Total	Deficient (≤ 20 ngm/dl)	Insufficient (> 20 ngm/dl-30 ng/dl)	Sufficient (> 30 ngm/dl)
0- ½ h	n (%)	56 (36.8)	45 (29.6)	10 (6.6)	1 (0.7)
Mean \pm SD		15.99 \pm 5.73	13.77 \pm 3.36	24.07 \pm 2.94	35.00
½-1 h	n (%)	55 (36.2)	31 (20.4)	24 (15.8)	0 (0.0)
Mean \pm SD		19.17 \pm 4.70	15.79 \pm 2.69	23.53 \pm 2.69	-
1-2 h	n (%)	30 (19.7)	9 (5.9)	17 (11.2)	4 (2.6)
Mean \pm SD		22.45 \pm 6.15	15.51 \pm 2.99	23.72 \pm 2.89	32.69 \pm 1.85
>2 h	n (%)	11 (7.2)	1 (0.7)	5 (3.3)	5 (3.3)
Mean \pm SD		28.38 \pm 4.61	19.50	26.37 \pm 3.01	32.17 \pm 1.17
P		<0.001 ^s	0.016 ^s	0.241 ^{ns}	0.291 ^{ns}

vitamin D deficiency is more common among the urbanized group than rural participant, the finding similar to our study.^[18]

As there is not availability of vitamin D fortified food and limited source of vitamin D containing natural food in our country, so sun exposure is the main source for the availability

of vitamin D. Still there is a controversy about the optimum duration of sun exposure required for the synthesis vitamin. Most of the Bangladeshi dark people belongs Fitzpatrick Type 5 skin which hinder the penetration of adequate UV-B radiation from the sun light.^[19] For this reason they require

Table 3: Vitamin D levels among different BMI groups (n=152)

BMI Category		Relation with BMI			
		25(OH)D Level of study subjects			
		Total	Deficient (≤ 20 ngm/dl)	Insufficient (> 20 ngm/dl-30 ng/dl)	Sufficient (> 30 ngm/dl)
<18.5	n (%)	4 (2.6)	3 (2.0)	1 (0.7)	0 (0.0)
	Mean \pm SD	16.29 \pm 4.06	14.93 \pm 3.70	20.37	-
18.5-24.0	n (%)	50 (32.9)	22 (14.5)	23 (15.1)	5 (3.3)
	Mean \pm SD	20.92 \pm 7.06	14.37 \pm 3.79	24.61 \pm 2.82	32.80 \pm 0.94
24.1-29.9	n (%)	74 (48.7)	41 (27.0)	29 (19.1)	4 (2.6)
	Mean \pm SD	19.29 \pm 5.99	14.89 \pm 3.01	23.78 \pm 2.86	31.90 \pm 1.92
≥ 30	n (%)	24 (15.8)	20 (13.2)	3 (2.0)	1 (0.7)
	Mean \pm SD	16.53 \pm 6.36	14.87 \pm 3.24	21.47 \pm 1.19	35.00
	P	0.032*	0.940 ^{ns}	0.160 ^{ns}	0.220 ^{ns}

Table 4: Association between fasting blood sugar (FBS) and 25(OH)D Level (n=152)

Diabetic Category		Relation with Diabetes			
		25(OH)D Level of study subjects			
		Total	Deficient (≤ 20 ngm/dl)	Insufficient (> 20 ngm/dl-30 ng/dl)	Sufficient (> 30 ngm/dl)
Non-diabetic	n (%)	61 (40.1)	31 (20.4)	24 (15.8)	6 (3.9)
	Mean \pm SD	19.97 \pm 6.88	14.44 \pm 3.21	23.89 \pm 2.95	32.84 \pm 1.90
Pre-diabetic	n (%)	48 (31.6)	27 (17.8)	17 (11.2)	4 (2.6)
	Mean \pm SD	18.81 \pm 6.64	14.07 \pm 3.44	23.16 \pm 2.40	32.39 \pm 1.16
Diabetic	n (%)	43 (28.3)	28 (18.4)	15 (9.9)	0 (0.0)
	Mean \pm SD	18.94 \pm 5.30	15.75 \pm 2.91	24.90 \pm 3.09	-
	P	0.586 ^{ns}	0.123 ^{ns}	0.231 ^{ns}	0.686 ^{ns}

Association between Fasting Blood Sugar (FBS) and 25(OH)D Level. Correlation Co-efficient (r): -0.066, Pearson correlation (2- tailed P): 0.419^{ns}

more duration of sun exposure than that of white people. We have divided our participant into the four different groups based on their history of sun exposure in the mid-day. In the recent study, we have found that more sun exposed participant have less hypovitaminosis D and more than 2 h sun exposure is needed to reduce vitamin D deficiency, the result is similar to the other study.^[18,19]

It is well recognized that there is an inverse relationship between body weight or high BMI and vitamin D status. Even some study has been reported that there is gender specific relationship between them especially among the female.^[20] Though the exact mechanism is unknown but the possible explanation may be that the increased body fat is associated with reduced serum bioavailability of vitamin D. On the other hand, the obese people seldom involve outdoor physical activities and expose to the sunny environment which prevent cutaneous synthesis of vitamin D. Vitamin D is stored in the adipose tissue because of its fat solubility and it may be trapped in the larger body pool of adipose tissue of obese person which is also the reason of hypovitaminosis D.^[21] We have divided our study participants in the different BMI groups and found that the obese person have shown more hypovitaminosis D than other groups which is consistence with other studies.^[18,20,21]

According to the standard fasting blood glucose measurement the recent study has revealed that prediabetes is diagnosed

as 31.6%, whereas diabetes frequency is 28.3% among the postmenopausal women. A Nigerian study has reported that the incidence of diabetes among the postmenopausal women is 38.8% and this value is higher than that of our recent study.^[22]

The outcome variable is to determine the association of hypovitaminosis D and diabetes in the recent study. Both these two conditions are increasing gradually worldwide with negative impact on the human body. To assess the debate of relationship between them, in our study, we have found no association between vitamin D deficiency and fasting blood sugar or diabetes mellitus among the postmenopausal women. This finding is similar to the other studies.^[23-25]

Limitations

- This is a cross-sectional observational study which denotes that measurement of Vitamin D and fasting blood glucose are assumed only once and that may have measurement error.
- We have failed extensive evaluation of the patients including measurement of postprandial blood sugar and HbA_{1c} of our study sample because of the lack funding.
- Though there are some limitations in our study, there is scarcity of data regarding postmenopausal women in relation to vitamin D and diabetes mellitus. This study will, of course, fill the data gap which is the main strength of this study.

Recommendation

Irrespective of the association between vitamin D deficiency and diabetes mellitus, there is high frequency of hypovitaminosis D and diabetes among the postmenopausal women in Bangladesh. So, we recommend vitamin D supplementation among the postmenopausal women. We also recommend a large scale nationwide study of vitamin D and diabetes mellitus in Bangladesh.

CONCLUSION

The recent study has shown that hypovitaminosis D is statically associated with obesity, education, and residence. More than 2 h sun exposure is required to maintain the normal value of vitamin D among the postmenopausal women. Though there is high frequency of diabetes mellitus and hypovitaminosis D among the postmenopausal women but we do not found any significant association between vitamin D deficiency and diabetes mellitus in our study.

Availability of data and material

The datasets used and analyzed during completing the study are available from the corresponding author on reasonable request.

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Conflicts of interest

There are no conflicts of interest.

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