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Ethnic Differences in Vitamin D Status: a Comparative Study among Indian and Malaysian Medical Students

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ABSTRACT

Background: The prevalence of vitamin D deficiency has been increasing among healthy population. Race , ethnicity, diet, sun exposure, physical activity are known to be strong predictors of vitamin D. Few studies have investigated the vitamin D status of Malaysia and India. But there is no comparative study of Vitamin D status among medical students of Indian and Malaysian ethnicity. The present study is undertaken to assess vitamin D status among students of Indian and Malaysian ethnicity, studying in medical colleges of Belagavi, India.

Objectives:

Materials and method: A total of 100 apparently healthy Medical students aged between 18 and 25 years studying in medical colleges of Belagavi were included. The study participants were divided into two groups; 50 Malaysian medical students and 50 Indian medical students. Students who are taking adequate dietary intake of Vitamin D > 10 µg /d (assessed by validated food frequency questionnaire) 15 were included in the study. All participants were asked regarding physical activity(IPAQ-Short), sun exposure, (Veritable Sun Exposure= multiplying daily sun exposure in hours and BSA (%)) ,sun protection behavior(Sun protection score (Sun protection score was derived through the sum of usage of sun block lotion, veil, cap/hat, long sleeve shirt, gloves, long pants, long skirts and umbrella (max = 8, min = 0) and detailed dietary intake (by food frequency questionnaire). Vitamin D analysis done by commercially available kit , by florescent immunoassay. Bone markers calcium, phosphorus and alkaline phosphatase estimated by commercially available kit by autoanalyser.. Results: Indian group has more vitamin D deficient students 39(78%) compared to Malaysian group 33(66%). In Malaysian group 9(18%) insufficient and 6 (12%) sufficient. In Indian group 6(12%) insufficient and 5(10%) sufficient. There is a no statistically significant difference in Vitamin D level between Malaysian group and Indian group. There was no significant difference between Malaysian group and Indian group regarding the level of vitamin D, Phosphorus and alkaline

phosphatase. Calcium levels were low in both the groups, with the mean of 8.80±1.14 in Malaysian group and

8.07±1.09 in Indian group and difference between the groups was statistically significant ($p<0.05$). There was statistically significant ($P <0.05$) positive correlation between vitamin D and sun exposure in hours, milk intake, physical activity in total group, Malaysian group and Indian group. There was significant ($P <0.05$) negative correlation between vitamin D and sun protection score in total group, Malaysian group and Indian group. Sun exposure, sun protection score, milk intake and physical activity shows statistically significant value ($p<0.05$) with different vitamin D (deficiency, sufficient and insufficient) levels.

Conclusion: Medical students with, lower milk intake, reduced sunlight exposure, less physical activity and frequent use of sun protection are more likely to experience vitamin D deficiency. This leads to alterations in calcium and phosphorus metabolism and elevated ALP levels, which reflect increased bone turnover. These biochemical imbalances not only affect bone health but may also impact overall well-being. The present study conducted on Indian and Malaysian medical students reinforces the importance of maintaining adequate vitamin D levels for optimal mineral metabolism and bone health. There is a need for increased awareness about the importance of adequate sun exposure, a balanced diet rich in vitamin D, and engaging in outdoor activities to optimize vitamin D levels among medical students

. **Keyword:** *Vitamin D deficiency, Indian Medical students, Malaysian medical students*

1. INTRODUCTION

Vitamin D deficiency is a global health problem. Despite all the medical progress made in this century, vitamin D deficiency remains widespread.[1]Vitamin D 'deficiency' can have serious health effects, such as increasing the risk of rickets and osteomalacia. There is ongoing debate about the additional health implications of vitamin D deficiency, especially in relation to cancers, dementia, and cardiovascular diseases. Clinical vitamin D "deficiency" is associated with most severe effects, but even "insufficiency" can result in symptoms including decreased bone density, vague muscle and joint discomfort, a higher risk of falls and fractures, and weaker muscles. Some of these, such bone density, fall risk, and fracture risk, have been demonstrated to be reversible with vitamin D treatment.[2]

Race and ethnicity are known to be strong predictors of vitamin D. Across the specific target population studied, vitamin D deficiency and insufficiency were seen particularly among females, Indians, and those of Malay ethnicity.[3] Comparatively, Malaysia has reported a better vitamin D status than other countries[2] due to its location near the equator. Despite this, research on a few chosen populations has shown that the Malay population is deficient in vitamin D. According to estimates, 67.4% of adults in Malaysia and 47 - 75% of children are predicted to be vitamin D deficient. This has to do with well-known factors that contribute to vitamin D insufficiency, like skin tone (melanin) and sun-avoidance behaviors like wearing clothing that covers up, which are primarily followed by Malay Muslims in Malaysia.[4]However, this is not a unique discovery. In India, a nation with an abundance of sunlight all year round, a similar pattern of deficit has been observed in adults, children, and infants.[5]

Race , ethnicity, diet, sun exposure, physical activity are known to be strong predictors of vitamin D. Few studies like Lhamo et al[6],Kaliya M et al[7], Al-Elq et al[8] have investigated the vitamin D status of Indian medical students . Few studies shows medical students are at high risk of vitamin D deficiency as they have to spend many hours indoor for studying for examination and getting entrance to professional courses. [9] But there is no comparative study of Vitamin D status among medical students of Indian and Malaysian ethnicity.The present study is undertaken to assess Vitamin D status among students of Indian and Malaysian ethnicity studying in medical colleges of Belagavi, India.

Materials and Methods

This cross sectional study was conducted in the department of biochemistry, USM KLE IMP Belgaum during January 2023 to January 2024. Ethical clearance obtained from institution ethics committee USM KLE IMP. Written informed consent taken from all participants. Students were interviewed for dietary intake of vitamin D. Students who are taking adequate dietary intake of Vitamin D > 10 µg /d (assessed by validated food frequency questionnaire) [10] were included in the study.

Inclusion criteria: Apparently healthy age group 18-25yrs, willing to consent, medical students of Indian and Malaysian ethnicity studying in medical colleges of Belagavi were included.

Exclusion criteria: Chronic renal disease, Chronic liver disease, Osteoporosis, drugs affecting vitamin D (phenobarbital, orlistat, steroids), taking Vitamin D and calcium supplementation, malabsorption, use of oral contraceptives, pancreatitis, cholecystectomy, metabolic bone disease, malignancy and pregnancy.

All participants were asked regarding height, weight, socioeconomic status, physical activity(IPAQ-Short)[11], sun exposure, (veritable Sun Exposure= multiplying daily sun exposure in hours and BSA (%)) ,sun protection behavior(sun protection score [12] (sun protection score was derived through the sum of usage of sun block lotion, veil, cap/hat, long sleeve shirt, gloves, long pants, long skirts and umbrella (max = 8, min = 0) and detailed dietary intake (by food frequency questionnaire

Adequate dietary intake of vitamin D was estimated by validated food frequency questionnaire. Dietary intake was marked by the subject and assembled through a structured interview. Average consumption of vitamin D was quantified from the questionnaire. Foods were grouped into sections within the questionnaire along with portion sizes. Individuals were asked about the exact number of servings of products from groups specified in food frequency questionnaire consumed per day/week/month. During analysis, in order to obtain the daily number of servings, the total number of servings in the case of products specified per week or per month, was divided per seven or per 30 days. The Vitamin D intake from each product was estimated using the following equation: Vitamin D intake (µg) = daily number of servings ×typical Vitamin D content in one serving. The total daily dietary Vitamin D intake was obtained as the sum of the Vitamin D intake values from all the analysed groups of products. As per ICMR 2020, intake of vitamin D more than 400IU(10 µg /d is sufficient for the Indian population, hence subjects consuming more than 400IU(10 µg /d)of vitamin d were included.

5 ml of venous blood drawn from antecubital vein and collected in plain vacutainer. Serum separated and stored at -20^0 c until analysis .Vitamin D analysis done by commercially available kit by flurocent immunoassay. Bone markers calcium, phosphorus and alkaline phosphatase estimated by commercially available kit by autoanalyser.Vitamin D levels is categorized according to Endocrine Society Guidelines as defciency, insufciency, and sufciency based on serum vitamin D level below 20 ng/ml ,21–29 ng/ml and 30–100 ng/ml respectively.[14]

Sample size calculation

Two Means - Hypothesis testing for two means (equal variances)

Standard deviation in the Ist group S1 = 10.1

Standard deviation in the IInd group S2 = 10.1

Mean difference between Ist and IInd sample = 8.24

Effect size = 0.815841584158416

Alpha Error(%) = 1

Power(%)= 90

sided = 2

Number needed (n) = 45 should be taken in each group

Sample size formula

$$n = \frac{2S^2(z_{1-\alpha} + z_{1-\beta})^2}{d^2}$$

Where, $Z_{1-\alpha}$= Z-value for α level (2.58 at 1% α error or 99% confidence)

$Z_{1-\beta}$ = Z-value for β level (1.282 at 10% β error or 90% power)

d=Margin of error=8.24

S=Pooled SD= (S1+S2)/2

STATISTICAL ANALYSIS

The statistical analysis was done using SPSS version 20.0.Data entered as mean, standard deviation, percentage and t test. Correlation between different paramete ,calculated by correlation coefficient. Kolmogorov Smirnov test for used for normality. Multiple linear regression analysis used for prediction Comparison done by independent sample t test and p value less than 0.05 was considered statistically significant.

Results:

A total of 100 apparently healthy Medical students aged between 18 and 25 years studying in medical colleges of belagavi

were included. The study participants were divided into two groups; Malaysian group includes 50 malaysian medical students and Indian group includes 50 Indian medical students .

Table 1 shows the baseline characteristics of the participants

There was a stastically significant difference among 2 groups regarding gender and age (P<0.05).Majority of study population were male, in malaysian group 36(72 %) were male and 14 (28%) were female, in Indian group 23(46 %) were male and 27 (54%) were female. Mean age of malaysian group was 20.54 ±0.50 and mean age of Indian group was 22.55±3.87.

	Malaysian group (50)	Indian group(50)	p-value
Gender			
Male	36 (72%)	23(46%)	0.0080*
Female	14(28%)	27(54%)	
Age	20.54 ±0.50	22.55±3.87	0.0010*

Table 2: Comparison of Malaysian group and Indian group with levels of Vitamin D ng/ml

Vitamin D (ng/ml)	Malaysian group	Indian group	
Sufficient(>30ng/ml)	8(16%)	5(10%)	Chi-square=0.9964, p=0.6076
Insufficient(20-30ng/ml)	9(18%)	6(12%)	
Deficiency(<20ng/ml)	33(66%)	39(78%)	
Total	50(100%)	50(100%)	

Figure 1: Comparison of Malaysian group and Indian group with levels of Vitamin D ng/ml

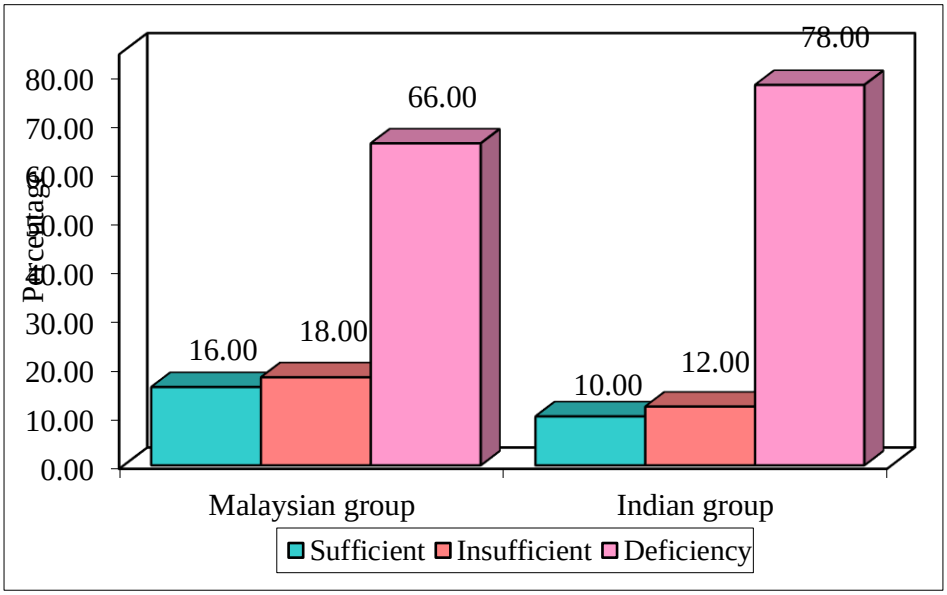

Table 2, Figure 1 shows Vitamin D status of Malaysian group and Indian group. Indian group has more vitamin D deficienct students 39(78%) compared to Malaysian group 33(66%). In Malaysian group 9(18%) insufficient and 6 (12%) sufficient. In Indian group 6(12%) insufficient and 5(10%) sufficient. There is a no statistically significant difference in Vitamin D level between Malaysian group and Indian group (p >0.05).

Table 3: Comparison of Malaysian group and Indian group with Vitamin D ng/ml, Calcium mg/dl, Phosphorus mg/dl and Alkaline Phosphatase IU/L levels.

	Malaysian group	Indian group	Mean Diff	p-value	95% Ci for mean Diff.	
					Lower	Upper
Vitamin D ng/ml	18.62± 9.56	17.09±8.27	1.52	0.3967	-2.03	5.07
Calcium mg/dl	8.80±1.14	8.07±1.09	0.73	0.0014*	0.29	1.17
Phosphorus mg/dl	4.12±0.58	3.91±0.66	0.21	0.0874	-0.03	0.46
Alkaline Phosphatase IU/L	110.74±22.55	116.30±25.95	-5.56	0.2556	-15.21	4.09

Figure 2: Comparison of Malaysian group and Indian group with Vitamin D ng/ml, Calcium mg/dl, Phosphorus mg/dl and Alkaline Phosphatase

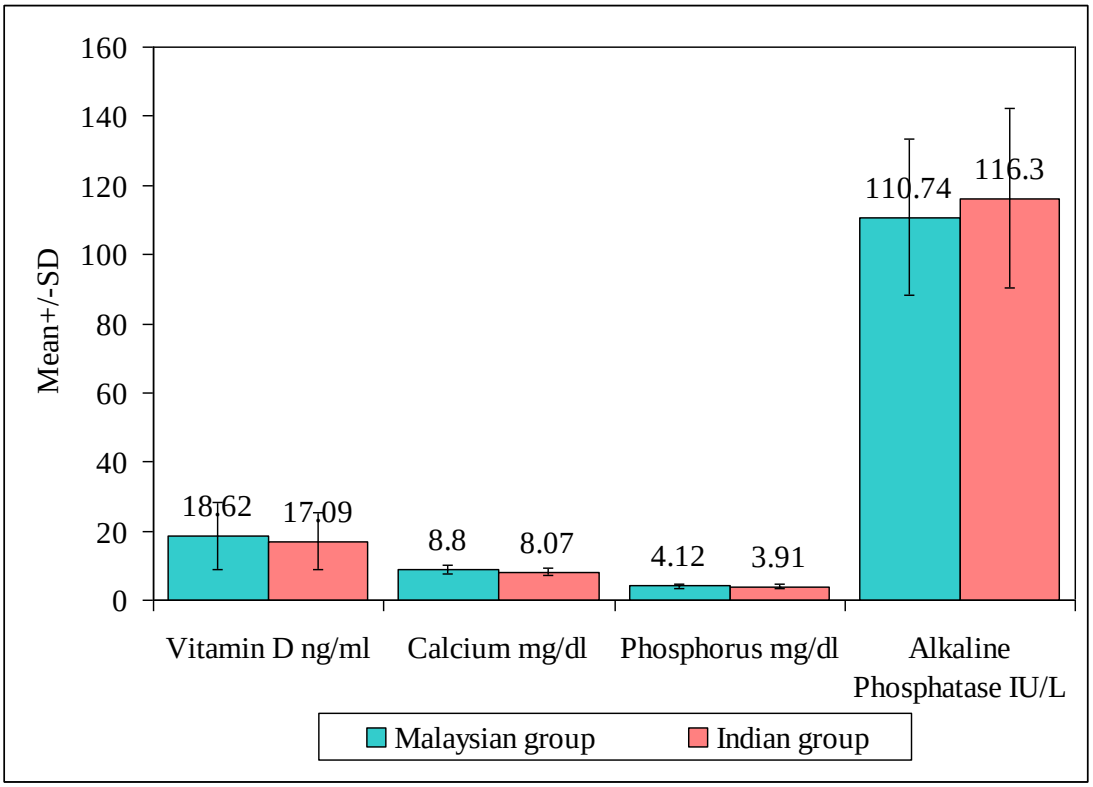

Table 3 Figure 2 shows the comparison of Malaysian group and Indian group with Vitamin D ng/ml, Calcium mg/dl, Phosphorus mg/dl and Alkaline Phosphatase IU/L levels. There was no significant difference between Malaysian group and Indian group regarding the level of vitamin D, Phosphorus and alkaline phosphatase. Calcium levels were low in both the groups, with the mean of 8.80±1.14 in Malaysian group and 8.07±1.09 in Indian group and difference between the groups was statistically significant ($p<0.05$). Table 3)

Table 4: Correlations between Vit D with other parameters in two groups by Spearman's rank correlation

Samples	Variable	Correlations between Vit D with			
		n	Spearman R	t-value	p-value
Total study group					
	Sun exposure in hours	100	0.7690	11.9097	0.0001*
	Sun protection score	100	-0.5748	-6.9539	0.0001*
	Milk intake	100	0.7119	10.0351	0.0001*
	Physical activity	100	0.7996	13.1814	0.0001*
Malaysian group					
	Sun exposure in hours	50	0.8137	9.6990	0.0001*
	Sun protection score	50	-0.6288	-5.6025	0.0001*
	Milk intake	50	0.7123	7.0304	0.0001*
	Physical activity	50	0.7513	7.8868	0.0001*
Indian group					
	Sun exposure in hours	50	0.7062	6.9100	0.0001*
	Sun protection score	50	-0.5382	-4.4243	0.0001
	Milk intake	50	0.7112	7.0082	0.0001*
	Physical activity	50	0.8746	12.4971	0.0001*

Table 4 shows the Correlations between Vitamin D with other parameters in two groups by Spearman's rank correlation. There was statistically significant($P<0.05$) positive correlation between vitamin D and sun exposure in hours, milk intake, physical activity in total group, Malaysian group and Indian group . There was significant ($P<0.05$) negative correlation between vitamin D and sun protection score in total group, Malaysian group and Indian group.

Table 5 shows correlation vitamin D levels (deficient, insufficient and adequate) with associated factors. Gender, does not show significant difference with different Vitamin D levels. Sun exposure, sun protection score, milk intake and physical activity shows statistically significant value ($p<0.05$) with different vitamin D levels.

Table 5: Correlation vitamin D levels (deficient, insufficient and adequate) with associated factors.

		Malaysian students				Indian students			
		Vitamin D defiency	Vitamin D insuffiency	Adequate Vitamin D	P value	Vitamin D defiency	Vitamin D insuffiency	Adequate Vitamin D	P value
Gender	Male	23	7	6	0.078	17	4	2	0.082
	Female	10	2	2		22	2	3	
Sun exposure in hours	<1 hour	30	6	1	<0.001*	35	2	1	0.032*
	≥1 hour	3	3	7		4	4	4	
Sun protection score	≥5	29	5	1	0.024*	33	5	0	0.002*
	<5	4	4	7		6	1	5	
Milk intake	≥ 1 glass	5	2	6	0.003*	7	4	4	0.042*
	<1 glass	28	7	2		32	2	1	
Physical exercise	<30 min	28	7	8	0.032*	33	1	0	0.041*
	≥30 min	5	2	0		6	5	5	

2. DISCUSSION:

In the present study, it was found that vitamin D deficiency was highly prevalent in Indian and Malaysian medical students ,studying in medical college belagavi .The study shows Indian students were more 78% vitamin D deficient compared to Malaysian students 66%. Results similar to our finding were reported in a study by Shafinaz I et al [15], Sadat N et al [5] , Mat S et al [16] and Tan K et al[17]. Shafinaz et al [12], showed Indian participants (80.9 %) had the highest proportion of vitamin D deficiency, followed by Malays (75.6 %), others (44.9 %) and Chinese (25.1 %).Sadat N et al [5] conducted a study on Vitamin D deficiency in, Malay ethnicity 80.2% ,followed by Chinese 7.7% , Indians 7.7% and other ethnic groups 3.0% .They found deficiency was significantly higher in girls (92.6%), Indian adolescents (88.6%) and urban-living adolescents (88.8%)

Mat S et al [15] showed that Vitamin D levels were significantly associated with ethnicity differences where Malays (OR 7.08; 95% CI 4.94-10.15) and Indians (OR 6.10; 95% CI 4.28-9.71) have lower levels of vitamin D compared to Chinese. They concluded that as vitamin D status is dependent on skin tone, diet and sunlight exposure, which are all affected by ethnicity. Darker complexion might be another contributing factor for higher deficiency levels in Indian since high level of melanin reduces cutaneous synthesis of vitamin D [17]. The determination of skin type using the fitzpatrick skin type chart and Mexameter (MX 18) among first trimester pregnant mothers in Malaysia found that the Indians were mostly within type V to VI (dark brown to black), followed by Malays within type III (light brown), and the Chinese within type II (white skin), that may be the reason for low levels of vitamin D among Indians and Malays. [3]

Our study shows malay students had 66% vitamin D deficiency. Ismail T S et al [18] study revealed that the majority of Malaysian adults (82.5%) had vitamin D insufficiency. The estimated value of Malaysia suffering from vitamin D deficiency

is 67.4% of adults and a range of 47-75% for children. This is related to widely known causes of vitamin D deficiency such as skin type (melanin) and sun avoidant lifestyles that include covering clothes, largely practiced by Malay Muslims in Malaysia. [7]Accoring to chin et al [19] Vitamin D deficiencies and insufficiency were more prevalent in the Malays compared to the Chinese.

In the present study serum calcium is low in both Indian and Malaysian students. Serum phosphorus and alkaline phosphatase levels were within the normal limit in both the groups which was similar to the study conducted in Shaheen K et al[20] *and* kiran et al [17]. Vitamin D increases the efficiency of intestinal absorption of calcium by 30-40% and phosphorus absorption by about 80% [21]. Vitamin D deficiency leads to secondary hyperparathyroidism, which results in a loss of phosphorus in the urine and reduces the intestinal absorption of phosphorus. This leads to a low or low normal phosphorus concentration. A low normal calcium level and a low normal phosphorus level lead to an insufficient calcium-phosphorus product, which is important for bone mineralization. Inadequate mineralization causes rickets in children and osteomalacia in adults [17]. In vitamin D deficiency, calcium and phosphorus levels should be low, while alkaline phosphatase levels should increase. However, in our study, calcium levels were reduced while phosphorus and alkaline phosphatase levels were within normal limits, indicating that bone mineralization was not yet impaired.

In the present study veritable sun exposure was positively correlating with vitamin D in both the groups and it was statistically significant. The sun protection score was negatively correlating with vitamin D in both the groups and it was statistically significant. Similar results were found in study done by shafinaz et al [12] .It is well known that the main source of vitamin D is the sun. Sun avoidant lifestyles such as the use of sunscreen, conservative clothing habits, and outdoor inactivity are also some of the important causes of low vitamin D status. A sunscreen with an SPF of 15 or more applied topically absorbs incoming UVB light, thus reducing vitamin D production in the skin [21]. Type of dress which involved covering the entire skin and preventing it from being exposed to sunlight also prevents the absorption, which explains why vitamin D deficiency is so widespread even in the sunniest parts of the world. This can be seen in populations where extensive skin coverage was practiced by the women as part of their religion or cultural norm as in malay muslim womens. Le Goaziou MF et al [22], Hatun Set al [23], Guzel Ret al [24] reported results were consistent with our study

Milk intake is often considered a significant dietary source of **vitamin D**, especially in countries where milk is fortified with this nutrient. In populations like **Malays** and **Indians,** where milk consumption can vary, the relationship between milk intake and vitamin D levels has been studied. Present study showed a positive correlation between Vitamin D and milk intake in both the groups and results were statistically significant. A study conducted on Indian students found that **low milk intake** (less than 1 glass per day) was associated with **lower vitamin D levels**. **Indian adolescents** often face a double burden of low milk consumption and limited sun exposure (due to school timings, urbanization, and cultural factors) [25].In contrast, students who consumed **1-2 glasses of milk** daily had relatively better vitamin D status. [8, 26]

The present study shows vitamin D deficiency is more prevalent in students who are engaging in physical exercise (less than 30min) compared to students who are engaging in physical exercise (more than 30min) but this difference is statistically not significant. In India, many medical students report limited outdoor physical activity due to rigorous academic schedules with exercise durations often lasting less than 30 min. While students may engage in some outdoor activities or sports, these brief sessions are often insufficient for significant sunlight exposure, especially if the exercise occurs during early morning or evening hours when the intensity of UVB radiation is lower. **Kaliya** et al [7] reported that students participating in physical activity for more 30min daily showed a **significant increase in vitamin D levels**. These students had prolonged exposure to sunlight during their physical activities, resulting in higher vitamin D production.

The present study shows Indian medical students (78%) are more vitamin D deficient compared to Malaysian medical students (66%) may be because of darker skin complexion compared to Malaysian which is affected by ethnicity. The present study conducted on Indian and Malaysian medical students reinforces the importance of maintaining adequate vitamin D levels for optimal mineral metabolism and bone health. Both groups of students, despite having access to vitamin D-rich foods like fish and dairy, often exhibit vitamin D deficiency due to factors such as limited sun exposure, indoor lifestyles, dietary habits and less physical activity. The lack of sufficient sun exposure is especially problematic for medical students who spend long hours studying indoors. The use of **sunscreen** and other forms of sun protection can reduce the skin's ability to produce vitamin D from sunlight. Although these protective measures are essential for skin health and reducing the risk of skin cancer, they also reduce the efficacy of UVB rays in vitamin D synthesis.

Medical students with higher BMI, lower fish and milk intake, reduced sunlight exposure, less physical activity and frequent use of sun protection are more likely to experience vitamin D deficiency. This leads to alterations in calcium and phosphorus metabolism and elevated ALP levels, which reflect increased bone turnover. These biochemical imbalances not only affect bone health but may also impact overall well-being. There is a need for increased awareness about the importance of adequate sun exposure, intake of balanced diet rich in vitamin D and engaging in outdoor activities to optimize vitamin D levels. Interventions such as **vitamin D supplementation, encouraging outdoor physical activity,** and **education on proper sun**

protection practices are crucial to addressing vitamin D deficiency among medical students.

Vitamin D levels should be screened once in all medical professionals as an opportunistic screening. Once it's confirmed, vitamin D supplement must be provided for corrections and prevention of complications. Intake of dairy products & exposure to sunlight should be advised for betterment.

3. LIMITATIONS OF THE STUDY

As this study was conducted on medical college students, the results of study can be applied only on this age group and cannot be generalized. All the information regarding health or dietary patterns taken in our study were based on self administered questionnaires. Recall bias from participants may also influence our results. Information on the medications and vitamin D supplements used among participants was another limitation.

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