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Vitamin D Deficiency: Highly Prevalent Among Apparently Healthy Female Adolescents In Both Urban And Rural Population Of Manipur, India

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Abstract
Background: *Although vitamin D deficiency has been documented as a frequent problem in studies of young adults, elderly persons and children in other countries and also in our country, there are limited data on the prevalence of this nutritional deficiency among healthy female adolescents in the North Eastern part of our country particularly in the state of Manipur.*
Objectives*: To determine the prevalence of vitamin D deficiency in healthy female adolescents of Manipur aged 11 to 19 years.*
Material and Methods: *A Cross sectional study conducted in the department of Physiology, RIMS, Imphal and from selected schools of urban and rural districts of Manipur. Serum vitamin D was analyzed by using Automated Microplate ELISA Reader and data collected was analyzed by using SPSS version 21(IBM).*
Results: *Out of 108 students, 24(22.2%) were vitamin D insufficient, 35(32.4%) were Vitamin D deficient and 49(45.4%) were having normal vitamin D level. Overall 59(54.6%) of study participants were either vitamin D deficient or insufficient. Mean ± SD of vitamin D levels in urban and rural adolescent girls were 28.58 ± 12.72 and 21.49 ± 9.15 respectively and was found to be statistically significant (p= .000).*
Conclusion: *In this study 59(54.6%) adolescent girls were having either deficient or insufficient 25-OH(D) level. There is significant difference in 25-OH(D) level between urban and rural areas.*
Keywords*: Healthy female adolescents, Vitamin D sufficiency, insufficiency and deficiency.*

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I. Introduction

Vitamin D refers to a group of fat-soluble vitamin responsible for enhancing intestinal absorption of calcium, iron, magnesium, phosphate and zinc[1] and also vitamin D is a classical steroid hormone, as its synthesis and activity occur in different locations, having both dietary and endogenous precursors.[2] Vitamin D was first discovered by McCollum and Davis in 1913 and in 1932 Askew et al isolated vitamin D_2 from an irradiation mixture of ergosterol and later vitamin D_3 was identified by Windaus and Bock in 1937, which was formed in the skin as a result of ultraviolet irradiation of 7-dehydrocholesterol and later on in 1978, actual isolation and identification of vitamin D_3 was proved by Esvelt et al by mass spectrometry.[3]

Dermal synthesis of vitamin D from 7 dehydrocholesterol is dependent on sun exposure (specifically ultra violet B radiation) which is the main source of vitamin D. Other sources for vitamin D like vitamin D_2 are from fungi like mushroom, fish liver oil. Vitamin D from diet or dermal synthesis from sunlight is biologically inactive.[4] A circulating level of 25-hydroxyvitamin D of >75 nmol/L, or 30 ng/ml, is required to maximize vitamin D's beneficial effects for health. In the absence of adequate sun exposure, at least 800–1000 IU vitamin D_3/day may be needed to achieve this in children and adults.[5]

The two major forms are vitamin D_2 or ergocalciferol, and vitamin D_3 or cholecalciferol. Vitamin D without a subscript refers to either D_2 or D_3 or both. These are known collectively as calciferol. Chemically, the various forms of vitamin D are secosteroids, i.e., steroids in which one of the bonds in the steroid rings is broken. The structural differences between vitamin D_2 and vitamin D_3 is the side chain of D_2 that contain a double bond between carbon 22 and 23, and a methyl group on carbon 24.[6]

Vitamin D_3 (cholecalciferol) after ingestion or from skin, is hydroxylated in the liver where it is converted into the prohormone calcidiol [25-hydroxycholecalciferol or 25(OH)D]. Circulating calcidiol is then converted into calcitriol [1,25 dihydrocholecalciferol or $1,25(OH)_2D$] in the proximal tubules of the kidneys, the biologically active form of vitamin D. Following the final converting step in the kidney, calcitriol is released into the circulation. The active vitamin D metabolite calcitriol mediates its biological effects by binding to the vitamin D receptor(VDR).[7] VDR(Vitamin D receptor) activation in the intestine, bone, kidney and parathyroid gland cells lead to the maintenance of calcium and phosphorus levels in the blood and to the maintenance of bone content. The conversion of calcidiol to calcitriol is catalyzed by the enzyme 25-hydroxyvitamin D3 1-alpha-hydroxylase, the levels of which are increased by parathyroid hormone (and additionally by low calcium or phosphate).[8]

Vitamin D deficiency is now recognized as a pandemic. It affects mainly the children and elderly population. The major cause of vitamin D deficiency is the lack of appreciation that sun exposure in moderation is the major source of vitamin D for most humans. Vitamin D deficiency is also common in those who are infirm and not exposed to sunlight like staying in-door or who live at latitude that do not provide them with sunlight mediated cholecalciferol during the winter months.[9] Also dark skin have a higher risk of lower serum 25 hydroxyvitamin D [25(OH)D] concentration as they contain more melanin to interfere in the synthesis of vitamin D.[10] A diet deficient in vitamin D in conjunction with inadequate sun exposure causes rickets in children and osteomalacia in adult. In this condition there will be softening of bones, weak and deformed long bones and fracture due to impaired bone mineralization and bone damage because of vitamin D deficiency.[11] Serum 25-OH vitamin D is not only a predictor for bone health but also an independent predictor for other diseases like cancer, cardiovascular diseases and other chronic diseases. Vitamin D deficiency or insufficiency prevails all over the Indian subcontinent with prevalence ranging from 70% to 100%. Vitamin D deficiency is the most under-diagnosed and undertreated global problem affecting majority of individuals irrespective of their age, gender, race, and geography.

Adolescent period is more vulnerable to Vitamin D insufficiency due to increased mineral demands of the skeletal activities especially in young girls. If we know the exact prevalence of Vitamin D deficiency in female adolescents, it can be one of the modifiable risk factors in them before the development of obesity and diabetes mellitus. Although vitamin D deficiency has been documented as a frequent problem in studies of young adults, elderly persons and children in other countries and also in our country, there are limited data on the prevalence of this nutritional deficiency among healthy female adolescents in the North Eastern part of our country particularly in the state of Manipur.

II. Objectives

To determine the prevalence of vitamin D deficiency in healthy female adolescents of Manipur aged 11 to 19 years.

III. Rationale Of Study

Most studies on the prevalence of vitamin D deficiency in healthy female adolescents have been done in all over the world. There is a paucity of study on the subject in the north eastern part of India where the race, culture, socio-demographic pattern and dietary habits are different from the rest of the country. A study to determine the status of vitamin D among the healthy female adolescents of Manipur, a north eastern state in India, will be significant in terms of comparison with similar study population elsewhere and contribute to understanding the need for further studies and intervention in the region in the near future.

IV. Material And Methods

A Cross sectional study conducted in the department of Physiology, RIMS, Imphal and from selected schools of urban and rural districts of Manipur. Serum vitamin D was analyzed by using Automated Microplate ELISA Reader and data collected was analyzed by using SPSS version 21(IBM).

Study design*:* Cross-sectional study

Settings*:* Department of Physiology, RIMS, Imphal.
Selected government and private schools in Imphal (Urban area) and Thoubal district (rural area) of Manipur.

Study duration: 7(seven) months from February to August 2017

Study tool: 25-OH Vitamin D Total ELISA (DIA source kit), Belgium Microplate ELISA Reader (Model no. SR no. 120710 Scan EM Transia Bio-Medical Ltd., Mumbai).

Study population: 108 (one hundred and eight) adolescent female students from urban and rural areas of manipur were selected for the study.

***Data collection**:* 2ml. of blood was collected from the study participants. These samples were then centrifuged at 3500 rpm for 10 minutes. Serum from the centrifuged sample were then collected and evaluated for 25-OH Vitamin D level.

Biochemical Profile:

- The subjects were divided into three groups according to their vitamin D status (deficiency ≤20 ng/mL; insufficiency: 20-29 ng/mL; sufficiency/normal ≥30 ng/mL).[12] However, these values were not unanimously accepted by all researchers.

Inclusion Criteria:

1. Apparently healthy female adolescents of Manipur aged 11 to 19 years from both rural and urban area.
2. Unmarried.

Exclusion Criteria:

1. Female adolescents having any history of chronic diseases.
2. History of thyroid, parathyroid, adrenal or gonadal disease.
3. History of any metabolic bone disease
4. Malignancy
5. Hepatic and Renal disease
6. Malabsorption syndrome or history of gastrointestinal resection, chronic diarrhea.

***Analysis**:*

Data was collected and analyzed statistically by using SPSS version 21(IBM). Descriptive statistics like mean, standard deviation, percentages and correlations were used. P-value of < 0.05 is taken as statistically significant.

V. Results

Figure1: Frequency distribution of vitamin D level in Urban (n=54)

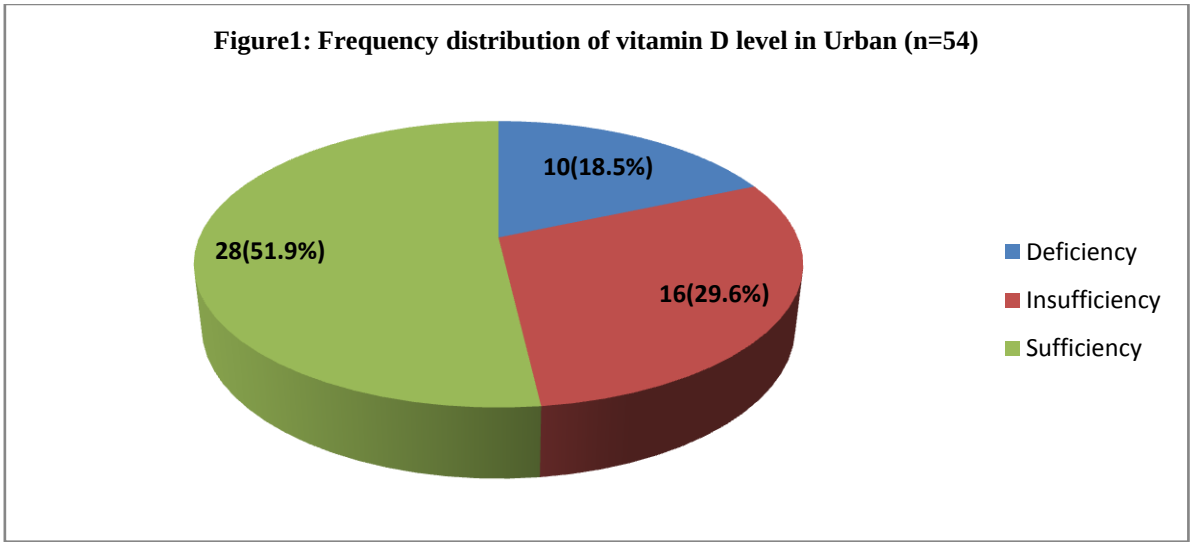

Figure 1: Shows the frequency distribution of vitamin D level in the urban female adolescent population. 51.9% has sufficient vitamin D levels and the rest were either deficient(18.3%) or insufficient(29.6%).

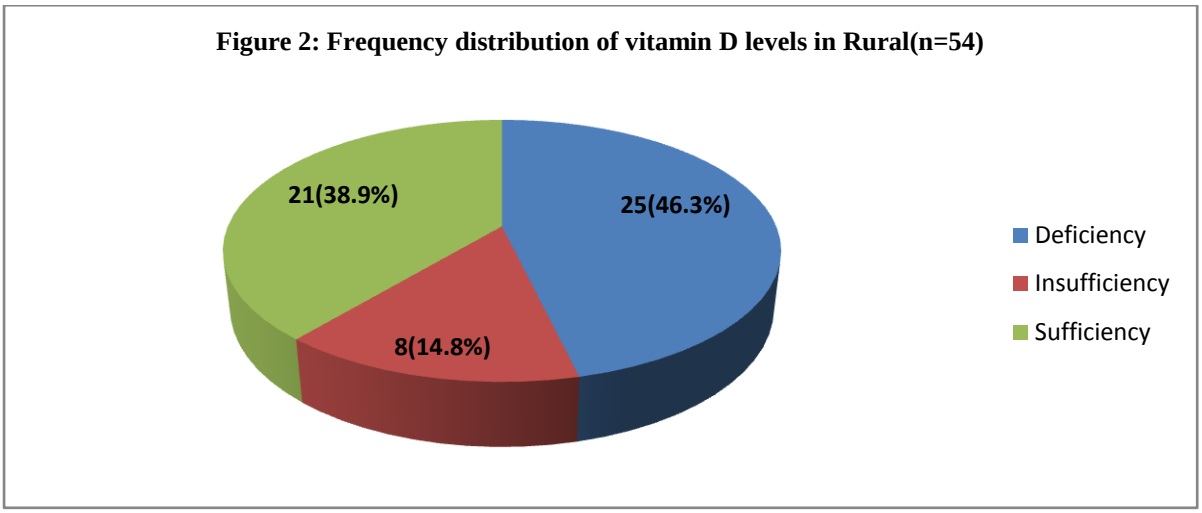

Figure 2: Shows the frequency distribution of vitamin D level in the rural female adolescent population. Only 38.9% has sufficient vitamin D levels, the rest were either deficient(46.3%) or insufficient(14.8%).

Table 1: Comparison of mean±SD of vitamin D levels between urban and rural adolescent females			
Demography	**Vitamin D levels**		**p-Value**
	Mean	Standard deviation (SD)	
Urban (n=54)	28.58	12.72	0.000*
Rural (n=54)	21.49	9.15	

Table 1: Shows the mean±SD of vitamin D levels in the Urban and Rural female adolescent population, which is statistically significant with p-value <0.01.

Table 2: Correlation between skin colour and vitamin D levels (n=108)				
Skin colour	***Deficiency***	***Insufficiency***	***Normal***	***p-Value***
Light brown	2(22.2%)	1(11.1%)	6(66.7%)	0.561
Dark brown	42(43.3%)	22(22.7%)	33(34.0%)	
Very dark	1(50.0%)	0(0.0%)	1(50.0%)	

Table 2: Shows the correlation between vitamin D levels and their skin colour, which was statistically not significant with p-value of >0.5.

VI. Discussion

Adolescence is a critical period in terms of skeletal development and bone density. In addition to genotype, physical activity, diet and sufficient vitamin D level are important factors for reaching optimal bone mass. The level of vitamin D is affected by many factors such as exposure to the sun, clothing style, skin pigmentation, latitude of region, consumption of dairy products and fish and vitamin supplementation.

In the present study, out of 108 female adolescents, 50%(54) were from the urban population and 50%(54) were from the rural.

In the urban population 48.1% of adolescent girls were having either deficient (18.5%) or insufficient (29.6%) vitamin D levels as shown in figure-1 whereas in the rural population 61.1% of the adolescent girls were having either deficient (46.3%) or insufficient (14.8%) vitamin D levels as shown in figure 2. From the above study, it was shown (Table 1) that vitamin D deficiency was more in girls from the rural area with the mean±SD of just 21.49±9.15 ng/ml as compare to girls from the urban area with the mean±SD of 28.58±12.72 ng/ml, which was of course slightly higher. The study found that the comparison between girls from the urban and the rural population to be statistically significant with p-value of <0.01. The differences may be due to their dietary habits. Female urban students were expected to be socioeconomically sound as well as educationally in a better advantage than those from the rural areas due to which their diet would have contain more meat and fishes.

Though rural students may exposed more to sunlight, but sensible exposure(usually 5-10 minutes of exposure of the arms and legs or the hands , arms and face, 2 or 3 times per week) may be lacking as described by Grant WB et al.[11] Timing of exposure may also have a contributory factor in influencing the level of vitamin D. Girls from the rural population may have more exposure to sunlight but their exposure may be during the early hours in the morning or late in the afternoon hence, they were deprived of exposure during the time when maximum vitamin D synthesis could occur in their skin which is usually between 11am to 2pm. This finding

clearly indicates that vitamin D deficiency is an important health issue in school children especially in female which is similar to the study conducted by Kim MS et al.[14]

The study between skin colour and vitamin D showed that light brown skin had vitamin D deficiency of 22.2%, insufficiency of 11.1% and sufficiency of 66.7%, dark brown skin had vitamin D deficiency of 43.3%, insufficiency of 22.7% and sufficiency of 34.0% and very dark skin had vitamin D deficiency of 50%, insufficiency of 0% and sufficiency of 50%. From the above, it was shown that vitamin D deficiency was more common among the darker skin despite the fact that the study was statistically not significant but was highly comparable with the similar study else where.[15] The darker skin is because of presence of more melanin which interfered in the formation of vitamin D_3 in the skin from sunlight, which is the main source of vitamin D.

VII. Conclusion

In this study 59(54.6%) adolescent girls were having either deficient or insufficient 25-OH(D) level. There was significant difference in 25-OH(D) level between urban and rural areas. Hence we concluded that there was a high prevalence of biochemical hypovitaminosis D in apparently healthy female adolescents in Manipur.

Therefore, calcium and vitamin D supplementation should be added to their daily diets by changing their dietary status and also educating the young female adolescents about the necessity of having sensible exposure to sunlight and its beneficial effect is the call of the hour.

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