A Comprehensive Analysis of Vitamin D Levels Based on Demographic Data at INMAS, Mohakhali

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ABSTRACT

Background: Sunshine Gold, a crucial element, namely vitamin D, is essential for maintaining calcium homeostasis and promoting bone mineralization. Its deficiency has become a global health issue, particularly concerning in our country, affecting people from all socioeconomic and geographic backgrounds, especially females and children.

Methods: 111 blood samples were investigated in the In-vitro Division of the Institute of Nuclear Medicine and Allied Sciences (INMAS) in Mohakhali, Dhaka from January to December 2024. Demographic and socio-economic impacts on vitamin D levels and their probable reasons are investigated through several statistical and mathematical analytics.

Results: About 75.67% of people are deficient in vitamin D (<20 ng/mL). Deficiency was noted in 61.90% of females (mean ± S.D.) 11.21 ± 4.50 ng/mL and 11.98 ± 3.43 ng/mL in males, indicating higher levels of vitamin D in males. Approximately 60.00% of participants aged 19-40 years had a deficiency with 11.29 ± 3.80 ng/mL. Seasonal studies showed higher vitamin D levels in summer due to increased sun exposure. Housewives exhibited notable deficiencies with an average level of 9.38 ± 4.50 ng/mL, comprising 19.05% of the deficient group. People from lower socioeconomic classes had longer sun exposure, resulting in higher vitamin D concentrations.

Conclusion: It is a pressing need for comprehensive public health interventions to address the significant prevalence of vitamin D deficiency among Bangladeshis. Increasing public awareness about the levels of vitamin D and its interrelations to sun exposure, boosting dietary sources of vitamin D, and considering food fortification initiatives are some possible strategies.

Keywords: Serum 25(OH)D, Vitamin D insufficiency, vitamin D deficiency, chemiluminescence, hypovitaminosis.

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INTRODUCTION

The development, growth, and maintenance of a healthy skeleton depend heavily on vitamin D, sometimes referred to as "the sunshine vitamin." Vitamin D is a steroid prohormone which maintains the calcium and phosphorous homeostasis (1). This fat-soluble vitamin is now known to have a gene-mediated pleotropic effect on a variety of extra-skeletal tissues in addition to its well-known effects on the musculoskeletal system. Furthermore, keratinocytes have a special photoendocrine vitamin D system that is activated by ultraviolet B (UVB) irradiation due to the vitamin D receptor (VDR) that is found within these cells (2). Vitamin D binding to keratinocyte VDR increases the synthesis of cathelicidines, a key element of the innate immune system with strong microbicidal properties (3). This suggests that vitamin D plays a significant part in immunological defense. In fact, VDRs are expressed by most of the body tissues and cells. Vitamin D has anti-inflammatory and immune-modulatory qualities, but there is also growing experimental and epidemiological evidence that it protects against diabetes mellitus, colorectal cancer, dental health, hypertension, secondary hyperparathyroidism, multiple sclerosis and cardiovascular mortality in addition to the risk of falls and fractures (4).There are two bioequivalent forms of vitamin D. Ergocalciferol, another name for vitamin D2, is acquired by oral supplements and dietary vegetable sources. Cholecalciferol, another name for vitamin D3, is mostly acquired through consumption of foods like oily fish and variously fortified foods (milk, juices, margarines, yogurts, cereals, and soy), oral supplements, and skin exposure to UVB radiation from sunlight. Our skin produces 80–90% of this vitamin D as a result of exposure to UVB rays. An additional 10–20% is obtained through diet (5). D2 and D3 have no biological effect. Following intestinal absorption, they undergo liver metabolism to produce 25-hydroxyvitamin D [25(OH)D], which is made up of 25(OH)D2 and 25(OH)D3; in the kidney and certain other tissues, the 1 α-hydroxylase enzyme transforms 25(OH)D (also known as calcidiol) into 1,25-dihydroxyvitamin D [1,25(OH)$_2$D], also called calcitriol. By activating the vitamin D receptor in cells, calcitriol's endocrine and autocrine actions produce the most vitamin D's effects (6). The best functional measure of vitamin D status is thought to be serum 25(OH)D, which reflects the total of oral intake and cutaneous synthesis (7). In South Asia, including Bangladesh, reaching sufficient vitamin D levels is especially difficult. Bangladesh is a tropical nation with year-round sunshine on its equator. About six to seven hours of sunshine are received daily by the people of Bangladesh. It was previously believed that vitamin D sufficiency was caused solely by sun exposure. Nonetheless, Bangladesh continues to have a high prevalence of vitamin D deficiency (8). The question of why our people are developing hypovitaminosis D struck and motivated us to conduct this study, even though Bangladesh has an abundance of sunshine that allows for the synthesis of vitamin D throughout the year. Many risk factors for vitamin D deficiency have been identified by researchers thus far, such as working indoors (9), wearing protective or long-sleeved clothing frequently (10), women's use of sunscreen and other sun-blocking products, the prevalence of vegetarian diets, financial barriers to obtaining vitamin D-rich foods (11), etc. The purpose of this study is to investigate vitamin D deficiency and insufficiency in urban populations and the relationships of vitamin D levels with age, gender, season, occupation, and socio-economic status.

METHODS

This observational, laboratory-based, retrospective analysis was conducted in the In-vitro Division of INMAS, Mohakhali, Dhaka, between January and December of 2024. Purposively, every patient who was referred to the center for vitamin D measurement during the study period was included. There were 111 participants in the study overall. Five milliliters of venous blood were drawn from each patient using a disposable syringe. Vitamin D levels were estimated using the separated serum that was obtained through centrifugation. Total 25-hydroxyvitamin D [25(OH)D; the sum of 25(OH)D2 and 25(OH)D3] was measured using the chemiluminescence (CLIA) method with the ADVIA Centaur XPT Immunoassay System (Siemens Healthcare AG, Germany) to estimate serum vitamin D levels. This technique is known for its accuracy and consistency in determining vitamin D levels. Participants' vitamin D levels were divided into three groups based on the most recent Endocrine Society guidelines: deficient (less than 20 ng/mL), insufficient (20–less than 30 ng/mL), and sufficient (30-100 ng/mL). A detailed examination of vitamin D levels across various demographic groups within the study population was made easier by this classification. Participants were divided according to age and gender. Regarding age distribution, they were separated into four groups: those under the age of 18, those between the ages of 19 and 40, those between the ages of 41 and 60, and those over 60. The effect of the seasons on vitamin D levels was also investigated. Three separate seasons—summer, rainy, and winter season—were broadly classified for this purpose. Participants involved in outdoor and indoor work, namely day labor, housewife, business, service, and unemployed, were considered for the investigation of the relationship between vitamin D levels and occupation. Furthermore, total income was used as an indicator to investigate the connection between vitamin D and socio-economic status. Three categories were used to report average monthly income: lower class (less than 20,000 BDT), middle class (between 20,000 and 50,000 BDT), and higher class (more than 50,000 BDT).

RESULTS

The study comprised 111 participants, with 69 females (62.16%) and 42 males (37.84%), resulting in a female to male ratio of 1.64 as depicted in figure 02. Among the participants, 6 (5.41%) had sufficient vitamin D levels, 21 (18.92%) had insufficient levels, and 84 (75.67%) were deficient in vitamin D (Table 1) as depicted in figure 01.

Table 1: Distribution of vitamin D among the study population

Vitamin D level (ng/mL)	Vitamin D status	Frequency (n)	Percent (%)
Adult: <20 Pediatric: <15	Deficient	84	75.67
Adult: 20 - <30 Pediatric: 15 - <20	Insufficient	21	18.92
Adult: 30 – 100	Sufficient	06	5.41

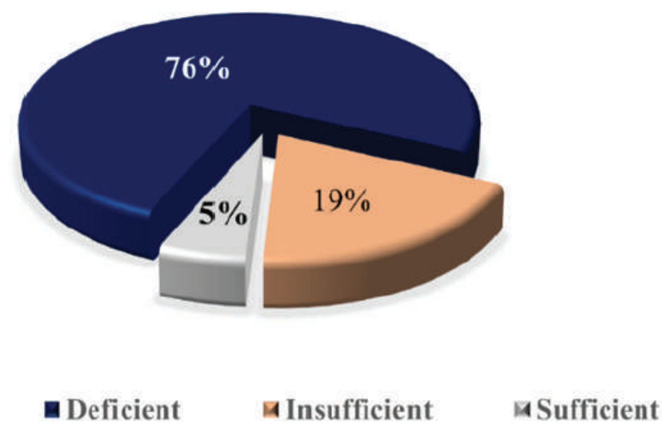

Figure 1: Vitamin D status of the participants

A closer look at the data through the lens of gender revealed a subtle difference in vitamin D levels between males and females. Males exhibited a slightly higher mean concentration of vitamin D, averaging 15.38 ± 7.00 with a median of 14.06. In contrast, females had an average concentration of 15.10 ± 8.32 with a median of 14.07 (Table 2).

Table 2: Average vitamin D status in male and female

Sex	N (%)	Mean ± SD	SEM	Median
Male	42 (37.84%)	15.38 ± 7.00	1.08	14.06
Female	69 (62.16%)	15.10 ± 8.32	1.01	14.07
Total	111 (100%)	15.21 ± 7.81	0.75	14.07

Furthermore, the study highlighted a disparity in vitamin D levels within the deficiency group. Female patients exhibited an average concentration of 11.21 ± 4.50, while their male counterparts had a slightly higher average of 11.98 ± 3.43. This suggests that males, even within the deficient category, tend to maintain marginally higher vitamin D levels (Table 3).

Table 3: Distribution of vitamin D according to gender

	Sex							
	Male				Female			
Vit D Status	N (%)	Mean ± SD	SEM	Median	N (%)	Mean ± SD	SEM	Median
VDD	32 (38.10%)	11.98 ± 3.43	0.61	12.38	52 (61.90%)	11.21 ± 4.50	0.62	11.09
VDI	08 (38.10%)	25.21 ± 2.51	0.89	25.03	13 (61.90%)	24.58 ± 3.09	1.55	23.52
VDS	02 (33.33%)	30.50 ± 0.05	0.04	30.50	04 (66.67%)	34.98 ± 2.58	1.29	35.94

The distribution of vitamin D levels by age is detailed in Table 4. Within the vitamin D deficiency range, the 0-18 age group had an average concentration of 11.97 ± 4.56 with a median of 12.05. Participants aged 19-40 years had an average concentration of 11.29 ± 3.80 with a median of 11.84. For the 41-60 age group, the average was 12.39 ± 4.22 with a median of 12.33. Participants older than 60 years showed an average concentration of 12.53 ± 4.49 with a median of 12.98.

Table 4: Distribution of vitamin D according to age

Age								
	0-18				**19-40**			
Vit D Status	N (%)	Mean ± SD	SEM	Median	N (%)	Mean ± SD	SEM	Median
VDD	10 (11.90%)	11.97 ± 4.56	1.52	12.05	50 (59.52%)	11.29 ± 3.80	0.54	11.84
VDI	01 (4.76%)	25.88 ± 0	-	25.88	10 (47.62%)	25.28 ± 3.33	1.05	26.18
VDS	00 (0.00%)	-	-	-	02 (33.33%)	32.81 ± 3.32	2.35	32.81
	41-60				**> 60**			
VDD	20 (23.81%)	12.39 ± 4.22	0.94	12.33	04 (4.76%)	12.53 ± 4.49	2.24	12.98
VDI	09 (42.86%)	24.21 ± 2.61	0.87	23.52	01 (4.76%)	24.60 ± 0	-	24.60
VDS	03 (50.00%)	34.67 ± 3.59	2.07	36.72	01 (16.67%)	31.28 ± 0	-	31.28

An analysis of the seasonal impact revealed that vitamin D deficiency was marginally lower in the winter (11.26 ± 4.53, 32.14%) compared to the rainy season (10.99 ± 4.05, 38.10%) as depicted in figure 03. Conversely, vitamin D insufficiency was more common during the winter (23.84 ± 2.62, 38.09%) than in the rainy season (24.94 ± 3.18, 19.05%). As anticipated, the summertime had the highest average concentration of vitamin D (34.13 ± 3.28, 50%) (Table 5)

Table 5: Vitamin D levels observed with seasonal variations

Season								
	Summer				**Rainy**			
Vit D Status	N (%)	Mean ± SD	SEM	Median	N (%)	Mean ± SD	SEM	Median
VDD	25 (29.76%)	12.40 ± 3.74	0.75	13.03	32 (38.10%)	10.99 ± 4.05	0.72	11.88
VDI	09 (42.86%)	26.23 ± 2.17	1.08	26.42	04 (19.05%)	24.94 ± 3.18	1.00	25.03
VDS	03 (50.00%)	34.13 ± 3.28	1.89	35.15	01 (16.67%)	32.99 ± 0	-	32.99
	Winter							
VDD	27 (32.14%)	11.26 ± 4.53	0.87	11.26				
VDI	08 (38.09%)	23.84 ± 2.62	0.99	23.84				
VDS	02 (33.33%)	33.63 ± 4.38	3.10	33.63				

In relation to occupation, individuals who worked outdoors, such as day laborers, exhibited the highest mean vitamin D concentration of 13.14 ± 4.15. On the other hand, housewives, who primarily engaged in indoor activities, had the lowest mean vitamin D concentration of 9.38 ± 4.50 (Table 6) as depicted in figure 02. This highlights the significant impact of sun exposure on vitamin D levels, with outdoor work contributing to higher concentrations compared to indoor activities.

Table 6: Distribution of vitamin D according to occupation

Profession	N (%)	Mean ± SD	SEM	Median
Day labor	06 (7.14%)	13.14 ± 4.15	1.69	13.14
Business	11(13.10%)	12.14 ± 2.66	0.80	12.29
Service	47(55.95%)	11.92 ± 3.93	0.57	12.58
Housewife	16(19.05%)	9.38 ± 4.50	1.13	7.90
Unemployed	04(4.76%)	10.87 ± 6.73	3.37	11.19

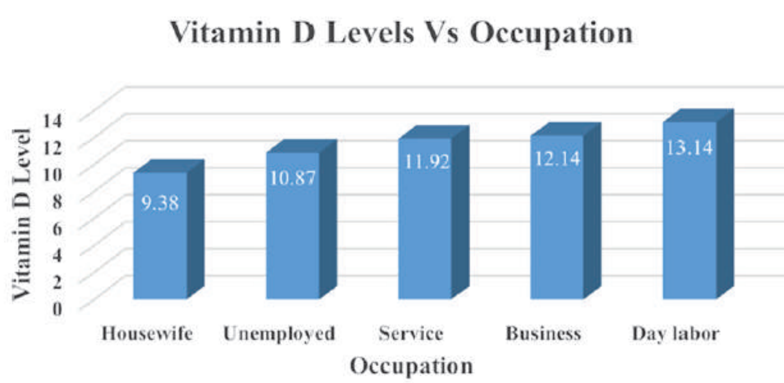

Figure 2: Vitamin D levels of participants from different occupations

The relationship between vitamin D levels and socioeconomic status revealed an intriguing pattern: individuals from lower socioeconomic backgrounds had the highest means of vitamin D concentration, while those from higher socioeconomic backgrounds had the lowest mean vitamin D levels (Table 7) as depicted in figure 03. This suggests that factors such as outdoor exposure and lifestyle choices, often associated with lower socioeconomic status, may play a key role in influencing vitamin D levels.

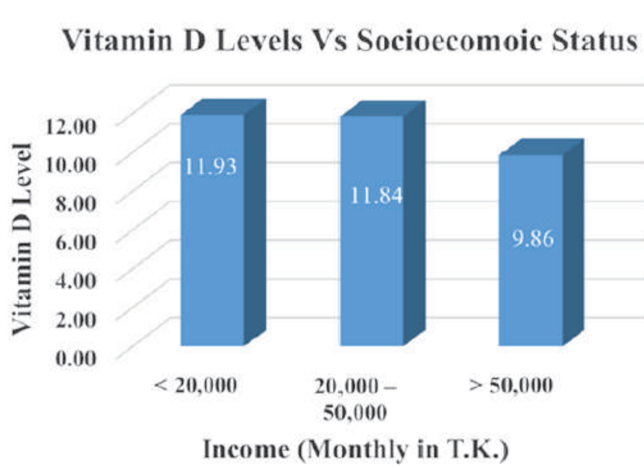

Figure 3: Vitamin D levels of participants based on socioeconomic status

Table 7: Distribution of vitamin D according to socio-economic status (monthly income)

Income (Monthly in BDT)								
	<20,000				**20,000 – 50,000**			
Vit D Status	N (%)	Mean ± SD	SEM	Median	N (%)	Mean ± SD	SEM	Median
VDD	12 (14.29%)	11.93 ± 3.93	0.53	12.29	55 (65.48%)	11.84 ± 4.76	1.37	11.84
VDI	04 (19.05%)	26.32 ± 3.13	1.57	26.32	16 (76.19%)	24.71 ± 2.64	0.66	24.45
VDS	02 (28.57%)	33.63 ± 4.38	3.10	33.63	04 (57.14%)	33.42 ± 3.03	1.52	33.22
		>50,000						
VDD	17 (20.24%)	9.86 ± 4.09	0.99	8.38				
VDI	01 (4.76%)	20.66 ± 0	-	20.66				
VDS	01 (14.29%)	31.05 ± 0	-	31.05				

DISCUSSION

Several environmental and behavioral variables contribute to the high prevalence of vitamin D deficiency, even in countries like Bangladesh (12), which receive plenty of sunlight. Although it is commonly known that sunlight is essential for the synthesis of vitamin D, Dhaka's urban living conditions, which include high-rise buildings and densely populated areas, drastically limit the amount of direct sunlight that city residents receive (13). Using the criterion of vitamin D deficiency [25(OH)D < 20 ng/ml], the present study showed that 75.67% of the total participants are vitamin D deficient. The mean vitamin D levels for men and women were 15.38 and 15.10, respectively, suggesting that both values are lower and that men's mean vitamin D levels are somewhat higher than women's. Lower vitamin D levels in women compared to men are caused by a lack of sun exposure from being indoors and wearing veils to conceal their skin. The participants' sex ratio highlights even more how crucial it is to take gender-specific health practices into account when treating vitamin D deficiency. All age groups in our study had hypovitaminosis D. Those aged 19 to 40 had the highest percentage of vitamin D deficiency. The outcome is somewhat surprising because other studies have shown that age can have a major impact on vitamin D status, with older persons being more susceptible to vitamin D shortage because of lower food intake and skin production capabilities (14, 15). With the revolution in information and technology (IT), taking advantage of globalization, remote jobs are becoming popular in Bangladesh. An increasing number of IT training centers and online-based knowledge-sharing platforms are working to enhance indoor remote jobs that successfully attract the young generation. Along with remote jobs, desk jobs are also socially recognized among the age groups between 19-40 years, directly impacting the level of vitamin D, leading towards deficiency. Interestingly, our study found that the summer months had the highest percentage of vitamin D adequacy while the rainy season had the highest rate of vitamin D shortage. With peaks usually occurring in the summer due to greater UVB radiation levels, this seasonal oscillation corresponds with known fluctuations in sun exposure and vitamin D production (16). Vitamin D deficiency is prevalent among housewives due to their limited outdoor activities and exposure to sunlight, as household chores often confine them indoors. Additionally, many housewives wear covered dresses for religious reasons and use sun protection creams, both of which impede the skin's ability to produce vitamin D. Additionally, this study showed that those with lower socioeconomic status have higher vitamin D percentages, which can be attributed to increased sun exposure. In contrast, individuals with higher incomes tend to have lower vitamin D levels, primarily due to spending extensive time in air-conditioned environments that restrict their exposure to sunlight.

CONCLUSION

Vitamin D deficiency is prevalent in urban Bangladesh, influenced by gender, age, occupation, and lifestyle choices. Males have higher levels due to outdoor exposure, while females and young adults are affected by indoor environments. Seasonal shifts and occupation also impact vitamin D levels. Addressing this requires promoting outdoor living, improving vitamin D-rich diets, raising awareness, and supplementation. This study's 111-sample size may not accurately represent the nation's population, but it serves as a foundation for future research and enhances the results.

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