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Effects of feeding on non-nutritive sucking habits and implications on occlusion in mixed dentition

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Background. Several studies have determined the effects of non-nutritive sucking habits on malocclusions, but provided conflicting results.
Aim. To analyse the influence of infant feeding In the presence of non-nutritive sucking habits in children after the first year of life and to assess the effects of non-nutritive sucking habits on occlusion in mixed dentition.
Design. Data were collected by self-reported questionnaire and confirmed by personal interview. Parents of 1451 children (aged 7–11) were asked about their children's infant feeding and non-nutritive sucking habits. A clinical evaluation of dental arches included classification of molar relationship (Angle classification), presence or absence of crossbite and open bite.
Results. Children with bottle or complementary feeding showed a higher risk of acquiring non-nutritive sucking habits after the first year of life ($P < 0.01$). Non-nutritive sucking habits are associated with a greater risk of crossbite, open bite, Class II molar relationship ($P < 0.01$).
Conclusions. Parents should be educated about benefits of the exclusive breast feeding in the first 6 months of age on mixed dentition. The activity of non-nutritive sucking should be diagnosed in a timely manner in order to reduce the development of posterior crossbite, anterior open bite, and Class II molar relationship.

Introduction

The development of the cranio-facial complex (jaws, dental arches, tongue, facial muscles) results from the interaction between genetic and environmental factors[1,2]. Early sucking activity may influence the growth of the cranio-facial complex and several studies have investigated the effects that nutritive and non-nutritive sucking has on it. It has been suggested that longer breastfeeding may be associated with fewer occlusal abnormalities[3–5]. It is clear that breast-feeding and bottle-feeding involve different oro-facial muscles, possibly leading to different effects on the harmonic growth of maxilla and dental arches[6].

Several studies have suggested that non-nutritive sucking (usually in the form of dummies/pacifiers or thumb-sucking) may be responsible for some forms of infancy malocclusion, including anterior open bite, increased overjet, and posterior crossbite[7–20]. These malocclusions are problematic and sometimes costly to treat; therefore, it is important to assess the effects of non-nutritive sucking habits on occlusion in order to prevent the development of such malocclusions in a timely manner.

Most studies, however, focus on the effects of non-nutritive sucking activity in primary dentition[7–15] and only few studies have determined the effects of non-nutritive sucking behaviour in mixed dentition[16–20] and provide conflicting results.

The aim of this study was to analyse the influence of breast-, bottle-, and complementary feeding on the presence of non-nutritive sucking habits in children after the first year of life and to assess the effects of non-nutritive sucking habits on occlusion in mixed dentition.

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Material and methods

Subjects and questionnaire

A group of 2303 white Caucasian children was recruited from a school project related to oral health monitoring; they were aged between 7 and 11 (mean age 9.5 ± 1.2), 1123 were males and 1180 were females. Fifty-eight children were excluded because they had cleft lip and palate, 63 because they had some forms of disability, and 499 either because they were undergoing orthodontic and/or orthopaedic treatment or because they had temporomandibular joint disorders. The parents of 232 children refused to participate in this study. Therefore, our sample included 1451 children, 687 were males and 764 were females with a mean age of 9.1 ± 1.3.

Data were collected by self-reported questionnaire and confirmed by personal interview. The study was approved by the Ethics Committee of the Second University of Naples. All parents provided written informed consent with guarantees of confidentiality. During the interview, the interviewer reviewed the parents' answers on the self-reported questionnaire for completeness and internal consistency. The main questions concerned the age and sex of the children, their past breast-, bottle-, or complementary feeding, their non-nutritive sucking habits, and the duration of them; more specifically, the questions were about whether the children regularly sucked on pacifiers, finger, or other objects.

Depending on the parents' answers, the sample of 1451 children was divided into three groups in relation to the type of feeding received: *exclusive breast-feeding*: children who were exclusively breast-fed from birth up to a maximum of 6 months of age; *exclusive bottle-feeding*: children who were exclusively bottle-fed from birth up to a maximum of 6 months of age; *complementary bottle-feeding*: when bottle feeding was given in addition to breast-feeding during the first 6 months of life. Each of these groups was divided into four further groups according to the kind of non-nutritive sucking habit. Non-nutritive sucking habits were considered if a child had sucked on an object (usually a digit or a dummy/pacifier) not related to feeding for longer than the first year of life.[9] *Group1*: (group1a) children with a finger-sucking habit that lasted longer than the first year of life and ceased by 3 years of age; (group1b) children with a finger-sucking habit that lasted longer than the first year of life but continued beyond 3 years of age. *Group2*: (group2a) children with a pacifier/object-sucking habit that lasted longer than the first year of life and ceased by 3 years of age; (group2b) children with a pacifier/object-sucking habit that lasted longer than the first year of life and continued beyond 3 years of age. *Group3*: (group3a) children with both a finger and a pacifier/object sucking habit that lasted longer than the first year of life and ceased by 3 years of age and (group3b) children with both a finger and a pacifier/object sucking habit that lasted longer than the first year of life and continued beyond 3 years of age. *Group4*: children with no non-nutritive sucking habits or with non-nutritive sucking habits that lasted less than 12 months.

Dental arches evaluation

Forty-five children refused to undergo the oral examination, therefore, clinical data were obtained for 1406 of 1451 children, 663 were males, 743 were females, and mean age was 9.1 ± 1.5. Dental examinations were carried out by using a mirror, an explorer, and an ordinary examination light. Clinical assessment was performed in centric occlusion by a previously calibrated examiner and, in each case, the examiner was kept blind to the child's questionnaire data. Dental arches evaluation included classification of permanent molar relationship (Angle classification), presence or absence of posterior crossbite and anterior open bite. An anterior open bite was recorded when, in centric occlusion, there was a lack of vertical overlap of more than 3 mm between the incisors. A posterior crossbite was recorded when the buccal cusp of one or more of the mandibular molars occluded buccal to the opposing maxillary teeth.

Statistical analysis

The Chi-square test or Fisher's exact test was used for the comparison between different groups. The odds ratio (OR) was evaluated by logistic regression. All analyses were conducted by using Statgraphics Centurion XV.II (Warrenton, VA, USA). Significance was set at the 1% level.

Results

Of 1451 children, 879 were exclusively breast-fed (61%), 235 were exclusively bottle-fed (16%), and 337 were complementary fed (23%). As many as 48% of breast-fed children had sucking habits after the first year of life whereas 74% of bottle-fed children and 61% of complementary fed children had sucking habits after the first year of life. Children with bottle- or complementary feeding showed a higher risk of having non-nutritive sucking habits after the first year of life [respectively OR 3.06; $P < 0.01$; 95% Confidence Interval (CI) 2.23–4.21 and OR 1.7; $P < 0.01$; 95% CI 1.32–2.2] (Table 1). From the results of this study, we can conclude that exclusive breast-feeding in the first 6 months of life decreases the risk of acquiring non-nutritive sucking habits after the first year of life.

Posterior crossbite was found in 46% of children with non-nutritive sucking habits (*Group1, 2, 3*) and in 15% of children with no non-nutritive sucking habits (*Group4*). Anterior open bite was found in 54% of children with non-nutritive sucking habits (*Group1, 2, 3*) and in 14% of children with no non-nutritive sucking habits (*Group4*) (Table 2). Compared with children in *Group4*, children in *Group1, 2 and 3* showed a higher risk of both posterior crossbite (OR 4.90; $P < 0.01$; 95% CI 3.78–6.35) and anterior open bite (OR 6.86; $P < 0.01$; 95% CI 5.28–8.91) (Table 2).

Compared with the finger sucking activity (*Group1*), the pacifier/object sucking (*Group2*) activity was responsible for a higher risk of determining a posterior crossbite (OR 1.72; $P < 0.01$; 95% CI 1.27–2.34). No statistically significant difference was found between the finger sucking activity (*Group1*) and the pacifier/object sucking (*Group2*) activity in determining open bite (OR 0.9; $P > 0.01$; 95% CI 0.7–1.2).

Crossbite was present in 39%, in 52%, and in 43% of *Group1a, Group2a,* and *Group3a* respectively and in 41%, in 55%, and in 43% of *Group1b, Group2b,* and *Group3b,* respectively. The percentage of posterior crossbite was not significantly greater as the duration of non-nutritive sucking habits continued beyond 3 years of age (OR 1.1; $P > 0.01$; 95% CI 0.8–1.5). Open bite was present in 50%, in 48%, and in 41% of *Group1a, Group2a,* and *Group3a,* respectively and in 64%, in 63%, and in 76% of *Group1b, Group2b,* and *Group3b,* respectively. Thus the percentage of open bite was significantly greater as the duration of non-nutritive sucking activity continued beyond 3 years of age (OR 2.04; $P < 0.01$; 95% CI 1.49–2.80) (Table 2).

The percentage of Class II molar relationship was higher in children with non-nutritive sucking habits (40%) than in children with no non-nutritive sucking habits (28%). Children with a history of non-nutritive sucking (*Group1, 2, 3*) compared with children with no history of non-nutritive sucking (*Group4*) showed a higher risk of Class II molar relationship (OR 1.7; $P < 0.01$; 95% CI 1.35–2.12). The percentage of Class III molar relationship did not increase significantly in children with non-nutritive sucking habits (7%) compared with children without these

Table 1. Effect of the type of feeding on the persistence of non-nutritive sucking habits in children after the first year of life.

	Breast feeding *N* (%)	Bottle feeding *N* (%)	Complementary feeding *N* (%)
Finger sucking habit	$P > 0.01$	$P < 0.01$	$P < 0.01$
Group1a < 3 years	137 (16)	44 (19)	54 (16)
Group1b > 3 years	64 (7)	27 (12)	31 (9)
Pacifier/object sucking habit	$P > 0.01$	$P < 0.01$	$P < 0.01$
Group2a < 3 years	118 (14)	48 (20)	66 (20)
Group2b > 3 years	58 (6)	28 (12)	31 (9)
Both finger and pacifier/object habit	$P > 0.01$	$P < 0.01$	$P < 0.01$
Group3a <3 years	33 (4)	17 (7)	16 (5)
Group3b >3 years	9 (1)	9 (4)	7 (2)
No sucking habit	$P < 0.01$	$P > 0.01$	$P > 0.01$
Group4	460 (52)	62 (26)	132 (39)

Table 2. Effect of non-nutritive sucking habits on posterior crossbite and anterior open bite.

	Posterior crossbite *N* (%)	Anterior open bite *N* (%)
Finger sucking habit	$P < 0.01$	$P < 0.01$
Group1a < 3 years	88 (39)	112 (50)
Group1b > 3 years	49 (41)	76 (64)
Pacifier/object sucking habit	$P < 0.01$	$P < 0.01$
Group2a < 3 years	116 (52)	108 (48)
Group2b > 3 years	62 (55)	70 (63)
Both finger and pacifier/object habit	$P < 0.01$	$P < 0.01$
Group3a < 3 years	27 (43)	26 (41)
Group3b >3 years	9 (43)	16 (76)
No sucking habit	$P > 0.01$	$P > 0.01$
Group4	96 (15)	93 (14)

habits (6%). Children with non-nutritive sucking habits did not show any statistically significant risk of Class III molar relationship ($P > 0.01$) (Table 3).

Discussion

Our data highlight that exclusive bottle-feeding in the first 6 months of life is a risk factor for non-nutritive sucking habits after the first year of age, whereas children who are exclusively breast-fed showed a lower risk of acquiring non-nutritive sucking habits after the first year of age. In fact, 48% of exclusively breast-fed children had a non-nutritive sucking habit after the first year of age whereas 74% and 61% of children who were, respectively, exclusively bottle- and complementary fed had a non-sucking habit after the first year of age. Breast-feeding may ensure a feeling of well-being, warmth, and security, which makes children less keen on satisfying their needs with non-nutritive sucking habits.

The detrimental effect of non-nutritive sucking activity on occlusion development, particularly anterior open bite and posterior crossbite, has been reported by several researchers since the 1870s[21]. These studies have focused on the effects of sucking activity in primary dentition[7–15] and, to date, few studies have been performed in mixed dentition[16–20]. Melsen *et al.*[16] investigated the relationship between sucking habits and malocclusions in children aged between 10 and 11, but they did not consider the duration of such habits. They found a correlation between the frequency of distal occlusion and crossbite, and sucking habits. Heimer *et al.*[17] found a positive correlation between sucking habits and an increased anterior open bite in children aged 7 and 8. Onyeaso and Isiekwe[18] found that, in mixed dentition, sucking habits had an effect on anterior open bite and distal occlusion, but not on crossbite. On the contrary, Cozza *et al.*[19] found that prolonged sucking habits and hyperdivergency in the mixed dentition were associated with an increased prevalence of posterior crossbite.

Our findings show that, in mixed dentition, children with non-nutritive sucking habits have a greater risk of both posterior crossbite and anterior open bite compared with children without these habits. These findings

Table 3. Effect of non-nutritive sucking habits on molar relationship.

	N	Class I molar relationship (%)	Class II molar relationship (%)	Class III molar relationship (%)
Finger sucking habit		$P > 0.01$	$P < 0.01$	$P > 0.01$
Group1a < 3 years	227	127 (56)	85 (37)	15 (7)
Group1b > 3 years	117	60 (51)	50 (43)	7 (6)
Pacifier/object sucking habit		$P > 0.01$	$P < 0.01$	
Group2a < 3 years	224	126 (57)	87 (38)	11 (5)
Group2b > 3 years	110	56 (51)	45 (41)	9 (8)
Both finger and pacifier/object habit		$P > 0.01$	$P < 0.01$	$P > 0.01$
Group3a < 3 years	62	30 (48)	27 (44)	5 (8)
Group3b > 3 years	21	9 (43)	10 (48)	2 (9)
No sucking habit		$P < 0.01$	$P > 0.01$	$P > 0.01$
Group4	645	416 (63)	181 (28)	48 (7)

agree with the study of Warren *et al.*[20] performed in mixed dentition as well as with previous studies performed in primary dentition[7,9,10,12–15]. Farsi and Salama, instead, found that, in primary dentition, sucking habits had an effect only on anterior open bite and not on crossbite[11].

Our data highlight different influences of non-nutritive sucking activity on posterior crossbite, depending on the type of habit. In mixed dentition, children with a pacifier/object sucking habit (*Group2*) showed a higher risk of acquiring a posterior crossbite compared with those children with a finger sucking habit (*Group1*). These data agree with the results obtained by Warren and Bishara[10] and by Peres *et al.*[15] in primary dentition. Posterior crossbite in children who had pacifier habits is the result of the combination of a significant increase in the mandibular arch width and a tendency to a decrease in maxillary arch width.

According to our data, those children with a non-nutritive sucking activity still ongoing after the age of 3 showed a greater risk of having an open bite than those children with a non-nutritive activity that ceased by the age of 3. This risk did not increase as regards posterior crossbite. Open bite was found in 48% of children with a non-nutritive sucking activity ceased by the age of 3 (*Group 1a, 2a, 3a*), and in 65% of children with a non-nutritive sucking activity persisting after the age of 3 (*Group 1b, 2b, 3b*). Posterior crossbite was detected in 45% of children with a non-nutritive sucking activity that ceased by the age of 3 (*Group 1a, 2a, 3a*) and in 48% of children with a non-nutritive sucking activity persisting after the age of 3 (*Group 1b, 2b, 3b*). Therefore, our findings enabled us to highlight that the percentage of anterior open bite was significantly greater as the duration of non-nutritive sucking continued beyond 3 years of age. The difference between the three *groups a* and the three *groups b* was statistically significant as regards anterior open bite whereas the presence of posterior crossbite did not differ significantly between the three *groups a* and the three *groups b*. Therefore, even though non-nutritive sucking fulfills physiological needs during infancy and may comfort toddlers, the persistence of these habits beyond 3 years of age significantly increases the probability of developing open bite.

Our data support a correlation between non-nutritive sucking activity and Class II molar relationship. Previous publications agree with this correlation[8,11,16,18,22,23]. No statistically significant association between Class III molar relationship and non-nutritive sucking habits were highlighted.

Based on the results, it is important for parents to be educated about benefits of the exclusive breastfeeding from birth up to 6 months of age for more favourable development of the mixed dentition. The activity of non-nutritive sucking should be diagnosed and its sequelae treated as promptly as possible in order to reduce the development of posterior crossbite, anterior open bite, and Class II molar relationship in mixed dentition.

What this paper adds

- This study examines the influence of non-nutritive sucking habits on occlusion in mixed dentition whereas most studies on this topic are performed in primary dentition. Only few studies are performed in mixed dentition, but they provide conflicting results.

Why this paper is important to paediatric dentists

- Malocclusions such as crossbite and anterior open bite are problematic and sometimes costly to treat, therefore, it is important to reveal to parents the effects of non-nutritive sucking habits on occlusion in order to prevent in a timely manner the development of such malocclusions.

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