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Relationship between childhood underweight and dental crowding in deciduous teething

Erika Bárbara Abreu Fonseca Thomaz,[1] Ana Maria Gondim Valença[2]

Abstract

Objective: To investigate the relationship between low anthropometric indices and dental crowding in deciduous teething.

Methods: We assessed 794 children from 3 to 5 years old, both boys and girls, enrolled in public preschools in the city of São Luís, state of Maranhão, Brazil. Single-stage cluster sampling was used. This is a cross-sectional study, including the administration of a questionnaire, evaluation of dental occlusion and anthropometric assessment. Dental crowding, which is characterized by lack of space for the eruption of teeth in the line of the alveolar crest, is the dependent variable. Weight-for-age (W/A) and height-for-age (H/A) indices were used for anthropometric assessments. Multivariate logistic regression analysis and descriptive analysis of the variables were used. Associations were estimated using odds ratio (OR), and the statistical inference was based on confidence intervals (95%CI). Type I error was set at 5% (alpha = 5%).

Results: The association between low anthropometric measures and dental crowding was statistically significant only when considering the W/A index and among those children who did not use pacifiers. We found 2.19 children with dental crowding and malnutrition for each children without dental crowding and with malnutrition (OR = 2.19; 95%CI 1.19-4.04).

Conclusion: This study suggests that low anthropometric measures are associated with dental crowding in deciduous teething among children who do not use pacifiers. However, further studies are needed to investigate possible causal relations between malnutrition and dental crowding.

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Introduction

Protein-energy malnutrition remains as the nutritional disease responsible for the highest number of deaths all over the world.[1] In Brazil, 11% of children younger than 5 years old suffer from malnutrition according to the height-for-age (H/A) index, and 6% have low weight-for-age (W/A).[2] Therefore, in spite of the significant decrease in child malnutrition achieved in Brazil in the last decade, the Northeast and North Regions still have high malnutrition rates. The state of Maranhão is ranked second in terms of child malnutrition, having a better rate only if compared to the state of Alagoas.[3]

Studies have demonstrated that child malnutrition is associated with several health problems.[1-5] When analyzing the consequences of malnutrition to oral health, some studies have associated malnutrition with a higher prevalence of dental caries,[6] as well as dental malformations[7] and soft tissue injuries.[6,8] Nevertheless, even though some authors have found a significant adverse effect of malnutrition on the growth and development of facial bones of children[9,10] and on the development of skeletal muscles[11] (demonstrated by reduced measures of the length of the skull base, height of the jaw,[9] width of the maxilla and mandible, lower face

1. Doutora. Professora adjunta, Departamento de Saúde Pública, Universidade Federal do Maranhão (UFMA), São Luís, MA, Brazil.
2. Doutora. Professora adjunta, Universidade Federal da Paraíba (UFPB), João Pessoa, PB, Brazil.

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height[10] and dental and skeletal ages[12]), a possible increase in the prevalence and/or severity of malocclusions has not been assessed, especially in terms of dental crowding, since such deficit in the growth and development of the bone-muscular system, including the maxilla and the mandible, could reduce the space for dental eruption, leading to bad positioning of the teeth in the dental arches. Therefore, malnutrition might also be associated with dental occlusion disorders.

Thus, the importance of the present study becomes evident when considering the high prevalence of malnutrition[1] and malocclusions[13] in children and the absence of studies that investigate the association between both problems, as well as the severe disorders caused by such health problems,[1-3,14] with sequelae in adulthood, in addition to the expensive orthodontic treatment offered to those who have dental crowding. The objective of this study is to investigate the relationship between low anthropometric measures and dental crowding in the deciduous teething.

Methods

This cross-sectional study involved a population of 794 children from 3 to 5 years old, both boys and girls, enrolled in the public preschools located in the rural and urban areas of the city of São Luís, state of Maranhão, Brazil in 2003. The size of the sample was calculated according to Cochran's recommendations.[15] Therefore, we used p = 0.1 (estimate of dental crowding prevalence), confidence interval of 1 - α = 0.95, sampling error d = 0.02 and N = 7,417. We estimated a sample of 775 children as being appropriate for the proposed analyses. Finally, considering possible losses, 5% additional subjects were added to the sample by drawing lots. Single-stage cluster sampling was used. Each one of the preschools constituted one cluster. For drawing lots, we used the list of preschools provided by the State Department of Education. We excluded: children with rampant caries, whose remaining dental structure was at 1/3 in the gingival level; children who had erupted permanent teeth; children who refused to be examined; and those whose guardians did not allow their participation in the study because they did not sign the written consent form.

This study protocol was approved by the Research Ethics Committee of the Center of Health Sciences of Universidade Federal da Paraíba. After getting written consent, one previously trained researcher performed data collection. We asked the children's guardians to answer a questionnaire. After that, we conducted occlusal and nutritional assessments.

This questionnaire comprised items related to the children's demographic characteristics (name, birth date, gender, address, telephone, race/skin color and city of birth), socioeconomic characteristics (educational level and parents' occupation, family income, personal belongings, real state ownership, and domestic appliances), dietary habits (breastfeeding, use of milk bottles, sucrose intake) and oral hygiene (teeth brushing, use of fluorine and floss), as well as history of harmful oral habits (pacifier use and/or finger sucking, object and/or mouth biting, bruxism, oral breathing, tongue interposition and onychophagy), and children's health history.

The evaluation of dental occlusion was carried out by means of visual inspection performed under natural lighting, using disposable wood spatulas and Community Periodontal Index (CPI/WHO) millimetered probe. Children stood in front of the researcher who remained seated. For anthropometric assessment, children's height was checked using a millimetered measuring tape, which was fixed to the wall in a straight line towards the floor, and body mass index was also measured. We used an electronic digital scale (Plenna, model MS-1) with a capacity of up to 150 kg and 100 g division placed on a flat surface. Measurements were performed according to the recommendations by Lohman et al.[16]

The analysis procedures included univariate and bivariate descriptive analysis, stratified analysis and logistic regression. Associations were estimated using prevalence ratio (PR) and odds ratio (OR) and the statistical inferences were based on 95% confidence intervals (95%CI).

The dependent variable was dental crowding. Those children whose incisive and canine deciduous teeth were misplaced regarding vestibular and tongue position considering the median line of the alveolar processes were diagnosed with dental crowding. Malnutrition was the main independent variable. The anthropometric indices W/A and H/A were used as criteria to define the exposition. The curves recently recommended by the World Health Organization were taken as reference, and the cutoff points were expressed in z score. Therefore, a child who had anthropometric indices, in z score, lower than -2 standard deviation (SD) of the reference population's curve was considered to have malnutrition (low W/A and low H/A). The absence of malnutrition was characterized by anthropometric index ≥ -2 SD.[17,18] The covariables studied were: age, gender, socioeconomic status, duration of breastfeeding and harmful oral habits such as pacifier use, finger sucking, oral breathing and onychophagy (nail biting). For analysis, the continuous variable age had the following categories: 0) 3 years; 1) 4 years; and 2) 5 years. The variable duration of breastfeeding, which was also a continuous variable, had the following categories: 0) > 12 months; 1) 3 to 12 months; and 2) < 3 months. Such variables were analyzed later as the dummy variables, using the categories 3 years and > 12 months as reference. For the socioeconomic profile, we used a classification adapted from the study by Barbosa,[19] considering three socioeconomic statuses: low, intermediate, and high.

We selected as potential effect modifying variables those variables that, in the stratified analysis, potentiated the main association and suggested heterogeneity of effect by means

of the homogeneity test using the Mantel Haenszel method ($\alpha = 0.05$).[20] Those variables that, in addition to being simultaneously associated with exposition and outcome and not belonging to the causes under investigation,[20,21] defined deviations from the measure of association for the adjusted PR in 10% or higher regarding the crude PR were chosen as confounding variables for the association between nutritional status and dental crowding. Therefore, in the stratified analysis, we selected potential confounding variables and potential effect modifying variables to be included in the model.

We used the backward modeling strategy in the logistic regression analysis, considering as confounding variables those that caused a difference in the measures of the associations ≥ 10% when excluded from the model. The likelihood ratio test was used as a criterion to evaluate interaction ($\alpha = 0.05$).[21] A diagnosis of the model was also performed using the goodness-of-fit test and calculation of Pearson residuals. Epi-Info and Stata® 8.0 software were used for these analyses.

Results

In the present study, only the W/A index showed a significantly statistical association with dental crowding. Therefore, we decided not to present the results of the analyses based on the H/A index.

The final population of the study comprised 794 individuals, 427 of them (53.8%) were boys and 367 (46.2%) were girls. Their mean age was 57.29 months (the median was 57.13 months and SD was 8.08). The descriptive analysis of covariables according to the anthropometric status (W/A) is shown in Table 1. There were statistically significant differences in the distribution of the covariable socioeconomic status among children with and without low W/A.

The results of the stratified analysis are shown in Table 2. Only the variable pacifier use was identified as potential effect modifying of low weight on the presence of dental crowding ($p = 0.05$).

In modeling, the heterogeneity of effect in the categories of the variable pacifier use remained, however it was not statistically significant. Nevertheless, we decided to show the results of the association between anthropometric status and dental crowding for children who used pacifiers and for those who did not use them (Table 3). These findings are surprising since there was a higher prevalence of dental crowding among those children whose mothers did not report the habit of using pacifiers if compared to the children who used pacifiers (Table 3). Among the children who did not use pacifiers, malnutrition, based on the W/A index, was associated with an increase of 119% in the probability of having dental crowding (OR = 2.19; 95%CI 1.18-4.04). On the other hand, among the children who used pacifiers, this association was not detected.

We used the goodness-of-fit test and the residual analysis to demonstrate that the logistic regression analysis was adequate for the model being investigated. Finally, the assessment of the percentage of outcome explanation based on the variables included in the final model resulted in quite low values (Pseudo R2 = 0.0167), that is, the variables investigated explained less than 2% of the variability regarding the occurrence of dental crowding.

Discussion

Even though we found a relationship between low anthropometric measures and dental crowding, the hypothesis that child malnutrition is associated with dental crowding in the deciduous teething must be carefully analyzed since this association was only detected when we considered malnutrition based on the fragile W/A index and considering children who did not use pacifiers. Taking this into consideration, several results deserve to be discussed, mainly those related to the limitations of this study.

The study design we used does not ensure the temporal antecedence of the exposition to malnutrition regarding dental crowding. Therefore, it is not possible to establish causality based on the results of this study. In addition, the effect modification found based on the use of pacifiers, leading to the need of controlling for this variable, reduced the number of individuals in each category, decreasing the accuracy of measures, although the amplitude of most confidence intervals did not change much. Furthermore, there is the possibility of information bias, which is inherent to studies that use recall questionnaires as the data collection instrument. We decided to use self-report questionnaires with the purpose of reducing the bias of false answers since the instrument included some personal questions.

In the present study, we used anthropometry, based on W/A and H/A indices, as a criterion to classify exposition. Anthropometry has been used as the diagnosis method of choice for the assessment of nutritional status of populations.[17,18] Among its advantages, the most important are low cost, simple techniques and good acceptance by part of the population. The indices based on weight and height are considered to be the first-choice method for monitoring the nutritional status of children up to 5 years old.[18] However, when anthropometric indices are the only available data they need to be carefully interpreted, and the World Health Organization[17,18] recommends additional data collection, such as socioeconomic and demographic characteristics, in order to better define the nutritional status of the population. Such suggestion was respected in the present study.

It is also important to highlight that if, on one hand, the restrictions imposed on this study made the data collection easier and allowed for the performance of a more accurate dental occlusal assessment and the respect of ethical recommendations, on the other hand, these restrictions affected the external validity of the study, so that it is advisable to use caution when trying to generalize the results of the present study

Table 1 - Absolute distribution and percentage of the population's characteristics according to the categories of anthropometric status (W/A) in preschool-aged children (São Luís, Brazil)

	Anthropometric status (W/A)		
Covariables	**With low weight, n (%)**	**Without low weight, n (%)**	**p**
Dental crowding			0.12*
Crowded	29 (27.4)	142 (20.6)	
Normal	77 (72.6)	546 (79.4)	
Age category			0.52†
3 years	21 (19.8)	102 (14.8)	
4 years	43 (40.6)	309 (44.9)	
5 years	42 (39.6)	277 (40.3)	
Gender			0.67*
Male	55 (51.9)	372 (54.1)	
Female	51 (48.1)	316 (45.9)	
Duration of breastfeeding			0.21†
< 3 months	13 (12.3)	69 (10.0)	
3 to 12 months	48 (45.3)	284 (41.3)	
> 12 months	45 (42.4)	335 (48.7)	
Pacifier use			0.51*
Yes	50 (47.2)	301 (43.7)	
No	56 (52.8)	387 (56.3)	
Finger sucking			0.65*
Yes	11 (10.4)	62 (9.0)	
No	95 (89.6)	626 (91.0)	
Oral breathing			0.10*
Yes	7 (6.6)	23 (3.3)	
No	99 (93.4)	665 (96.7)	
Nail biting			0.32*
Yes	24 (22.6)	187 (27.2)	
No	82 (77.4)	501 (72.8)	
Socioeconomic status			< 0.01*
Low	90 (84.9)	496 (72.1)	
Intermediate	16 (15.1)	192 (27.9)	

W/A = weight-for-age.
* Pearson's chi-square.
† Chi-square for trend.

to the general population. Finally, the low percentage of model explanation suggests that there is need of further studies including variables that were not used in the present investigation, mainly those related to hereditary characteristics.

Nevertheless, it is important to emphasize the careful plan/design of the study, evidenced by the use of probability sampling and population-based design, which contributed to increase the external validity of this study. Other important aspects were the researcher's training process and the reassessment of the subsample of preschool-aged children, with low interrater intra-examiner variability, adding to the internal validity of data. Furthermore, the absence of studies assessing the association between nutritional status and malocclusion in the deciduous teething in the scientific literature, mainly regarding dental crowding, demonstrates the pioneering aspect of this study, highlighting its importance in terms of providing greater visibility to the harmful effects of malnutrition on oral/orthodontic health.

Based on some studies, one could assume that such association was possible, since malnutrition brings consequences

Table 2 - Prevalence ratios and respective 95%CI of the association between anthropometric status (W/A) and dental crowding according to covariables (São Luís, Brazil)

	W/A*			
Covariables	**n**	**PR**	**95%CI**	**Chi-square†**
Crude PR	794	1.32	0.94-1.87	0.12
Age category				
3 years	123	1.71	0.77-3.83	
4 years	352	1.26	0.69-2.28	
5 years	319	1.26	0.77-2.07	
Adjusted PR		1.33	0.94-1.88	0.79
Gender				
Male	427	1.62	1.17-2.81	
Female	367	0.99	0.52-1.59	
Adjusted PR		1.32	0.93-1.86	0.07
Duration of breastfeeding				
< 3 months	82	0.41	0.06-2.86	
3 to 12 months	332	1.39	0.86-2.22	
> 12 months	380	1.49	0.89-2.47	
Adjusted PR		1.32	0.94-1.86	0.44
Pacifier use				
Yes	351	0.87	0.50-1.65	
No	443	1.79	1.14-2.62	
Adjusted PR		1.32	0.94-1.86	0.05‡
Finger sucking				
Yes	73	0.63	0.09-4.46	
No	721	1.39	0.98-1.96	
Adjusted PR		1.33	0.95-1.87	0.43
Oral breathing				
Yes	30	1.09	0.13-8.94	
No	764	1.35	0.95-1.94	
Adjusted PR		1.34	0.95-1.89	0.84
Nail biting				
Yes	211	1.44	0.72-2.85	
No	583	1.29	0.87-1.92	
Adjusted PR		1.32	0.94-1.87	0.79
Socioeconomic status				
Low	586	1.47	1.01-2.14	
Intermediate	200	1.00	0.41-2.42	
Adjusted PR		1.37	0.97-1.94	0.43

95%CI = 95% confidence interval; W/A = weight-for-age; PR = prevalence ratio.
* Stratified analysis.
† Homogeneity test = Mantel Haenszel chi-square.
‡ Effect modification with statistically significant difference for alpha = 0.05.

Table 3 - Association between nutritional status (W/A) and dental crowding, controlled by pacifier use

Pacifier use	n	OR*	95%CI
Yes	351	0.96	0.45-2.04
No	443	2.19	1.18-4.04†

95%CI = 95% confidence interval; OR = odds ratio; W/A = weight-for-age.
* Odds ratio adjusted for socioeconomic status and finger sucking.
† Effect modification of malnutrition (W/A) on the presence of dental crowding with statistically significant difference for alpha = 0.05.

for the maxillofacial development because this disorder has an influence on the hormonal development and, as a consequence, it affects morphological functions.[22] In addition, malnutrition causes a significant adverse effect on dental and skeletal ages,[12] and it provokes statistically significant decreases in the length of the skull base and height of the jaw.[9] The width of the maxilla and mandible, as well as the lower face height are also adversely influenced by malnutrition,[10] causing changes in the pattern of facial growth and in the relationship between bone and chronological ages.[10,23] Malnutrition is also considered a risk factor for enamel lesions and dental caries,[6,7] which is the main cause of early loss of deciduous teeth, resulting in an increased risk of malocclusions.[24] Malnutrition also causes delayed bone maturation; therefore, it is possible to assume that malnutrition is associated with higher prevalence of malocclusion.

In a study involving samples of lab rats, some authors found that malnutrition could restrict the growth and development of skull bones in several directions (anteroposterior, transversal and longitudinal), and it also could affect the development of skeletal muscles,[11] even having an impact on the bone-muscular systems related to chewing and respiratory functions.[23,25-27]

In the present study, the association between malnutrition and dental crowding was found only after the variable pacifier use was identified as being effect modifying, which allowed for a more accurate investigation based on the heterogeneity of effect on the population. We found positive association between malnutrition, based on the W/A index, and dental crowding among those children who did not use pacifiers, that is, the habit of using pacifiers serves as a protection against the occurrence of dental crowding among the children with malnutrition. This finding is extremely instigating since the literature has consistently suggested that the use of pacifiers causes adverse effects regarding malocclusions,[28] such as open bite and protrusion. On the other hand, it sounds reasonable to believe that if it causes protrusion (teeth extending too far forward), the use of pacifiers reduces the chances of lack of space.

In conclusion, the present study provides evidence that low anthropometric measures, based on the W/A index, are associated with dental crowding in the deciduous teething among children who do not use pacifiers, stressing the importance of a healthy and balanced diet since early childhood with the purpose of also bringing benefits to the oral health. However, it is advisable that further studies are conducted, mainly prospective longitudinal studies, in order to investigate possible causal relations between malnutrition and dental crowding.

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Correspondence:
Érika Bárbara Abreu Fonseca Thomaz
Avenida Brasil, Chácara Brasil, 792
CEP 65065-770 - São Luís, MA - Brazil
Tel.: +55 (98) 3232.5495
E-mail: ebthomaz@globo.com