ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 18, Issue 4, 2025

Online - 2455-3891
Print - 0974-2441

Research Article

A CROSS-SECTIONAL STUDY ON THE IMPACT OF PHYSICAL ACTIVITY AND BODY MASS INDEX ON VITAMIN D LEVELS AMONG MEDICAL STUDENTS

BHAGYASHREE N[1]*, SHILPASREE JANA[2], SMITHA N[1], SAI SAILESH KUMAR GOOTHY[3]

[1]Department of Physiology, Adichunchanagiri Institute of Medical Sciences, B. G. Nagara, Karnataka, India. [2]Department of Radiation Oncology, NEIGRIHMS Shillong, Meghalaya, India. [3]Department of Physiology, NRI Institute of Medical Sciences, Visakhapatnam, India. Email: bhagyashivanugraha@gmail.com

Received: 14 January 2025, Revised and Accepted: 26 February 2025

ABSTRACT

Objective: Vitamin D has non-calcemic effects, like enhancing immunity and prevents premature aging. Vitamin D has antioxidant-like property, which is necessary for maintenance of body's mineral balance. Severe vitamin D deficiency is associated with an increased risk of death from diseases such as cardiovascular conditions, diabetes, cancer, and infertility. Researchers have developed a growing interest in Vitamin D due to its functions beyond calcium metabolism.

Methods: This study was undertaken to clarify the relationship between body mass index (BMI), physical activity and levels of Vitamin D, especially in medical students. It was a cross-sectional study conducted in 1st year and 2nd year MBBS students with the age group of 17–22 years, consisting of both sexes and the participants were allocated by random sampling. Vitamin D levels in serum were measured using ELISA method. Students were asked to fill the Questionnaire Short Form - International Physical Activity – (IPAQ – SF) and based on the categorical scoring, physical activity is classified as low, moderate, and high. Pearson's correlation coefficient was used to find out the correlations between the variables. BMI showed significant negative correlation ($r=-0.15$, $p=0.04$) with serum Vitamin D.

Results: It was found that mean Vitamin D (49.7±30.50) was higher in BMI<25 (normal weight) which showed statistically significant difference ($p=0.04$) when compared with BMI 25 to 30 (over weight) (42.6±31.73) and BMI>30 (obese) (34.6±25.16).

Conclusion: Physical inactivity and obesity have an adverse effect of Vitamin D. The present study reinforces that screening of population for Vitamin D is mandatory, particularly among people who are overweight and obese.

Keywords: Physical activity, Vitamin D, Body mass index, Cardiovascular disease, Overweight.

 DOI: http://dx.doi.org/10.22159/ajpcr.2025v18i4.53928. Journal homepage: https://innovareacademics.in/journals/index.php/ajpcr

INTRODUCTION

Vitamin D is vital for the well-being and for the bone growth and it maintains homeostasis between calcium and phosphorous [1]. It has non-calcemic effects, like enhancing immunity and prevents premature aging. Antioxidant properties are present in Vitamin D, which is vital for keeping the body's mineral constant. It can be obtained from external sources or produced internally through the skin's exposure to the sun's ultraviolet rays [2]. Physical activity may also increase serum Vitamin D by increasing lysis of lipids and by increasing movement of Vitamin D from fat compartments [3].

Physical activity is described as "any movement generated by skeletal muscles that leads to higher energy expenditure than resting levels." In contrast, physical exercise refers to a well-structured, planned, and repetitive form of physical activity aimed at enhancing health and physical fitness [4] "Physical activity" includes both indoors and outdoors [2]. Engaging in outdoor physical activity offers dual benefits from both the exercise itself and the synthesis of Vitamin D, particularly with sun exposure [4].

Vitamin D deficiency has emerged as a global health concern affecting both children and adults. Reports have shown that individuals with severe Vitamin D deficiency have significantly higher risk of death due to diseases such as cancer, cardiovascular diseases, diabetes, infertility, and miscarriage [5,6]. Higher adipose tissue has been reported with reduced serum Vitamin D concentrations [3]. Researchers' interest in Vitamin D has been enhanced of late as it plays an important role far beyond calcium metabolism in various extra-skeletal tissues such as adipocytes, skeletal striated muscle, and pancreatic tissue, modulation of immunity and inflammation [7].

There are research works available regarding physical activity, but without mentioning significance of Vitamin D [8]. Similarly, while studies exist on the synthesis of Vitamin D through the skin's exposure to sunlight, they do not establish a correlation between physical activity and sun exposure [9]. Hence, the present study was planned to elucidate the relationship between body mass index (BMI), physical activity and levels of Vitamin D especially in medical students.

METHODS

It was a cross-sectional study conducted in 1st year and 2nd year MBBS students with the age group of 17–22 years, consisting of both sexes and the participants were allocated by random sampling. Written informed consent was obtained from each participant. Sample size was calculated for the study to reach power of 80% at 5% level of significance, and it was found to be 184. Healthy volunteers were included and students who reported any health problem or active infection and those who are receiving therapeutic dosage of Vitamin D during the past 6 months were excluded from the study. Approval from Institutional Human Ethics Committee had been taken before the commencement of the study.

Information of individual's identity, medical history, and details regarding type of physical activity were collected. Anthropometric parameters such as sex, height, and weight were recorded. BMI was calculated by dividing weight (kg) by height in meter squared (m^2). Waist circumference (WC) was measured at the end of normal exhalation, between the lower rib margin and iliac crest [10] with the help of non-elastic measuring tape. Blood pressure (BP) has been recorded in participants seated using a Sphygmomanometer [10]. Two ml of blood sample was collected from all the participants and serum Vitamin D level was measured using ELISA method. Furthermore, students were asked to fill the International Physical Activity Questionnaire – Short Form (IPAQ – SF) and based on the categorical scoring; physical activity is classified as low, moderate, and high.

Statistical analysis

SAS 9.2 version software was used for statistical analyses. Continuous variables values were expressed as mean and standard deviation (mean ± SD). Correlations were investigated by correlation coefficient of Pearson. Chi-square test was done for analysis of categorical variables and if assumptions are not satisfied, then Fisher exact test was done. Kruskal–Wallis test was done to compare between the groups if continuous variable is not following normal distribution. If p<0.05, it is considered as statistically significant.

RESULTS

Basic characteristics of the study population (n=184) are recorded in Table 1. Accordingly, the mean age of the participants was 18.98 (±0.96) years and other baseline parameters like BMI was 24.78 (±4.7) kg/m^2, average waist circumference was 90.31 (±13.5) cm, mean systolic and diastolic blood pressure were found to be 117.75 (±10.72) and 75.15 (±8.49) mmHg. Furthermore, the serum Vitamin D level of the study population was found to be 45.41 ng/ml.

Furthermore, analysis of Pearson's correlation of Vitamin D with anthropometric parameters and blood pressure are depicted in Table 2. The result showed that none of the parameters except BMI had significant correlation; the BMI showed significant negative correlation (r=−0.15, p=0.04) with serum Vitamin D.

Analysis of Pearson's correlation of Vitamin D and BMI along with physical activity score is mentioned in Table 3. Result showed non – significant negative correlation of Vitamin D with BMI in low and moderate categories of physical activity, whereas high category showed positive correlation of Vitamin D with BMI even though it is not significant.

Comparison of Vitamin D between different categories based on physical activity score is shown in Table 4. Accordingly, median values of Vitamin D in low, moderate, and high categories of physical activity were 36.5, 39, and 68. It did not show significant difference (p=0.51) among themselves.

Table 5 compared (Fig. 1) the Vitamin D level in different BMI. It was found that mean vitamin D (49.7±30.50) was higher in BMI<25 (normal weight) which showed statistically significant difference (p=0.04) when compared with BMI 25–30 (over weight) (42.6±31.73) and BMI>30 (obese) (34.6±25.16).

Table 1: Basic characteristics of the study population (N=184)

Parameter	Mean	SD
Age (years)	18.98	0.96
BMI (kg/m^2)	24.78	4.70
WC (cm)	90.31	13.50
SBP (mmHg)	117.75	10.72
DBP (mmHg)	75.15	8.49
Vitamin D (ng/ml)	45.41	30.68

Values are expressed in mean±SD

Table 2: Correlation of Vitamin D with anthropometric parameters and blood pressure: (N=184) *p<0.05 is significant

Parameter	Pearson's correlation coefficient (r)	p-value
BMI	−0.15001	0.0421*
WC	−0.01793	0.8091
SBP	0.07032	0.3429
DBP	0.05120	0.4900

Values are expressed in Person's correlation coefficient (r) and p-value

Table 3: Correlation of Vitamin D, BMI, and physical activity (N=184)

Levels of physical activity	Pearson's correlation coefficient (r)	p-value
Low	−0.17	0.12
Moderate	−0.15	0.14
High	0.52	0.23

Values are expressed in Person's correlation coefficient (r) and p-value

DISCUSSION

This study was designed to know the implication of physical activity and BMI with Vitamin D levels among teenagers. In this study, the basic parameters of the participants age, BMI, waist circumference, BP recorded, and their relationship with serum Vitamin D3 was analyzed (Tables 1 and 2). Further, the students were asked to fill IPAQ – SF (International Physical Activity Questionnaire – Short Form) questionnaire.

The present study correlated serum Vitamin D level with anthropometric parameters and blood pressure (Table 2). The result showed that there was a significant negative correlation observed between BMI and Vitamin D. Estimation of serum Vitamin D seems to be the best marker to assess Vitamin D status as it indicates both dietary intake and endogenous production of Vitamin D [11]. Researchers have shown the negative correlation of BMI with Vitamin D (r=−0.18, p<0.01) [12], which is in parallel with the result of present study. There are number of literatures available to show the important role of Vitamin D in various anthropometric parameters. Vitamin D has key role in the functioning of adipocytes. Vitamin D receptors and CYP27B1 gene expression takes place in adipocytes [13]. Researchers have reported the inverse relation of vitamin D with obesity including BMI, percentage of body fat, and waist circumference [14,15]. It has been shown that supplementation of Vitamin D decreases visceral fat in overweight and obese individuals [16]. The occurrence of Vitamin D deficiency is increasing worldwide [11]. Vitamin D deficiency among obese individuals has been observed in the literature [17]. It was considered as epidemic of obesity [18]. Deficiency of Vitamin D in obesity have been associated with cardiovascular diseases, type 2 diabetes, and cancer. [18] Hence, researchers are focusing on this direction to know the relationship between obesity and Vitamin D deficiency [18]. The result of this study also endorses the above findings as in this study also BMI and Vitamin D level had negative correlation.

Physical activity is important which increases bone mass. Researchers [19] observed significant positive association between Vitamin D and physical activity and they stated that physical activity is correlated with Vitamin D levels. It was evident which supports the result of present study though the correlation observed in the present work was not significant (Tables 3 and 4). Significant association between vigorous physical activity and vitamin D was reported [20], which were in consistent with the result of the present study. Studies have shown that obesity and physical activity are modifiable factors that contribute to the status of Vitamin D [21]. It has been observed that physical activity causes mobilization of stored Vitamin D from adipose tissues and increases lipolysis [3].

Furthermore, the present study compared Vitamin D levels in different levels of BMI (Table 5). Researchers have shown the negative correlation of normal BMI with Vitamin D (r=−0.18, p<0.01) [12], which is in parallel with the result of present study. It has been found in literatures that lower Vitamin D levels were observed in overweight

Table 4: Comparison of Vitamin D between categories of physical activity (N=184)

Vitamin D/Category	Low	Moderate	High	Chi-sq value	DF	Kruskal–Wallis test, p–value
Median (25th perc, 75th perc)	36.5 (18,67)	39 (16,67)	68 (29,78)	1.3085	2	0.51

Values are expressed in Median (25th percentile, 75th percentile) with degrees of freedom and p-value

Table 5: Comparison of vitamin D with different BMI: (N=184) *p<0.05 is significant

Parameter	Median	(25 perc, 75 perc)	Chi-square	p-value
BMI <25 (Normal weight)	41.5	25.5, 75.24	6.0303	0.049*
BMI, 25–30 (over weight)	39	14.7, 64		
BMI >30 (obese)	29	13.9, 46.43		

Values are expressed in Median (25th percentile, 75th percentile) with Chi-square value and p-value

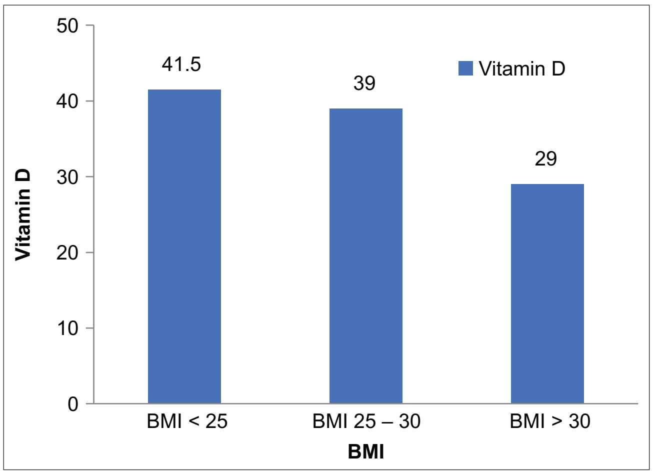

Fig. 1: Comparison of Vitamin D with different BMI (Table 5): p=0.04 (n=184). Values are expressed in Median (25th and 75th percentile).

and obese subjects. This relationship can be explained by the fact that Vitamin D is stored in adipocytes as it is lipid soluble. Furthermore, reduced exposure to sunlight as their physical activity is limited with restricted mobility [3] Similar to the findings of present study, other cross-sectional studies showed a significant correlation between the low Vitamin D and obesity [3]. One reason for Vitamin D deficiency in obesity is the decreased bioavailability of Vitamin D, as it becomes sequestered in adipose tissue [22]. Furthermore, it is assumed that decrease in circulating Vitamin D in calcidiol form causes increase in fat mass, leading to obesity [23]. Correcting vitamin levels is crucial for proper body function, with maintaining balanced Vitamin D being especially important in treating various diseases and preventing many others [24].

CONCLUSION

Since, physical inactivity and high BMI might have an adverse effect on Vitamin D levels, intervention measures like supplementation of Vitamin D can be recommended at earliest. This will help in preventing further complications. The present study reinforces that screening of population for Vitamin D is mandatory, particularly among people who are overweight and obese. Awareness should be given about the importance of Vitamin D status, the deficiency of which causes various ailments helping in reducing the disease burden.

ACKNOWLEDGMENT

The authors express their gratitude to the Indian Council of Medical Research for funding the short-term studentship project.

CONFLICTS OF INTEREST

None declared.

REFERENCES

1. Alsedairy S, Badr NA, Bekhaeit Z, Binobead M, Aldubaykhi H, Aljurbua T. Relationship between vitamin D status and blood pressure, age, physical activity, and nutritional status in Saudi males and females. Nutr Food Sci. 2018;2(3):164-74.
2. Bhagyashree N, Ramaswamy C, Abeetha S, Sureka V, Ganesh M, Suma S. Comparison of anthropometric and physiological hemodynamic parameters in metabolic syndrome population. Natl J Physiol Pharm Pharmacol. 2022;12(3):277-80.
3. Bjørgen K. Physical activity in light of affordances in outdoor environments: Qualitative observation studies of 3-5 years old in kindergarten. Springerplus. 2016;5(1):950. doi: 10.1186/s40064-016-2565-y, PMID 27386394
4. Brock K, Huang WY, Fraser DR, Ke L, Tseng M, Stolzenberg-Solomon R, *et al*. Low vitamin D status is associated with physical inactivity, obesity and low vitamin D intake in a large US sample of healthy middle-aged men and women. J Steroid Biochem Mol Biol. 2010;121(1-2):462-6. doi: 10.1016/j.jsbmb.2010.03.091, PMID 20399270
5. Caprio M, Infante M, Calanchini M, Mammi C, Fabbri A. Vitamin D: Not just the bone. Evidence for beneficial pleiotropic extraskeletal effects. Eat Weight Disord. 2017;22(1):27-41. doi: 10.1007/s40519-016-0312-6, PMID 27553017
6. Dong Y, Pollock N, Stallmann-Jorgensen IS, Gutin B, Lan L, Chen TC, *et al*. Low 25-hydroxyvitamin D levels in adolescents: Race, season, adiposity, physical activity, and fitness. Pediatrics. 2010;125(6):1104-11. doi: 10.1542/peds.2009-2055, PMID 20439594
7. Fernandes MR, Barreto WD. Association between physical activity and vitamin D: A narrative literature review. Rev Assoc Med Bras (1992). 2017;63(6):550-6. doi: 10.1590/1806-9282.63.06.550, PMID 28876433
8. Florez H, Martinez R, Chacra W, Strickman-Stein N, Levis S. Outdoor exercise reduces the risk of hypovitaminosis D in the obese. J Steroid Biochem Mol Biol. 2007;103(3-5):679-81. doi: 10.1016/j.jsbmb.2006.12.032, PMID 17267209
9. Foss YJ. Vitamin D deficiency is the cause of common obesity. Med Hypotheses. 2009;72(3):314-21. doi: 10.1016/j.mehy.2008.10.005, PMID 19054627
10. Gannagé-Yared MH, Helou E, Zaraket V, Abi Akl S, Antonios L, Moussalli ML, *et al*. Serum 25 hydroxyvitamin D in employees of a middle eastern university hospital. J Endocrinol Investig. 2014;37(6):541-6. doi: 10.1007/s40618-014-0061-1, PMID 24658790
11. Hashemipour S, Larijani B, Adibi H, Javadi E, Sedaghat M, Pajouhi M, *et al*. Vitamin D deficiency and causative factors in the population of Tehran. BMC Public Health. 2004;4(1):38. doi: 10.1186/1471-2458-4-38, PMID 15327695
12. Kavadar G, Demircioğlu DT, Özgönenel L, Emre TY. The relationship between vitamin D status, physical activity and insulin resistance in overweight and obese subjects. Bosn J Basic Med Sci. 2015;15(2):62-6. doi: 10.17305/bjbms.2015.399, PMID 26042515
13. Koszowska AU, Nowak J, Dittfeld A, Brończyk-Puzoń A, Kulpok A, Zubelewicz-Szkodzińska B. Obesity, adipose tissue function and the role of vitamin D. Cent Eur J Immunol. 2014;39(2):260-4. doi: 10.5114/ceji.2014.43732, PMID 26155133
14. Li J, Byrne ME, Chang E, Jiang Y, Donkin SS, Buhman KK, *et al*. 1α,25-dihydroxyvitamin D hydroxylase in adipocytes. J Steroid Biochem Mol Biol. 2008;112(1-3):122-6. doi: 10.1016/j.jsbmb.2008.09.006, PMID 18840526
15. Ohta H, Kuroda T, Onoe Y, Orito S, Ohara M, Kume M, *et al*. The impact of lifestyle factors on serum 25-hydroxyvitamin D levels: A

cross-sectional study in Japanese women aged 19-25 years. J Bone Miner Metab. 2009;27(6):682-8. doi: 10.1007/s00774-009-0095-1, PMID 19436945
16. Pannu PK, Zhao Y, Soares MJ. Reductions in body weight and percent fat mass increase the vitamin D status of obese subjects: A systematic review and metaregression analysis. Nutr Res. 2016;36(3):201-13. doi: 10.1016/j.nutres.2015.11.013, PMID 26923506.
17. Rogerson M, Gladwell VF, Gallagher DJ, Barton JL. Influences of green outdoors versus indoors environmental settings on psychological and social outcomes of controlled exercise. Int J Environ Res Public Health. 2016;13(4):363. doi: 10.3390/ijerph13040363, PMID 27023580
18. Rosenblum JL, Castro VM, Moore CE, Kaplan LM. Calcium and vitamin D supplementation is associated with decreased abdominal visceral adipose tissue in overweight and obese adults. Am J Clin Nutr. 2012;95(1):101-8. doi: 10.3945/ajcn.111.019489, PMID 22170363
19. Ross AC, Manson JE, Abrams SA, Aloia JF, Brannon PM, Clinton SK, *et al*. The 2011 report on dietary reference intakes for calcium and vitamin D from the institute of medicine: What clinicians need to know. J Clin Endocrinol Metab. 2011;96(1):53-8. doi: 10.1210/jc.2010-2704, PMID 21118827
20. Vanlint S. Vitamin D and obesity. Nutrients. 2013;5(3):949-56. doi: 10.3390/nu5030949, PMID 23519290
21. Wang EW, Pang MY, Siu PM, Lai CK, Woo J, Collins AR, *et al*. Vitamin D status and cardiometabolic risk factors in young adults in Hong Kong: Associations and implications. Asia Pac J Clin Nutr. 2018;27(1):231-7. doi: 10.6133/apjcn.022017.08, PMID 29222903
22. Wintermeyer E, Ihle C, Ehnert S, Stöckle U, Ochs G, De Zwart P, *et al.* Crucial role of vitamin D in the musculoskeletal system. Nutrients. 2016;8(6):319. doi: 10.3390/nu8060319, PMID 27258303
23. Wortsman J, Matsuoka LY, Chen TC, Lu Z, Holick MF. Decreased bioavailability of vitamin D in obesity. Am J Clin Nutr. 2000;72(3):690-3. doi: 10.1093/ajcn/72.3.690, PMID 10966885
24. Al-Shahwan M, Gacem SA, Shamseddin S, Sammour M. Vitamin D impact on human health and its relation with several diseases. Int J Appl Pharm. 2018;10(6):60-4.