

Relationship between Maternal Prenatal Vitamin D Status and Early Childhood Caries in Their Children: A Cross-sectional Survey

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ABSTRACT

Background: Vitamin D deficiency in expectant mothers is very common in India. As a consequence, the possibility of hypoplasia of teeth and resultant propensity for faster progression of early childhood caries (ECC) is expected to be higher in Indian children.

Aim: This study aimed to determine the relationship between prenatal vitamin D intake of mothers and dental caries experience in their preschool children, and whether vitamin D deficiency in mothers could be a risk factor for tooth decay in their children.

Design: This cross-sectional study included 120 mothers of children aged up to 71 months with dental caries attending the Department of Pediatric Dentistry in India. Mothers were surveyed about their prenatal vitamin D intake and their practices regarding vitamin D and sunlight exposure. Children were clinically examined, and their caries status was recorded using the decayed, extracted, filled teeth (deft) index.

Results: Data were analyzed descriptively and correlated using an independent *t*-test. Binary logistic regression was employed to predict the effects of the duration of sun exposure and vitamin D deficiency on dental decay. The correlation of mothers' prenatal vitamin D intake was significantly associated weekly with children's caries experience. Their sun exposure ($p = 0.002$) and practices adopted ($p = 0.0001$) regarding vitamin D levels were statistically significant for children's caries status. Improper brushing frequency was also significantly associated with higher deft scores.

Conclusion: The association between mothers' prenatal vitamin D intake and health practices related to vitamin D with dental caries was not confirmed. Subjects with vitamin D deficiency and their children had significantly higher odds of developing dental decay. However, our findings suggest that 25-hydroxyvitamin D insufficiency may be a risk factor for developing dental caries in children.

Keywords: 25-hydroxy vitamin D, Decayed, extracted, filled teeth, Dental caries, Mothers, Vitamin D.

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INTRODUCTION

Vitamin D plays an essential role in the development of the craniofacial complex and aids in maintaining good oral health. It has been evidently studied that low levels of 25-hydroxyvitamin D affect the enamel and dentin of teeth.¹ It is also associated with periodontal disease and interdental alveolar bone loss.² Vitamin D deficiency *in utero* is associated with enamel hypoplasia due to metabolic insult to ameloblasts.³ Therefore, prenatal nutritional status directly influences the phenomenon of amelogenesis. Mostly, expecting mothers are prescribed iron, calcium, and folic acid supplements during pregnancy, which are major constituents required for the development of the fetus *in utero*. However, in a developing country like India, vitamin D deficiency in expectant mothers is very common.⁴ Therefore, the possibility of hypoplasia of teeth and resultant propensity for faster progression of early childhood caries (ECC) is expected to be higher in Indian children.⁵

Early childhood caries has been a global burden affecting younger children. Since diet plays an important role in the progression of caries, nutritional deficiencies in children or their mothers during pregnancy have been correlated with alterations in a child's oral health. Awareness of vitamin D and its effect on bones and teeth is crucial for maintaining good general as well as oral health. Furthermore, during the initial years of growth and development, children are solely dependent on their mothers for diet, nutrition, and overall well-being. Therefore, health practices and awareness levels among mothers regarding vitamin D intake

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are indispensable. Moreover, to the best of our knowledge, there is a gap in the evidence regarding the correlation between maternal vitamin D status and caries experience in young children in India. Therefore, the present study was conducted to test the null hypothesis that there is no relation between maternal prenatal vitamin D intake and the presence of ECC in preschool children.

AIM AND OBJECTIVE

To evaluate and correlate the knowledge and practices of mothers regarding prenatal intake of vitamin D and clinically

correlate the presence of ECC in their children in Faridabad, Haryana, India.

METHODOLOGY

Study Design

This study was an observational cross-sectional study conducted in the Department of Pediatric and Preventive Dentistry, Faridabad, Haryana, India, from January to July 2023.

Sample Size Estimation

Using the sample size calculator with a confidence level of 95% and a confidence interval of 9, considering the population of children <6 years of age (approximately 250,000), the sample size was computed to be 119. It was increased to 120 to ensure the representativeness of the sample.

Ethical Clearance and Consent

Ethical clearance was obtained from the Institutional Ethics Committee (SRCDSP/ACAD/2021/10452), and informed consent was obtained from all participants in the study after a detailed explanation of the study protocol.

Data Collection

A self-administered questionnaire was validated and field-tested before the main study was conducted. The questionnaire consisted of three sections; the first section included demographic data of the child and mother (occupation), history of pregnancy (normal/C-section), visit gynecologists, and maternal vitamin D intake prescribed in the first section. The next section comprised questions related to the knowledge of mothers on vitamin D—the importance of vitamin D, the source of vitamin D, normal levels of vitamin D in the blood, and complications of vitamin D deficiency. The last section comprised questions about the duration of daily sun exposure, and health practices by the mothers to improve vitamin D levels such as diet, and vitamin D supplementation. Additional data included snacking habits and brushing practices of the child.

A total of 120 mothers of children under 71 months of age were interviewed using face-to-face interviews at the Department of Pediatric Dentistry during their first dental visit. Children were orally examined for dental caries, and their status was recorded using the decayed, extracted, filled teeth (deft) index (Gruobbel AO, 1944) by a single well-trained calibrated investigator under natural daylight, using a diagnostic set comprising a mirror and dental explorer.

Addressing Potential Source of Bias

All children meeting the eligibility criteria were recruited while attending the dental clinics on the day of examination with their mothers, minimizing selection bias. Performance bias was addressed by employing standardized assessment criteria, and a well-trained, precalibrated investigator conducted the study. All data were reported to avoid reporting bias. Recall bias among mothers was minimized by recruiting only those who had written prescription records of vitamin D intake.

Statistical Analysis

Data were collected and statistically described. Parametric data were expressed as means and standard deviation, while nonparametric data were presented as numbers and percentages, respectively. The data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) Statistics for Windows version 20.0 (SPSS Inc., Chicago, Illinois). Maternal vitamin D intake and their

health practices were correlated with their child's decay status using independent *t*-tests. Values of $p \leq 0.05$ were considered statistically significant. Binary logistic regression was used to predict the effect of the duration of sun exposure and vitamin D deficiency on dental decay. Multiple linear regression tests were employed to assess the relationship of deft with other variables.

RESULTS

Out of 120 children clinically examined, 61 (50.8%) were males and 59 (49.2%) were females, with a mean age of 4.19 years. The mean deft score was 4.88 ± 3.60 . The survey included 120 mothers of children with dental caries, and their demographic details are presented in Table 1, respectively. Almost all mothers had visited their gynecologists during pregnancy and taken prescribed supplements (83.4%), such as iron and calcium. Approximately, 82.5% of mothers were exposed to sunlight daily, but only 22.5% of study subjects were exposed to sunlight for >30 minutes. Additionally, 62.5% of mothers were vitamin D deficient (according to prior history) and were prescribed vitamin D before delivery; the rest had sufficient vitamin D levels. Results of brushing frequency of children showed

Table 1: Demographic, socioeconomic, and behavioral factors

Features/variable	Number (N)	Percentage (%)
Number of children		
1	34	28.4%
2	74	61.6%
3	12	10%
History of pregnancy		
Normal	86	71.6%
C-section	34	28.4%
Occupation		
Housewife	95	79.2%
Working	23	19.1%
Student	2	1.7%
Visited gynecologist during pregnancy		
Yes	114	95%
No	6	5%
Vitamin D taken		
Yes	75	62.5%
No	45	37.5%
Other supplements		
Yes	100	83.4%
No	20	16.6%
Exposure to sunlight		
Yes	75	82.5%
No	45	17.5%
<30 minutes	58	48.3%
About 30 minutes	35	29.2%
>30 minutes	27	22.5%
Brushing frequency		
Once	100	83.3%
Twice	20	16.7%
Midday snacking		
Yes	68	56.6%
No	52	43.4%

that the majority brushed once daily (83.3%). Approximately, 56.6% of children consumed midday snacks at school.

The correlation of mothers' vitamin D status with the dental caries experience of their children was not significant ($p = 0.193$). However, children of mothers with insufficient vitamin D₃ levels showed significantly higher deft scores (6.8 ± 2.76) compared to those with sufficient levels (3.06 ± 2.34) ($p < 0.0001$). There was a significant relationship between brushing frequency; brushing once daily was associated with higher deft scores ($p = 0.023$). Midday snacking practices were found to be insignificant. The correlation of health practices related to vitamin D status with dental caries was highly significant ($p = 0.0001$), and lesser exposure to sun was also significant ($p = 0.002$) (Table 2). According to the binary logistic regression test, subjects with vitamin D deficiency had significantly higher odds of developing dental decay in their children (Table 3).

A multiple linear regression model was used to predict caries level (deft level) from maternal vitamin D and other assessed factors. Linearity was confirmed through partial regression plot tests and studentized residuals plotted against predicted values. The overall study model was significant ($p = 0.006$); however, maternal vitamin D levels could not be significantly associated with caries experience ($p = 0.51$).

DISCUSSION

The early childhood period is crucial for a child's overall growth and development. Their growth is largely dependent on their nutritional status and overall activities. However, their diet and their mother's diet during pregnancy significantly affect both their general health and their oral health. Moreover, it has been proven that nutritional deficiencies can lead to altered oral health status, resulting in decay and changes in the periodontium.^{6,7} Usually, during pregnancy, expecting mothers are prescribed supplements such as iron, folic

acid, and calcium. However, vitamin D, which is crucial for the absorption of calcium in the body, is not typically included in the regular prescription regimen for pregnant females in India. Vitamin D plays a role in tooth formation, and its deficiency can lead to enamel hypoplasia and dental caries. Additionally, it promotes the release of peptides, cathelicidin, and defensins in the oral cavity, which exert cariostatic properties.⁸ Hypovitaminosis D is a prevalent condition affecting all age-groups. When vitamin D deficiency is suspected as an underlying factor for early decay in young children, evaluating the knowledge about vitamin D intake and health practices of mothers and their children becomes pivotal. Testing blood vitamin D₃ levels is quite invasive and discomforting in young children; therefore, prenatal intake of vitamin D by mothers or their children after birth was considered an indicator to evaluate its correlation with ECC.

In the present study, the effect of various variables was evaluated and correlated with dental caries experience in young children. However, an insignificant relationship was found between the vitamin D status of mothers and caries in their children up to the age of 6 years through multiple linear regression analysis, thus proving the assumed null hypothesis. Similar results were found in a study conducted on 51 Egyptian children aged three to 5 years with diagnosed insufficient vitamin D levels and their mothers' status.⁹ (Ref: El Shiekh and Hanafy, BMC Oral Health (2023) 23:374. <https://doi.org/10.1186/s12903-023-03065-0>) Binary logistic regression tests predicted higher odds of developing dental decay in children with mothers who had deficient vitamin D and less exposure to sun.

In the present study, the mean deft score in 120 children was 4.88, which was lower (about 2.47) in a study conducted by Schroth et al. However, a significant correlation was established with low vitamin D serum levels in this study.¹⁰ Another study conducted by Chhonkar et al. reported a higher mean deft score of 8.46 in 30 children compared to our study, along with a significant association with low serum vitamin D levels.⁵ Moreover, higher deft scores were found in children with vitamin D deficient mothers and the results were concurrent with studies conducted by Chen et al.¹¹ and Schroth et al.¹² which concluded higher vitamin D levels in caries-free children. On the contrary, Beckett et al. concluded insufficient maternal vitamin D levels in the third trimester of pregnancy were significantly associated with greater caries experience in deciduous dentition.¹³ Our insignificant results might have been due to the limited sample size.

Most of the mothers were exposed to the sun daily, but half of the participants were exposed for <30 minutes and failed to identify the best time for sun exposure. Less sun exposure may be attributed to sedentary lifestyles, lack of exercise, and busy work schedules. Similar results were found in a study conducted by Fuleihan, which suggested limited sun exposure due to cultural practices, hot climatic conditions, and darkly pigmented skin, which reduces the absorption of vitamin D.¹⁴ In the current study, a lesser duration of sun exposure by mothers was significantly correlated with a higher deft status in children. While no specific studies on maternal exposure to sunlight have been conducted, countries with lower sunshine exposure have reported higher incidences of dental caries.¹⁵ Health practices improving vitamin D status in mothers were also found to be significant in relation to mean caries experience in children. Similarly, health practices related to vitamin D intake were evaluated in 166 women (aged 35–65 years) in Riyadh, Saudi Arabia, where only 29.5% of them took vitamin D supplements.¹⁶ In another study, young women in Riyadh were evaluated for the risk of osteopenia and osteoporosis. They were found to have a diet low in vitamin D, especially with

Table 2: Association and correlation of mean dental caries of children with caries indicators in mothers. All values are presented as values in decimals. One-way ANOVA $p < 0.05$ statistically significant

Caries indicators	Mean deft <i>p</i> -value
Maternal vitamin D status	0.193
Brushing frequency	0.023*
Midday snacking	0.089
Daily sun exposure	0.071
Duration of sunlight	0.002*
Health practices that you would want to apply to manage your/your child's vitamin D	0.0001*

*Significant at $p < 0.05$

Table 3: Binary logistic regression to predict the effect of duration of exposure to sun and vitamin D deficiency on dental decay

	<i>B</i>	Standard error	Wald	Degree of freedom	<i>p</i> -value	Odds ratio
Duration of exposure to sun	−0.107	0.426	0.063	1	0.802	0.899
Maternal vitamin D status	−1.447	0.670	4.672	1	0.031	0.235
Constant	−1.367	0.905	2.283	1	0.131	0.255

less fish intake and a higher reliance on energy-dense fast food, reflective of modern lifestyle habits. Similarly, mothers in our study also consumed a diet lower in vitamin D, largely due to religious sentiments and unawareness of the essentiality of vitamin D.¹⁷ Similar results were obtained by Selim et al., where only 46% of mothers had good practices toward vitamin D and its supplementation.¹⁸ Olczak-Kowalczyk et al. conducted a questionnaire-based study and determined the association between parental-reported vitamin D supplementation and ECC in a younger child population in Poland. They found significantly lower decayed, missing, filled teeth/surfaces scores in children with vitamin D supplementation, suggesting a possible relation between caries and vitamin D.¹⁹

In-between snacking and consumption of refined foods have been associated with greater caries experience in primary as well as permanent dentition. However, in the current study, an insignificant association was found between midday snacking and dental caries experience, possibly due to the smaller sample size in the study. Lesser brushing frequency in children has been linked to plaque accumulation and caries occurrence, consistent with findings in the present study. Similar results were observed in 336 children with improper brushing, where it was concluded that the relative risk (RR) for caries was significantly increased for those brushing less than twice daily at ages 2 and 3 years in Sweden.²⁰

Limitations

The present study was a preliminary cross-sectional study with a smaller sample size, limiting conclusive interpretations regarding the causal relationship of low vitamin D intake with ECC. Many confounding factors, such as dietary habits of children, socioeconomic status, level of education, and oral hygiene measures, known to contribute to dental caries, were addressed in the current study. Additionally, the caregiver questionnaire involved mothers providing retrospective answers about their pregnancy and childbirth, subject to recall and response bias. However, only sample subjects with written prescriptions were considered.

CONCLUSION

In conclusion, confirming the association between mothers' knowledge and health practices regarding vitamin D with dental caries experience in their children proved challenging. However, our findings suggest that 25-hydroxy vitamin D insufficiency may be linked to dental caries. Therefore, prenatal intake of vitamin D by expecting mothers should be considered for inclusion in general health guidelines by policymakers. Additionally, variables such as brushing practices and exposure to sun were correlated with caries experience.

Clinical Significance

To the best of our knowledge, no data is available assessing the correlation between prenatal intake of vitamin D by mothers during pregnancy and ECC in their children. Thus, this study was planned with the objective to evaluate any such correlation in a noninvasive manner. Exposure to sun affects the vitamin D status of mothers and may also influence the caries experience of young children. Nutritional supplements and health practices play an important role in reducing dental caries in primary dentition.

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