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Anterior open-bite and sucking habits in Italian preschool children

ABSTRACT

Aim To evaluate the consequences of prolonged sucking habits on the development of the orofacial complex in deciduous dentition.

Materials and Methods A cross-sectional study was carried out involving 235 preschool children. A questionnaire for children parents and clinical examinations were carried out by calibrated blinded examiners. The chi-square test and the T-Student test were used for statistical analysis.

Results The prevalence of non-nutritive sucking habits (NNSH) in the sample was 74%. Anterior open-bite (AOB) was detected in 18%, and it was significantly related to non-nutritive sucking habits, bottle-feeding (only in the 3-year-old group) and persistent use of pacifier ($p < 0.05$).

Conclusions NNSH and type of feeding were important contributing factors in the development of anterior open-bite in deciduous dentition.

Keywords Anterior open-bite; Breast-feeding and bottle-feeding; Non-nutritive sucking habits.

Introduction

Non-nutritive sucking is a common behaviour among young children [Adair et al., 1995; Farsi et al., 1997]. Its prevalence is quite variable and depends on several factors, such as age, gender, ethnic origin, socio-economic status, type of feeding, duration of breast-

feeding, mother's age, number of siblings and cultural level [Farsi et al., 1997; Larsson and Dahlin, 1985; Larsson et al., 1992; Paunio et al., 1993].

The relationship between prolonged non-nutritive sucking habits and occlusal abnormalities has been studied by many authors [Infante, 1976; Ravn, 1976; Svedmyr, 1979; Winter, 1980; Adair et al., 1992; Paunio et al., 1993; Turgeon-O'Brien et al., 1996; Farsi et al., 1997; Aarts et al., 1999; Warren et al., 2001; Warren and Bishara, 2002; Charchut et al., 2003; Macena et al., 2009]. Malocclusions are associated with an altered development of dental arches in the three planes of the space: in the vertical plane, reduced overbite and anterior open-bite; in the transversal plane, posterior cross-bite; in the sagittal plane, increased overjet and Class II molar and canine relationships. These malocclusions are directly determined by the sucking mechanism [Turgeon-O'Brien et al., 1996; Viaggiano et al., 2004; Dimberg et al., 2011]. In fact, during breast-feeding, the muscular activity supplies the physiological growth of the mandible and, at the same time, the correct tongue position facilitates the development of proper swallowing technique [Dimberg et al., 2011]. On the contrary, during bottle-feeding and finger- or pacifier-sucking, muscular activity is altered, so that certain muscles involved in breast-feeding are either hypoactive (orbicularis oris, masseter), overactive (chin and cheek muscles) or malpositioned (tongue) [Turgeon-O'Brien et al., 1996].

The effects of sucking habits on maxillary and mandibular development and on the dental arches depend on the frequency, intensity and duration of the habits, the osteogenic development, and the genetic endowment of the child [Turgeon-O'Brien et al., 1996].

The prolonged use of pacifier causes more damage to both the front and the posterior portion of the occlusion, compared to digit-sucking. However, since pacifier-sucking generally is abandoned before finger-sucking, the long-term effects of finger-sucking on the occlusion are more important [Larsson, 1972; Svedmyr, 1979]. The prevalence of anterior open-bite (AOB) is significantly higher in children with artificial sucking habits [Ravn, 1974; Svedmyr, 1979; Paunio et al., 1993; Farsi et al., 1997; Karjalainen et al., 1999; Charchut et al., 2003; Katz et al., 2004; Viaggiano et al., 2004; Katz and Rosenblatt, 2005; Heimer and Katz, 2008; De Vasconcelos et al., 2011]. The prevalence of anterior open bite in different studies is reported in Table 1.

Authors reported that many cases of open-bite in the deciduous dentition would resolve spontaneously before the age of 12 due to the abandonment of the detrimental habits and the maturation of a proper swallowing pattern [Larsson, 1986; Charchut et al., 2003; Katz and Rosenblatt, 2005; Heimer et al., 2008].

The aim of this study is to evaluate the consequences of prolonged sucking habits in the development of the orofacial structures and deciduous occlusion.

Authors	Year	Country	Design of the study	Sample	Age in years	AOB (%)	
						NNSH+	NNSH-
Ravn	1976	Denmark	Cohort study	310	3	66.5	10.56
Paunio, Rautava, Sillanpää	1993	Finland	Randomized trial	1018	3	83.8	5.1
Farsi, Salama	1997	Saudi Arabia	Cross-sectional	583	3-5	14.9	3.58
Karjalainen, Rönning, Lapinleimu, Simell	1999	Finland	Randomized trial	148	3	60	7.6
Viaggiano, Fasano, Monaco, Strohmenger	2004	Italy	Cross sectional	1099	3-5	17	4
Katz, Rosenblatt	2005	Brazil	Longitudinal study	330	4-5	78	8.2
Heimer, Katz, Rosenblatt	2008	Brazil	Cohort study	287	4-6	79	6.9
Vasconcelos et al.	2011	Brazil	Cross sectional	1308	2.5-5	68.1	8
Dimberg, Lennartsson, Söderfeldt, Bondemark	2011	Sweden	Longitudinal Study	457	3	63	1

TABLE 1 Prevalence of AOB in different studies.

Subjects and methods

Subjects

This research is a cross-sectional study approved by the Ethical Committee of University Hospital "San Martino" (Genoa) and by the Local Health Centre "Asl 4 Chiavarese" and it has been conducted in full agreement with the Helsinki Declaration. It was conducted in the preschools in Chiavari, a town nearby Genoa (Italy).

In the study were enrolled 273 children (3 and 5 year-old) selected from the 7 schools that allowed their participation in the study.

Exclusion criteria were: parents' lack of consent; presence of cavities and/or extensive restorations; absence at the date of the visit; no compliance; orthodontic treatment; marked occlusal wear or early loss of primary teeth; alterations in the number, size and shape of teeth; syndromes or systemic problems affecting craniofacial growth; cleft palate. The final resulting sample comprised 235 children.

Clinical examination

Data were collected with a questionnaire, that was filled out by the parents before the clinical examination, which included questions on child's clinical history, the type of feeding, the use of baby-bottle, the history of non-nutritive sucking habits (dummy-sucking and digit sucking) and the consent to the clinical examination.

Two WHO-calibrated examiners carried out the clinical examinations. They were blinded to the information collected from the parental questionnaires.

Dental examinations were performed in a classroom environment under natural light, using gloves and masks in compliance with the infection control protocol, mouth mirrors and disposable paper rulers to measure overjet and overbite (in millimeters). The occlusion was assessed in centric occlusion and was classified according to Foster and Hamilton criteria [Foster and Hamilton, 1969] Radiographic examination was not performed.

Examiners' training and Error of Method

Two examiners (P. A. and A. U.) with previous

experience in aepidemiological surveys participated in the study. The calibration process was performed at the WHO Collaborating Centre for Epidemiology and Community Dentistry (University of Milan, Italy). It began with a theoretical phase in order to verify examiners' knowledge about aepidemiological diagnosis, according to WHO criteria. After that, clinical training sessions were completed with a discussion among the examiners and the WHO trainer, with regard to clinical diagnosis and criteria used, recording the other errors. Following the clinical training exercises, the examiners undertook two calibration exercises for the WHO diagnostic criteria. In the present study, during the clinical examination, the two examiners randomly re-examined 15 children of the sample in order to verify the intra-examiner error. Mean kappa values of 0.95 for the WHO diagnostic criteria were obtained during this phase.

Statistical analysis

The sample size was calculated with Z-test for comparison of proportions from the results of De Vasconcelos [2011]. The minimum required sample thus obtained was 62 children for each age.

The data were transferred to a spreadsheet on the Excel software. The statistical analyses were carried out by the Department of Medical Statistic of the University of Genoa. To determine significant differences, Pearson's chi-square test and T-Student test were used. Each sagittal, vertical and transverse malocclusion was dichotomised and correlated with sucking habits. Differences in probabilities of less the 5 per cent ($p < 0.05$) were considered to be statistically significant.

Results

Table 2 shows the characteristics of the sample according to age, gender, ethnic origin and non-nutritive sucking habits (NNSH). The sample was homogeneous for age and gender. The prevalence of NNSH (previous or persisting) was 74.4%. The prevalence of exclusive dummy-sucking is 58.7% and of exclusive digit-sucking

Variable	n	%
Age (in years)		
3	117	49.8
5	118	50.2
Total	235	100.0
Gender		
Male	111	47.2
Female	123	52.8
Total	235	100.0
Ethnic origin		
Italian	191	81.3
Foreign	44	18.7
Total	235	100.0
NNSH present or past		
No	60	25.6
Only dummy	138	58.7
Only finger	28	11.9
Both	9	3.8
Total	235	100.0

TABLE 2 Distribution according to age, gender, ethnic origin and non-nutritive sucking habits.

was 11.9%; 3.8% of the sample showed both dummy- and digit-sucking. The prevalence of dummy-sucking in 3-year-olds and 5-year-olds is 66.7% and 58.5% respectively (Table 3). The prevalence of digit-sucking was 12.0% in 3-year-olds and 19.5% in 5-year-olds. The use of pacifier was more common than finger-sucking. At the time of examination 41% of the 3-year-old children and 3% of the 5-year-olds were still using pacifier. Digit-sucking was still present in 64.3% and in 72.7% among 3- and 5-year-olds respectively of those with positive history for finger-sucking.

The prevalence of AOB in the total sample was 17.9%, in 3-year-old children 21.2% and 14.8% in 5-year-old group. AOB was associated with non-nutritive sucking habits ($p < 0.05$) (chi-square: 6.217): the prevalence of this malocclusion is 22% in the NNSH+ group and only 6.5% in the NNSH- group. In 3-year-old children, AOB is associated with bottle-feeding ($p < 0.05$); in fact, all the children having this type of malocclusion used or were still using baby-bottle. In the same group, there was also a relationship with previous and persisting dummy-sucking: 78.3% of the children with AOB were still using a pacifier. The correlation with persisting dummy-sucking was also found in 5-year-old children. In fact, all the children with persisting pacifier-sucking at this age had AOB (Table 4).

Discussion

In the present sample of 235 children, NNSH are important contributing factors in the development of anterior open-bite in deciduous dentition.

The prevalence of non-nutritive sucking habits was higher than that found in other studies [Svedmyr, 1979; De Vasconcelos et al., 2011]; dummy-sucking was the most common (according to Svedmyr and Larsson)

Variable	Yes (%)	No (%)
Dummy-sucking (past and/or present)		
3	66.7	33.3
5	58.5	41.5
Digit-sucking (past and/or present)		
3	12.0	88.0
5	19.5	80.5
Present dummy-sucking (of total sample)		
3	27.5	72.5
5	1.7	98.3
Present digit-sucking (of total sample)		
3	6	94
5	13.7	86.3

TABLE 3 Distribution of NNSH according to age.

Age	Factor	Proportion with AOB	χ^2	P value
3	Breast-feeding		3.98	0.046
	Yes	16.3%		
	No	5.9%		
	Baby-bottle		6.474	0.011
	Yes	21.2%		
	No	0%		
	Dummy		10.008	0.002
	Yes	19.5%		
	No	1.7%		
5	Dummy present		18.190	0.001
	Yes	15.3%		
	No	4.2%		
	Breast-feeding		0.08	0.77
	Yes	11.3%		
	No	3.5%		
	Baby-bottle		1.212	0.271
	Yes	11.3		
	No	3.5%		
5	Dummy		0.017	0.897
	Yes	8.7%		
	No	6.1%		
	Dummy present		11.550	0.001
	Yes	1.7%		
	No	6.9%		

TABLE 4 Associations between AOB and sucking habits.

[Svedmyr, 1979; Larsson et al., 1992]. In agreement with the study of Svedmyr [1979], dummy-sucking was more common in 3-year-old than in 5-year-old children. The prevalence of digit-sucking was higher in 5-year-olds (19.5%) than 3-year-olds (12.0%).

Persisting dummy-sucking was frequent at 3 years of age (41%), while at 5 years prevailed persisting digit-sucking. Therefore the present study confirms that it is easier to dismiss pacifier-sucking than digit-sucking [Infante, 1976; Charchut et al., 1993; Duncan et al., 2008]. These data support an aetiological role of NNSH

and type of feeding on anterior open-bite [Ravn, 1974; Svedmyr, 1979; Paunio et al., 1993; Farsi et al., 1997; Karjalainen et al., 1999; Katz et al., 2004; Viaggiano et al., 2004; Katz and Rosenblatt, 2005; Heimer et al., 2008; De Vasconcelos, 2011; Romero et al., 2011]. In preschool children, the prevalence of AOB in children with NNSH varies from 14.9% to 68.1%, while in those without these habits it is from 3.58% to 8% [Farsi et al., 1997; Viaggiano et al., 2004; De Vasconcelos et al., 2011]. In the present study, the prevalence of AOB is 22% in children with NNSH and 6.5% in children without the habits.

In 3-year-old children, AOB was statistically associated with use of baby-bottle, according to a Brazilian study [Romero et al., 2011]. On the contrary, an Italian study [Viaggiano et al., 2004] reported that feeding type and duration of breast-feeding are not risk factors for the development of anterior open-bite. In fact, Viaggiano [2004] reported that AOB was associated (89% of children with open-bite) with non-nutritive sucking, with a risk factor more than quadruple (adjusted OR=4.61; 95% CI 2.69 to 7.92; $p < 0.0001$); while the type of feeding had no effect on open-bite (adjusted OR=0.93%; 95% CI 0.65 to 1.33; $p = 0.678$). Luzzi et al. [2011], in a study on 81 5-year-old children, concluded that there was no difference in type of habit in children with AOB. Instead, Romero [2011] demonstrated an inverse relationship between breastfeeding duration and prevalence of AOB and for each additional year of persistence with non-nutritive sucking, there was a 2.38 times greater chance of having the malocclusion. Prolonged breast-feeding was associated with less chances of acquiring non-nutritive sucking habits. Dummy-sucking had an important role in the onset of AOB both in 3- and in 5-year-old children. In particular, the malocclusion seems to be related with the use of the pacifier at the time of examination, in agreement with many other studies [Ravn, 1974; Svedmyr, 1979; Paunio et al., 1993; Farsi et al., 1997; Karjalainen et al., 1999; Katz et al., 2004; Viaggiano et al., 2004; Katz and Rosenblatt, 2005; Heimer et al., 2008; De Vasconcelos, 2011].

These results seem to confirm that AOB persists until the NNSH is abandoned.

Conclusions

The present study pointed out that:

1. NNSH were present in almost 2/3 of preschool children; dummy-sucking was the most common habit. The prevalence of NNSH reduced with age.
2. AOB was related with NNSH, particularly with the prolonged use of dummy and bottle-feeding.
3. NNSH and type of feeding were important contributing factors in the development of anterior open-bite in deciduous dentition.

References

- › Aarts C, Hornell A, Kylberg E, Hofvander Y, Gebre-Medhin M. Breastfeeding patterns in relation to thumb sucking and pacifier use. *Pediatrics* 1999; 104:1-10.
- › Adair SM, Milano M, Dushku JC. Evaluation of the effects of orthodontic pacifiers on the primary dentitions of 24- to 59-month-old children: preliminary study. *Pediatric Dentistry* 1992; 14:13-18.
- › Adair SM, Milano M, Lorenzo I, Russell C. Effects of current and former pacifier use on the dentition of 24- to 59-month old children. *Pediatric Dentistry* 1995; 17:437-44.
- › Charchut SW, Allred EN, Needleman HL. The effects of infant feeding patterns on the occlusion of the primary dentition. *J Dentistry Children* 2003; 70:197-203.
- › De Vasconcelos FMN, Massoni ACLT, Heimer MV, Ferreira AMB, Katz CRT, Rosenblatt A. Non-nutritive sucking habits, anterior open bite and associated factors in Brazilian children aged 30-59 months. *Brazilian Dental J* 2011; 22:140-145.
- › Dimberg L, Lennartsson B, Soderfeldt B, Bondemark L. Malocclusions in children at 3 and 7 years of age: a longitudinal study. *Eur J Orthodontics*. Oct 31; 2011. [Epub ahead of print]
- › Farsi NMA, Salama FS, Pedro C. Sucking habits in Saudi Children. Prevalence, contributing factors and effects on the primary dentition. *Pediatric Dentistry* 1997; 19: 28-33.
- › Foster TD, Hamilton MC. Occlusion in the primary dentition: study of children aged at 2 1/2 to 3 years of age. *British Dental Journal* 1969; 21:76-80.
- › Heimer MV, Katz CRT, Rosenblatt A. Non-nutritive sucking habits, dental malocclusions, and facial morphology in Brazilian children: a longitudinal study. *European Journal of Orthodontics* 2008; 30: 580-585.
- › Infante PF. An epidemiologic study of finger habits in preschool children, as related to malocclusion, socioeconomic status, race, sex and size of community. *Journal of Dentistry for Children* 1976; 1:3-38.
- › Karjalainen S, Rönning O, Lapinleimu H, Simell O. Association between early weaning, non-nutritive sucking habits and occlusal anomalies in 3-year-old Finnish children. *International Journal of Pediatric Dentistry* 1999; 9:169-173.
- › Katz CRT, Rosenblatt A, Gondim PPC. Non nutritive sucking habits in Brazilian children: effects on deciduous dentition and relationship with facial morphology. *Am J Orthod Dentofacial Orthop* 2004; 126:53-57.
- › Katz CRT, Rosenblatt A. Non nutritive sucking habits and anterior open bite in Brazilian children: a longitudinal study. *Pediatric Dentistry* 2005; 27:369-373.
- › Larsson E. Dummy- and finger-sucking habits with special attention to their significance for facial growth and occlusion. 4. Effect on facial growth and occlusion. *Swedish Dental Journal* 1972; 65:605-634.
- › Larsson E. The effect of dummy-sucking on the occlusion: a review. *European Journal of Orthodontics* 1986; 8:127-130.
- › Larsson E, Dahlin KG. The prevalence and the etiology of the initial dummy and finger sucking habit. *American Journal of Orthodontics and Dentofacial Orthopedics* 1985; 87:432-435.
- › Larsson E, Øgaard B, Lindsten R. Dummy- and finger-sucking habits in young Swedish and Norwegian children. *Scandinavian J Dental Research* 1992; 100:292-295.
- › Luzzi V, Guaragna M, Ierardo G, Saccucci M, Consoli G, Vestri AR, Polimeni A. Malocclusions and non-nutritive sucking habits: a preliminary study. *Prog Orthod*. 2011 Nov;12(2):114-8.
- › Macena MCB, Katz CRT, Rosenblatt A. Prevalence of posterior cross-bite and sucking habits in Brazilian children aged 18-59 months. *Eur J Orthod* 2009; 31:357-361.
- › Paunio P, Rautava P, Sillanpää M. The Finnish Family Competence Study: the effects of living conditions on sucking habits in 3-year-old Finnish children and the association between these habits and dental occlusion. *Acta Odontol Scand* 1993; 51: 23-29.
- › Ravn JJ. Sucking Habits and occlusion in 3-year-old children. *Scandinavian Journal of dental Research* 1976; 84: 204-209.
- › Romero CC, Scavone-Jr H, Garib DG, Cotrim-Ferreira FA, Ferreira RI. Breastfeeding and non-nutritive sucking patterns related to the prevalence of anterior open bite in primary dentition. *J Applied Oral Science* 2011; 19:161-168.
- › Svedmyr B. Dummy sucking. A study of its prevalence, duration, and malocclusion consequences. *Swedish Dental J* 1979; 3: 205-210.
- › Turgeon-O'Brien H, Lachapelle D, Gagnon PF, Laroque I, Maheu-Robert LF. Nutritive and nonnutritive sucking habits: a review. *J Dentistry for Children* 1996;63: 321-327.
- › Viaggiano D, Fasano D, Monaco G, Strohmer L. Breastfeeding, bottlefeeding, and non-nutritive sucking; effects on occlusion in deciduous dentition. *Archives of Disease in Childhood* 2004; 89:1121-1123.
- › Warren JJ, Bishara SE, Steinbock KL, Yonezu T, Nowak AJ. Effects of oral habits' duration on dental characteristics in the primary dentition. *Journal of American Dental Association* 2001; 132:1685-1693.
- › Warren JJ, Bishara SE. Duration of nutritive and non-nutritive sucking behaviors and their effects on the dental arches in the primary dentition. *Am J Orthod Dentofacial Orthop* 2002; 121:347-356.
- › Winter GB. Problems involved with the use of comforters. *Int Dental J* 1980; 30:28-38.