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Maternal malnutrition of calcium in last second trimester pregnancy affecting early childhood caries

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Abstract

Background: Calcium is essential for muscle contraction, bone formation and enzyme/hormone functioning, and deficiency during pregnancy can have an impact on oral health, such as early childhood caries.

Purpose: To provide an overview of the effect of calcium malnutrition in last second trimester pregnancy in order to educate people about the malnutrition affecting early childhood caries.

Materials and Methods: This research is a literature review of up to 20 journals on the subject from different sources. Review or progress articles that were published in these journals between 2013 and 2023 were chosen.

Results: The electronic search through databases and the manual search through literature allowed us to identify some journals that support the criteria. The included studies evaluated the relationship between early childhood caries with calcium intake or vitamin D supplementation.

Conclusion: Early childhood caries are affected by calcium intake during pregnancy. Deficiency of micronutrients, either calcium or other associated such as vitamin D, especially at the second last trimester, increase in the risk of developing dental caries in comparison with children whose mothers were in the balance diet group.

Keywords: Pregnancy; Calcium malnutrition; Childhood caries; Second trimester

1. Introduction

Early childhood caries (ECC) is the term used to describe caries found in young children's primary "milk" teeth. Despite tremendous improvements in preventative dentistry, ECC still has a substantial worldwide impact on young people. ECC is one of the most prevalent chronic illnesses among children and is more prevalent in low-income, underprivileged, and minority populations [10]. Early childhood caries (ECC) is a significant dental health issue, particularly in socially disadvantaged groups. Worldwide, ECC has an impact on young children in preschool. The incidence of ECC varies depending on the population being studied, and among underprivileged groups, a frequency of up to 85% has been documented. When a kid is 71 months old (5 years) or younger, they have one or more primary teeth that are decaying, missing, or filled. White-spot lesions along the gingival border of the upper primary incisors signal the onset of the condition. If the condition persists, caries may advance and cause the crown's destruction. Microbiological, nutritional, and environmental risk factors can be classified as critical risk factors for the development of ECC. Although it is largely preventable, ECC is still one of the most prevalent childhood illnesses. Inappropriate food patterns, familial socioeconomic status, a lack of parental knowledge, and a lack of access to dental care are the leading causes of the high

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frequency of ECC. Children's oral health is crucial for maintaining oral functions, which are necessary for feeding, speech development, and a healthy self-image. ECC is a severe health condition found among children living in socially disadvantaged communities in which malnutrition is a social and health disparity [2].

Micronutrients are described as dietary components that are necessary for human health but only in trace levels. They consist of all recognized vitamins and necessary trace elements. One-third to fifty percent of people worldwide suffer from micronutrient deficiency. In terms of untapped human potential and lost economic production, it imposes enormous costs on society and creates immeasurable pain levels in individuals. Lack of access to a range of foods significantly contributes to micronutrient deficiency in low-income communities. People rely on cheap sources of calories, including grains and tubers, to satisfy their energy needs when their salaries are low [8]. Malnutrition has pre- and post-eruptive effects and is known to produce significant morbidities. Based on WHO standards for malnutrition, underweight, overweight, obesity, stunted growth, and wasting can all be signs of malnutrition in children. Dental comorbidities have been connected to malnutrition and its variations. For instance, obesity and dental cavities have been connected to hypomineralization and stunted development, respectively.

Additionally, the co-existence of these dental disorders is possible. An illness with multiple causes is dental caries. Dietary composition, dental hygiene, socioeconomic status, bacterial load, salivary immunoglobulin levels, and fluoride consumption are potential risk factors for developing this illness. It has been identified as the one chronic condition that affects children the most frequently [3].

Maternal malnutrition is frequent in underdeveloped countries and has negative consequences for both the mother and the newborn. Nutritional health prior to pregnancy and weight increase during pregnancy are linked to fetal growth and development. Malnutrition during pregnancy is common in low-income women in the developing world due to insufficient dietary intake combined with increased nutrient requirements; the potential for complications for the mother and child in this at-risk population is manifested in increased maternal and infant mortality as well as lifelong effects of fetal malnutrition [9]. Maternal and neonatal health, as well as nutrition status, are important markers of disease burden. Calcium is the most prevalent mineral in the body and is required for a wide range of processes and reactions, including muscular contraction, bone production, and enzyme and hormone activity. Calcium in extracellular fluid maintains its physiologic balance in three forms: ionic, protein-bound, and complex [7].

The best way to feed a baby is through breastfeeding, which has advantages for everyone involved, including women, babies, the environment, the economy, and society. The World Health Organization (WHO) and other international health organizations advise exclusively breastfeeding for six months following delivery. It is also advised that breastfeeding be continued for at least two years while consuming complementary foods that are nutritionally adequate [1]. The body's calcium metabolism alters during breastfeeding to provide an adequate supply of this mineral [6]. The research on newborn nutrition as a risk factor for dental caries is mixed. The carbohydrate content of breast milk or formula and variables determining the length of contact between breast milk or formula and the erupted teeth are linked to the incidence of dental caries. Early and extensive oral colonization by cariogenic bacteria is linked to increased caries risk.

In contrast to formula, breast milk includes Lactobacilli exclusive to the breast and proteins, such as human casein and secretory IgA, that prevent the development and adherence of cariogenic bacteria, notably oral Streptococci. The risk of dental caries also depends on the number of teeth and increases as the number of teeth increases. The risk increases when the infant's diet begins to incorporate foods and beverages other than breast milk or formula, depending on the new diet's carbohydrate content, acidity, and frequency of intake [20].

This journal aims to understand more about how early childhood caries can be affected by calcium deficiency during a mother's pregnancy in the second trimester.

2. Material and methods

We researched up to 20 journals on this topic from various sources. Reviews and progress papers from these journals published between 2013 and 2023 were selected. All ratings were evaluated against a few criteria and steps from available information integration standards. Are the specific objectives of the evaluation stated? Were the sources and methodology of the citation search disclosed? Did the inclusion and exclusion of specific material in the review follow any guidelines? Has the methodological validity of the review data been assessed? Has the data limitations and discrepancies been accounted for, and has the information been aggregated systematically? Was the information aggregated, weighted, or measured? Relevant studies Are summaries of results provided? Are specific guidelines recommended for new research initiatives?

3. Results

Table 1 Relationship between Maternal Dairy Product Consumption during Pregnancy, Calcium intake, and the Risk of Early Childhood Caries

Variable	Tertile of Intake				
		1	**2**	**3**	**P for trend**
Total Dairy Products	Intake (g/day)[1]	82.0	171.0	264.6	
	Range	72.8 – 122.2	122.3 – 204.7	204.8 – 582.7	
	Risk	31/105 (29.5 %)	21/105 (20.0 %)	22/105 (21.0 %)	
	Crude OR (95 % CI)[2]	1.00	0.60 (0.31, 1.12)	0.63 (0.33, 1.18)	0.15
Milk	Adjusted OR (95 % CI)[3]	1.00	0.58 (0.28, 1.18)	0.51 (0.23, 1.09)	0.08
	Intake (g/day)[1]	31.6	123.4	182.7	
	Range	8.2 – 80.1	80.2 – 153.8	153.9 – 468.0	
	Risk	28/105 (26.7 %)	23/105 (21.9 %)	23/105 (21.9 %)	
	Crude OR (95 % CI)[2]	1.00	0.77 (0.41, 1.45)	0.77 (0.41, 1.45)	0.39
Yogurt	Adjusted OR (95 % CI)[3]	1.00	0.74 (0.36, 1.49)	0.64 (0.29, 1.37)	0.23
	Intake (g/day)[1]	7.9	36.6	90.1	
	Range	1.43 – 17.8	17.9 – 62.3	62.4 – 167.5	
	Risk	29/105 (27.6 %)	25/105 (23.8 %)	20/105 (19.1 %)	
	Crude OR (95 % CI)[2]	1.00	0.82 (0.44, 1.52)	0.62 (0.32, 1.17)	0.15
Cheese	Adjusted OR (95 % CI)[3]	1.00	0.97 (0.47, 1.99)	0.51 (0.23, 1.10)	0.07
	Intake (g/day)[1]	0.5	3.5	10.1	
	Range	-7.7 – 2.1	2.2 – 4.8	4.9 – 90.4	
	Risk	37/105 (35.2 %)	22/105 (21.0 %)	15/105 (14.3 %)	
	Crude OR (95 % CI)[2]	1.00	0.49 (0.26, 0.90)	0.31 (0.15, 0.59)	0.001
Calcium	Adjusted OR (95 % CI)[3]	1.00	0.56 (0.27, 1.14)	0.37 (0.17, 0.76)	0.01
	Intake (mg/day)[1]	408.1	533.4	690.3	
	Range	95.9 – 476.6	476.7 – 607.4	607.5 – 1221.6	
	Risk	31/105 (29.5 %)	22/105 (21.0 %)	21/105 (20.0 %)	
	Crude OR (95 % CI)[2]	1.00	0.63 (0.33, 1.18)	0.60 (0.31, 1.10)	0.12
	Adjusted OR (95 % CI)[3]	1.00	0.65 (0.31, 1.31)	0.50 (0.23, 1.07)	0.08

[1] Median intake in each tertile; [2] Crude OR and 95 % CI were obtained using unadjusted logistic regression; [3] Adjusted OR and 95 % CI were obtained using logistic regression adjusted for maternal calcium intake during pregnancy.

A study was carried out in controlling maternal dairy products such as yogurt and cheese intake during pregnancy as a sign to relating association calcium maternal intake and the risk of early childhood caries. After accounting for maternal calcium intake during pregnancy, the inverse relationship between maternal cheese consumption and the risk of childhood dental caries remained essentially unchanged in this analysis: the additional adjusted ORs from the lowest intake tertile to the highest were 1.00 (reference), 0.57 (95 % CI: 0.27-1.16), and 0.40 (0.18-0.86), respectively (P for trend = 0.03). However, a further adjustment for maternal calcium intake attenuated the marginally significant inverse associations between consumption of total dairy products and yogurt in the highest tertile and the risk of dental caries in children. The additional adjusted ORs were 0.58 (95 % CI: 0.19-1.70, P for trend = 0.33) and 0.58 (95 % CI: 0.25-1.32, P for trend = 0.18), respectively [9][19].

Table 2 Effects of Calcium Supplementation during Pregnancy on Primary and Secondary Outcomes Related to Dental Health in Children

Outcomes	Calcium Supplementation (n = 98)	Placebo (n = 97)	RR (95% CI)	p-Value
Primary outcome				
Children with at least one decayed, missing, or filled teeth in the permanent and primary teeth (DMFT/dmft)	62 (63.3 %)	84 (86.6 %)	0.73 (0.62, 0.87)	<0.001
Number of decayed, missing, or filled surfaces in the permanent and primary teeth (DMFS/dmfs)	3.1 (4.05)[a]	4.4 (4.11)[a]	0.67 (0.57, 0.79)[b]	<0.001
Secondary outcomes				
Children with at least one decayed, missing, or filled teeth in the permanent teeth (DMFT)	59 (60.2 %)	79 (81.4 %)	0.73 (0.61, 0.89)	<0.001
Children with at least one decayed, missing, or filled teeth in the primary teeth (dmft)	11 (11.2 %)	14 (14.4 %)	0.78 (0.37, 1.63)	0.530
Children with erupted permanent second molars	42 (42.9 %)	45 (46.4 %)	0.92 (0.68, 1.26)	0.620
Children with mixed dentition	25 (25.5 %)	27 (27.8 %)	0.92 (0.58, 1.46)	0.714
Children with enamel hypoplasia	26 (26.5 %)	22 (22.7 %)	1.17 (0.71, 1.91)	0.532

[a] Mean (Standard Deviation); [b] Risk ratio (RR) calculated using adjusted analysis.

It displays the results of the primary and secondary outcomes. The proportion of children with at least one DMFT/dmft was statistically different in the group whose mother took calcium supplementation (63.3%) compared to those whose mother was in the placebo group (86.6%). The children whose mothers received the intervention had a 27% reduction in the risk of developing at least one DMFT/dmft (RR: 0.73, CI 95%: [0.62; 0.87]). The average number of DMFS/ dmfs per child was 4.4 in the placebo group and 3.1 in the intervention group. The multilevel analysis that considered the surface of the teeth as the unit of analysis shows a reduction of 33% (OR: 0.67, CI 95%: [0.57; 0.79]). Concerning the secondary outcomes, an intervention effect was seen in the proportion of children with at least one DMFT (60.2 and 81.4% in the calcium supplementation and placebo group, respectively; $p < 0.001$). No significant differences between groups were seen in the proportion of children with at least one dmft, with erupted permanent second molars, with mixed dentition, and with enamel hypoplasia [5] [9] [19].

4. Discussion

Micronutrients help our body to yield hormones, enzymes, and other essential substances necessary for proper growth and development. Calcium deficiency poses a significant threat to the health and development of the population. This fulfills between 6 until 12 months' children half of their energy and a third of their energy needs between 12 and 24 months. Breast milk is also an essential energy source and nutrient during illness, reducing mortality in malnourished children.

UNICEF claimed that one solution to make interventions aimed at benefiting mothers and other nutritionally at-risk women has enough calcium intake during pregnancy. Women must lift their essential nutrient intake in their dietary requirements in the maternal period to support changes in tissue development, metabolism, and fetal growth. Those essential nutrients are protein, vitamins, and minerals such as iron, folic acid, and calcium. Compared to the non-pregnancy woman, with pre-pregnancy, energy requirements increase by an average of 300 kcal/day during pregnancy with daily calcium supplementation (1.5–2.0 g of oral elemental calcium/day) [21].

Initial research suggests that a higher maternal intake of calcium-rich cheese, yogurt, and milk during pregnancy is associated with a lower risk of tooth decay in children [19]. These three of her foods—cheese, yogurt, and milk—are called dairy products in this study. However, there was no clear association between breast milk intake and childhood dental caries risk. This study showed a possible inverse relationship in pregnancy calcium intake and dental caries in children. Food and nutrient intake levels are highly correlated between mothers and children. Therefore, in the present study, dairy intake during pregnancy probably has little to do with the frequency of dairy intake by children.

Improper diet may lead to premature birth, low birth weight, anemia, cardiovascular diseases, hypertension, diabetes, obesity, intrauterine growth inhibition, morphological changes in the kidneys, high risk of metabolic syndrome in adulthood, as well as abnormal neurogenesis (abnormal brain development, neural tube defects, abnormal development of the skeletal system). A pregnancy diet refers to the well-balanced nutritional status of a woman both before conception and during pregnancy has an impact on the development and future health of the child. A well-balanced diet in caries prevention is not limited to the choice of appropriate nutrients but is also associated with the way of consumption (food consistency, frequency of meals). Those are aiming to avoid nutrient deficiency. A well-balanced diet shapes the child's future dietary habits as taste receptors develop at month 4 of pregnancy (2nd last trimester). High maternal intake of confectionery during this period may, in the future, increase the child's tendency to consume sweet food products [7].

Chronic diseases in adulthood are the implications of events during or immediately after birth. This leads us to understand how the mother's nutritional status before and during pregnancy plays a vital role in determining the weight and height of the later-born baby and the subsequent dietary status of the child. The link between early-life health and chronic disease also applies to dental and oral diseases, especially tooth decay. Teeth are the most essential and crucial mineralized body structures, but their formation depends on the influence of fetal diet and metabolism immediately after birth. During pregnancy, maternal health is as important as the continuity of tooth formation [4].

Various studies have shown a significant association between the nutritional history of pregnant women and dental caries in children. Pregnant women who give birth to malnourished children are 7.1 times more likely to develop tooth decay in childhood. Some studies have also shown that children with low birth weight are at a higher risk of developing caries in their deciduous teeth earlier in life than children of average weight due to abnormal calcification of teeth during formation. [8].

The process of tooth mineralization begins after the first trimester. This is the critical stage when the enamel matrix forms a complex network in the deciduous tooth structure. Macronutrients and micronutrients play a role here, so deficiencies lead to changes in tooth structure. For example, calcium is essential in maintaining epithelial cell integrity and differentiation. Calcium deficiency in late pregnancy affects the activity of ameloblasts, which form tooth enamel. Vitamin D plays a closely related role in growth. This means that it is essential in the processes of the immune system through the metabolism of calcium and phosphorus, which are very important for teeth and bones [17]. The deciduous matrix is attached prenatally via calcium and phosphate metabolism. Deficiencies in some of these micronutrients compromise the integrity of fetal teeth. Thus, the combination of prenatal vitamin D intake and calcium can predict the development of dental caries in early childhood. Pregnant women with higher calcium intake were associated with lower caries risk in children ($p = 0.03$).

Based on the review, increasing maternal intake of vitamin D, dairy products, and other calcium sources after the first trimester of pregnancy is essential in reducing the risk of caries in children [10]. The risk of early childhood caries is lifted in the case of maternal vitamin D deficiency, the minimum of calcium supplementation, and a diet rich in fatty acids and carbohydrates.

5. Conclusion

Early childhood caries are affected by calcium intake during pregnancy. Deficiency of micronutrients, either calcium or other associated such as vitamin D, especially at the second last trimester, increase in the risk of developing dental caries in comparison with children whose mothers were in the balanced diet group.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this document.

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