

ORIGINAL ARTICLE

Correlation of Hypovitaminosis D with Socioeconomic Status and Dental Caries in Children

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ABSTRACT

Objective: To find out the correlation of vitamin D levels with socioeconomic status and dental caries.**Study Design:** Cross sectional study.**Place and Duration of Study:** The study was conducted at Islamic International Medical College from September 2015 to March 2016.**Materials and Methods:** Eighty children, between 2-8 years of age, were recruited after fulfilling a questionnaire from their parents or caregiver. The sample population was divided into two groups keeping in mind their dental health. Group 1 consisted of children suffering from dental caries and is comprised of 60 patients. Group 2 consisted of children with sound healthy teeth and was comprised of 20 children. Questionnaires assessing children's socioeconomic background, dietary habits were included. The data was studied using Likert scale. The diagnosis of childhood caries was based on oral health diagnostic criteria defined by WHO. Total caries score, dmft index (decayed, missed, filled teeth) was obtained. Venipuncture of participants was done for determining Vitamin D levels of the study population by using ELISA procedure. Pearson correlation and Chi-square analysis were applied to the results.**Results:** Results have established that Vitamin D levels in children have positive association to their socioeconomic status. Vitamin D deficiency is seen in offspring belonging to low socioeconomic status and dental caries was also present in them. Pearson correlation and Chi-square analysis have showed that increased dmft caries score is correlated with vitamin D concentrations less than 30ng/ml and lower monthly income. This cross-sectional study showed that caries, less serum vitamin D levels and low socioeconomic status are directly related with each other.**Conclusion:** Dental caries lower 25 hydroxy vitamin D levels and low socioeconomic status is closely linked. Improving children's vitamin D levels by providing vitamin D supplementation or awareness of food rich in vitamin D may be helpful in decreasing the incidence of dental caries in young children.**Key Words:** *Decayed, Early Childhood Caries (ECC), Filled Teeth (dmft), Missed, 25 Hydroxy Vitamin D (25OHD).*

Introduction

Vitamin D also known as calciferol is fat soluble sterol derived vitamin. It is a prohormone. Its two forms are vitamin D₂ and vitamin D₃.¹ Vitamin D₂ or ergocalciferol is derived from plants, vitamin D₃ or

cholecalciferol is synthesized in human skin from 7dehydrocholesterol,² on exposure to ultraviolet B irradiation with wavelength 290 to 320 nm convert 7dehydrocholesterol to D₃.^{2,3} Serum vitamin D levels depend on not only on Sun exposure but also on its oral supply. Few of these dietary sources include cod liver oil, fishes like salmon, sardines, cod fish and mackerel, red meat and liver.⁴ Certain foods are well fortified with vitamin D like breakfast cereals, margarine, fruit juices and dairy products.⁵ Ergocalciferol or cholecalciferol are inactive till their activation by two hydroxylases in liver and then in kidney so that it becomes metabolically active. Calcium in the diet is absorbed from small intestine with help of vitamin D, which induces the formation of protein called calbindin-D9k.⁶ This protein increases binding of calcium present in food. Vitamin D deficiency in humans produce defects in bone

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mineralization resulting in a disease, rickets which occurs in children and osteomalacia, occurs in adults. Vitamin D also has a definitive role in regulating acquired and Innate Immunity immune response. Calcitriol also effect the differentiation and mineralization of osteoblasts. Early Childhood Caries (ECC) is defined as carious lesions in incisors of the deciduous dentition of the children.⁷ It is seen that ECC is associated with low family income^{8,9} and it has also been observed that vitamin D insufficiency is mostly seen in children with low socioeconomic status. In other words it can be assumed that malnourished children have more tendencies to develop dental caries and hypovitaminosis D.¹⁰ Dental caries is a decay of teeth by different strains of bacteria, *Streptococcus mutans* and *Streptococcus sobrinus* mostly that results in cavitated and non cavitated (white-spot) carious lesions.¹¹ According to various studies, the frequency of caries in school going children of Pakistan was 41%. However in the five year old children this index was found as high as 75% .⁹ Risk factor of low income is because of unhealthy dietary habits.¹² A highly significant association is found between caries and family income patterns.⁸ It is established that a strong association exists between early childhood caries and low socioeconomic status.⁹ Chances of defective amelogenesis causing enamel hypoplasia , large pulp chambers and dentinal anomalies are enhanced when there is deficiency of vitamin D during development of tooth which is suggested as a significant risk factor for early childhood caries ECC.^{7,13,14} These defects in enamel increase the chances of caries causing bacteria to develop caries.¹⁰ Chances of having dental caries are more if the mineralization of enamel and dentin is decreased.¹⁵ Prolonged vitamin D deficiency, decreases serum calcium levels and increases parathyroid hormone.¹⁶ Vitamin D level is measured from plasma concentration of the circulating 25(OH)D.³ Serum 25(OH)D levels < than 20 ng/ml shows deficiency: serum 25(OH)D levels between 20-30 ng/ml denotes insufficiency: 30-44 ng/ml as sufficiency and 50-70 ng/ml is considered as optimal level.¹⁷ Problems arising from caries are immeasurable, there is difficulty in eating as the affected child has to face the consequences¹⁸ expensive dental treatment and there is chance of

reoccurrence.¹² Nutritional and sleep problems affect growth of children.¹⁹

To find out the correlation between vitamin D, childhood caries and socioeconomic background, the following study was undertaken. It means that hypovitaminosis D is present in children with low socioeconomic background and they have more chances to develop dental caries. Our study is done at small scale but it can be a significant breakthrough.

Materials and Methods

It was a cross-sectional observational study, held in the Biochemistry department of IIMC-T (Islamic International Medical College) Rawalpindi in collaboration with IIDC (Islamic International Dental College) Islamabad after the approval from Institutional Review Committee, and Ethics Committee of Riphah International University for a period of six months, from September 2015 till March, 2016. Sixty Children with early childhood caries (ECC) as group 1 and twenty children with sound, healthy teeth as group 2 were included in this study. Size of the sample was calculated, on the basis of prevalence and duration of study period. Simple randomized sampling technique was used for sample collection. The patient were allocated without any bias or prior notification during the entire study period. Samples were collected from different hospitals to ensure a fair degree of randomness.

For grading dental caries an index, dmft was used which was achieved by adding d (decayed), m (missed), f (filled) teeth of children. The index is internationally accepted by the dental community for recording of decayed, missed and filled teeth. For each individual the occurrence of dental caries is obtained by calculating the number of decayed teeth d (the carious teeth), Missed teeth m and the number of teeth have Fillings or Crown on tooth as f. Score 0 for dmft shows that there is no caries and those having dmft score >4 were considered having excessive caries. A questionnaire which was given to the parents of the children revealed facts about their children food intake and their socioeconomic status. Venipuncture of participants was done to determine serum vitamin D levels. Serum samples were stored in freezers of post graduate laboratory at -70°C, Biochemistry department of IIMC Rawalpindi. Serum total 25(OH) D of the study subjects were measured using enzyme linked immunosorbent assay (ELISA).

Questionnaire data was analyzed using Likert scale. To find out the relationship between serum vitamin D levels, socioeconomic background and childhood caries, Pearson's correlation method was applied. For data processing SPSS 21 was used. Frequencies, means and standard deviations were determined. Chi-square analysis was also applied. *P* value less than 0.05 was considered as significant.

Results

Results have established association of Vitamin D levels in Children with Early Childhood Caries. Total number of children participated in the study was 80. In them 43, 54% were male and 37, 46% were female. The mean age of the patient was 5 years and 3 months.

Table I: Frequency Distribution of Vitamin D Levels in Study Subjects

Vitamin D levels mg/ml	Frequency, percent	Group 2 Caries Free	Group 1
Vitamin D Deficiency <20	42, 52.5%	0	42
Vitamin D Insufficiency (20 -30)	13, 16.3%	1	12
Vitamin D Sufficiency (30-44)	17, 21.3%	11	6
Vitamin D Optimal (>44)	8, 10%	8	0
Total	80, 100%	20	

Table II: Economic Status Distribution of Study Subjects

Economy (More than Rs. Per month)	Frequency & Percentage	Group1	Group2 (Caries Free)
15000/- pm	22, 27.5	22	0
30000/- pm	31, 38.8	23	8
50000/- pm	16, 20	11	5
80000/- pm	11, 13.8	4	7
Total	80	60	20

Table III: Descriptive Statistics of Vitamin D Levels

Group	N	Vitamin D level ng/ml Min.	Vitamin D level ng/ml Max.	Mean	Std. Deviation ±
1	60	2.12	40.35	16.83	8.696
2	20	22.95	139.65	57.79	36.33

Table IV: Association of Vitamin D levels with socioeconomic status

Vitamin D Levels	Frequency on the basis of Socioeconomic status of the study subjects				P value
	Level 1	Level 2	Level 3	Level 4	
Vitamin D Deficient (1)	20	14	6	2	0.00
Vitamin D Insufficient (2)	2	6	4	1	
Vitamin D Sufficient (3)	-	9	3	5	
Vitamin D Optimal (4)	-	2	3	3	

Vitamin deficiency, insufficiency, sufficiency and optimal values are grouped as level 1, 2, 3 and 4 respectively on Likert scale. Socioeconomic status of the study subjects is also divided into four levels on Likert scale in which level 1 indicates subjects whose economy is more than Rs. 15,000 per month, level 2 indicates subjects whose economy is more than Rs. 30,000 per month, level 3 indicates subjects whose economy is more than Rs. 50,000 per month and level 4 indicates subjects whose economy is more than Rs. 80,000 per month. Chi-square analysis has showed that vitamin D levels have significant association with the socioeconomic status levels. Statistically significant difference (*p* value less than 0.01) is seen in Table no. IV when vitamin D levels of the study subjects are compared with socioeconomic status levels.

The results of our study reveal statistically significant difference (*p* value less than 0.001) in vitamin D levels of the study subjects with socioeconomic status groups. This study has showed that vitamin D deficiency, insufficiency and sufficiency is significantly related with socioeconomic status levels as shown in Table no. IV

Combined correlation of Vitamin D levels, and caries score of patients with socio economic status revealed that Vitamin D and socio economic status have positive correlation of value 0.508 whereas, socio economic status and vitamin D levels have reverse correlation with caries of values -0.51 and -0.89 respectively with *p* value is 0.00 and correlation is significant at the 0.01 level.

Discussion

This study was undertaken to find out the correlation between vitamin D, socioeconomic background and caries in young children. A cross-sectional study was conducted which includes physical calculations, laboratory tests and interviews of parents. There were 80 children between age 3-8 years who were visiting dental hospital. In total 80 study subjects 20 children have sound teeth without caries (group 2) and 60 children were having dental caries at different levels (group 1), which was measured by dmft score.

The current study examined the correlation of vitamin D levels with different groups of socioeconomic status of children and relates this with extent of dental caries. This study has showed that vitamin D deficiency, vitamin D insufficiency and vitamin D sufficiency is significantly related with socioeconomic status levels. Vitamin D levels and socioeconomic backgrounds are strongly correlated to extent of dental caries in childhood.

Improving the diet of children by including food rich in vitamin D may have valuable effects on overall health of the child and on dental health. There should be mass education on awareness of foods having vitamin D and calcium so that general health of our population will be improved.

A study done by Sufia et al in 2011, It is concluded that dental caries is more prevalent in preschool children living in metropolitan areas and in lower middle class.⁹ Charani et al in 2011 have also found that there is a correlation between childhood caries and family social background.⁸ Leghari et al in 2012 have also revealed that there is more frequency of dental caries in children of public schools than private schools.²⁰

Our study has showed that vitamin D deficiency and insufficiency is related to low and middle economy levels. A study conducted in Canada by Schroth et al in 2013 has concluded that vitamin D deficiency and insufficiency is more common in children of lower socioeconomic status and also there is more ECC in them.²¹ It is also suggested that this vitamin D deficiency and insufficiency plays main role in development of dental caries in children. These findings match with results of our study. In a study held in Germany by Kühnisch et al. in 2015 suggested that higher serum vitamin D levels were linked with fewer chances of having extensive dental caries in

permanent dentition.²² The results also support our study. The mechanisms behind that how sufficient vitamin D reduce the risk of caries might be that there is improved tooth development, better amelogenesis which results in perfect enamel formation, enhanced dentinal mineralization response to caries. Vitamin D also induces cathelicidin and certain defensins which protect the teeth from caries causing bacterias.

In a study conducted by Forrest et al in 2011, it is concluded that vitamin D deficiency is a marker of low socioeconomic status.²³ A study conducted by Mehboobali et al in 2015 have analyzed that vitamin D deficiency is present in population residing outskirts of Karachi, who have low economy.²⁴ A cross-sectional study performed in Canadian schools in 2015 by R.J. Schroth et al, showed that hypovitaminosis D is closely related with extensive dental caries. The results of this study matches with our findings.²⁵

Nowadays sugar consumption is increased a lot in the form of sweets and chocolates and children are less aware of brushing techniques and oral hygiene practices. It is also suggested by different studies that despite of all the facts described above, decreased oral hygiene, lack of education and increased consumption of sugar in diet and drinks are prominent risk factors for caries.^{20,26}

In most of the cross-sectional, case control and prospective studies, vitamin D deficiency has been considered to be linked with more chances of dental caries. It is also worth mentioning that vitamin D deficiency in individuals might result from lack of sun exposure or it might be due to malnutrition or some gene polymorphism is involved.

Conclusion

Our study concludes that sufficient level of 25(OH) D in children has a significant role in decreasing dental caries and is also related to socioeconomic status of the children. This study has not only established the close relationship of vitamin D and dental caries but has also revealed the effect of socioeconomic status as a significant contributing factor in this region. It is therefore suggested that our children's vitamin D status should be improved by fortification of food at national level and there should be awareness among people about food rich in vitamin D and calcium.

REFERENCES

1. Harvey RA, Ferrier DR. *Biochemistry*: Lippincott Williams & Wilkins; 2011.
2. Del Valle HB, Yaktine AL, Taylor CL, Ross AC. *Dietary reference intakes for calcium and vitamin D*: National Academies Press; 2011.
3. Rodwell VW, Bender DA, Botham KM, Kennelly PJ, Weil PA. *Harpers illustrated biochemistry*: McGraw-Hill Medical Publishing Division; 2015.
4. Bowden SA, Robinson RF, Carr R, Mahan JD. Prevalence of vitamin D deficiency and insufficiency in children with osteopenia or osteoporosis referred to a pediatric metabolic bone clinic. *Pediatrics*. 2008;121(6):e1585-e90.
5. Holick MF. Vitamin D deficiency. *New England Journal of Medicine*. 2007;357(3):266-81.
6. Anderson P, May B, Morris H. Vitamin D metabolism: new concepts and clinical implications. *Clinical Biochemist Reviews*. 2003;24(1):13-26.
7. Schroth RJ, Lavelle C, Tate R, Bruce S, Billings RJ, Moffatt ME. Prenatal vitamin D and dental caries in infants. *Pediatrics*. 2014;133(5):e1277-e84.
8. Charani A, Mohsin S, Sufia S, Khan A. Prevalence of early childhood caries among 3-5-year old children of Clifton, Karachi. *J of Pak Dent Assoc*. 2011;20:89-92.
9. Sufia S, Chaudhry S, Izhar F, Syed A, Qayum Mirza BA, Ali Khan A. Dental Caries Experience in Preschool Children Is It Related to A Child's Place of Residence and Family Income? *Oral Health and Preventive Dentistry*. 2011;9(4):375.
10. Marwaha RK, Tandon N, Reddy DRH, Aggarwal R, Singh R, Sawhney RC, et al. Vitamin D and bone mineral density status of healthy schoolchildren in northern India. *The American journal of clinical nutrition*. 2005;82(2):477-82.
11. Banerjee A, Pickard HM, Watson TF. *Pickard's manual of operative dentistry*: Oxford university press; 2011.
12. Syed S, Nisar N, Khan N, Dawani N, Mubeen N, Mehreen Z. Prevalence and factors leading to early childhood caries among children (71 months of age or younger) in Karachi, Pakistan. *Journal of Dentistry and Oral Hygiene*. 2015;7(9):153-9.
13. Berdal A, Bailleul-Forestier I, Davideau J, Lezot F. Dento-alveolar bone complex and vitamin D. *Vitamin D*. 2005;1:599-607.
14. Slayton RL. Prenatal Vitamin D Deficiency and Early Childhood Caries. *AAP Grand Rounds*. 2014;32(5):57-.
15. Antonenko O, Bryk G, Brito G, Pellegrini G, Zeni S. Oral health in young women having a low calcium and vitamin D nutritional status. *Clinical oral investigations*. 2014:1-8.
16. Haussler MR, Whitfield GK, Kaneko I, Haussler CA, Hsieh D, Hsieh J-C, et al. Molecular mechanisms of vitamin D action. *Calcified tissue international*. 2013;92(2):77-98.
17. Anderson PH, Lam NN, Turner AG, Davey RA, Kogawa M, Atkins GJ, et al. The pleiotropic effects of vitamin D in bone. *The Journal of steroid biochemistry and molecular biology*. 2013;136:190-4.
18. Clementino MA, Gomes MC, de Almeida Pinto-Sarmiento TC, Martins CC, Granville-Garcia AF, Paiva SM. Perceived Impact of Dental Pain on the Quality of Life of Preschool Children and Their Families. *PloS one*. 2015;10(6).
19. Leghari MA. A pilot study on oral health knowledge of parents related to dental caries of their children-Karachi, Pakistan. 2012.
20. Leghari MA, Tanwir F. Dental caries prevalence and risk factors among school children age 12-15 years in Malir, Karachi. *Pakistan Oral & Dental Journal*. 2012;32(3).
21. Schroth RJ, Levi JA, Sellers EA, Friel J, Kliewer E, Moffatt ME. Vitamin D status of children with severe early childhood caries: a case-control study. *BMC pediatrics*. 2013;13(1):174.
22. Kühnisch J, Thiering E, Kratzsch J, Heinrich-Weltzien R, Hickel R, Heinrich J, et al. Elevated serum 25 (OH)-vitamin D levels are negatively correlated with molar-incisor hypomineralization. *Journal of dental research*. 2015;94(2):381-7.
23. Forrest KY, Stuhldreher WL. Prevalence and correlates of vitamin D deficiency in US adults. *Nutrition research*. 2011;31(1):48-54.
24. Mehboobali N, Iqbal SP, Iqbal MP. High prevalence of vitamin D deficiency and insufficiency in a low income peri-urban community in Karachi. *JPMA The Journal of the Pakistan Medical Association*. 2015;65(9):946-59.
25. Schroth R, Rabbani R, Loewen G, Moffatt M. Vitamin D and Dental Caries in Children. *Journal of dental research*. 2015;0022034515616335.
26. Bener A, Al Darwish MS, Hoffmann GF. Vitamin D deficiency and risk of dental caries among young children: A public health problem. *Indian Journal of Oral Sciences*. 2013;4(2):75.