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Effects of breastfeeding and sucking habits on malocclusion in a birth cohort study

Efeitos da amamentação e dos hábitos de sucção sobre as oclusopatias num estudo de coorte

ABSTRACT

OBJECTIVE: To estimate the prevalence of malocclusion and to examine the effects of breastfeeding and non-nutritive sucking habits on dentition in six-year-old children.

METHODS: A cross-sectional study was carried out nested into a birth cohort conducted in Pelotas, Southern Brazil, in 1999. A sample of 359 children was dentally examined and their mothers interviewed. Anterior open bite and posterior cross bite were recorded using the Foster & Hamilton criteria. Information regarding breastfeeding and non-nutritive sucking habits was collected at birth, in the first, third, sixth and 12th months of life, and at six years of age. Control variables included maternal schooling and child's birthweight, cephalic perimeter, and sex. Data were analyzed by Poisson regression.

RESULTS: Prevalence of anterior open bite was 46.2%, and that of posterior cross bite was 18.2%. Non-nutritive sucking habits between 12 months and four years of age and digital sucking at age six years were the main risk factors for anterior open bite. Breastfeeding for less than nine months and regular use of pacifier between age 12 months and four years were risk factors for posterior cross bite. Interaction between duration of breastfeeding and the use of pacifier was identified for posterior cross bite.

CONCLUSIONS: Given that breastfeeding is a protective factor for other diseases of infancy, our findings indicate that the common risks approach is the most appropriate for the prevention of posterior cross bite in primary or initial mixed dentition.

KEYWORDS: Child. Open bite. Cross bite. Malocclusion. Breast feeding. Sucking behavior. Fingersucking. Cross-sectional studies.

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ABSTRACT

OBJETIVO: Analisar a prevalência de oclusopatias e o efeito da amamentação e dos hábitos de sucção não nutritivos aos seis anos de idade.

MÉTODOS: Foi realizado um estudo transversal aninhado numa coorte de nascidos vivos em Pelotas, RS, em 1999. Crianças com seis anos de idade (N=359) foram examinadas e suas mães entrevistadas. Utilizaram-se os critérios de Foster & Hamilton para a definição dos desfechos mordida aberta anterior e mordida cruzada posterior. Informações sobre amamentação e hábitos de sucção não nutritivos foram coletadas ao nascimento, ao primeiro, terceiro, sexto e 12º meses de vida e aos seis anos de idade. As variáveis de controle incluíram escolaridade materna, peso ao nascer, perímetro cefálico e sexo da criança. Foi realizada a regressão de Poisson.

RESULTADOS: A prevalência de mordida aberta anterior foi 46,2% e a de mordida cruzada posterior foi 18,2%. Presença de hábitos de sucção não nutritivos entre 12 meses e quatro anos de idade e presença de sucção digital aos seis anos de idade foram os fatores de risco para mordida aberta anterior. Amamentação por menos do que nove meses e uso regular de chupeta entre 12 meses e quatro anos de idade foram os fatores de risco para mordida cruzada posterior. Identificou-se interação entre duração da amamentação e uso de chupeta para mordida cruzada posterior.

CONCLUSÕES: Considerando que a amamentação é um fator de proteção às outras doenças da infância, a abordagem dos fatores de risco comuns pode ser o meio mais apropriado para a prevenção de mordida cruzada posterior na dentição decídua ou início da dentição mista.

DESCRITORES: Criança. Mordida aberta. Mordida cruzada. Maloclusão. Aleitamento materno. Comportamento de sucção. Sucção de dedo. Estudos transversais.

INTRODUÇÃO

With the decline in dental caries among children in many countries,¹⁵ including Brazil,* other oral health disorders, such as malocclusion, have become relatively more important public health issues. Malocclusion is a developmental disorder of the craniofacial complex that affects jaw, tongue and facial muscles,¹⁷ and is the result of an interaction of genetic and environmental factors.³ Such disorders can appear in primary dentition, where anterior open bite and posterior cross bite are the most prevalent conditions.⁷ Malocclusion causes functional and aesthetic disturbances in affected individuals, and treatment is often costly.¹⁵

There are a number of controversies regarding the major causes of malocclusion in primary dentition and whether or not these are predictive of malocclusion in the permanent dentition. Anthropological studies that investigated population trends with respect to malocclusion have shown that environmental conditions are

the primary explanation for changes observed in the occlusion patterns of populations.^{2,24} Notable among these environmental conditions are dietary habits, including the tendency in recent decades to adopt foods with a softer texture that require less chewing strength, habits of non-nutritive sucking such as the use of a pacifier, bottle-feeding, and early weaning.²³

Although these conditions are potential causal factors for malocclusion, little is known about the effects of time of onset, duration, and cessation of these exposures and their possible combinations. A search of the National Library of Medicine – Medline database covering the period from January 1995 to June 2005, with no restriction on language, for articles on the relationship between breastfeeding and malocclusion in the primary dentition found five studies, all from developed countries, examining the hypothesis that breastfeeding could be a protective factor against the

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occurrence of malocclusion. In addition, only two of these studies used a longitudinal design.

The aim of the present study was to determine the prevalence of malocclusion and analyze the effect of breastfeeding and non-nutritive sucking habits on the occurrence of malocclusion in six-year-old children participating in a birth cohort study.

METHODS

In 1993, a cohort study was begun which included all live births occurred in Pelotas, Southern Brazil, a city of approximately 300 thousand inhabitants. The main objective of this cohort study was to investigate health characteristics in the perinatal period and infancy, and included five major sub-studies: perinatal, follow-up, infant mortality, hospital admissions, and psychological development of the child.²²

In the perinatal sub-study (N=5,249), the five hospitals in Pelotas were visited twice a day by a team of medical residents between January 1st and December 31st, 1993. The children identified accounted for 99% of the babies born to mothers living in the urban area of the city. During the course of these visits an interview was carried out with the mothers which included questions on breastfeeding and pacifier use. In addition, information was collected regarding socioeconomic and demographic characteristics, gestation, access to health care services, morbidity, and maternal occupation. Mothers were weighed and measured and children were weighed, measured and examined. In the follow-up sub-study, a systematic sample of children was selected and visited during their first (N=649), third (N=644), sixth (N=1,414), and 12th month (N=1,383) of life. In 1998, a sample consisting of all low birthweight children plus 20% of the remainder was revisited. Of 1,460 eligible children, 87% (1,270 children) were located. In each of these cohort follow-ups, breastfeeding and non-nutritive sucking habits were investigated in detail in order to determine whether the mother had begun breastfeeding, and if so, if she was still breastfeeding or when she had stopped. Use of pacifier was also investigated in these follow-up visits. Details on methodology and the major results of the five sub-studies can be found elsewhere.²²

The oral health study began in 1999 and adopted a cross-sectional design nested into the aforementioned cohort study. A sub-sample of the 1998 follow-up visits was examined in order to estimate the prevalence of anterior open bite and posterior cross bite. This was done to test, among other things, the hypothesis that breastfeeding acts as a protective factor against the development of malocclusion at age six years. The sample size needed to estimate the prevalence of these two conditions was calculated using the prevalence of

anterior open bite described in the literature – approximately 45% – with an error of 5 percentage points. The calculation for a finite population of 5,249 children resulted in a sample size of 355. The sample size required to test the association between breastfeeding and malocclusion was estimated for an exposure defined as duration of breastfeeding < 9 months. Considering the detection of relative risks of at least 1.9 for anterior open bite and 2.5 for posterior cross bite, with respective prevalences of 54% and 20% in children breastfed for less than nine months (exposed),⁸ a sample of 342 children was needed to provide 80% power at a significance level of 5%.

The sample was inflated by 10% to allow for losses or refusals, resulting in a rounded value of 400 children. Since low birthweight children (9.7% in the perinatal study) were overrepresented in the sample (29.7%), all analyses were weighted using a factor of 0.34 for low birthweight children and 1.27 for the remainder.¹⁴ EpiInfo 6.04 software was used for sample size calculations.

Dental examination included evaluations of malocclusion, dental caries, and soft tissue lesions. Fieldwork was carried out by three dentists, responsible for oral examination, and three interviewers, who administered the questionnaires. The dentists underwent a training and calibration exercise with 20 children not included in the sample and of the same age as the children studied. One of the examiners was considered as representing the “gold standard”. Diagnostic reliability was determined for each of the clinical conditions by means of the Kappa coefficient, following methodology described in detail elsewhere.¹³ Diagnosis of malocclusion was based on the classification by Foster & Hamilton.⁵ Anterior open bite was defined as lack of vertical contact between the upper and lower teeth in the anterior region and unilateral or bilateral posterior cross bite was defined as transverse and reverse inter-relationship of one or more posterior teeth in one or both hemi-arches. Children were examined in their homes, seated, under artificial light. When necessary the mandible was gently guided towards centric occlusion by the examiner. Examiners wore suitable clothing and all recommended biosafety measures were observed. The outcomes studied (dependent variables) were anterior open bite and posterior cross bite, dichotomised (absence/presence), at six years of age.

Following examination, a structured interview was carried out with the mother, which included questions on the habit of digital sucking since the last cohort follow-up in 1998. Confounders and other risk factors of interest were obtained from the data collected in the previous follow-ups, and included parental schooling (>8 or ≤8 years of study), birthweight (adequate or low), cephalic perimeter at birth (>10th percentile or

$\leq 10^{\text{th}}$ percentile), and regular use of a pacifier before the age of four (yes/no). Information regarding the onset and duration of breastfeeding was also obtained from previous follow-up visits.²²

Crude associations between outcomes and predictors were estimated and significance was determined using the Chi-square test. Since prevalence of the first outcome was approximately 40%, Poisson regression was used in multivariable analyses to allow the estimation of correct prevalence ratios.¹ Initially, all risk factors of interest (time of breastfeeding, use of pacifier, and habit of digital sucking) were included in the model. Then, regardless of their statistical significance, variables sex of the child, birth weight, cephalic perimeter, and maternal schooling were used for adjustment in the final model. This last variable was considered as an indicator of family socioeconomic status.²¹ The interaction between breastfeeding and pacifier use was explored for the outcomes of interest, using the standard 5% significance level. All analyses were performed using Stata 9.0 software.

The parents or guardians of the children included in the study were informed of the study's objectives, and written informed consent was obtained prior to the interviews and to oral examination. The study protocol was approved by the Committee for Ethics in Research of the Faculdade de Medicina – Universidade Federal de Pelotas.

RESULTS

The response rate in the present study was 89.8%, with 359 children being investigated. Losses were due mostly to families moving out of Pelotas. Diagnostic reliability, as assessed by the Kappa coefficient, was at least 0.85 (the value obtained for posterior cross bite). The sample comprised 193 (53.8%) boys and 166 (46.2%) girls. Prevalence of anterior open bite was 46.2% (95% CI: 41.0;51.4) and that of posterior cross bite was 18.2% (95% CI: 14.2;22.2). Prevalence of breastfeeding for less than one month, 1–3.9 months, 4–8.9 months, and nine months or longer were 15.7%,

Table 1. Sample distribution according to anterior open bite, posterior cross bite, and associated factors (χ^2). Pelotas, Southern Brazil, 1999. (N=359)

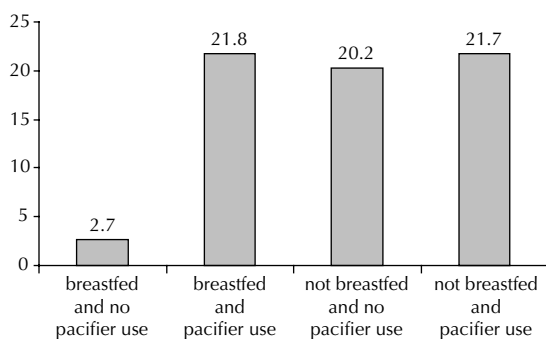
Variable	N	Anterior open bite (%)*	Posterior crossbite (%)*
Maternal schooling (years)		p=0.30	p=0.56
> 8	86	41.2	4.3
≤ 8	273	48.1	35.1
Breastfeeding (months)		p<0.01	p=0.03
≥ 9	78	28.2	8.2
4 to 8,9	78	51.8	21.1
1 to 3,9	139	54.2	23.1
< 1	71	46.4	15.8
Sex		p=0.92	p=0.72
Male	190	46.1	9.4
Female	169	46.7	8.8
Weight at birth (grams)		p=0.09	p=0.68
Adequate ($\geq 2,500$)	256	45.4	16.6
Low weight (<2,500)	103	54.3	1.6
Cephalic perimeter (percentile 10)		p=0.08	p=0.83
> 10	245	44.2	15.1
≤ 10	110	56.2	3.1
Pacifier sucking between 12 months and 4 years old		p<0.01	p=0.14
None or partially	142	18.2	1.9
All period	217	65.9	16.3
Digital sucking (6 years)		p=0.13	p=0.40
No	327	40.9	18.6
Yes	32	58.3	14.3

* weighted percentage
p of Yates χ^2

36.3%, 23.9%, and 23.6% respectively. Regular use of pacifier between one and four years of age was observed in 60.4% of children.

In crude analysis, anterior open bite was associated with breastfeeding for less than nine months ($p=0.004$) and with regular use of pacifier between 12 months and four years of age ($p<0.001$). Posterior cross bite was associated only with duration of breastfeeding ($p=0.036$) (Table 1).

Table 2 presents the results of Poisson regression for



$p=0,03$

(p: interaction value)

Adjusted for birthweight, cephalic perimeter, sex, and maternal schooling

* weighted percentage

Figure. Prevalence of posterior crossbite* according to breastfeeding (9 months or more) and pacifier use (between age 12 months and 4 years) among 6-year-old children. Pelotas, Southern Brazil, 1999.

anterior open bite. After adjustment for use of pacifier, breastfeeding duration lost statistical significance, whereas digital sucking became statistically significant. Children who used pacifier regularly between 12 months and four years of age showed a risk of anterior open bite 3.6 (95% CI: 2.4;5.4) times greater than those who did not. Children with the habit of digital sucking at six years of age had a risk 1.4 (95% CI: 1.1;2.0) times greater than those who did not. These results did not change substantially after confounder adjustment. The interaction between duration of breastfeeding and use of pacifier was tested but did not show statistical significance ($p=0.146$).

Table 3 presents the result of Poisson regression for posterior cross bite. In contrast to anterior cross bite, here, the interaction between breastfeeding and use of pacifier was statistically significant ($p=0.03$). These risk factors showed similar prevalence ratios (7.4 and 7.9 respectively), and the interaction term was 0.1. This interaction works basically by zeroing the effect of one of the exposures in the presence of the other. This is shown in the Figure, where the prevalence of posterior cross bite is presented for the four exposure groups. Children who either were breastfed for less than nine months or used pacifier regularly between 12 months and four years are under a risk that was about 7.5 times greater than those who breastfed longer and did not use a pacifier. These results show that the concomitant presence of breastfeeding for at least nine months and the non-regular use of pacifier between 12 months and four years of age is necessary to ensure a protective effect (Table 3).

Table 2. Association between anterior open bite, breastfeeding, and non nutritive sucking habits in six-year-old children. Pelotas, Southern Brazil, 1999. (N=359)

Variable	PR (CI 95%) crude	PR (CI 95%) adjusted	PR (CI 95%) adjusted for control variables**
Breastfeeding (months)			
≥ 9	1.0	1.0*	1.0***
< 9	1.8(1.2;2.7)	1.2(0.8;1.7)	1.2(0.8;1.7)
Pacifier use between 12 months and 4 years			
None or partially	1.0	1.0*	1.0***
All period	3.6(2.4;5.3)	3.5(2.3;5.4)	3.5(2.3;5.4)
Digital sucking at 6 years			
No	1.0	1.0**	1.0****
Yes	1.3(1.0;1.8)	1.4(1.1;2.0)	1.5(1.1;2.1)

PR: Prevalence ratios

CI 95%: Confidence intervals

* Breastfeeding and pacifier use adjusted for each other

** Adjusted for breastfeeding and pacifier use

*** Breastfeeding and pacifier use adjusted for each other and for birthweight, cephalic perimeter, sex, and maternal schooling

**** Adjusted for breastfeeding, pacifier use, birth weight, cephalic perimeter, sex, and maternal schooling

Table 3. Association between posterior cross bite, breastfeeding, and non nutritive sucking habits in six-year-old children. Prevalence ratios, joint effect of breastfeeding and pacifier use, and confidence intervals (CI 95%). Pelotas, Southern Brazil, 1999. (N=359)

Variable	PR (CI 95%) crude	PR (IC 95%) adjusted*	PR (IC 95%) adjusted for control variables**
Breastfeeding (months)			
≥ 9	1.0	1.0*	1.0***
< 9	2.6(1.1;5.4)	7.4(1.4;38.3)	7.6(1.5;39.5)
Pacifier use between 12 months and 4 years			
None or partially	1.0	1.0*	1.0***
All period	1.7(1.0;2.8)	7.9(1.4;46.6)	7.5(1.3;44.3)
Digit sucking at 6 years			
No	1.0	1.0**	1.0****
Yes	0.8(0.3;2.0)	0.8(0.3;2.0)	0.8(0.3;1.9)
Breastfeeding* No pacifier use between 12 months and 4 years [†]	0.1(0.2;0.9)	0.1 (0.0;0.9)	0.1 (0.0;0.9)
Join Effect (Prevalence ratios)*****			
Breastfeeding < 9 months-Pacifier use throughout period			1.0
Breastfeeding ≥ 9 months-No or partial pacifier use			0.1(0.0;0.9)
Breastfeeding ≥ 9 months-Pacifier use throughout period			1.0(0.4;2.3)
Breastfeeding < 9 months-No or partial pacifier use			0.9(0.5;1.6)

* Breastfeeding and pacifier use adjusted for each other and for the interaction factor

** Adjusted for breastfeeding, pacifier use, and for the interaction factor

*** Breastfeeding and pacifier use adjusted for each other, for the interaction factor, and for birth weight, cephalic perimeter, sex, and maternal schooling

**** Adjusted for breastfeeding, pacifier use, interaction factor, birth weight, cephalic perimeter, sex, and maternal schooling

***** Adjusted birth weight, cephalic perimeter, sex, and maternal schooling

[†]: Interaction term

DISCUSSION

The present paper reports a cross-sectional study nested into a birth cohort investigating the prevalence of the main occlusal changes present at aged six years and the influence of breastfeeding and of non-nutritive sucking habits on the development of these conditions. In our sample, only 5% of children had permanent molars and/or permanent incisors, which means that dentitions were predominantly composed of primary teeth. Major strengths in the present investigation include high response rates during follow-up studies, high level of diagnostic reliability, and knowledge of the prospective factors investigated, in addition to its population base. A further aspect to note is that, although the outcomes investigated were ascertained by a cross-sectional study, these outcomes are unlikely to have developed before the main exposures analyzed, since breastfeeding and pacifier use precede dental eruption. The study design makes the occurrence of recall bias unlikely since the information used was collected during or shortly after exposure, leading to short recall periods. Observation bias is unlikely to have occurred, since observers, when performing oral examination, were unaware of the children's exposure status. Taken together, these methodological aspects ensured high internal validity. In spite of the fact that the dental outcomes analyzed in

this study can be easily assessed in the epidemiological context, i.e., during field work, relying on natural light and on a household chair, it is likely that the accuracy of examinations would have been greater in the clinical context, where X-rays, artificial lighting, and dental chairs are available. Moreover, the present results should be extrapolated with caution, particularly when considering that Pelotas shows more favorable socioeconomic conditions when compared to Brazil as a whole.

The positive effects of extended breastfeeding on the normal development of occlusion may be explained by the effect of sucking on the skeletal and muscular development of the child's face. The growth and development of facial structures takes place during the first four years of the child's life, and 90% of this process is complete by age 12 years. The mechanics of sucking differs between children who are breastfed and those who are fed from a bottle. Breastfeeding promotes the correct development of the jaws, strengthening the muscles involved in the process of sucking to obtain breast milk. The mother's nipple adapts itself to the internal shape of the oral cavity, enabling a perfect oral seal.⁴ On the other hand, the artificial nipple of a baby bottle is made from more rigid material, which can "force" the interior of the oral cavity, causing inappropriate alignment of teeth and the transverse growth of the palate, conditions

which can lead to the development of posterior cross bite.⁴ It is for this reason that national standards exist for regulating such products, the restriction of which is recommended, especially during the first months of life. In addition, the position of lower lip and tongue during breastfeeding aids in the development of the habit of physiological swallowing – thus promoting this swallowing mechanism in adult life –, which does not occur with the use of a bottle.⁴

The habit of regular pacifier sucking between age 12 months and four years was the main risk factor for the occurrence of anterior open bite at age six years, even after adjustment for breastfeeding duration. Breastfeeding for nine months or more, without regular use of pacifier between age 12 months and four years, decreased the risk of posterior cross bite.

There are few multidimensional studies^{8,12,19} on the etiology of malocclusion, and the majority of these^{8,19} analyze the risk factors separately, without measuring concurrent impact or assessing potential interactions. Indeed, there are no previous studies in Brazil that follow a procedure similar to that employed in the present study.

Comparison with international studies showed that the prevalence of anterior open bite found in the current study (46.2%) was higher than that found in Germany (16%)¹⁸ and Italy (13%).²³ On the other hand, a study⁸ carried out in Recife, Northeastern Brazil, also detected higher prevalence (36.4%). Prevalence of posterior cross bite was 18.2%, which is higher than that found in the Italian study (7%),²³ and in the other Brazilian study (12.1%).⁸ These differences may be attributed, in part, to the use of different diagnostic criteria, as well as to the differences as to the age ranges studied, which can influence the prevalence these outcomes. For example, samples with different ages may bias results, since prevalence of anterior open bite and posterior cross bite tend to be higher in younger children than in six-year-olds, whose primary dentition is complete.¹⁹ Consequently, older children have larger exposure time to orthodontic treatment, as well as a tendency to abandon non-nutritive sucking habits. In addition, it is well known that the prevalence and severity of dental caries are risk factors for malocclusion. Since dental caries are more prevalent in developing countries, it is reasonable to suppose that prevalence of malocclusion should be higher in these regions as well. Moreover, prevalence of malocclusion is expected to vary with the prevalence of non-nutritive sucking habits. There are considerable differences in feeding, as well as in artificial sucking habits, between different areas of the world and during different periods.¹¹ Finally, substantial variation in epidemiological criteria may also influence the prevalence found in these different studies.

In the present study, the nature of feeding during the first years of the child's life, as well as the presence of non-

nutritive sucking habits, showed different effects on the different occlusal changes investigated. The protective effect of breastfeeding for nine months or more against the development of anterior open bite was offset by the regular pacifier use between 12 months and four years of age. Previous studies analyzing this same relationship found conflicting results, showing either an effect²⁰ or no effect of breastfeeding on the occurrence of malocclusion.²³ Such conflict in results may be related to cultural differences between the populations studied, to different non-nutritive sucking habits, and also to the range of study designs and statistical methodologies employed. Our findings agree with those of Viggiano et al²³ with regard to the etiological role of the pacifier and to the lack of – or, at most, small influence of – breastfeeding on anterior open bite. The occurrence of anterior open bite appears to be more related to local deformation (related to the use of a pacifier) than to a deficiency in musculoskeletal development due to lack of breastfeeding.

An inverse relationship between duration of breastfeeding and presence of posterior cross bite has already been described in a previous study.²³ However, in the present study the protective effect of breastfeeding was only detected in the absence of regular pacifier use. Either breastfeeding for less than nine months or regular pacifier use implied in a similarly increased risk of malocclusion.

The effect of non-nutritive sucking habits on the development of occlusion has been under investigation for several decades, while studies of the effects of breastfeeding on occlusion are a more recent phenomenon.²³ The main question arising from these studies is whether such conditions disappear once the risk factors for malocclusion have been identified and removed. The limited amount of data in the literature show that anterior open bite tends to disappear with the disappearance of the habit, while the same does not occur in the case of posterior cross bite.^{9,10} Further studies specifically designed to elucidate this relationship are required; such studies could also help determine whether or not the presence of malocclusion in primary dentition is predictive of malocclusion in permanent dentition.

Breastfeeding protects against various childhood health problems. The advantages of maternal milk are related to maturation of the baby's immune system, less intense allergic reactions to the nutrients of maternal milk, and protection against malnutrition, diarrhea, and respiratory diseases. Other positive aspects include the nutritional benefit resulting from the milk's composition, improvements in the child's psychological well-being, and the substantial economic advantages.⁶

Health care strategies can include intersectorial approaches to health promotion, based on population strategies and on the common risks approach.¹⁶ Public policies that include an extension of current maternity leave allowances, as a stimulus for longer duration

of breastfeeding, and incentives to the establishment of nurseries in the workplace could contribute in this regard. On the other hand, a guide to orient mothers as to the appropriate use of pacifiers could also provide

a contribution. From the public health point of view the perspective of the common risks approach appears to be the most effective strategy for the prevention of malocclusion.

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