Pesquisa Brasileira em Odontopediatria e Clínica Integrada
ISSN: 1519-0501
apesb@terra.com.br
Universidade Estadual da Paraíba
Brasil

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Pesquisa Brasileira em Odontopediatria e Clínica Integrada, vol. 15, núm. 1, 2015
Universidade Estadual da Paraíba
Paraíba, Brasil

Brazilian Research in Pediatric Dentistry and Integrated Clinic 2015, 15(1):131-142
DOI: http://dx.doi.org/10.4034/PBOCI.2015.151.15
ISSN 1519-0501

Original Article

No Impact of Lower Intake of Micronutrients on Severe Early Childhood Caries: Findings from a Prospective Cohort Study

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Academic Editors: Alessandro Leite Cavalcanti and Wilton Wilney Nascimento Padilha

Received: 10 October 2014 / Accepted: 29 April 2015 / Published: 05 June 2015

Abstract

Objective: To investigate the association between micronutrients intake at 12 months of age and the occurrence of severe early childhood caries (S-ECC) at four years of age among children in southern Brazil. **Material and Methods:** The baseline sample was made up of 500 mother-child pairs followed since the birth of the child in São Leopoldo, Brazil. After the first birthday, micronutrients intake (calcium, iron, sodium, zinc, vitamin A, vitamin C, vitamin B12 and folate) was recorded using the 24-hour recall method. At four years of age, a calibrated examiner evaluated the occurrence of S-ECC based on internationally accepted criteria. Poisson regression was used to investigate associations between exposures and the outcome. **Results:** The final sample comprised 314 children. The occurrence of S-ECC was higher among children who consumed less calcium (p=0.009), zinc (p=0.021) and vitamin C (p=0.036). However, after the multivariable adjustments, no micronutrient was associated with the occurrence of S-ECC. **Conclusion:** A lower intake of micronutrients at 12 months of age did not represent a risk factor for the occurrence of S-ECC at four years of age, suggesting that advice on feeding practices for dental caries prevention should focus mainly on dietary aspects (local effect) rather than nutritional aspects (systemic effect).

Keywords: Dental Caries; Risk Factors; Micronutrients.

Introduction

Early childhood caries is highly prevalent throughout the world and is related to pain, difficulty chewing, speech problems, gastrointestinal disorders, psychological problems, high treatment costs and even the need for hospitalization [1,2]. Recent investigations employing validated assessment tools have demonstrated the impact of this adverse oral condition on the quality of life of children and their families [3,4].

Caries prevention strategies should be based on knowledge regarding the network of causality. Although the scientific literature stresses the role of cariogenic dietary practices [5], few longitudinal studies have addressed the definition of specific orientations regarding nutritional aspects that may exert an influence on the occurrence of dental caries [1]. Moreover, divergent opinions are found on the association between micronutrient intake and early childhood caries. While some studies have found no such association, others suggest that micronutrients have a cariostatic effect and others suggest a cariogenic effect [6-13]. However, the majority of these findings come from animal studies or investigations involving human subjects using a cross-sectional design.

Considering the established relationship in the scientific literature between micronutrient deficiencies and different adverse health conditions in childhood [14], the clarification of this issue in studies with adequate methodological quality can contribute to the improvement of child health promotion guidelines and protocols. Indeed, the establishment of guidelines that integrate general and oral health has been one of the goals of the World Health Organization since the beginning of the century [15].

The aim of the present study was to investigate the association between micronutrient intake at 12 months of age and the occurrence of severe early childhood caries (S-ECC) at four years of age among children in southern Brazil.

Material and Methods

Subjects and Study Design

The present cohort study was nested in a randomized field trial involving 500 children recruited at birth in the São Leopoldo Municipal Hospital in southern Brazil. The larger project consisted of two components: (a) the evaluation of the effectiveness of nutritional intervention regarding a reduction in the rates of anemia, diarrhea, symptoms of respiratory disorders, low weight for age and dental caries at 12 months and four years of age; and (b) the investigation of risk factors for general and oral health outcomes.

The city of São Leopoldo has a population of approximately 200,000 inhabitants, nearly all of whom have access to fluoridated water (0.7 ppm). Subsequent the birth of children between October 2001 and June 2002, all mothers who had a full-term pregnancy (> 37 weeks), no impediment to breastfeeding (HIV/AIDS), who had children with a normal birth weight (≥ 2500 g) and no congenital malformations were asked to participate in the study. The intervention consisted of orientations to mothers through 10 home visits in the first year of the child's life contained in the

"Ten Steps for Healthy Feeding: A Dietary Guide for Children under Two Years of Age", developed through an initiative of the Brazilian Health Ministry and Pan American Health Organization [16]. Further details on the methodology and outcomes, including dietary practices in the first year of life that represent risk factors for the occurrence of caries at four years of age, have been published elsewhere [5,17].

The present study investigated the association between micronutrient intake at 12 months of age and the occurrence of S-ECC at four years of age. Socioeconomic variables and data on cariogenic dietary practices were investigated as confounding factors in the establishment of the association between micronutrient intake and the outcome.

The calculation of the sample size necessary to identify cariogenic dietary habits associated with S-ECC determined the need to examine at least 233 four-year-old children. Considering an 80% power and 95% confidence level, the sample size allowed detecting a relative risk of 1.5 among exposed (lesser micronutrient intake) and non-exposed (greater micronutrient intake) children.

Socioeconomic Data, Dietary Practices and Oral Hygiene – Confounding Variables

Postgraduate students in nutrition who were not involved in the intervention held face-to-face interviews with the mothers at their homes when the children were six and 12 months of age. Socioeconomic variables (mother's schooling, household income and mother's and father's occupation) were investigated when the child was six months of age. Dietary habits were evaluated at both six and 12 months of age through structured interviews addressing the duration and frequency of dietary habits in the previous six months. Data on breastfeeding, bottle feeding, frequency and composition of complementary foods as well as the use of sugar, honey, soft drinks, cookies, chocolate and other foods were collected for each month separately. Oral hygiene practices were recorded on the questionnaire administered at 12 months of age, on which the mother was asked if and how often she brushed her child's teeth.

Micronutrients Intake – Exposure Variables

At 12 months, a 24-hour recall method was employed to determine the intake of different micronutrients, which were considered the exposure variables of the study. The mothers were asked about all foods and drinks consumed by the child in the previous day. The interviewer asked for details on the types of food, amounts, brand names and modes of preparation. At the end of the interview, a detailed review was made of all foods reported for the correction of any mistaken or forgotten information. The portions consumed were determined using household measures (cup, soup spoon, tea spoon) with the aid of a photo album created specifically for the present study containing images of utensils and foods. The nutrition calculation based on food intake was performed using the NutWin, version 1.5, and complemented with food composition tables. Micronutrient intake (calcium, sodium, iron, zinc, folate and vitamins A, B12 and C) was then calculated.

The questionnaires were tested in a pilot study involving 16 mothers of children between six and 12 months of age who sought primary healthcare services and who did not comprise the sample of this study. Only the sequence of questions was modified after the pilot study. To ensure the methodological quality of the data collection, the field researchers were submitted to a) a 12-hour training program involving simulated questions and answers using a standardized questionnaire and the 24-hour recall method; b) blinded to the allocation of each child (intervention or control group); and c) supervisions during the fieldwork and verification of the data by an experienced nutritionist.

Severe Early Childhood Caries - Outcome

At four years of age, a single examiner (specialist in Pediatric Dentistry) who had undergone a training and calibration exercise performed the clinical dental exam of the children. The teeth were first brushed and dried with gauze and each surface was inspected with the aid of a mouth mirror. The outcome was the occurrence of S-ECC as defined by the National Institute of Dental and Craniofacial Research [18]: one or more decayed (cavitated lesion), filled or missing surfaces on anterior teeth or dmft index (including non-cavitated lesions) equal to or greater than 5. The examiner was blinded to the independent variables. Reliability was previously determined on two exams of 20 children aged three to five years (Kappa coefficient = 0.90).

Statistical Analysis

Data analysis was performed using PASW program, version 17.0. Absolute and percentage frequencies of the exposure variables and outcome were determined. The intake of each nutrient was categorized in quartiles to calculate the effect of differences in micronutrient intake on the occurrence of S-ECC. The chi-square test was used to determine associations between the independent variables and outcome (significance level: $p<0.05$). Simple and multivariate Poisson regression analyses with robust variance were performed, with the calculation of relative risk (RR) and 95% confidence interval (CI). The backward stepwise procedure was used to select covariates.

In the multivariate analysis, different models were generated to test the influence of confounding variables. Socioeconomic status (mother's schooling) and dietary practices at 12 months (breastfeeding frequency, number of meals per day, use of a bottle for juice and consumption of foods with a high sugar content) were incorporated into the multivariate models since they were previously identified as associated with the occurrence of S-ECC in the sample [5]. Hygiene practices at 12 months of age were also incorporated into the models. Considering the strong magnitude of the association identified between frequency of breastfeeding and S-ECC, a stratified analysis was performed to investigate the association between micronutrient intake and S-ECC separately for children who were still breastfed at 12 months and those who were not (chi-square test). The level of significance was set to 5% ($p < 0.05$).

Ethical Considerations

This study received approval from the Human Research Ethics Committee of the Universidade Federal de Ciências da Saúde de Porto Alegre (Brazil) and was carried out in compliance with Resolution 196/96 of the Brazilian National Health Board (Process number: 200245 and 200286). All parents/guardians received an explanation of the intervention in all phases of the data collection process and signed a statement of informed consent authorizing the participation of their children.

Results

Complete data on micronutrient intake at 12 months of age were obtained from 370 children and oral examinations at four years of age were carried out in 314 of them; clinical data from 56 were not available because they did not attend clinical examination. Age at the time of examination ranged from 48 to 53 months (mean 50.4; SD 1.7); 58.3% were boys; maternal education ranged from 1 to 13 years, with 71.0% of mothers having 8 or fewer years of formal education; 78.5% of families earned a per capita income below the national minimum wage.

Table 1 displays the distribution of micronutrient intake at 12 months of age, demonstrating considerable variation among the children, especially with regard to vitamins A and B12.

Table 1. Distribution of daily micronutrient intake at 12 months in sample (São Leopoldo, 2007).

Micronutrients	Median	(P25-P75)	Mean	(SD)
Calcium (mg)	687.7	(222.8-1.043.2)	693.5	(497.2)
Iron (mg)	4.2	(3.0-6.1)	4.8	(2.6)
Sodium (mg)	619.2	(385.6-878.1)	685.1	(436.5)
Zinc (mg)	3.9	(2.7-5.7)	4.3	(2.4)
Vitamin A (mcg)	284.3	(140.9-643.8)	598.5	(1,006.6)
Vitamin C (mg)	26.5	(11.6-52.3)	37.7	(37.5)
Vitamin B12 (mg)	2.0	(0.5-3.2)	3.2	(8.2)
Folate (mcg)	66.8	(44.0-99.7)	81.5	(68.0)

The prevalence of S-ECC at four years of age was 36.3% (114/314). The dmft index ranged from 0 to 18 (mean: 2.0; standard deviation: 3.2; median 0; P25-P75: 0 to 3. In the crude model (Table 2), the risk of S-ECC at four years of age was significantly greater among children with a lower intake of calcium ($p = 0.009$), zinc ($p = 0.021$) and vitamin C ($p = 0.036$). No other micronutrients were associated with the outcome.

After adjusting for breastfeeding duration (Model 1) and cariogenic dietary practices in the first year of life (Model 2), no micronutrients remained associated with the outcome (Table 3).

Table 2. Occurrence and crude relative risk (RR) with 95% confidence interval (95% CI) of severe early childhood caries (S-ECC) at four years of age according to quartile for intake of different micronutrients at 12 months (São Leopoldo, 2007).

Micronutrients	N	With S-ECC		p	Crude model		
		N	(%)		RR	(95% CI)	p
Calcium				0.009			
1st Quartile	78	35	(44.9)		1.67	(1.07-2.59)	0.023
2nd Quartile	79	33	(41.8)		1.55	(0.99-2.43)	0.055
3rd Quartile	79	25	(31.6)		1.18	(0.72-1.92)	0.517
4th Quartile	78	21	(26.9)		1.00		
Iron				0.528			
1st Quartile	78	29	(37.2)		1.12	(0.24-0.46)	0.616
2nd Quartile	79	31	(39.2)		1.18	(073-171)	0.443
3rd Quartile	79	28	(35.4)		1.06	(0.69-1.64)	0.781
4th Quartile	78	26	(33.3)		1.00		
Sodium				0.207			
1st Quartile	78	33	(42.3)		1.18	(0.80-175)	0.414
2nd Quartile	79	31	(39.2)		1.09	(0.73-1.64)	0.666
3rd Quartile	79	22	(27.8)		0.78	(0.49-1.23)	0.282
4th Quartile	78	28	(35.9)		1.00		
Zinc				0.021			
1st Quartile	78	36	(46.2)		1.44	(0.96-2.15)	0.076
2nd Quartile	79	32	(40.5)		1.26	(0.83-1.92)	0.274
3rd Quartile	79	21	(26.6)		0.83	(0.51-1.35)	0.453
4th Quartile	78	25	(32.1)		1.00		
Vitamin A				0.172			
1st Quartile	78	33	(42.3)		1.22	(0.82-1.82)	0.326
2nd Quartile	79	31	(39.2)		1.13	(0.75-1.71)	0.549
3rd Quartile	79	23	(29.1)		0.84	(0.53-1.33)	0.461
4th Quartile	78	27	(34.6)		1.00		
Vitamin C				0.036			
1st Quartile	78	33	(42.3)		1.32	(0.87-2.00)	0.189
2nd Quartile	79	36	(45.6)		1.42	(0.95-2.13)	0.087
3rd Quartile	79	20	(25.3)		0.79	(0.48-1.30)	0.353
4th Quartile	78	25	(32.1)		1.00		
Vitamin B12				0.059			
1st Quartile	78	33	(42.3)		1.38	(0.90-2.10)	0.139
2nd Quartile	79	33	(41.8)		1.36	(0.89-2.07)	0.156
3rd Quartile	79	24	(30.4)		0.99	(0.62-1.58)	0.958
4th Quartile	78	24	(30.8)		1.00		
Folate				0.093			
1st Quartile	78	36	(46.2)		1.39	(0.93-2.06)	0.106
2nd Quartile	79	27	(34.2)		1.03	(0.66-1.59)	0.911
3rd Quartile	79	25	(31.6)		0.95	(0.61-1.49)	0.821
4th Quartile	78	26	(33.3)		1.00		

Table 3. Adjusted relative risk (RR) and 95% confidence interval (95% CI) for occurrence of severe early childhood caries (S-ECC) at four years of age according to quartile for intake of different micronutrients at 12 months.

Micronutrients	S-ECC - Adjusted model 1*			S-ECC - Adjusted model 2†		
	RR	(95% CI)	p	RR	(95% CI)	p
Calcium						
1st Quartile	1.00	(0.44-2.29)	0.994	1.22	(0.54-2.76)	0.630
2nd Quartile	0.89	(0.42-1.87)	0.751	1.06	(0.53-2.15)	0.866
3rd Quartile	0.97	(0.53-1.77)	0.921	1.03	(0.54-1.86)	0.933
4th Quartile	1.00			1.00		
Iron						
1st Quartile	0.82	(0.44-1.52)	0.522	0.92	(0.49-1.71)	0.789
2nd Quartile	0.93	(0.53-1.64)	0.808	0.95	(0.55-1.64)	0.862
3rd Quartile	0.89	(0.55-1.44)	0.642	0.93	(0.58-1.49)	0.754
4th Quartile	1.00			1.00		
Sodium						
1st Quartile	0.78	(0.45-1.35)	0.378	0.78	(0.44-1.36)	0.778
2nd Quartile	0.85	(0.53-1.37)	0.506	0.98	(0.61-1.57)	0.982
3rd Quartile	0.75	(0.47-1.20)	0.232	0.86	(0.53-1.39)	0.861
4th Quartile	1.00			1.00		
Zinc						
1st Quartile	1.22	(0.70-2.11)	0.480	1.27	(0.71-2.27)	0.412
2nd Quartile	1.25	(0.77-2.04)	0.365	1.37	(0.83-2.26)	0.223
3rd Quartile	0.79	(0.48-1.30)	0.360	0.83	(0.50-1.37)	0.460
4th Quartile	1.00			1.00		
Vitamin A						
1st Quartile	0.91	(0.56-1.47)	0.686	0.39	(0.56-1.57)	0.810
2nd Quartile	1.11	(0.71-1.73)	0.652	1.15	(0.73-1.80)	0.547
3rd Quartile	0.83	(0.51-1.37)	0.468	0.90	(0.55-1.50)	0.694
4th Quartile	1.00			1.00		
Vitamin C						
1st Quartile	1.11	(0.68-1.79)	0.681	1.18	(0.70-2.00)	0.523
2nd Quartile	1.41	(0.91-2.19)	0.128	1.47	(0.93-2.31)	0.097
3rd Quartile	0.81	(0.48-1.35)	0.412	0.85	(0.50-1.43)	0.539
4th Quartile	1.00			1.00		
Vitamin B12						
1st Quartile	0.66	(0.34-1.26)	0.204	0.76	(0.39-1.46)	0.409
2nd Quartile	0.91	(0.51-1.59)	0.729	0.96	(0.55-1.67)	0.877
3rd Quartile	0.86	(0.46-1.62)	0.638	0.99	(0.54-1.81)	0.973
4th Quartile	1.00			1.00		
Folate						
1st Quartile	1.18	(0.65-2.17)	0.585	1.17	(0.65-2.17)	0.581
2nd Quartile	0.94	(0.55-1.63)	0.831	0.88	(0.55-1.63)	0.643
3rd Quartile	0.99	(0.59-1.68)	0.979	1.22	(0.67-1.88)	0.662
4th Quartile	1.00			1.00		

*Model 1: Adjusted for number of times/day child was breastfed; †Model 2: Adjusted for cariogenic dietary practices in first year of life

Two additional models were run controlling for mother's schooling (Model 3) and oral hygiene practices at 12 months of age (Model 4). No micronutrients were associated with the outcome in either of these analyses (not in a Table). Moreover, the analysis stratified by breastfeeding at 12 months (yes/no) revealed no associations between micronutrient intake and the outcome in either group of children (with and without breastfeeding at 12 months) (Table 4).

Table 4. Occurrence of severe early childhood caries (S-ECC) at four years of age according to quartile intake of different micronutrients at 12 months following stratification by breastfeeding at 12 months of age.

Micronutrients	Breastfeeding at 12 months: No (N = 169)				Breastfeeding at 12 months: Yes (N = 145)			
	N	With S-ECC N	With S-ECC (%)	p*	N	With S-ECC N	With S-ECC (%)	p*
Calcium				0.832				0.628
1st Quartile	42	10	(23.8)		36	16	(44.4)	
2nd Quartile	42	13	(31.0)		36	16	(44.4)	
3rd Quartile	43	10	(23.3)		37	20	(54.1)	
4th Quartile	42	12	(28.6)		36	17	(47.2)	
Iron				0.682				0.579
1st Quartile	42	10	(23.8)		36	19	(52.8)	
2nd Quartile	43	12	(27.9)		36	16	(44.4)	
3rd Quartile	42	11	(26.2)		37	18	(48.6)	
4th Quartile	42	12	(28.6)		36	16	(44.4)	
Sodium				0.252				0.567
1st Quartile	42	11	(26.2)		36	19	(52.8)	
2nd Quartile	42	8	(19.0)		36	15	(41.7)	
3rd Quartile	43	11	(25.6)		37	20	(54.1)	
4th Quartile	42	15	(35.7)		36	15	(41.7)	
Zinc				0.404				0.394
1st Quartile	42	11	(26.2)		36	18	(50.0)	
2nd Quartile	42	9	(21.4)		36	17	(47.2)	
3rd Quartile	43	11	(25.6)		37	21	(56.8)	
4th Quartile	42	14	(33.3)		36	13	(36.1)	
Vitamin A				0.922				0.280
1st Quartile	42	11	(26.2)		36	13	(36.1)	
2nd Quartile	42	12	(28.6)		36	18	(50.0)	
3rd Quartile	43	11	(25.6)		37	21	(56.8)	
4th Quartile	42	11	(26.2)		36	17	(47.2)	
Vitamin C				0.832				0.148
1st Quartile	42	10	(23.8)		36	19	(52.8)	
2nd Quartile	42	13	(31.0)		36	18	(50.0)	
3rd Quartile	43	10	(23.3)		37	20	(54.1)	
4th Quartile	42	12	(28.6)		36	12	(33.3)	
Vitamin B1				0.922				0.677
1st Quartile	42	12	(28.6)		35	17	(48.6)	
2nd Quartile	42	12	(28.6)		37	15	(40.5)	
3rd Quartile	43	8	(18.6)		37	19	(51.4)	
4th Quartile	42	13	(31.0)		36	18	(50.0)	
Folate				0.572				0.579
1st Quartile	42	13	(31.0)		36	18	(50.0)	
2nd Quartile	42	9	(21.4)		36	17	(47.2)	
3rd Quartile	43	14	(32.6)		37	19	(51.4)	
4th Quartile	42	9	(21.4)		36	15	(41.7)	

* chi-square test

Discussion

The present study investigated the possible association between micronutrient intake at 12 months of age and S-ECC at four years of age among children in southern Brazil. After controlling for socioeconomic factors, cariogenic dietary practices and oral hygiene habits, no micronutrients were associated with the outcome. The same was true when the sample was stratified based on the absence/presence of breastfeeding at 12 months of age. To the best of our knowledge, this is the first longitudinal study to investigate the influence of micronutrient intake in the first year of life on the occurrence of dental caries in the subsequent years with the analysis of possible confounding factors.

Findings from previous studies are contradictory, with reports of no relationship [10], a weak relationship [9] and even a direct relationship between micronutrient deficiencies and dental caries [7,11,13]. However, studies that have related malnutrition or micronutrient deficiencies to dental caries in the primary dentition offer indirect evidence of this association [19-22]. In contrast, some studies suggest a cariogenic effect of micronutrients [6,8]. A systematic review of randomized clinical trials identified vitamin D as a promising caries prevention agent, despite the low degree of certainty regarding the reduction in the incidence of tooth decay [23]. Similar to our findings, a recent cross-sectional study with a large sample size of schoolchildren in Taiwan showed that calcium intake was only associated with dental in the crude model. However, after adjustment for confounding factors, the daily intakes of Ca/P ratio was associated with dental caries [13].

The fact that most previous investigations into this issue have been carried out on animals or using a cross-sectional design may partially explain the divergences and also hinders comparisons with the present findings. Cross-sectional studies can even conceal a reverse causality relationship, in which the occurrence of caries can determine a lower intake of nutrients. Indeed, it has been already suggested that S-ECC is a risk factor for nutritional deficiency and not vice versa [24]. The clarification of this issue is important because it is the basis for the planning of prevention strategies aimed at adverse health conditions in childhood. In one of the few longitudinal studies with a reasonable sample size, the authors investigated 21 micronutrients in 259 South African children at 12 months of age and reported an effect on oral health at five years of age [9]. However, the authors found a weak, isolated association without clinical importance between magnesium intake and dental caries.

Exclusive breastfeeding is recommended for the first six months of an infant's life, after which solid foods should gradually be incorporated into the diet until reaching meals similar to those eaten by the rest of the family at 12 months of age. Micronutrient intake from healthy eating habits in the first years of life is necessary to proper physical and immunological development and also reduces the rates of morbidity and mortality in children. Stunted growth, anemia and infections are directly related to micronutrient deficiencies [25].

The relationship between micronutrient intake and dental caries may occur in different ways. It is possible that micronutrients are protective elements against the occurrence of dental caries by contributing to the formation of tooth enamel or by protecting the enamel from bacterial effects [7, 26, 27]. This effect is plausible, since micronutrient intake at 12 months of age may reflect intake in the previous months, when the primary molars are undergoing the process of calcification. Moreover, micronutrient deficiencies are reported to increase the risk of enamel hypoplasia [28], which could indirectly contribute to the occurrence of dental caries [29]. The present sample had a sufficient size and included children with a wide variety of intake regarding different micronutrients. Thus, one would expect a clinically important association between the exposure variables and outcome if such an association existed in the source population.

Our results together with previously published data suggest that the effects of eating habits in the first year of life on the occurrence of dental caries is much more related to dietary practices *per se*, such as the consumption of fermentable carbohydrates [1,5], than issues regarding nutrition or tooth formation. The theoretical implications of these findings underscore the need for further studies that investigate the effect of dietary practices on the occurrence of S-ECC.

From the practical standpoint, the present findings have implications on both the individual and collective levels. A large portion of the population believes that dental caries is related to a "lack of calcium", "weak teeth" or the chemical constitution of teeth. These beliefs may lead individuals to the notion of the inexorability of dental caries, against which one can do nothing. It therefore seems fundamental for health professionals to demonstrate that adequate oral health is achieved with simple dietary habits that do not represent additional expenditures to the family [30] and also involve the protection of general health in children by combating risk factors that are common to different chronic conditions. Thus, the present findings can serve as support to health professionals, educators, administrators and students from different communities.

Some aspects regarding the methodology of the present study merit mention. The proportion of children lost to follow up was considerable. This is a major problem in cohort studies, especially among populations that move frequently. Despite the exhaustive collection of personal identification data, a significant number of families moved in the first weeks following the birth of the child without informing the researchers. However, a sensitivity analysis described in a previous article demonstrated similarity in the baseline characteristics between the children who remained in the study and those lost to follow up [5]. Therefore, selection bias is unlikely. The data on dietary habits were based on interviews with the mothers, with no assurance that the quantities reported were indeed those consumed. However, if any information bias had occurred, it is unlikely to have made a significant difference. Moreover, the methodology employed, which involved interviews in the families' homes for the collection of data on dietary practices, is the most indicated when collecting nutritional data in a relatively large sample. It is possible that the collection of behavioral data in the families' homes leads to truer responses. The fact that the questions on eating habits involved recent practices also reduces the possibility of recall bias.

Conclusion

The results of the present study showed that variations in the intake of micronutrients at 12 months of age were not a risk factor for the occurrence of severe early childhood caries at four years of age. These findings suggest that orientations regarding feeding practices for dental caries prevention should focus more on dietary aspects (local effect) than nutritional aspects (systemic effect). However, this hypothesis should be investigated in well designed intervention studies.

Acknowledgments

The Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul (FAPERGS) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) supported this work. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

References

1. Ismail AI. Prevention of early childhood caries. Community Dent Oral Epidemiol 1998; 26(suppl 1):49-61.
2. Boeira GF, Correa MB, Peres KG, Peres MA, Santos IS, Matijasevich A, Barros AJ, Demarco FF. Caries is the main cause for dental pain in childhood: findings from a birth cohort. Caries Res 2012; 46(5):488-95.
3. Abanto J, Carvalho TS, Mendes FM, Wanderley MT, Bönecker M, Raggio DP. Impact of oral diseases and disorders on Oral Health- Related Quality of Life of preschool children. Community Dent Oral Epidemiol 2011; 39 (2):105-14.
4. Kramer PF, Feldens CA, Ferreira SH, Bervian J, Rodrigues PH, Peres MA. Exploring the impact of oral diseases and disorders on quality of life of preschool children. Community Dent Oral Epidemiol 2013; 41(4):327-35.
5. Feldens CA, Giugliani ER, Vigo A, Vitolo MR. Early feeding practices and severe early childhood caries in four-year-old children from southern brazil: A birth cohort study. Caries Res 2010; 44(5):445-52.
6. Kwon HK, Suh I, Kim YO, Kim HJ, Nam CM, Jun KM, Kim HG. Relationship between nutritional intake and dental caries experience of junior high students. Yonsei Med J 1997; 38(2):101-10.
7. Miguel JC, Bowen WH, Pearson SK. Influence of iron alone or with fluoride on caries development in desalivated and intact rats. Caries Res 1997; 31(3):244-8.
8. Watson GE, Davis BA, Raubertas RF, Pearson SK, Bowen WH. Influence of maternal lead ingestion on caries in rat pups. Nat Med 1997; 3(9):1024-5.
9. MacKeown JM, Cleaton-Jones PE, Fatti P. Caries and micronutrient intake among urban south african children: A cohort study. Community Dent Oral Epidemiol 2003; 31(3):213-20.
10. Ohlund I, Holgerson PL, Backman B, Lind T, Hernell O, Johansson I. Diet intake and caries prevalence in four-year-old children living in a low-prevalence country. Caries Res 2007; 41(1):26-33.
11. Turnbull B, Lanigan J, Singhal A. Toddler diets in the u.K.: Deficiencies and imbalances. 1. Risk of micronutrient deficiencies. J Fam Health Care 2007; 17(5):167-70.
12. Yen CE, Huang YC, Hu SW. Relationship between dietary intake and dental caries in preschool children. Int J Vitam Nutr Res 2010; 80(3):205-15.
13. Lin HS, Lin JR, Hu SW, Kuo HC, Yang YH. Association of dietary calcium, phosphorus, and magnesium intake with caries status among schoolchildren. Kaohsiung J Med Sci 2014; 30(4):206-12
14. World Health Organization: Vitamin and mineral requirements in human nutrition. 2nd. ed. Geneva, 2004.
15. World Health Organization: Global strategy for the prevention and control of non-communicable diseases in World Health Organization. Geneva, 2000.
16. Brazil Health Ministry. Ten steps for healthy feeding. Brasília, Health Ministry, 2002.
17. Feldens CA, Kramer PF, Sequeira MC, Rodrigues PH, Vitolo MR. Maternal education is an independent determinant of cariogenic feeding practices in the first year of life. Eur Arch Paediatr Dent 2012; 13(2):70-5.
18. Drury TF, Horowitz AM, Ismail AI, Maertens MP, Rozier RG, Selwitz RH. Diagnosing and reporting early childhood caries for research purposes. A report of a workshop sponsored by the national institute of dental and craniofacial research, the health resources and services administration, and the health care financing administration. J Public Health Dent 1999; 59(3):192-7.
19. Alvarez JO, Caceda J, Woolley TW, Carley KW, Baiocchi N, Caravedo L, Navia JM. A longitudinal study of dental caries in the primary teeth of children who suffered from infant malnutrition. J Dent Res 1993; 72(12):1573-6.
20. Clarke M, Locker D, Berall G, Pencharz P, Kenny DJ, Judd P. Malnourishment in a population of young children with severe early childhood caries. Pediatr Dent 2006; 28(3):254-9.
21. Atasoy HB, Ulusoy ZI. The relationship between zinc deficiency and children's oral health. Pediatr Dent 2012; 34(5):383-6.

22. Schroth RJ, Levi J, Kliewer E, Friel J, Moffatt ME. Association between iron status, iron deficiency anaemia, and severe early childhood caries: A case-control study. BMC Pediatr 2013; 13:22.
23. Hujoel PP. Vitamin d and dental caries in controlled clinical trials: Systematic review and meta-analysis. Nutr Rev 2013 ;71(2):88-97.
24. Shaoul R, Gaitini L, Kharouba J, Darawshi G, Maor I, Somri M. The association of childhood iron deficiency anaemia with severe dental caries. Acta Paediatr 2012; 101(2):76-9.
25. Fomon SJ, Ziegler EE, Nelson SE. Erythrocyte incorporation of ingested 58fe by 56-day-old breast-fed and formula-fed infants. Pediatr Res 1993; 33(6):573-6.
26. Lippert F. Dose-response effects of zinc and fluoride on caries lesion remineralization. Caries Res 2012; 46(1):62-8.
27. Ribeiro CC, Ccahuana-Vasquez RA, Carmo CD, Alves CM, Leitao TJ, Vidotti LR, Cury JA. The effect of iron on streptococcus mutans biofilm and on enamel demineralization. Braz Oral Res 2012; 26(4):300-5.
28. Purvis RJ, Barrie WJ, MacKay GS, Wilkinson EM, Cockburn F, Belton NR. Enamel hypoplasia of the teeth associated with neonatal tetany: A manifestation of maternal vitamin-d deficiency. Lancet 1973; 13(2):811-4.
29. Hong L, Levy SM, Warren JJ, Broffitt B. Association between enamel hypoplasia and dental caries in primary second molars: A cohort study. Caries Res 2009; 43(5):345-53.
30. Feldens CA, Rodrigues PH, Rauber F, Chaffee BW, Vitolo MR. Food expenditures, cariogenic dietary practices and childhood dental caries in southern brazil. Caries Res 2013; 47(5):373-81.