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Maternal breastfeeding, parafunctional oral habits and malocclusion in adolescents: A multivariate analysis☆

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ABSTRACT

Objective: Malocclusion may result in esthetic impairment and functional disorders such as bad chewing, speech and swallowing, with a negative impact on quality of life. There is uncertainty regarding the effects of breastfeeding on dentofacial malocclusions. The purpose of the study was to evaluate the relationship between maternal breastfeeding and dental malocclusions and facial characteristics in adolescents with permanent dentition.

Methods: Probabilistic sampling of 2060 12- to 15-year-old students in a cross-sectional study was used. Malocclusion, as defined by Angle, and facial characteristics were the dependent variables. The duration of breastfeeding was the main independent variable. Other covariates were tested as effect modifiers or confounders. The associations were estimated using the odds ratio (OR) in multinomial logistic regression analysis ($\alpha = 5\%$).

Results: There was an association between a short duration of breastfeeding (less than 6 months) and Angle class II (OR = 3.14; 95% CI: 1.28–7.66) and class III (OR = 2.78; 95% CI: 1.21–6.36) malocclusion only in students with a prolonged history of bruxism. A higher occurrence of severe convex profile (OR = 3.4; 95% CI: 0.63–18.26) and a lower occurrence of cancave profile (OR = 0.43; 95% CI: 0.21–0.88) were also observed only among adolescents who had been breastfed for a short period and exposed to a long periods of mouth breathing.

Conclusions: These findings support the hypothesis that breastfeeding alone seems not to be directly associated with malocclusions, but it may have a synergetic effect with parafunctional oral habits on the development of occlusofacial problems. It is recommended that deleterious oral habits be avoided, especially by children who were breast-fed for less than 6 months.

1. Introduction

Satisfactory maternal breastfeeding has been associated with growth and development of the maxillomandibular complex [1–7]. This association can be a consequence of neuromuscular stimuli resulting from the act of sucking the nipple, which increases perioral tonus [1] and favors the correct arrangement of the structures responsible for chewing, swallowing, nose breathing and phonation [6–11]. However, it has been speculated that such stimuli, when produced abnormally, could generate bone reactions [7,12], with possible repercussions in the inadequate maxillary growth [13]. Hence, although the pattern of growth and development of facial bones is strongly associated with genetic factors [7], it is believed that the environment can affect this process [14]. Changes in the pattern of growth and development of craniofacial bones can in turn lead to poor relationships between the dental elements, reflected in dental malocclusions [12]. For this reason, failure to breast-feed/breastfeeding for a short period (FB/BSP) may be related to occlusofacial abnormalities [15]. This relationship may be a result of the influence of perioral muscular activity on the craniofacial growth and development process [5,6,16,17] or because parafunctional oral habits (POH) are more common in people exposed to FB/BSP [1,18–21].

There are many evidences on the effect of the POH in malocclusion. Bottle feeding [22], digit and pacifier sucking [22–26], mouth breathing [27] and bruxism [28,29] have been associated to alteractions on the shape and size of the jaws and to higher prevalences of malocclusion. Nevertheless, reports in the literature regarding breastfeeding and occlusofacial problems

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differ in their findings. Studies have failed to confirm this association empirically [1,19,20,30]. This may be because they use mainly univariate analytical techniques and therefore do not take into account confounding or interactions between variables [20], because they use relatively small [1,20] or convenience samples or because they evaluate the effects of this practice on deciduous dentition [19]. The aim of this study was therefore to evaluate, using multivariate analysis, the relationship between maternal breastfeeding and dental malocclusions and facial characteristics in adolescents with permanent dentition.

2. Methods

2.1. Study design and sample design

The study was a cross-sectional one, and the reference population consisted of 12- to 15-year-old adolescents enrolled in secondary schools in Salvador, BA, Brazil. Probabilistic stratified two-stage cluster sampling was used. The schools were the primary sampling units, and the students the secondary units. The proportion of students from public and private schools was maintained in the sample.

It was estimated that a sample of 1580 individuals would have an 80% chance of detecting a 10% difference in the prevalence of malocclusion – estimated at around 35% [31] – between the exposed and unexposed groups (α = 5%) in the proportion 1:1 with a design effect equal to 2. However, to compensate for possible non-responses and losses and the need to subdivide the database to control interactions, the study population was increased by 30% to 2060 adolescents.

If a student was not found in the school, even after three attempts, the information relating to that student would be considered lost. Students with a history of orthodontic/orthopedic treatment were excluded from the study (n = 4). For students to take part in the study, their parents or guardians had to sign the voluntary informed-consent form. The project was approved by the Research Ethics Committee under reference no. 012-04/CEP-ISC-UFBA on July 6, 2004.

2.2. Definition of the variables

Type of facial profile and presence of dental malocclusion were the dependent variables. Dental malocclusions were classified into three categories according to the Angle classification: '*normal occlusion or class I malocclusion*'; '*class II malocclusion*'; or '*class III malocclusion*' [12]. Facial profile was classified as '*normal*' (*straight/mildly convex*), '*severely convex*' or '*concave*' [12].

Duration of breastfeeding was the main independent variable and was classified according to the information provided by the mother or guardian as either '*never breast-fed/breast-fed until the age of six months*' or '*breast-fed for more than six months*'.

The covariates were duration of bottle feeding ('0–12 *months*' or '>12 *months*'); family income ('<2 *minimum monthly wages*', '2–5 *minimum monthly wages*' or '>5 *minimum monthly wages*'); level of education ('*low*' – illiterate to primary education not completed, '*average*' – primary education completed to secondary education completed, or '*high*' – graduation not completed to postgraduate completed); age ('12 *to* 13′ or '14 *to* 15 *years*'); sex ('*male*' or '*female*'); color ('*black*' or '*non-black*'); stunting ('*yes*' or '*no*'); loss of permanent teeth ('*yes*' or '*no*'); mouth breathing, digit sucking, pacifier sucking and bruxism (both classified as '*never had/had these habits but stopped before the age of six years*' or '*had these habits until after the age of six years*'). The age of 6 years was chosen as the cut-off for oral habits as the first permanent teeth erupt at this age [32].

The indicator height-for-age (h/a) was used for the anthropometric assessment. The AnthroPlus® program was used with the reference curves recently advocated by WHO [33], and individuals were classified as having stunting or a moderate height-for-age deficit (z-score more than 2SD below the reference population); a mild height-for-age deficit ($-2\text{SD} \leq z\text{-score} < -1\text{SD}$); or a normal/high/very high height-for-age ($z\text{-score} \geq -1\text{SD}$). Because of the low prevalence of stunting and moderate height-for-age deficit in the sample (4.58%, n = 88), it was decided to group all types of malnutrition (as measured by the height-for-age index) together in a single category, and the adolescents were classified as having '*normal height-for-age*' ($z\text{-score} \geq -1\text{SD}$) or '*some degree of height-for-age deficit*' ($z\text{-score} < -1\text{SD}$). Color was self-reported in accordance with the recommendations of the Brazilian Institute for Geography and Statistics [34], and because of the small number of Asians or indigenous natives, these were excluded from the analysis (n = 19).

2.3. Data collection

To ensure the internal validity of the study, a pilot study was set up and the intra- and inter-examiner agreements were determined by kappa analysis. Only those examiners with agreements ≥0.85 were included in the collection team. The students were examined in their schools, in good natural light using sterilized or disposable material. Occlusion was assessed in accordance with the WHO protocol [35]. Anthropometric measurements were taken twice using a double-blind method following the WHO recommendations [36]. The mean of the two measurements was used as the final measurement, and an inter-examiner variation in height of up to 0.1 cm was accepted [37]. Data were collected from July to October 2004.

2.4. Data analysis

A descriptive analysis was carried out, in which the differences in the distribution of the study covariates in the dependent variable categories were assessed using the chi-square test and a trend test (α = 5%). The associations between the dependent and independent variables were estimated using the odds ratio (OR) in multinomial logistic regression analysis. A confidence interval of 95% was used as the criterion for statistical inference. A backward modeling approach was used, and variables with a p-value of 0.2 or less were selected for the multivariate models. The likelihood ratio test was used to assess interaction (α = 5%). Variables that resulted in deviations of more than 10% in association measures between breast-feeding and malocclusion when removed from the model were considered confounders of the association of interest [38].

Estimates took into account the complex selection of the study sample. Standard errors were corrected, design effect (deff) was estimated, and the stratification variable and variable representing the primary sample units were incorporated in the analysis so that the intra-cluster correlation was taken into account [39]. In addition, as the selection probability was not the same for adolescents of different ages and also depended on the school in which they were enrolled – students in smaller schools having a greater probability of being selected – the estimates were weighted by the inverse of the selection probability for each adolescent [39]. The variables age and school were used for the weighting. Stata SE® version 9.0 was used for the analysis.

3. Results

Three private schools were substituted because they declined to take part in the study. Of the questionnaires sent to students 100%

were returned, and the corresponding figure for those sent to parents or guardians was 78.1%.

The characteristics of the study group are presented in Table 1. Most of the adolescents are girls, from 12 to 13 years old and with non-black color, from families who received <2 minimum monthly wage and that has low level of education of the head of the family. Most have neither low height-for-age nor posterior teeth lost. The duration of finger sucking, pacifier sucking, mouth breathing, bruxism and breastfeeding was especially from 0 to 6 years. But bottle feeding occurred until more than 6 years old in most of the study group.Normal occlusion, according to the Angle criterion, was seen in 347 (18%) people. Class I (n = 824, 39%), class II (n = 399, 19.8%) and class III (n = 465, 23.2%) malocclusion were commonly observed in the sample. Normal, convex and concave profiles were seen in 1759 (85.5%), 47 (2.2%) and 251 (12.3%) adolescents, respectively.Lower frequency of breastfeeding was seen in female adolescents (P = 0.03), who used a bottle for more than 6 months ($P < 0.0001$), and with a history of pacifier sucking for more than 6 years old (P = 0.0002).

Table 1
Characteristics of the study group (2060 adolescents). Salvador, BA, Brazil, 2004.

	n	%
Age		
12–13 years	1070	51.9
14–15 years	990	48.1
Sex		
Male	892	44.1
Female	1168	55.9
Race/color		
Non-black	1547	72.1
Black	498	27.9
Family income[a]		
+5 MMW	98	3.2
2–5 MMW	410	25.7
<2 MMW	970	71.1
Not known	582	–
Level of education[b]		
High	83	2.8
Average	750	47.7
Low	709	49.5
Not known	518	–
Low height-for-age		
No	1448	75.0
Yes	473	25.0
Not known	139	–
Posterior teeth loss		
No	1789	85.8
Yes	271	14.2
Duration of breastfeeding		
0–6 months	1197	73.6
>6 months	405	26.4
Not known	558	–
Duration of bottle feeding		
0–6 months	248	15.7
>6 months	1254	84.3
Not known	558	–
Duration of finger sucking		
0–6 years	1390	87.2
>6 years	214	13.8
Not known	456	–
Duration of pacifier sucking		
0–6 years	1489	92.7
>6 years	107	7.3
Not known	464	–
Duration of mouth breathing		
0–6 years	966	62.7
>6 years	588	37.3
Not known	506	–
Duration of bruxism		
0–6 years	1199	75.5
>6 years	380	24.5
Not known	481	–

Estimates were weighted for the design effect (deff) and for the inverse of the selection probability for the subjects.

[a] Values of the minimum monthly wage (MMW) between August and October 2004 (R$ 260.00).

[b] Level of education of the head of the family: low (illiterate until primary education not completed), average (primary education completed until secondary education completed) and high (graduation not completed until postgraduate completed).

No association was found between duration of breastfeeding and malocclusion according to the Angle classification in the univariate model. However, bottle feeding for more than 12 months was associated with an increase in the odds of class III (Angle) malocclusion (OR = 1.54). There was a trend for the prevalence of class III (Angle) malocclusion to increase as the level of education of the head of the family fell. A greater prevalence of class II (Angle) malocclusion was observed among adolescents who had lost posterior teeth (OR = 1.41) and had a history of mouth breathing until after the age of 6 years (OR = 1.43) (Table 2).

FB/BSP (OR = 0.58), low family income (OR = 0.39) and low height-for-age (OR = 0.62) were associated with reduced odds of a concave facial profile. The prevalence of concave facial profile was 73% higher in female than male adolescents (OR = 1.73). Digit sucking for more than 6 years old was associated with increased odds of a convex facial profile (OR = 2.55) (Table 3).

Analysis of the multivariate relationship between breastfeeding and malocclusion revealed a first-order interaction between breastfeeding and bruxism (P = 0.03). While a concave profile was more common among female adolescents (OR = 1.73), a severe convex profile was observed more frequently in adolescents with a history of digit sucking until after the age of 6 years (OR = 2.55) (Table 2). Class II (OR = 3.14; CI: 1.28–7.66) and III (OR = 2.78; CI: 1.21–6.36) malocclusions were more frequent among adolescents who had been breast-fed for less than 6 months and had a history of bruxism until after the age of 6 years than among those who were breast-fed for more than 6 months and did not have a history of bruxism for a long period after adjustment for age, gender, family income, level of education of the head of the family, bottle feeding, digit sucking, pacifier sucking and mouth breathing (Table 4).

A history of mouth breathing until after the age of 6 years modified the effect of breastfeeding on the odds of severe convex or concave facial profiles (P = 0.02). A history of FB//BSP behaved as a protection factor for a concave profile (OR = 0.43; CI: 0.21–0.88) and had increased the prevalence of severe convex profile (OR = 3.4; CI: 0.63–18.26) only among adolescents with a history of mouth breathing for longer than 6 years, after adjustment for the confounding variables (Table 5).

4. Discussion

We found an association between failure to breast-feed/breastfeeding for a short period (FB/BSP) and an increased prevalence of class II and III (Angle) malocclusions only in adolescents with a history of bruxism until after 6 years of age. A relationship between breastfeeding and type of facial profile was also observed only in adolescents with a long history of mouth breathing.

These results agree with the existing body of knowledge suggesting that breastfeeding is an important physiological factor in the development of anatomical and physical structures in the maxillomandibular complex [6,14,40]. Adequate breastfeeding is associated with growth of the lower jaw during the first years of life [5,11,24] and with a good shape of the dental arch [19,24], resulting in a lower prevalence of dental and skeletal malocclusions [6,11,19,41]. Fabac et al. [42] evaluated 272 children who have been divided into two groups according to the way they were fed and confirmed a statistically significant link between

Table 2
Frequency of malocclusions (according to Angle) and unadjusted association between malocclusions and covariates in 2060 adolescents. Salvador, BA, Brazil, 2004.

Variables	Class I		Class II		Class III		*P*-value	deff	Class II		Class III	
	n	%	*n*	%	*n*	%			OR	95% CI	OR	95% CI
Duration of breastfeeding							0.99[a]	2.28				
0–6 months	695	73.6	211	74.0	291	73.3			1.02	0.61–1.71	0.99	0.68–1.43
>6 months	233	26.4	67	26.0	105	26.7			Ref.		Ref.	
Not known	260	–	129	–	69	–						
Duration of bottle feeding							**<0.01**[a]	1.55				
0–12 months	627	65.8	170	58.1	233	55.6			Ref.		Ref.	
>12 months	302	34.2	106	41.9	164	44.4			1.39	0.98–1.97	**1.54**	**1.14–2.08**
Not known	259	–	131	–	68	–						
Posterior teeth loss							**0.05**[a]	0.85				
No	1043	87.1	344	82.6	402	85.6			Ref.		Ref.	
Yes	145	12.9	63	17.4	63	14.4			**1.41**	**1.10–1.82**	1.13	0.81–1.56
Duration of mouth breathing							**0.06**[a]	1.16				
0–6 years	573	64.3	149	55.7	244	63.8			Ref.		Ref.	
>6 years	331	35.7	119	44.3	138	36.2			**1.43**	**1.03–1.99**	1.02	0.78–1.32
Not known	284	–	139	–	83	–						

Unadjusted OR, odds ratio; 95% CI, 95% confidence interval; Ref., reference category. Bold values represent statistically significant estimates ($P < 0.05$).
Only statistically significant covariates were kept ($\alpha = 5\%$). Estimates were weighted for the design effect (deff) and for the inverse of the selection probability for the subjects.
[a] Pearson's chi-square test.

Table 3
Frequency of types of facial profiles (according to Angle) and unadjusted association between types of facial profile and covariates in 2060 adolescents. Salvador, BA, Brazil, 2004.

Variables	Normal		Convex		Concave		P-value	deff	Convex		Concave	
	n	%	*n*	%	*n*	%			OR	95% CI	OR	95% CI
Duration of breastfeeding							**0.06**[b]	2.21				
0–6 months	1036	74.8	31	77.9	130	63.2			1.19	0.37–3.85	**0.58**	**0.38–0.88**
>6 months	338	25.2	11	22.1	56	36.8			Ref.		Ref.	
Not known	385	–	8	–	65	–						
Sex							**<0.01**[b]	1.34				
Male	777	45.4	28	58.2	87	32.5			Ref.		Ref.	
Female	982	54.6	22	41.8	164	67.5			0.60	0.33–1.08	**1.73**	**1.25–2.40**
Family income[a]							**0.05**[b]	1.39				
+5 MMW	70	2.8	5	6.2	23	6.3	**<0.01**[c]		Ref.		Ref.	
2–5 MMW	344	25.2	11	26.1	55	29.3			0.45	0.15–1.41	0.51	0.24–1.09
<2 MMW	856	72.0	24	67.7	90	64.4			0.41	0.13–1.39	**0.39**	**0.18–0.84**
Not known	489	–	10	–	83	–						
Low height-for-age							**0.01**[b]	0.86				
No	1219	74.0	36	72.4	193	82.0			Ref.		Ref.	
Yes	421	26.0	12	27.6	40	18.0			1.08	0.56–2.09	**0.62**	**0.45–0.85**
Not known	119	–	2	–	18	–						
Duration of digit sucking							**0.02**[b]	1.29				
0–6 years	1203	87.6	30	73.5	157	86.8			Ref.		Ref.	
>6 years	175	12.4	11	26.4	28	13.2			**2.55**	**1.20–5.38**	1.08	0.69–1.67
Not known	381	–	9	–	66	–						

Unadjusted OR, odds ratio; 95% CI, 95% confidence interval; Ref., reference category. Bold values represent statistically significant estimates ($P < 0.05$).
Only statistically significant covariates were kept ($\alpha = 5\%$). Estimates were weighted for the design effect (deff) and for the inverse of the selection probability for the subjects.
[a] Values of the minimum monthly wage (MMW) between August and October 2004 (R$ 260.00).
[b] Pearson's chi-square test.
[c] Trend test.

Table 4
Association between breastfeeding and malocclusion (Angle) in permanent teething by history of bruxism in 2060 adolescents. Salvador, BA, Brazil, 2004.

	No history of bruxism, or had bruxism but stopped by the age of 6 years			Had bruxism until after the age of 6 years		
	OR[a]	95% CI	*P*-value	OR[a]	95% CI	*P*-value
Class II malocclusion	0.70	0.36–1.35	0.28	**3.14**	**1.28–7.66**	**0.01**
Class III malocclusion	0.76	0.52–1.11	0.15	**2.78**	**1.21–6.36**	**0.01**

Bold values represent statistically significant estimates ($P < 0.05$).
[a] Odds ratio adjusted for age, sex, family income, level of education of the head of the family, use of a bottle, digit-sucking, pacifier-sucking and mouth-breathing.

Table 5
Association between breastfeeding and type of facial profile in adolescents between 12 and 15 years of age by history of mouth-breathing in 2060 adolescents. Salvador, BA, Brazil, 2004.

	No history of mouth-breathing, or had the habit but stopped by the age of 6 years			History of mouth-breathing until after 6 years of age		
	OR[a]	95% IC	*P*-value	OR[a]	95% IC	*P*-value
Severe convex profile	1.04	0.25–4.43	0.95	**3.40**	**0.63–18.26**	**0.14**
Concave profile	0.64	0.35–1.18	0.15	**0.43**	**0.21–0.88**	**0.02**

Bold values represent statistically significant estimates ($P < 0.05$).
[a] Odds ratio adjusted for sex, color, family income, anthropometric failure, history of digit-sucking, bruxism and bottle-feeding.

breastfeeding for less than 6 months and Angle class II malocclusion; this evidence corroborates the findings of the present study.

Breastfeeding produces stresses and relaxation in the perioral musculature that act as a neuromuscular stimulus during mandibular growth and remodeling [2]. According to Moss [8], bone and cartilage grow in response to functional relationships between structures known as "functional matrices" [8]. The resulting mandible osteogenic process would occur in two ways: endochondral or intramembranous ossification [7]. Natural breastfeeding favors especially the endochondral ossification in cartilaginous tissue at the head of the condylar process [7]. This would therefore explain how FB/BSP could adversely affect mandibular growth, resulting in a potentially smaller, retropositioned bone, which in turn would influence the relationship between the alveolar processes and teeth [4], and a potentially more convex profile, as observed in our study. Sanchez-Molins et al. [4], evaluating lateral teleradiographs of the cranium of 197 patients, observed that subjects belonging to the breast-fed group presented a tendency to a retruded mandibular bone in the bottle-fed group, resulting in class II and convex profile. Another investigation in 226 children has observed that those who had enjoyed mixed feeding (breast/bottle combination) had a great length of the anterior maxillary arch and a significantly greater depth of the palatal arch than children receiving breast-feeding alone [24]. These results reinforce our findings.

On the other hand, Luz et al. [20] did not indicate a statistically significant association between breastfeeding duration and mandibular deficiency or class II malocclusion among 249 children in the mixed dentition. However, statistically significant associations were found between short breastfeeding duration (<6 months) and nonnutritive sucking habits, and between nonnutritive sucking habits and class II malocclusions. The same was found by Warren and Bishara [16], that collected data on 372 children followed longitudinally from birth to 5 years. Differences in the results can be due to the sample size and design, different age groups and analytical methods.

Another important discovery made in this study relates to the interaction between FB/BSP and POH on the development of malocclusions. To our knowledge, these results are unprecedented in the literature, as studies of the effects of breastfeeding on dental and skeletal occlusion traditionally fail, with certain exceptions [10,11,41,43], to assess confounding bias or interactions and instead merely observe the unadjusted associations between variables. In this sense, some studies report an unadjusted association between FB/BSP and Angle malocclusion [19], between bruxism and Angle malocclusion [44,45], and between mouth breathing and malocclusions [46]. Mouth breathers demonstrated considerable backward and downward rotation of the mandible, increased overjet [47], such as skeletal class II or class III facial profiles [48], compared to the nasal breathers group. However, all these results are not based on multivariate analysis.

The results of our study highlight the importance of taking into account multiple relationships and interactions between variables when carrying out studies in this area. They also suggest that in the absence of other risk factors, FB/BSP may not affect maxillomandibular growth or the development of malocclusion. However, breastfeeding in association with POH appears to have a synergetic effect on the development of occlusofacial problems. This would also go some way to explaining why most studies to date have failed to record associations between such events. An interaction effect of breastfeeding and pacifier sucking habits on the prevalence of malocclusion was also recorded in a previous study [41].

Sucking the breast places great demands on the perioral musculature. The constant repetitive effort promotes the correct development of this musculature, increasing its tone and ensuring that correct oral functions are established [1,9]. FB/BSP results in the child doing fewer oral exercises, leading to underdevelopment of the muscles, incorrect posture of the lip and tongue, and favoring the acquisition of bad oral habits [1,2,9,49,50]. So, we can speculate that POH, as bruxism and mouth breathing, would have stronger effects in children exposed to FB/BSP than in those who have been breastfed for long enough.

It has recently been suggested that the relationship between breastfeeding and dental occlusion is not direct, but is mediated by bad oral habits. So, FB/BSP is associated with POH [1,18,20,21,49,50], and these habits constitute one of the most important environmental factors involved in the genesis of malocclusions [11,12,16,17,19,21,49,50]. Theories that endeavor to explain this trend suggest that children who are naturally breast-fed satisfy their sucking needs and thus have less need to suck a pacifier, digit or other object [13,49]. In addition, by satisfying their psychological and affective requirements through close, intimate contact with the mother when breast-feeding, the child becomes calmer and has less need to search for other objects commonly used for oral satisfaction [49,50].

In spite of the precautions adopted as part of the methodology in this study, the possibility of memory bias cannot be ruled out. Such bias is inherent to cross-sectional studies and contributes to systematic classification errors, especially in relation to the duration of risk factors for dental malocclusions, such as maternal breastfeeding. However, when information provided by mothers about the duration of breastfeeding was validated using studies that compared prospective and retrospective information, there was strong evidence that this information, which was based on short-term memory (<10 years), was reliable [51,52]. A study of a Brazilian cohort [52] reported 70% concordance for breast-feeding for 3 months and 79% concordance for breast-feeding for 1 month when the respondents were asked again, when the child was 4 years old, about the duration of breastfeeding. But, concordance was considered weak when 30 or 50 years had passed since the child was breast-fed [52].

In order to safeguard the internal validity of this study, three other arguments must be considered. Firstly, the duration of breastfeeding was classified in broad categories (up to 6 months or longer than 6 months), thus avoiding the more detailed recollec-

tions that would be required for more narrowly defined categories, and reducing memory bias. Secondly, we investigated the total duration of breastfeeding rather than the period during which the infant was only breast-fed, information that is both more complex and more difficult to collect. Thirdly, the results of a study of preschool children in Salvador (BA, Brazil) in 2001 indicated that almost 50% of children under the age of 2 years were breast-fed for approximately 4.5 months and that 3.5% had never breast-fed [53]; this is in line with the prevalence of 74.7% for the condition "never breast-fed or breast-fed up to the age of 6 months" observed in this study. Observer bias is also unlikely to have been present, as the observers were unaware of the exposure status of the students when the oral examinations were carried out and had also been exhaustively trained in how to collect the data.

Although the exposure being investigated took place before the outcomes that were analyzed, as breastfeeding occurs before teeth begin to appear, the evidence that breastfeeding plays a protective role against the development of malocclusions must be interpreted with caution, as the transverse nature of this study means that an association between these events can only be indicated.

However, irrespective of the mechanisms through which breastfeeding and occlusofacial alterations are related, our results highlight the benefits to oral health of maternal breastfeeding until after the age of 6 months. They also indicate that FB/BSP alone seems not to be directly associated with malocclusions, but it may have a synergetic effect with POH on the development of occlusofacial problems. These findings thus reinforce the arguments for the prevention of bad oral habits, especially among children who have not been fed at their mother's breast or were breast-fed for a short period.

Conflict of interest

The authors report no commercial, proprietary, or financial interest in the products or companies described in this article. There is no conflict of interest.

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