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Original Research Article

Age and sex-specific variations of vitamin D level in Bangladeshi population: a laboratory-based study

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ABSTRACT

Background: In Bangladesh, vitamin D deficiency (VDD) is a silent epidemic that is neither recognized nor managed properly. The purpose of this research was to compare vitamin D levels across age groups and sexes in the population of Bangladesh.

Methods: This was a laboratory-based retrospective study conducted in Dhaka, Bangladesh. Data on the age, gender, and vitamin D status of all 1074 people of all ages and both sexes who had their vitamin D levels checked at Ibn Sina D. Lab and Consultation Centre, Doyagonj, Dhaka, on a doctor's recommendation were collected. Vitamin D levels (ng/ml) were categorized as deficiency (0 to <20), insufficiency (20-<30), sufficiency (30-100), and potential toxicity (>100). Participants were then divided into 0-10, >10-25, >25-50, and >50 years age group.

Results: The participants' average age was 29.15±20.32 years, with the majority (39.5%) being over 25-50 years old. Nearly two-thirds [702 (65.4%)] of the participants were female. Participants aged 0-10, >10-25, >25-50, and >50 years had mean vitamin D levels of 26.68±20.30, 16.47±7.18, 20.30±9.35, and 22.73±13.55 ng/ml, respectively. The participants' average vitamin D levels varied dramatically with age. Among the subjects, 605 (56.3%) were vitamin D deficient (95% confidence interval: 53.4-59.1). VDD was detected in 52.2% of males and 58.5% of females, indicating that females are significantly more affected.

Conclusions: VDD is extremely common among Bangladeshi people. It is more prevalent among young and females. Ensuring proper nutritional supplementation among at-risk groups can help to prevent the long-term negative health consequences of VDD.

Keywords: Insufficiency, Female, Prevalence, Retrospective study, Vitamin D deficiency

INTRODUCTION

Vitamin D deficiency (VDD) is becoming an increasingly important public health concern for people of all ages, regardless of gender, race, or geographic location. Roughly one billion people globally suffer from relative VDD.[1] VDD is currently quite common in South Asian countries, including Bangladesh, one of the most densely

populated countries in the world.[2] Bangladesh receives an adequate amount of UV radiation (290-315 nm) due to its location in a tropical to subtropical climate zone that stretches from 200°43' to 260°36'N and 880°3' to 920°40'E. Hence, the assumption that Bangladeshis have adequate vitamin D levels has persisted for quite some time. Although Bangladesh is blessed with abundant sunlight, prior studies consistently demonstrated that VDD is a silent epidemic.[3-6] However, information on vitamin D levels in Bangladesh is scarce. The majority of the data we found were from small-scale cross-sectional studies that focused on specific populations, like preschoolers, school-aged children, women who were not pregnant or nursing, medical professionals, and people with diabetes.[3-5,7,8] Hypovitaminosis D prevalence varied from 21 to 75% among babies, children, and adolescents; 38 to 100% among premenopausal women; 66 to 94.2% among pregnant women; 6 to 91.3% among adult men; and 82 to 95.8% among postmenopausal women.[9] Certain variables, including genetics, age, skin contact with sunlight, sun exposure duration, geographical latitude, air pollution, seasonal changes, clothing choices, melanin levels, sunscreen use, dietary supplements, dietary elements, and hereditary traits, have been found to be associated with VDD.[1]

Vitamin D regulates calcium mobilization, renal reabsorption, and intestinal calcium and phosphorus absorption to maintain calcium homeostasis and bone mineralization.[10,11] In adults, VDD can lead to osteomalacia and osteoporosis, but in children, it may result in rickets.[12] The skeletal system is compromised by osteoporosis, a disease characterized by weakened bones and decreased bone density. This increases the likelihood of fractures later in life.[13] When compared to men, the likelihood of this disorder occurring in female is four times higher.[14] Although there is a lack of data at the moment, the high prevalence of VDD in Bangladesh likely makes the elderly more vulnerable to osteoporosis and fractures. Furthermore, a deficiency in vitamin D is linked to diabetes, cardiovascular disease (CVD), hypertension, cancer, dementia, schizophrenia, multiple sclerosis, impaired immunological function, and infectious disorders like tuberculosis.[15-17] Numerous research studies have demonstrated a correlation between inadequate vitamin D levels during pregnancy and preterm birth, diminished birth weight, and small for gestational age. Vitamin D levels are linked to susceptibility to viral illnesses such as COVID-19 and SARS-CoV-2.[16,17]

Over the past twenty years, there has been a limited number of studies conducted on VDD across Bangladesh's numerous population groups.[2] Recently, there has been an increasing emphasis on VDD or vitamin D insufficiency as a potential public health issue, accompanied by an expanding range of research in our country. This study aimed to look into the potential age- and gender-specific differences in vitamin D levels within the Bangladeshi population.

METHODS

Study design and population selection

The laboratory-based retrospective study was conducted in Dhaka. The study was conducted with all the 1074 patients who had their vitamin D levels evaluated in Ibn Sina D. Lab and Consultation Centre, Doyagonj, Dhaka, based on a doctor's suggestion of testing between 1st January and 31st December of 2023. Participants of all ages, including both males and females were included in this study. After receiving formal written consent, the laboratory information system (LIS) of that diagnostic centre was accessed to extract data on age, sex, and vitamin D levels. Maintaining the appropriate level of anonymity that restricted the researcher from identifying individual patients during or after data collection, the data was accessed on February 3, 2024.

The research was carried out in accordance with the principles outlined in the Declaration of Helsinki. Ethical approval of the study was taken from the Institutional Ethical Review Board (IERB) of Dhaka National Medical College (Ref: DNMC/IERB/Ethical/2024/01/286).

Sample collection and examination

Three millilitres of blood samples were collected from every study participant and poured into gel tubes. The serum was separated using a 5-minute centrifugation at 4,000 rpm. The serum levels of 25-hydroxy vitamin D [25(OH) vitamin D] were estimated using the Abbott Architect ci4100 analyzer (Abbott, Max-Planck Ring 2, Germany), which has an analytical measurement range of 4.0–160 ng/ml. The results of standard internal and external quality control fell within the assay's suggested range.

The immunodiagnostic enzyme-linked immunosorbent assay test (ELISA) was applied to quantify 25(OH)D. The assay uses a specific monoclonal antibody that uses a competitive ELISA approach to identify 25(OH)D. Vitamin D status was defined as follows- deficiency (0 to <20 ng/ml), insufficiency (20-<30 ng/ml), sufficiency (30-100 ng/ml), and potential toxicity (>100 ng/ml). However severe deficiency was considered if vitamin D level was <10 ng/ml. Subsequently, subjects were divided into four groups as per their age: 0-10, >10-25, >25-50, and >50 years.

Statistical analysis

The analysis was carried out using the Statistical Package for Social Scientists (SPSS) (version 26). The categorical data were shown through frequency and percentages, whereas the continuous variables were represented with mean and standard deviation. The Shapiro-Wilk test was used to evaluate the normality of the data distribution. The Kruskal-Wallis test was used to assess the variation in vitamin D levels among different age groups. Chi-square

tests were used to examine vitamin D status across various age groups and genders. A difference was deemed statistically significant when the p value was below 0.05.

RESULTS

Demographic characteristics of the study participants

A total of 1074 vitamin D level reports were analysed during the study. The mean age of the participants was 29.15±20.32 years. The majority of the participants (39.5%) were from >25-50 years age groups. Almost two-thirds of the participants were female (Table 1).

Vitamin D status of the study participants

Among the participants, 78 (7.2%) (95% confidence interval: 5.7-8.9) were suffering from severe VDD, 527 (49.1%) (95% confidence interval: 46.2-52.0) were suffering from moderate VDD, 314 (29.2%) (95% confidence interval: 26.5-32.1) were from insufficiency, and 149 (13.9%) had sufficient vitamin D levels and 6 (0.6%) (95% confidence interval: 0.2-1.0) had a toxic level of vitamin D level (Table 2). Among the participants, 605 (56.3%) (95% confidence interval: 53.4-59.3) were suffering from VDD. Moreover, hypovitaminosis D affected 85.5% (95% confidence interval: 83.4-87.5) of the people surveyed in this study.

Table 1: Distribution of the participants according to demographic characteristics (n=1074).

Demographic characteristics		Frequency	Percentage
Age (years)	0-10	270	25.1
	>10-25	209	19.5
	>25-50	424	39.5
	>50	171	15.9
	Mean±SD	29.15±20.32	
	Median (range)	28.00 (0.10-85.00)	
Gender	Male	372	34.6
	Female	702	65.4

SD: Standard deviation. Data was presented as frequency (percentage), mean± SD, median (range).

Table 2: Vitamin D status of the study participants (n=1074).

Vitamin D Status	Frequency	Percentage	95% confidence interval	
			Lower	Upper
Severe deficiency	78	7.2	5.7	8.9
Moderate deficiency	527	49.1	46.2	52.0
Insufficiency	314	29.2	26.5	32.1
Sufficiency	149	13.9	11.9	16.0
Toxicity	6	0.6	0.2	1.0

Data was presented as frequency (percentage), 95% confidence interval

Table 3: Distribution of the vitamin D level according to gender (n=1074).

Gender		Vitamin D level (ng/ml)
Male (n=372)	Mean±SD	23.29±17.37
	Median (range)	19.68 (5.62-148)
Female (n=702)	Mean±SD	20.63±11.30
	Median (range)	18.30 (5.36-151.00)

Age and sex specific variations of vitamin D level

Study samples were collected both from male and female patients. The mean vitamin D level of the male participants was 23.29±17.37 ng/ml and the vitamin D level among female participants was 20.63±11.30 ng/ml (Table 3).

The mean vitamin D level of the participants aged 0-10 years, >10-25 years, >25-50 years, and >50 years was 26.68±20.30 ng/ml, 16.47±7.18 ng/ml, 20.30±9.35 ng/ml and 22.73±13.55 ng/ml, respectively. A significant difference in mean vitamin D levels was observed between different age groups of participants (p value: <0.001) (Table 4).

About 56.3% were suffering from VDD. Among the male participants, 52.2% were suffering from VDD, 17.2% had sufficient vitamin D, 4 (1.1%) had a toxic level of vitamin D. Whereas, among the female participants 58.5% were suffering from VDD, and only 12.1% had sufficient vitamin D. Our result showed that female patients suffered significantly more from VDD than males (p value: 0.029). Among the participants of the 0-10 years age group, 39.3% were suffering from VDD, 24.1% had sufficient vitamin D and 1.9% had toxic levels of vitamin D. Among the

participants of the >10-25 years age group, 78.5% were suffering from VDD, and only 4.8% had sufficient vitamin D. Among the participants of the >25-50 years age group, 59.7% were suffering from VDD, and 11.3% had sufficient vitamin D. Among the participants of the >50 years age group, almost half of the participants were suffering from VDD, and only 15.2% had sufficient vitamin D. A significant association was observed between age group and vitamin D status of the participants (p value: <0.001) (Table 5).

Table 4: Distribution of the vitamin D level according to age group (n=1074).

Age (years)			Vitamin D level (ng/ml)	P value
0-10	(n=270)	Mean±SD	26.68±20.30	<0.001
		Median (range)	22.24 (7.65-151.00)	
>10-25	(n=209)	Mean±SD	16.47±7.18	
		Median (range)	15.19 (5.36-59.20)	
>25-50	(n=424)	Mean±SD	20.30±9.35	
		Median (range)	18.29 (6.64-72.37)	
>50	(n=171)	Mean±SD	22.73±13.55	
		Median (range)	20.40 (6.81-134.48)	

SD: Standard deviation. Kruskal Wallis test was done. Data was presented as mean±SD, median (range)

Table 5: Association of Vitamin D status with the age group and gender of participants (n=1074).

Variables		Vitamin D status				Total	P value
		Deficiency	Insufficiency	Sufficiency	Toxicity		
Age (group)	0-10	106 (39.3)	94 (34.8)	65 (24.1)	5 (1.9)	270 (100.0)	<0.001
	>10-25	164 (78.5)	35 (16.7)	10 (4.8)	0 (0.0)	209 (100.0)	
	>25-50	253 (59.7)	123 (29.0)	48 (11.3)	0 (0.0)	424 (100.0)	
	>50	82 (48.0)	62 (36.3)	26(15.2)	1 (0.6)	171 (100.0)	
Gender	Male	194 (52.2)	110 (29.6)	64 (17.2)	4 (1.1)	372 (100.0)	0.029
	Female	411 (58.5)	204 (29.1)	85 (12.1)	2 (0.3)	702 (100.0)	
Total		605 (56.3)	314 (29.2)	149 (13.9)	6 (0.6)	1074 (100.0)	

A chi-square test was done. Data was presented as frequency (percentage).

DISCUSSION

Vitamin D deficiency (VDD) and insufficiency, or hypovitaminosis D, affects about half of the world's population.[1,18,19] As a public health issue, it is currently getting more and more attention. Bangladesh has a tropical environment with plenty of sunshine, yet VDD can still result from dietary choices, cultural customs, timing and length of sun exposure, wearing full-body clothing, living indoors, and impairment of vitamin D synthesis.[20] A lack of vitamin D has been connected to numerous detrimental or chronic health conditions. It is useful to assess and interpret age- and sex-specific deficient status to better understand and manage risk groups (children, youth, adults, and the elderly, as well as males and females) and prevent adverse health consequences related to VDD. Hypovitaminosis D affected over eighty-five percent (95% confidence interval: 83.3-87.6) of the people surveyed in this study. More than fifty-six percent (95% confidence interval: 53.4-59.1) were suffering from VDD, with a higher prevalence among younger and women.

The average age of the participants was 29.15±20.32 years. More than 40% of the participants were children or adolescents. Almost two-thirds of the participants were female. Six patients (0.6%) had a toxic level of vitamin D, more than seven percent had severe VDD, and nearly half had VDD. The prevalence of hypovitaminosis D was found to be 85.5% in a study that was carried out by Islam et al and involved 793 individuals as participants from Bangladesh.[21] Research published in peer-reviewed journals in Bangladesh reveals that hypovitaminosis D affects a wide range of age groups, including infants, children, and adolescents (21-75%), women (38-100%), pregnant women (66-94%), adult males (6-91%), and women (82-95%) after menopause.[9] A study conducted in Gurgaon, India, involving 26,346 individuals who had an executive health check-up found that 59% of the subjects had hypovitaminosis D.[22] 60,937 participants in a large-scale study carried out in Pakistan had a prevalence of VDD of 66.1%.[23] Thus, there is essentially a similar prevalence of hypovitaminosis D in Bangladesh, India, and Pakistan, the three tropical Asian countries. Insufficient sun exposure has also been linked to VDD in tropical nations including Pakistan, India, Kuwait, and other Middle Eastern nations.24-26 However, the hypovitaminosis in the Bangladeshi person might have resulted from less sunlight exposure.

It was often thought that VDD was a disorder that only affected the elderly. However, there has been a recent shift in this pattern. In this study, VDD was found in almost half of the people over 50 years old, almost 60% of participants over 25-50 years old, and nearly four out of every five persons aged >10-25 years. Furthermore, about 40% of children between the ages of 0 and 10 have vitamin D deficiencies. Children from Bangladesh participate in indoor activities instead of outdoor ones in the sun, live in dimly lit locations, and have a more sedentary lifestyle, according to a study done on them.[20] People who were >10-25 years old were far more likely to suffer from VDD. A retrospective study with over 10,000 subjects that took place in an Indian laboratory found similar results.[27] Age-wise analysis in that study revealed that the maximum proportion (69.7%) of VDD was found in the 10-25 age group. However, Shukla et al study showed that the group with the highest level of VDD was 41-60 years old.[22] The age group of ≥18-≤30 years had the highest rate of VDD (82.5%), followed by >30-≤40 (80.4%), >40-≤50 (76.6%), and >50-≤65 (74.1%), according to a study by Goel.[28] Additionally, a significant ($p<0.001$) relationship was found in the data between the age group and the vitamin D status of Indian subjects. This silent disease is also present in a substantial number of younger Indians, as indicated by research on bone mineral density (BMD) in healthy Indians.[29] The study undertaken by Shivane et al revealed that 70% of the 1137 patients within the age range of 25-35 exhibited a deficiency in vitamin D.[30] The analysis carried out by Garg et al revealed that 65.5% of females under the age of 30 were diagnosed with VDD.[31]

In the current study, the mean level of vitamin D in male participants was 23.29±17.37 ng/ml, whereas in female participants it was 20.63±11.30 ng/ml. The research carried out in India showed a significant disparity in the average serum 25(OH)D levels between male and female participants.[22] Kiani et al did not find any such variances, though. Identical information on the distribution of vitamin D levels by gender has been obtained from numerous previous researches.[32] This study reported that female participants were significantly more affected by VDD compared to their male counterparts. According to a study by Islam et al, women have hypovitaminosis D at a higher severity than men.[21] According to a recent study done in Islamabad by Khan et al, VDD was as common as 71% of the population, with a larger percentage of females (56%) being affected.[33] These results are all consistent with what this study found. Bangladesh is a predominantly Muslim country where women often lead sedentary lifestyles, remain homebound, and wear veils to cover themselves in public and less sun exposure may have contributed to reduced vitamin D levels than males.[9] Given that the majority of studies on VDD have demonstrated a preponderance of females.

There are a few limitations to the current study. The research was conducted in retrospect and depended entirely on results from the diagnostic laboratories. Numerous physiological and pathological aspects, such as skin tone, quantity of sun exposure, dietary habits, and medication use, might cause perplexity regarding serum vitamin D status. It was impossible to look into the patients' use of vitamin D in relation to their dangerous levels. The findings are not applicable to a larger setting. Despite these limitations, the study sheds some light on the reasons why a diverse population of Bangladeshis has a higher prevalence of hypovitaminosis D. This study supports the notion that, in order to gather reliable data on VDD, a cross-sectional study with proper design and a nationwide survey are required. This information will be useful in the future when developing relevant public health strategies.

CONCLUSION

The prevalence of vitamin D deficiency and insufficiency is notably high among the Bangladeshi population. Although people of all ages and genders were suffering from VDD, the young people and females were more likely to be affected. Ensuring proper nutritional supplementation among young and females will help to prevent the enduring adverse health outcomes linked to VDD. Alongside offering accessible and affordable laboratory measurement facilities for the public, appropriate policy implications, including the generation and dissemination of knowledge regarding the prevalence and risk factors for VDD and its nutritional supplementation, will contribute to addressing this silent epidemic.

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