

## IMPACT OF VITAMIN D ON DEVELOPMENT OF EARLY CHILDHOOD CARIES

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### ABSTRACT

**Objective:** To compare the levels of vitamin D in children with early childhood caries and children with healthy sound dentition.

**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.

**Material 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. Group 1 consisted of children suffering from dental caries and was comprised of 60 patients. Group 2 consisted of children with sound healthy teeth and was comprised of 20 children. Questions assessing children's socioeconomic background, dietary habits particularly frequency of sweet and milk intake, outdoor activity and dental hygiene related behavior were included. The diagnosis of childhood caries was based on oral health diagnostic criteria defined by World Health Organization (WHO). Overall total caries score (decayed missing filled teeth index) was obtained. Levels of 25-hydroxyvitamin D (25(OH) D) was measured from serum samples of the children participating in this study using enzyme linked immunosorbent assay (ELISA). Correlation analysis was done with Pearson correlation and t-test was applied.

**Results:** Results have established association of Vitamin D levels in children with early childhood caries. Pearson correlation and t-test have revealed that total decayed, missing, filled primary teeth (dmft) caries score was also associated with 25(OH) D concentrations less than 30ng/ml, decreased oral hygiene, lower monthly income, increased sugar consumption, decreased milk intake and decrease outdoor activities. This cross-sectional study showed that carries and lower serum vitamin D are closely related with each other.

**Conclusion:** Data from this cross-sectional study showed that dental caries and lower serum vitamin D were closely related. Improving children's vitamin D status may be an additional preventive consideration to lower the risk for caries.

**Keywords:** ECC, (Early childhood caries), vitamin D, 25OHD (25 Hydroxy vitamin D), dmft (decayed, missed, filled teeth).

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## INTRODUCTION

Vitamin D also known as calciferol is fat soluble sterol derived vitamin. It is a prohormone. Its two forms are vitamin D<sub>2</sub> and vitamin D<sub>3</sub><sup>1</sup>. Vitamin D<sub>2</sub> or ergocalciferol is derived from plants, vitamin D<sub>3</sub> or cholecalciferol is synthesized in human skin from 7-dehydrocholesterol, on exposure to ultraviolet B irradiation with wavelength 290 to 320 nm convert 7dehydrocholesterol to D<sub>3</sub><sup>2,3</sup>. Vitamin D,

in its D<sub>2</sub> or D<sub>3</sub> form, is metabolically inactive. The only difference in the structure of Vitamin D<sub>2</sub> and Vitamin D<sub>3</sub> is their side chain. This difference has no affect on metabolism and activation, and they are inactive till their activation by two hydroxylases in liver and then in kidney so that it becomes metabolically active. The form of Vitamin D that can exert biological activity is 1,25(OH)<sub>2</sub>D. It is basically a hormone obtained after hydroxylation at carbon number 25 by enzyme 25-hydroxylase in the liver to form 25-hydroxyvitamin D, followed by another hydroxylation at carbon number 1 by the enzyme 1 $\alpha$  hydroxylase to form, 1,25-dihydroxyvitamin

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D, active form vitamin D. A reliable assessment of vitamin D status is done by measuring plasma concentration of the circulating 25(OH)D<sup>2</sup>.

The accepted classification used to determine a patient's vitamin D status is that serum 25 (OH)D levels <20 ng/ml denotes deficiency: serum 25 (OH)D levels between 20-30 ng/ml denotes insufficiency: 30-44 ng/ml is considered as sufficiency, 50-70 ng/ml is considered as optimal level<sup>4,5</sup>. Prolonged vitamin D deficiency, decreases serum calcium levels and increases parathyroid hormone resulting in decreased mineralization of the collagen matrix<sup>6</sup>. Chances of having dental caries are more if the mineralization of enamel and dentin is decreased<sup>7</sup>. It has been observed in vitamin D resistant rickets that there is defective mineralization of dentine resulting in enlarged pulp chambers and dentinal defects<sup>8,9</sup>. Maternal vitamin D deficiency during periods of tooth development has affects on the tooth structure<sup>10,11</sup>. There is defective enamel formation which leads to enamel hypoplasia<sup>12</sup>. These defects in enamel increase the chances of caries causing bacteria to form their colonies resulting in early and severe caries. Dental caries is very common disease of childhood. Early Childhood Caries (ECC) is defined as increased carious lesions in incisors of the deciduous dentition of the children<sup>11</sup>. Pain and complications arising from caries are vast, quality of life is compromised<sup>13</sup>, expenses of dental treatment are also high also there are side effects and chances of secondary infections<sup>14</sup>. Nutritional and sleep problems affect growth of children<sup>15</sup>.

Vitamin D may have role in management of dental caries during childhood, most probably by increasing calcium absorption which increases serum calcium levels, also it promotes remineralization of enamel and reduces its demineralization<sup>16</sup>. This study was undertaken to assess the relationship between vitamin D and dental caries in children. To our knowledge this is the first study in Pakistan, although it is not done at a large scale but our study can be a milestone in finding cause of caries in childhood.

Some steps should be taken prophylactically to reduce caries in children.

## **MATERIAL AND METHODS**

It was a cross-sectional observational study, conducted 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 and also on the basis of WHO calculator. Simple randomized sampling technique was used for sample collection. Child patients with renal, liver, parathyroid and thyroid disorders, vitamin D and calcium supplements were not included in the study.

Child Patients taking medication that affects vitamin D metabolism such as anticonvulsant drugs were not included in the study. The extent of caries was assessed using the dmft index (a cumulative score of decayed, missing, filled primary teeth). 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. Those having a dmft score of 0 were considered caries-free and those having dmft score >4 were considered having excessive caries. Parents completed a questionnaire which revealed information about the child's milk and sugar intake, outdoor activity regarding sun exposure, oral hygiene practices, 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, Biochemistry department of IIMC Rawalpindi. Serum total 25 (OH)D of the study subjects were measured using enzyme linked immunosorbent assay (ELISA). Lab results and questionnaire data were entered into an Excel (Microsoft Office) spreadsheet and analyzed using number codes assigned to each group i.e. Likert scale. SPSS 21 was used for data processing. Analysis included descriptive statistics, frequencies, means ± standard deviations (SD), Pearson correlation and t-test. A *p*-value <0.05 was considered as significant.

**RESULTS**

Results have established association of Vitamin D levels in children with early childhood

Vitamin D and caries level (dmft) were significantly associated with each other, with 25 OH vitamin D levels child were deficient (<20ng/ml) had high caries score i.e. dmft =4 or >4, shown as yellow and magenta colors, means more decayed, carious ,missed and filled teeth. Similarly with 25 OH vitamin D levels of a adequate (>44ng/ml) had low caries score i.e. dmft <1 which was shown in blue and gray colors.

T-test has showed that childhood caries has significant association with Vitamin D levels. Statistically significant difference (*p*-value=0.001) was found in vitamin D levels of sample population with caries and without caries.

This study has showed that vitamin D

**Table-I: Frequency distribution of Vitamin D Levels in study subjects.**

Vitamin D levels ng/ml	Frequency	Percent	Mean serum vitamin D levels ng/ml
VitD Deficiency<20	42	52.5	26.8 ± 14.6
VitD Insufficiency (20-30)	13	16.3	
VitD Sufficiency (30-44)	17	21.3	
VitD Optimal (>44)	8	10.0	
Total	80	100	

**Table-II: Correlation of vitamin D with outdoor caries and no caries.**

Group on basis of Caries	N	Mean vitamin D conc. (ng/ml)	Std. Deviation	Std. Error Mean	<i>p</i> -value
No Caries	20	47.2	14.0	3.14	0.001
Caries	60	20.0	5.9	0.76	

**Table-III: Correlation of children having outdoor activities with serum vitamin D levels.**

Correlation of Variables	Outdoor Activity	Vitamin D	Caries	Significance
Outdoor Activity	1	.803**	-.738**	.000
VitD_Level	.803**	1	-.890**	.000
Caries_Level	-.738**	-.890**	1	.000

caries. A total of 80 children were selected to participate in the study and of these 43were male and 37 were female. The mean age of the patient was 5 years and 3 months with SD ± 1.3.

The mean serum vitamin D level in the study was 26.8 ± 14.6. It was found that 52% children had vitamin D deficiency, 16% children had vitamin D insufficiency, 21% children had vitamin D sufficiency and 10% children had optimal vitamin D levels (table-I).

deficiency, insufficiency and sufficiency was strongly correlated with caries score (dmft) (table-II), serum vitamin D levels between 10-20 ng/ml is associated with excessive dental caries and serum vitamin D levels above 40ng/ml was associated with healthy teeth without caries.

The correlation analysis has also revealed that there was direct correlation present between serum 25 OH vitamin D levels and outdoor activity (table-III) (figure).

Outdoor activity of children and their exposure to sunlight was also examined and it was seen that it had a beneficial effects on dental health.

Children having outdoor activities had positive correlation with serum vitamin D, whereas children having outdoor activities had reverse correlation with caries score (table-III).

The results of our study revealed statistically significant difference ( $p$ -value=0.001) of vitamin D levels in sample population with caries and without caries (population with sound dentition).

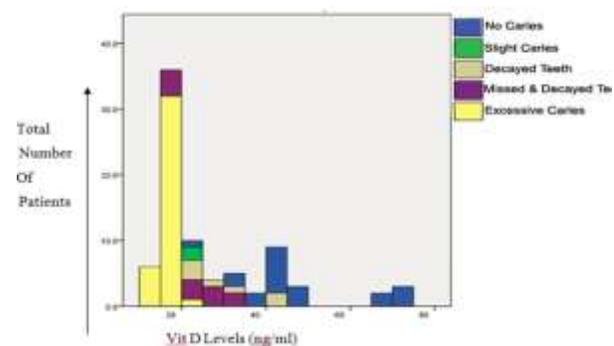
## DISCUSSION

The current study examined different aspects of early childhood caries and effect of serum vitamin D levels on extent of caries in children. Outdoor activity of children and their exposure to sunlight was also included in our study.

In a study conducted by Grant et al in 2011, It was also assumed that vitamin D deficiency and insufficiency was also due to decrease sun light exposure<sup>17</sup>, It had also been 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. A cross sectional study was conducted in Qatar over a period from August 2009 to June 2010 by Bener et al, also concluded that exposure to sun was necessary for the synthesis of vitamin D and decreased sun light exposure was responsible for vitamin D deficiency and a cause for extensive dental caries in children<sup>18</sup>. These results were similar to findings our study. A meta-analysis on role of vitamin D on the onset and progression dental caries by Hujuel 2013 showed that with vitamin D supplementation chances of dental caries were reduced to 47%. Hujuel et al had also concluded that vitamin D has topical fluoride like characteristics<sup>19</sup>. These results were in accordance with our findings. A cross-sectional study performed in Canadian schools in 2015 by Schroth et al, showed that hypovitaminosis D was closely related with extensive dental caries. The results of this study matches with our findings<sup>20</sup>. A case-control study

conducted in the city of Winnipeg, Manitoba, Canada from 2009 to 2011 by Schroth et al, concluded that statistically significant difference in vitamin D and calcium levels between children with severe dental caries and caries free children. This finding was in line with our results for children with extensive childhood caries. Nowadays sugar consumption is increased a lot in the form of sweets and chocolates and children were less aware of brushing techniques and oral hygiene practices. It was also suggested by different studies that despite of all the facts described above, decreased oral hygiene and increased consumption of sugar in diet and drinks were prominent risk factors for caries<sup>18,21</sup>.

In most of the cross-sectional, case control



**Figure: Association of vitamin D levels with caries.**

and prospective studies, vitamin D deficiency had been considered to be associated with increased risk of dental caries. It was important to note that vitamin D deficiency in individuals might result from lack of sun exposure or it might be due to malnutrition or some gene polymorphism are involved.

## CONCLUSION

Data from this cross-sectional study showed that dental caries and lower serum vitamin D were closely related. Improving children's vitamin D status may be an additional preventive consideration to lower the risk for caries.

## CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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