Prevalence of Vitamin D Deficiency in Adolescents with recent onset poor Scholastic Performance

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ABSTRACT

Background: Although vitamin D deficiency has been documented as a frequent problem of young adults, elderly persons, and children in other countries, there are limited data on the prevalence of this nutritional deficiency as a probable cause of recent onset poor scholastic performance among adolescents and young adults.

Objective: To determine the prevalence of vitamin D deficiency in healthy adolescents presenting with school reports of recent onset poor scholastic performance.

Design: A cross-sectional clinic- based sample.

Setting: An urban hospital in Thiruvananthapuram.

Main Outcome Measures: Serum levels of 25-hydroxyvitamin D (25OHD), weekly physical activity and lifestyle variables that were potential risk factors for hypovitaminosis D.

Results: 41 patients (66.13%) were vitamin D deficient (serum 25OHD level, ≤15 ng/mL [≤37.5 nmol/L]), of whom 16 (25.8%) were severely vitamin D deficient (25OHD level, ≤8 ng/mL [≤20 nmol/L]). By using a broader definition (25OHD level, ≤20 ng/mL [≤50 nmol/L]), 50 patients (80.64%) were vitamin D insufficient.

Conclusions: Vitamin D deficiency was present in adolescents in this urban clinic-based sample. The prevalence was highest in adolescents with scholastic backwardness, and interventions targeting this also need to be considered in the holistic management of scholastic backwardness.

Keywords: Vitamin D Deficiency, Recent onset Scholastic Backwardness, Adolescents

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AIM

Vitamin D has been traditionally considered as one important for bone and muscle growth. The other effects of this vitamin in children and adolescents and Vitamin D inadequacy in adults and the effects were hardly discussed. In the recent years the beneficial effect of vitamin D in the extra skeletal tissues are being increasingly studied. In accordance to the recent studies throwing implications of Vit D deficiency, this study is aimed to look into the relationship between Vit D def and recent onset poor scholastic performance in children & young adults.

REVIEW OF LITERATURE

Interestingly, Vitamin D deficiency is being increasingly associated with a number of psychiatric conditions, in particular those with a developmental basis.[1] The neurobiological plausibility of this association is strengthened by the preclinical data indicating vitamin D deficiency in early life affects neuronal differentiation, axonal connectivity, dopamine ontogeny and brain structure and function.[2]

1, 25 (OH)2D is the biologically active form of vitamin D responsible for maintaining calcium and phosphorus homeostasis. It accomplishes this by interacting with its nuclear receptor, the vitamin D receptor (VDR) in the small intestinal cells.[3,4] The 1, 25(OH)2D–VDR structure complexes with retinoic acid X receptor (RXR) in the nucleus. The 1, 25(OH)2D-VDR-RXR complex binds to the vitamin D–responsive element (VDRE) for the epithelial calcium channel. The increased expression of the calcium channel permits more calcium to enter the cell, where the vitamin

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D–dependent calcium-binding protein calbindin 9K helps calcium's translocation into the bloodstream. 1,25 (OH)2D also enhances phosphorus absorption in the small intestine. The VDR is present not only in tissues that regulate serum calcium, including the small intestine, bone cells, and kidney, but also in essentially all tissues and cells in the body, including brain, colon, breast, prostate, pancreas, heart, skin, skeletal muscle, monocytes, and activated T and B lymphocytes.[5] This perhaps would throw light on the effects that Vit D has on other tissues of body.[6,7]

Vitamin D status in Indian adolescents and children has been studied by Agarwal KS etal[8] and few other workers. The above mentioned study concluded that the children living in areas of high atmospheric pollution are at risk of developing vitamin D deficiency. Other studies conducted at various parts of India showed a highly variable range of Vit D levels[9] with a data suggesting 3% to 70% children having inadequate levels of vit d (i.e. <20 nmol/l). The average levels ranged between 31 ±14 to 68 ±29 nmol/l. The factors the investigators identified regarding the decrease in vit d levels in Indian children and adolescents are lower summer sun exposure, female gender, Higher BMI, smaller percentage of body surface area exposed to sunlight, Female gender, lower socioeconomic status, Lowerserum25(OH)D in mother. But material correlating sudden onset deterioration in scholastic performance and Vitamin D inadequacy is not available till date.

Vitamin D (where D represents D2 or D3) is biologically inert and metabolized in the liver to 25-hydroxyvitamin D [25(OH)D], the major circulating form of vitamin D that is used to determine vitamin D status. 25(OH)D is activated in the kidneys to 1,25-dihydroxyvitamin D [1,25(OH)2D], which regulates calcium, phosphorus, and bone metabolism.

During exposure to sunlight, the ultraviolet B (UVB) radiation (290–315 nm) is absorbed by 7-dehydrocholesterol in the skin to form preVitamin D3.[10,11] PreVitamin D3 is inherently unstable and rapidly converts by a temperature-dependent process to vitamin D3. Once formed, it is ejected out of the skin cell into the extracellular space, where it is drawn into the dermal capillary bed by the vitamin D–binding protein (DBP).[5]

The efficiency of vitamin D3 synthesis in the skin is dependent on the number of UVB photons that penetrate into the epidermis. An increase in skin melanin pigmentation[12] and the topical application of a sunscreen,[13] both of which efficiently absorb UVB photons, can markedly diminish by more than 90% the production of vitamin D3.

METHODS AND METHODOLOGY

Study Design and Participants: We studied 62 adolescents, school and college going students (aged 10-19 years) who presented to the outpatient clinic at Thiruvananthapuram with complaints of recent onset poor scholastic performance according to school/college reports for last 6 months.

Study Design: A cross-sectional clinic-based sample

Prior to the data collection, written informed consent was obtained from a parent or guardian of all participating students along with verbal assent from each student.

The exclusion criteria for children included children consuming nutritional supplements, and those participating in another nutritional program, children with chronic illness and use of medications known to affect bone metabolism, children with other diagnosed causes of learning disabilities and poor attention.

Non-fasting venous blood samples were collected in tubes containing anticoagulant (EDTA–K2). Blood samples were stored at 4 _C and analyzed within 4 hours

Academic performance was measured using age- and gender-standardized end-of-term test scores retrieved from the school administration system. Academic tests were designed and administered by the schools and scores obtained 6 months before the interview were compared with those obtained at the time of interview. Test scores were analyzed using a percentage grading system, with 100 as the maximum grade and 60 percent as the minimum passing grade. The subjects of Mathematics, English, Social Science, Science and Malayalam were evaluated in the present study.

Micronutrient Status

Vitamin D was measured with electrochemiluminescence technique (Elecsys 2010, Roche Diagnostics, Mannheim, Germany). Deficiencies of vitamin D was defined as vitamin D less than 20 ng/mL as Vit D insufficiency, as vitamin D less than 15 ng/mL as Vit D deficiency and vitamin D less than 8 ng/mL as severe Vit D deficiency.

The patients were divided into 3 diagnostic categories according to their serum 25OHD concentrations, as rounded to the nearest integer. In increasing order of severity, the 25OHD levels were as follows: vitamin D insufficiency, 20 ng/mL or less (≤50 nmol/L); vitamin D deficiency, 15 ng/mL or less (≤37.5 nmol/L); and severe vitamin D deficiency, 8 ng/mL or less (≤20 nmol/L).

Statistical Analysis

Data management and data analysis were performed using SPSS (Statistical Package for the Social Sciences for Windows, IBM, Armonk, NY, USA) version 23.0. The nominal variables are presented as frequency and proportion.

RESULTS

1. Age

The mean age of the students at the time of study was 15.74±2.718 years.

2. Gender

The study sample included more boys 41 (66.1%) and 21 girls (33.9%) **(table 1).**

Table 1. Sex distribution

	Frequency	Percent
Male	41	66.1
Female	21	33.9
Total	62	100.0

3. Vitamin D Status

Percentage Of Young Adults With With Viamin D Insufficiency Among Students Presenting With Poor Scholastic Performance In An Urban Clinic In Trivandrum **(table 2)**

Table 2. frequency of Vit D deficiency

	Frequency	Percent
Vit D Insufficiency	50	80.6
Normal	12	19.4
Total	62	100.0

Proportion Of Vitamin D Deficiency And Insufficiency In Young Adults Attending An Urban Clinic In Trivandrum With Scholastic Backwardness **(table 3)**

Table 3. Degree of Vit D deficiency

Vitamin D status	frequency	Percentage
Insufficiency (< 20 nd/dl)	9	18
Deficiency(<15ng/dl)	25	50
Severe deficiency(<8ng/dl)	16	32
Total	50	100

Prevalence (%) Of Vitamin D Deficiency And Insufficiency Among Young Adults Presenting With Poor Scholastic Performance In An Urban Clinic In Trivandrum **(figure 1)**

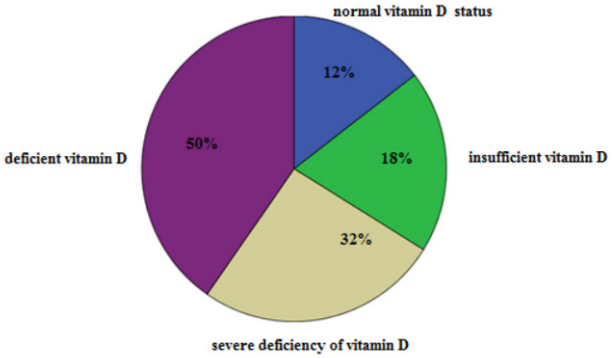

Figure 1. **Vitamin D status**

Association Between Gender And Vitamin D Status In Young Adults Presenting With Scholastic Backwardness In An Urban Clinic In Trivandrum **(table 4)**

Table 4. Vit D status and sex distribution

Gender	Vit D status		Total
	Insuff Vit D	Normal	
male	33	8	41
female	17	4	21
Total	50	12	62

Chi-Square: 0.002 Degree of freedom: 1 p value: not significant

DISCUSSION

This study has shown that 80.6% (50 out of 62) of adolescents presenting with recent onset poor scholastic performance had either insufficiency or deficiency of Vitamin D. This finding points to the possibility of considering Vitamin D deficiency as one of the causative factors for poor academic performance among adolescents.

Despite the fact that our part of the world has adequate sunlight, which is regarded as one of the major prerequisites for synthesis of Vitamin D, the fact that a number of students have deficiency and insufficiency of Vitamin D, is a matter worth pondering over, as it calls for some modification in the lifestyle of the younger generation, including necessity for more physical activity with exposure to sunlight.

Micronutrient deficiencies have been linked to damaging physical performance,[14] impaired cognitive functioning,[15] suboptimal learning,[16] and poor academic performance.[17] These endpoints, in turn, may lead to an increased risk of adulthood obesity,[18,19] living in poverty,[20] depression,[21] and other psychiatric disorders.[22] So, interventions targeted at correcting these deficiencies can have long standing impact on cognitive functions, academic performance and health of adolescents in general. Hence, there is a need to

identify and evaluate safe, tolerable, and cost-effective nutritional interventions in school children and adolescents.

CONCLUSIONS

Vitamin D inadequacy is a global problem, especially among elderly patients and patients with osteoporosis. Few data are available regarding the prevalence of this nutritional deficiency among healthy children and adolescents.[23] Thus, these findings suggest that vitamin D deficiency is a problem spanning the age spectrum, beginning from childhood. Vitamin D deficiency is commonly seen in adolescents with scholastic backwardness, and interventions targeting this also need to be considered in the holistic management of scholastic backwardness.

END NOTE

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Editor's Remarks: This study is very unique due to the fact that the relation between Vit D and scholastic ability is being analysed in the field setting. This original study needs validation with more extensive studies and followup studies.

Conflict of Interest: None declared

REFERENCES

1. Eyles DW, Burne TH, McGrath JJ: Vitamin D, effects on brain development, adult brain function and the links between low levels of vitamin D and neuropsychiatric disease. Front Neuroendocrinol. 2013 Jan; 34(1):47-64.
2. Wang Y, Chiang YH, Su TP, Hayashi T, Morales M, Hoffer BJ, et al. Vitamin D(3) attenuates cortical infarction induced by middle cerebral arterial ligation in rats. Neuropharmacology. 2000 Mar 3;39(5):873–80.
3. Bouillon, R. Vitamin D: from photosynthesis, metabolism, and action to clinical applications. In Endocrinology. L.J. DeGroot and J.L. Jameson, Editors. W.B. Saunders. Philadelphia, Pennsylvania, USA. 1009–1028.
4. Christakos S, Dhawan P, Liu Y, Peng X, Porta A.: Review New insights into the mechanisms of vitamin D action J Cell Biochem. 2003 Mar 1; 88(4):695-705.
5. Holick MF. High prevalence of vitamin D inadequacy and implications for health. Mayo Clin Proc. 2006 Mar;81(3):353–73
6. Shearer, K.D.; Stoney, P.N.; Morgan, P.J.; McCaffery, P.J.: A vitamin for the brain. Trends Neurosci. 2012, 35, 733–741.
7. Eyles, D.W.; Burne, T.H.; McGrath, J.J.: Vitamin D, effects on brain development, adult brain function and the links between low levels of vitamin D and neuropsychiatric disease. Front. Neuroendocrinol. 2013, 34, 47–64.
8. K S Agarwal1, M Z Mughal2, P Upadhyay3, J L Berry4, E B Mawer4, J M Puliyel1 The impact of atmospheric pollution on vitamin D status of infants and toddlers in Delhi, India Archives of Disease in Childhoodadc.bmj.com Arch Dis Child 2002
9. van der Meer IM, Middelkoop BJC, Boeke AJP, Lips P. Prevalence of vitamin D deficiency among Turkish, Moroccan, Indian and sub-Sahara African populations in Europe and their countries of origin: an overview. Osteoporos Int. 2011 Apr;22(4):1009–21.
10. Holick, M.F. 2005. Vitamin D. In Modern nutrition in health and disease.10th edition. M. Shils et al., editors. Lippincott Williams & Wilkins. Baltimore, Maryland, USA. 329–345.
11. MacLaughlin JA, Anderson RR, Holick MF. Spectral character of sunlight modulates photosynthesis of previtamin D3 and its photo isomers in human skin. Science. 1982 May 28; 216(4549):1001-3
12. Clemens TL, Adams JS, Henderson SL, Holick MF.: Increased skin pigment reduces the capacity of skin to synthesise vitamin D3. Lancet. 1982 Jan 9; 1(8263):74-6
13. Matsuoka LY, Ide L, Wortsman J, MacLaughlin JA, HolickMF.: Sunscreens suppress cutaneous vitamin D3 synthesis. J Clin Endocrinol Metab. 1987 Jun; 64(6):1165-8
14. Gera, T.; Sachdev, H.P.; Nestel, P. Effect of iron supplementation on physical performance in children and adolescents: Systematic review of randomized controlled trials. Indian Pediatr. 2007, 44, 15–24.
15. Black, M.M. Micronutrient deficiencies and cognitive functioning. J. Nutr. 2003, 133, 3927S–3931S.
16. Osendarp SJM, Baghurst KI, Bryan J, Calvaresi E, Hughes D, Hussaini M, et al. Effect of a 12-mo micronutrient intervention on learning and memory in well-nourished and marginally nourished school-aged children: 2 parallel, randomized, placebo-controlled studies in Australia and Indonesia. Am J Clin Nutr. 2007 Oct;86(4):1082–93.
17. Syam, A.; Palutturi, S.; Djafar, N.; Astuti, N.; Thaha, A.R. Micronutrients, Academic Performance and Concentration of Study: A Literature Review. 2016.
18. Alatupa, S.; Pulkki-Råback, L.; Hintsanen, M.; Ravaja, N.; Raitakari, O.T.; Telama, R.; Viikari, J.S.; Keltikangas-Järvinen, L.: School performance as a predictor of adulthood obesity: A 21-year follow-up study. Eur. J. Epidemiol. 2010, 25, 267–274.
19. Sobol-Goldberg, S.; Rabinowitz, J. Association of childhood and teen school performance and obesity in young adulthood in the US National Longitudinal Survey of Youth. Prev. Med. 2016, 89, 57–63.
20. Hoddinott, J.; Behrman, J.R.; Maluccio, J.A.; Melgar, P.; Quisumbing, A.R.; Ramirezzea, M.; Stein, A.D.; Yount, K.M.; Martorell, R. Adult consequences of growth failure in early childhood. Am. J. Clin. Nutr. 2013, 98, 1170–1178.
21. Lehtinen, H.; Raikkonen, K.; Heinonen, K.; Raitakari, O.T.; Keltikangas-Jarvinen, L.: School performance in childhood and adolescence as a predictor of depressive symptoms in adulthood. Sch. Psychol. Int. 2006, 27, 281–295.
22. Björkenstam E, Dalman C, Vinnerljung B, Weitoft GR, Walder DJ, Burström B. Childhood household dysfunction, school performance and psychiatric care utilisation in young adults: a register study of 96 399 individuals in Stockholm County. J Epidemiol Community Health. 2016 May;70(5):473–80.
23. Holick MF. High prevalence of vitamin D inadequacy and implications for health. Mayo Clin Proc. 2006 Mar;81(3):353–73.