

Bottle feeding, increased overjet and Class 2 primary canine relationship: is there any association?

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Abstract: The aim of this study was to investigate the association between bottle feeding and prevalence rates of increased overjet and Class 2 primary canine relationship. The sample consisted of 911 children (461 boys, 450 girls) aged 3 (13.9%), 4 (40.8%), 5 (34%) and 6 (11.3%) years, with complete primary dentition. Information about nutritive and nonnutritive (pacifier and/or digit) sucking habits was collected through questionnaires. Three calibrated dentists (κ : 0.9-1.0 and $R_s > 0.90$) performed the clinical assessments. The children were divided into four groups: G1 – not bottle-fed; G2 – exclusively bottle-fed; G3 – breast- and bottle-fed, bottle feeding ceased before 3 years of age; and G4 – breast- and bottle-fed, bottle feeding ceased between 3 and 4 years of age. Associations between nutritive and nonnutritive sucking behaviors and the malocclusions studied were analyzed by multiple binary logistic regression ($\alpha = 0.05$). The frequencies of increased overjet were: 25.3% (G1), 38.8% (G2), 39.2% (G3) and 47.8% (G4). The percentages of Class 2 canine relationship were: 27.9% (G1), 48.8% (G2), 43.4% (G3) and 43% (G4). No significant effect of bottle feeding was found. The chances of diagnosing increased overjet (O.R. = 4.42, $p < 0.001$) and Class 2 canine relationship (O.R. = 4.02, $p < 0.001$) were greater for children with pacifier and/or digit-sucking habits, compared to those without a history of nonnutritive sucking behavior. It may be suggested that bottle feeding alone is not directly associated with higher prevalence rates of increased overjet and Class 2 canine relationship in the primary dentition.

Descriptors: Bottle Feeding; Sucking Behavior; Malocclusion; Dentition, Primary.

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Introduction

Breast milk provides all the nutrients that newborn children require in the first six months of life.^{1,2} Breast-feeding promotes nasal breathing from proper use of the sucking function, where the lips remain completely in contact with the mother's breast and the nose is stimulated to initiate inspiration and expiration respiratory movements.³ This kind of breathing stimulates growth of the maxilla, since the air pressure created in the maxillary sinus expands its limits.

Bottle feeding, allergic rhinitis and nonnutritive sucking habits have been associated with malocclusions in the primary dentition.^{4,5} It was observed that 53% of bottle-fed children presented myofunctional altera-

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tions from the tongue's resting on the mandibular arch or between the dental arches, indicating muscle hypotonicity.⁶ With the use of artificial nipples, there is lack of palatal support from the tongue and increased activity of the cheeks. The dynamic balance between the influence of the tongue and that of the cheeks is upset, resulting in a broader mandibular arch.⁷ Alteration of the oral motor development brought on by bottle feeding may negatively affect mastication, deglutition, breathing and speech-sound articulation, as well as promote malocclusion.⁸

Several authors have pointed out that bottle-fed children have a strong tendency to develop a pacifier-sucking habit.⁹⁻¹² Nutritive and nonnutritive sucking habits, namely bottle feeding and pacifier use, are associated to an atypical swallowing pattern, with tongue thrusting, which may be related to the development of malocclusions such as posterior crossbite.^{5,7} However, while some authors have focused on the relationship between pacifier use and malocclusion in the primary dentition,^{13,14} the degree of association between bottle feeding and the prevalence of occlusal alterations in the sagittal plane is still subject to conjecture. Thus, the aim of the present study was to assess a possible association between bottle feeding duration and the prevalence of both increased overjet and Class 2 canine relationship, in the primary dentition. The study groups were established based on previous research, which indicated a beneficial influence of breastfeeding without the use of artificial nipples on occlusion;¹⁵ which recommended nonnutritive sucking habit cessation at 2 or 3 years of age,^{13,14} and which demonstrated that bottle feeding is discontinued at a higher frequency between 3 and 4 years of age.⁹

Methodology

This epidemiological study was conducted in accordance with the ethical principles foreseen in Resolution 196/96 of the Brazilian National Health Council.

Sample

The parents of a total of 2,700 children aged 3 to 6 years, of both genders, attending 11 public schools in São Paulo City, Southeastern region of

Brazil, received a free and informed consent form to participate in the study. The mothers were asked to answer a questionnaire containing items about infant feeding methods and nonnutritive sucking habits. A pilot study was conducted to test the consistency of the information obtained. Thirty mothers answered the questionnaire twice, with an interval of 6 months between the first and second surveys. The whole study presented variables with a high degree of reliability, and the Kappa coefficient values (κ) were approximately 0.93. These questionnaires were not included in the present study sample.

In this study, 1,758 mother-child dyads were excluded because the mothers did not sign the consent form, did not return the questionnaires or filled them out incorrectly, or else the children did not allow clinical examination or did not meet the research criteria. All of the children included in the sample met the following criteria:

- never underwent orthodontic treatment or speech-language therapy;
- readily accepted clinical examination;
- had complete primary dentition, with no erupted or erupting permanent teeth;
- had no extensive caries lesions, crown destruction or proximal restorations that could compromise occlusion;
- had no early primary tooth loss and/or dental anomalies; and
- had no cleft lip or palate, or any other developmental anomaly that could preclude breast-feeding.

The sample consisted of children diagnosed with symmetrical primary canine relationships, i.e., on the right and left sides. The last inclusion criterion was based on a clinical standpoint, because if a Class 2 or Class 3 primary canine interarch relationship is diagnosed on one side, the child has an occlusal alteration, even if there is a Class 1 canine relationship on the opposite side. Furthermore, considering that the Class 3 primary canine relationship has not been related to nutritive and nonnutritive sucking habits, children presenting this symmetrical occlusal feature ($n = 31$) were also excluded. Hence, the final study sample comprised 911 children.

Based on questionnaire data, the demographic and socioeconomic characteristics indicated that the population studied had a low to medium income level and consisted of a culturally homogeneous sample. In general, the families had two or more children at home; most parents were not college graduates and reported relatively low salaries.

Occlusal features

The clinical assessments were conducted in the school environment, with the children seated, under an adequate source of artificial light. During the clinical examinations, the children were instructed to remain in maximal habitual intercuspation. Overjet was measured directly in the children's mouth, using millimetric disposable orthodontic rulers (Morelli®, Sorocaba, SP, Brazil), and was classified as:¹⁶

- Normal (horizontal space between maxillary and mandibular central incisors not exceeding 2 mm, or equal to zero);
- Increased (horizontal space between maxillary and mandibular central incisors in excess of 2 mm);
- Anterior crossbite: the mandibular central incisors were positioned anteriorly to the maxillary central incisors, in an inverted relationship.

The primary canine relationships were categorized as:¹⁶

- Class 1: the cusp of the maxillary canine was on the same plane as that of the distal surface of the mandibular canine;
- Class 2: the cusp of the maxillary canine was positioned anteriorly to the distal surface of the mandibular canine;
- Class 3: the cusp of the maxillary canine was positioned posteriorly to the distal surface of the mandibular canine.

Study groups

After clinical assessments, and based on the inclusion criteria, the children were divided into 4 groups:

- G1: not bottle-fed children;
- G2: exclusively bottle-fed children;

- G3: children who received breast and bottle feeding, bottle feeding discontinued before 3 years of age;
- G4: children who received breast and bottle feeding, bottle feeding discontinued between 3 and 4 years of age.

Statistical methods

For statistical purposes, normal overjet and Class 1 canine relationship were analyzed in relation to increased overjet and Class 2 canine relationship, respectively, since these malocclusions may be associated to sucking behaviors in childhood.¹⁴ Multiple binary logistic regression models were adjusted to analyze the effects of bottle feeding and other independent variables, i.e., exclusive breast-feeding (discontinued before 6 months *versus* sustained for periods equal to or longer than 6 months), gender (male *versus* female) and nonnutritive sucking habits (no history *versus* a history of pacifier and/or digit-sucking habits).^{1,2,4,9,13,14} The reference categories were: G1 (not bottle-fed), *breast-feeding for less than 6 months*, *male*, and *no history of nonnutritive sucking habits*. The significance level was set at 0.05.

Results

Reliability of the occlusal assessments

Three calibrated dentists, who were unaware of the questionnaire data, performed the clinical examinations. Training and calibration involved occlusal examination of 24 children (who were not included in the study sample) on two different occasions, with a 15-day interval between the first and second assessments. Kappa coefficients (κ) ranging from 0.9 to 1.0 were obtained for the three dentists, indicating a good level of intra-examiner agreement. Spearman correlation coefficient values (R_s) greater than 0.90 were obtained for each pair of examiners, demonstrating homogeneity of the diagnoses performed.

Study sample distribution

In the total sample, the percentages of boys ($n = 461$) and girls ($n = 450$) were similar (50.6% and 49.4%, respectively). The frequencies of boys

and girls in the study groups presented small variations, except for G1 and G3. The percentage of girls in G1 was higher (22.7% *versus* 17.6%). The opposite was observed in G3, since 28.4% were boys and 21.6% were girls. Most of the children were 4 (40.8%) or 5 (34%) years old. Only 11.3% were 6 years old.

Bottle feeding versus increased overjet and Class 2 canine relationship

In the total sample, normal overjet was the most prevalent feature (58.7%), followed by increased overjet (39.5%). Only 16 children (1.8%) had anterior crossbite. A Class 1 canine relationship, considered as the satisfactory pattern in the primary dentition, also occurred in more than half of the sample (59.4%).

Although the prevalence rates of increased overjet and Class 2 primary canine relationship were higher in G2, G3 and G4 (bottle-fed children) than in G1 (not bottle-fed children), no significant effect of bottle feeding was found (Tables 1 and 2). No significant differences were observed between subgroups of children who received exclusive breast-feeding (for periods shorter than, equal to or longer than 6 months) and genders (Tables 1 and 2). Nonetheless, nonnutritive sucking habits were significantly associated with higher frequencies of increased overjet and a Class 2 primary canine relationship.

Children with a positive history of pacifier use and/or digit-sucking habits were found to have 4.42 times more chance of presenting increased overjet, when compared to those without history of nonnutritive sucking behavior (Table 1). A similar finding was observed for Class 2 canine relationship (Table 2). Children with pacifier and/or digit-sucking habits were found to have a fourfold increased chance of presenting a Class 2 canine relationship, compared with those children in the no-such-habits subsample.

Discussion

No significant associations were demonstrated between bottle feeding and high prevalence rates of the malocclusions studied (Tables 1 and 2). Although bottle feeding, even among breast-fed children, may interfere negatively with orofacial development,⁶ this infant feeding method seems not to be directly associated with some types of malocclusions. A study conducted in a subsample of children aged 2-6 years with no history of nonnutritive sucking habits found no significant associations between the presence of an overjet greater than 3 mm and bottle feeding.¹¹

Besides the specific objective of this study – to investigate the strength of the association among bottle feeding, increased overjet and Class 2 primary canine relationship – other independent and con-

Table 1 - Logistic regression model for the prevalence rates of increased versus normal overjet (n = 895).

Independent variables	Categories	Overjet				Logistic regression		
		Normal		Increased		OR	(95% C.I.)	p-value
		n	%	n	%			
Groups	G1	136	74.7	46	25.3	-	-	-
	G2	52	61.2	33	38.8	0.94	(0.49-1.83)	0.863
	G3	135	60.8	87	39.2	1.02	(0.61-1.70)	0.953
	G4	212	52.2	194	47.8	1.49	(0.94-2.38)	0.092
Breast-feeding	< 6 months	292	55.9	230	44.1	-	-	-
	≥ 6 months	243	65.1	130	34.9	1.31	(0.91-1.87)	0.144
Gender	Male	266	58.6	188	41.4	-	-	-
	Female	269	61.0	172	39.0	0.92	(0.69-1.22)	0.548
Pacifier/Digit-sucking	No history	270	79.2	71	20.8	-	-	-
	Pacifier and/or Digit habits	265	47.8	289	52.2	4.42	(3.07-6.34)	0.000

Table 2 - Logistic regression model for Class 2 versus Class 1 primary canine relationships (n = 911).

Independent variables	Categories	Canine Relationship				Logistic regression		
		Class 1		Class 2		OR	(95% C.I.)	p-value
		n	%	n	%			
Groups	G1	132	72.1	51	27.9	-	-	-
	G2	44	51.2	42	48.8	1.45	(0.77-2.76)	0.253
	G3	129	56.6	99	43.4	1.20	(0.73-1.98)	0.476
	G4	236	57.0	178	43.0	1.16	(0.74-1.83)	0.519
Breast-feeding	< 6 months	297	56.0	233	44.0	-	-	-
	≥ 6 months	244	64.0	137	36.0	1.41	(0.99-2.00)	0.055
Gender	Male	276	59.9	185	40.1	-	-	-
	Female	265	58.9	185	41.1	1.10	(0.83-1.45)	0.510
Pacifier/Digit-sucking	No history	271	77.4	79	22.6	-	-	-
	Pacifier and/or Digit habits	270	48.1	291	51.9	4.02	(2.83-5.71)	0.000

foundings variables, such as exclusive breast-feeding duration, gender and a history of nonnutritive sucking habits (pacifier and/or digit-sucking), were assessed because they could have some relation with both bottle feeding and malocclusions.^{4,5,9-11,13-15,17,18} Not surprisingly, no significant effects were found for breast-feeding duration and gender. However, children with positive history of pacifier and/or digit-sucking habits were found to be 4.42 times more susceptible to the development of increased overjet (95% C.I., 3.07-6.34, $p < 0.001$) and to have a fourfold greater chance of presenting Class 2 canine relationship (95% C.I., 2.83-5.71, $p < 0.001$), compared to children without any history of nonnutritive sucking behavior (Tables 1 and 2).

Exclusive bottle feeding may be related to inadequate muscular stimuli for proper mandibular development.¹⁹ However, as it happens with breast-feeding, the effects of bottle feeding in the developing occlusion are difficult to assess because pacifier use intertwines with this artificial infant feeding method. Bottle feeding was found to be strongly connected to pacifier use between 3 and 4 years of age.⁹ This nonnutritive sucking habit has often been implicated in the etiology of malocclusions diagnosed in the primary dentition.^{4,5,13-15}

In fact, there is evidence of a complex interplay among breast-feeding, bottle feeding, nonnutritive sucking habits (specially pacifier use), irregular

orofacial functions and malocclusions.^{3-7,9-11,13-15,17,18} Prolonged breast-feeding is related to lower frequencies of nonnutritive sucking habits.^{4,9,15} Nevertheless, early weaning has been associated to the introduction of artificial nipples for nourishment or only for calming the child.¹ Regarding occlusal alterations, it has been estimated that bottle-fed children have five times higher chances of developing malocclusions as compared with those who are breast-fed.¹⁰ During breast-feeding, mostly the masseter and temporalis muscles are used, and their activities stimulate facial development favorably, with form and function balance.^{4,19} Bottle feeding would contribute to the development of malocclusions through three different mechanisms:

1. alteration of the direction of growth and of the development of the facial bones during childhood,
2. an increased tendency towards an atypical swallowing pattern and
3. higher prevalence rates of nonnutritive sucking habits (digit and pacifier-sucking).¹²

A Danish study¹⁷ showed that children with tongue-thrust and teeth-apart swallowing patterns had increased frequencies of extreme maxillary overjet, which was associated with digit-sucking. Many authors agree that nonnutritive sucking habits, even of a short duration, may have an indirect

effect through their association with an abnormal swallowing pattern, as well as a direct influence in the etiology of malocclusions.^{17,18} The results of a longitudinal Slovenian study¹⁸ demonstrated that sucking behavior (digit or pacifier-sucking, bottle feeding) that persisted at 5 years of age was statistically significant for an atypical swallowing pattern at 6-9 years of age. Accordingly, an atypical swallowing pattern at 6-9 years of age was significantly correlated with a morphological malocclusion severity score at 12 years of age. At an older age, malocclusion severity is also related to incorrect orofacial functions at an early stage of dental development.¹⁸ Therefore, sucking habits may influence morphology and function in the developing occlusion.

According to Tables 1 and 2, expressive percentages of children with histories of bottle feeding and nonnutritive sucking habits were diagnosed with increased overjet (38.8% to 52.2%) and a Class 2 canine relationship (43% to 51.9%). In the primary

dentition, increased overjet may self-correct when nonnutritive sucking and/or artificial nipple use are discontinued. Nevertheless, a Class 2 canine relationship requires professional follow-up and may need interceptive orthodontic treatment. Although longitudinal studies with large samples are needed to clarify the effect of bottle feeding on the development of both the stomatognathic system and occlusion on the three spatial planes – sagittal, transversal and vertical – the results of this study provide evidence for supporting the importance of encouraging breast-feeding to prevent the establishment of nonnutritive sucking behaviors.

Conclusion

According to the results of this study, it may be suggested that bottle feeding alone is not directly associated with higher prevalence rates of increased overjet and Class 2 canine relationship in the primary dentition.

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