

Breastfeeding and non-nutritive sucking habits as covariates of malocclusion in the primary dentition among Tanzanian children: A cross-sectional study

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Abstract

Introduction: Studies on the effect of feeding practices and sucking habits on malocclusion traits in the primary dentition of pre-schoolchildren from developing countries are scarce.

Purpose: Assessing the association of feeding and sucking habits with malocclusion traits, and the association of malocclusion traits with observed oral functional problems.

Methods: It was a cross-sectional survey of children aged 3-5 years residing in Kinondoni and Temeke Districts of Dar es Salaam region in Tanzania. Data was analyzed using Statistical Package for Social Scientists, SPSS version 21.0. Univariate analysis was applied to generate frequencies of different variables. Cross tabulations and Chi-square statistics were used to assess bivariate relationships and multivariate analyses were performed by multiple logistic regression.

Results: Most pre-schoolchildren (82.5%) were breastfed for less than two years. A history of non-nutritive sucking habits was reported in 28.1% of the children, mostly in boys than girls (33.6% versus 21.8%, respectively). The current non-nutritive sucking habits were reported in 17.8% of the participants. Overall, malocclusion traits were most significantly seen in children who were breastfed for less than two years, compared with those who were breastfed for two years or more (48.5% versus 27.3%, respectively). The presence of various malocclusion traits was significantly found among most of the children who had a history of non-nutritive sucking habits, compared with those who had never performed the habits (65.9% versus 38.6%, respectively). In the logistic regression analyses, children who were breastfed for a shorter duration (<2 years), their probability of being found with different traits of malocclusion in the primary dentition was almost three times that for those who were breastfed for a longer duration (≥ two years). Also, children who were not actively performing non-nutritive sucking habits were less likely to have an open bite compared with those who were actively performing non-nutritive sucking habits. An open bite in children was significantly associated with speech problems ($p < 0.01$) and swallowing with tongue thrusting ($p = 0.000$).

Conclusion and recommendations: Most of the children who were breastfed for a shorter duration and children who had non-nutritive sucking habits were found with various malocclusion, compared with those who were breastfed for a longer duration and those who had no non-nutritive sucking habits. It is crucial to recommend exclusive breastfeeding for up to 6 months and continuation of breastfeeding practice, possibly for up to 2 years of age due to its nutritional, immunological, and stomato-gnathic system developmental benefits.

Keywords: Breastfeeding, non-nutritive sucking, habits, malocclusions, primary dentition, pre-schoolchildren

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Introduction

Literature has described sucking habits in children as being either nutritive or non-nutritive (Ling et al., 2018). The nutritive sucking habits include breastfeeding and bottle-feeding (Lopes-Freire et al., 2015). Breastfeeding has several advantages for children, including nutritional, psychological, immunological, orofacial-developmental and general health benefits (Jackson & Nazar, 2006). It was formerly mentioned that breastfeeding promotes oro-facial muscle exercise while activating breathing, swallowing, mastication and phonation (Freire et al., 2015; Roscoe et al., 2018). In bottle feeding, children are fed using a bottle that expels milk through an artificial rubbery nipple-like object (Orimadegun & Obokon, 2015).

A prior study noted that replacing breastfeeding with bottle feeding can have unfavourable oral effects in children (Carrascoza et al., 2006). Notably, the World Health Organization (WHO) recommends that children be breastfed exclusively during the earliest six months of their lives (WHO, 2021). In some instances, children are breastfed for up to two years of age (Peres et al., 2007; WHO, 2021). Turgeon-O'Brien et al. (1996) suggested that when infants are not sufficiently breastfed, they may develop some sucking habits. Concerning the non-nutritive sucking habits, these are numerous, comprising habits such as finger sucking, thumb sucking and pacifier or dummy sucking (Moimaz et al., 2014).

Non-nutritive sucking habits are used to soothe, comfort or calm infants and children (Benis, 2002). Nevertheless, the habits are considered significant factors for altered occlusion in primary dentition/teeth

Methods

Study area and design.

This cross-sectional study was conducted in pre-schools of Kinondoni and Temeke districts in the Dar es Salaam region. Dar es Salaam is the most socially and culturally heterogeneous region in Tanzania. According to the 2012 population and housing survey in Tanzania (NBS, 2016), Dar es Salaam was

(Bishara et al., 2006; Frazão et al., 2002; Proffit et al., 2007; Warren & Bishara, 2002). More studies (Capsi Pires et al., 2012; Viggiano et al., 2004) supported the fact that non-nutritive sucking habits are among environmental factors related to the occurrence of malocclusion in children. On the other hand, appropriate breastfeeding practices were suggested to be protective against malocclusion development (Moimaz et al., 2014; Narbutytė et al., 2013).

Malocclusion is growth and developmental deviations involving the muscles and jaw bones during childhood (Moimaz et al., 2014). As regards the specific types of malocclusion, studies found posterior crossbite, open bite, deep bite, Class II molar relation and increased overjet to be malocclusion which may develop due to non-nutritive sucking habits and prolonged bottle-feeding in children (Moimaz et al., 2014; Ling et al., 2018).

Existing African literature shows that limited studies have addressed the effect of the duration or frequency of performing the habits. Moreover, some studies could not confirm the association between specific types of malocclusion and bottle-feeding, as well as the duration of breastfeeding or non-nutritive sucking habits (Ling et al., 2018). Notably, there are some conflicting conclusions in studies which have reported the association between feeding practices, non-nutritive sucking and malocclusion development (Pegoraro et al., 2021; Roscoe et al., 2018; Warren & Bishara, 2002). This study thus aimed to assess the association between breastfeeding practices and non-nutritive sucking as covariates of malocclusion in the primary dentition of Tanzanian pre-schoolchildren.

Tanzania's most highly populated region. It is divided into five districts: Kinondoni, Ilala, Ubungo, Temeke and Kigamboni. Kinondoni and Temeke were somewhat diverse districts in their socio-demographic profile, with the former having higher employment and literacy rates (NBS, 2016).

Study sample

Study participants were obtained from 8 selected pre-schools in Kinondoni district (5 pre-schools) and Temeke district (3 pre-schools). A census of 3-5-year-olds attending the schools was utilized for the study, where all 3-5-year-olds and their parents/caregivers were invited to participate. All consenting parents of the 3-5-year-olds were given specific days to be present for the study. 253 of 305 eligible preschool children and their parents participated in the survey, making the response rate 83%.

Survey instrument!

Two trained research assistants administered A structured interview schedule and responded by parents/caregivers of the 3-5-year-old preschool children in face-to-face interviews in a classroom setting. The questionnaire was translated from English to Kiswahili and included questions on socio-demographic characteristics, breastfeeding/feeding modalities, and children's sucking habits. The questionnaire was pilot-tested and adjusted accordingly before being used in the field.

Clinical examination

One trained and calibrated researcher (the Principal Investigator, PI) conducted all clinical examinations in a classroom setting with natural daylight as the source of illumination and a trained assistant was recording the findings. The clinical examination occurred in a private space for this study. Pre-school children were clinically examined in the presence of their parents/caregivers (after their parents had completed the interview). All preschool children who participated were clinically examined for the presence/absence of malocclusion. The registration criterion was according to Björk et al. (1964) with some modifications by al-Emran et al. (1990). For specific malocclusion, the molar relationship was assessed and classified as Angle Class I, II or III when the distal plane of the second deciduous molars in centric occlusion was straight, distal (distal step) or had a mesial (mesial step) discrepancy, respectively.

Socio-demographics were assessed regarding location (Kinondoni/Temeke), gender, age, and parental education. The history of sucking was assessed by asking the parents whether their children had ever sucked their thumb/finger, tongue, or lip. Response categories were given as (1) 'yes' and (2) 'no'. These were then recoded into (0) 'no' and (1) 'yes' for use in further analyses. Current sucking habits were assessed by asking the parents if their children had any sucking habits currently. Response categories were given as (1) 'yes' and (2) 'no'; these were then recoded into (0) 'no' and (1) 'yes'. Parental education was constructed into (0) 'high' and (1) 'low' levels of education. The feeding methods were assessed by asking the parents whether they breastfed or bottle-fed their infants, and the duration was assessed and categorized into (0) 'Breastfeed for ≥ 2 years' and (1) 'Breastfeed for < 2 years'. Tongue thrust swallowing and speech problems in children were recorded and scored as (1) 'presence' and (0) 'absence'.

Similarly, the deciduous canine was in a Class I relationship when the tip of the maxillary deciduous canine occluded in the embrasure of the mandibular deciduous canine and the first deciduous molar, Class II when the tip of the maxillary deciduous canine was anterior to Class I relationship and Class III when it was posterior to Class I relationship. Absence (0)/ presence (1) of the following recordings was also examined; a maxillary overjet, a mandibular overjet, a Class II/Class III molar occlusion, an open bite, a deep bite, a lateral crossbite, a midline shift, crowding and spacing.

Occlusion in the anterior segment could not always be determined in preschool children due to the shedding of their primary incisors. Such cases were excluded from overjet and overbite analyses but included in other malocclusion analyses. A sum score of malocclusion (SMO) was constructed to provide the overall prevalence of malocclusion, based on the diagnosis of absence (0)/ presence (1) of the following

recordings: a maxillary overjet, a mandibular overjet, a Class II/Class III molar occlusion, an open bite, a deep bite, a lateral crossbite, a

midline shift, crowding and spacing. Speech and thrusting problems were also assessed.

Data analysis

Data was analysed using the Statistical Package for Social Sciences version 21.0 (SPSS et al., Illinois, USA). Frequencies were generated to assess percentage distribution/prevalence of different variables. Cross tabulations and Chi-square statistics were used to assess bivariate relationships. Multivariate analysis was conducted using multiple logistic regression analysis. The *p*-value for statistical significance was set at $p < 0.05$, with 95% Confidence Interval.

Ethical considerations

Ethical clearance was obtained from the Research and Publication Committee of the Muhimbili University of Health and Allied Sciences, MUHAS. Permission to work with pre-school children was obtained from Kinondoni and Temeke municipalities, their respective educational authorities, schools administrations and parents. Only those pre-school children whose parents provided consent participated in the study. The informed verbal and written consent were thus obtained from all pre-school children's parents/caregivers who were involved in the survey.

Results

Table 1. Socio-demographics and behavioral characteristics of children 3-5 years.

Variable	Boys % (n)	Girls % (n)	Total % (n)
Age			
3/4 years	19.4 (26)	26.9 (32)	22.9 (58)
5 years	80.6 (108)	73.1 (87)	77.1 (195)
District			
Kinondoni	70.9 (95)	68.9 (82)	70.0 (177)
Temeke	29.1 (39)	31.1 (37)	30.0 (76)
Parents' education			
At least primary school	88.8 (119)	82.4 (98)	85.8 (217)
Above primary school	11.2 (15)	17.6 (21)	14.2 (36)
Breastfeeding duration			
≥ 2 years	17.4 (23)	17.6 (21)	17.5 (44)
< 2 years	82.6 (109)	82.4 (98)	82.5 (207)
Feeding method			
Bottle/cup	64.9 (87)	64.7 (77)	64.8 (164)
Breast	35.1 (47)	35.3 (42)	35.2 (89)
Ever sucking			
Yes	33.6 (45)	21.8 (26)	28.1 (71)
No	66.4 (89)	78.2 (93) *	71.9 (182)
Current sucking			
Yes	17.2 (23)	18.5 (22)	17.8 (45)
No	82.8 (111)	81.5 (97)	82.2 (208)
Swallowing			
Normal	90.3 (121)	92.4 (110)	91.3 (231)
Tongue thrusting	9.7 (13)	7.6 (9)	8.7 (22)
Speech problem			
No	90.3 (121)	95.0 (113)	92.5 (234)
Yes	9.7 (13)	5.0 (6)	7.5 (19)

*= $p < 0.05$.

In Table 1, most of the pre-school children were above 5 years of age (77.1%). Majority were from Kinondoni district (70.9%). A greater proportion of the pre-school children's parents (85.8%) were educated at the level of primary school or below; few had a higher level of education of above primary school (14.2%). Regarding breastfeeding practices, few children (17.5%) were breastfed for up to 2 years or more. Bottle and cup feeding were the feeding methods utilized by

most parents (64.8%); few parents practiced only breastfeeding (35.2%). Concerning sucking habits, a history of non-nutritive sucking was reported in 28.1% of the children and was mostly among boys compared with girls (33.6% versus 21.8%, $p < 0.05$). Whereas 17.8% of the children had active non-nutritive sucking habits. Tongue thrust swallowing was observed in 8.7% of the pre-school children and 7.5% had speech problems, mainly in form of lisping.

Table 2. Percentage (n) of children with malocclusions by feeding modalities and breastfeeding duration.

Malocclusion	Breastfeeding % (n)	Bottle feeding. % (n)	Breastfeed ≥ 2 years. % (n)	Breastfeed < 2 years % (n)
Maxillary overjet	0.0 (0)	2.8 (3)	3.0 (1)	1.5 (2)
Mandibular overjet	3.4 (3)	6.7 (11)	0.0 (0)	6.8 (14)
Angle's Class II or III	3.4 (3)	12.2 (20) *	2.3 (1)	10.6 (22) *
Open bite	13.5 (12)	21.3 (35)	15.9 (7)	18.8 (39)
Cross bite	3.4 (3)	0.0 (0) *	0.0 (0)	1.4 (3)
Midline shift	10.1 (9)	6.7 (11)	6.8 (3)	8.2 (17)
Scissors bite	23.6 (21)	14.0 (23) *	11.4 (5)	18.4 (38)
Crowding	1.1 (1)	0.6 (1)	0.0 (0)	1.0 (2)
Spacing	14.6 (13)	22.6 (37)	18.2 (8)	20.3 (42)
Total malocclusion score	45.9 (28)	43.5 (47)	27.3 (9)	48.5 (66) *

*= $p < 0.05$.

Angle's Class II or III was recorded in a significantly greater proportion of children who were bottle-fed compared to those who were breastfed (12.2% versus 3.4%, $p < 0.05$); and was significantly most frequently recorded in children who were breastfed for a lesser duration compared with those who were breastfed for >2 years (10.6% versus 2.3%, $p < 0.05$). But scissors bite was found in significantly most of those who were breastfed compared with those who were bottle-fed (23.6% versus 14.0%, $p < 0.05$); and was found in the majority of those who were breastfed for shorter duration (18.4% versus 11.4%, but not statistically significant). Overall, the total malocclusion score was found in a significantly greater percentage of those who were breastfed for <2 years compared with those who were breastfed for a longer duration (48.5% versus 27.3%, $p < 0.05$) (Table 2).

Table 3. Angle's Class II or III malocclusion, scissors bite and total malocclusion score above o regressed on feeding methods at first 6 months and breastfeeding duration. Adjusted for age, gender, parents' education, ever sucking and current sucking behaviors.

Malocclusion	Feeding methods	Categories	Adjusted OR	95% CI
Angle's Class II or III	Feeding first 6 months	Bottle/cup	1	
		Breast	0.25	0.1-0.8
	Breastfeeding duration	≥ 2 years	1	
		< 2 years	5.2	0.6-40.2
Scissors bite	Feeding first 6 months	Bottle /cup	1	
		Breast	1.9	1.0-3.7
Total malocclusion	Breastfeeding duration	≥ 2 years	1	
		< 2 years	2.7	1.2-6.8

OR=Odds Ratio; CI= Confidence interval.

In Table 3, compared with those who were bottlefed, children who were breastfed for the first 6 months of life were less likely to be found with Angle's Class II or III malocclusion (OR=0.25, CI=0.1-0.8). But those who were breastfed were more likely to have Scissors bite than those who were bottle fed (OR=1.9,

CI=1.0-3.7). Regarding breastfeeding duration, children who were breastfed for <2years were more likely to have a total malocclusion score of >0, than those who were breastfed for a longer duration (≥2years) (OR=2.7, CI=1.2-6.8).

Table 4. Percentage (n) of children with malocclusion by ever sucking and current sucking habits.

Malocclusion	Ever sucking % (n)	Never sucking % (n)	Current sucking % (n)	No current sucking % (n)
Maxillary overjet	5.4 (2)	0.8 (1)	0.0 (0)	1.9 (3)
Mandibular overjet	2.8 (2)	6.6 (12)	2.2 (1)	6.3 (13)
Angle's Class II or III	5.6 (4)	10.4 (19)	4.4 (2)	10.1 (21)
Open bite	38.0 (27)	11.0 (20) **	57.8 (26)	10.1 (21) **
Cross bite	1.4 (1)	1.1 (2)	2.2 (1)	1.0 (2)
Midline shift	12.7 (9)	6.0 (11)	11.1 (5)	7.2 (15)
Scissors bite	21.1 (15)	15.9 (29)	24.4 (11)	15.9 (33)
Crowding	15.9 (29)	1.1 (2)	0.0 (0)	1.0 (2)
Spacing	26.8 (19)	17.0 (31)	20.0 (9)	19.7 (41)
Total malocclusion	65.9 (24)	38.6 (51) **	60.0 (9)	42.9 (66)

**= $p < 0.01$.

Table 4 depicts that; open bite was found in many of those (children) who ever performed non-nutritive sucking habit (38%) compared with those who never performed the habit (11%, $p < 0.01$). Similarly, open bite was found in majority of children who had active non-nutritive-sucking habit (57.8%) as opposed to those who had no current non-nutritive sucking habit (10.1%, $p < 0.01$). Also, a greater percentage (65.9%) of children who ever performed non-nutritive sucking habit had a

total malocclusion score >0 compared with those who never had non-nutritive sucking habit (38.6%, $p < 0.01$).

Table 5. Open bite regressed on ever sucking, current sucking (adjusted for age, gender, parental education), total malocclusion regressed on current sucking (adjusted for age, gender, parental education and breastfeeding duration).

Malocclusion	Sucking habit	Categories	Adjusted OR	95% CI
Open bite	Ever sucking	Yes	1	
		No	0.15	0.07-0.31
Total malocclusion	Current sucking	yes	1	
		No	3.0	1.3-6.7
Open bite	Current sucking	Yes	1	
		No	0.07	0.03-0.16

OR=Odds Ratio; CI= Confidence interval.

Table 5 shows that open bite was less likely to be found in children who never performed non-nutritive sucking habits compared with those who ever performed the habits (OR=0.15, OR=0.07-0.31). Also, children who did not have current non-nutritive sucking habits were less likely to have an open bite,

compared with those who were performing current non-nutritive sucking habits (OR=0.07, OR=0.03-0.16). But children who had no current non-nutritive sucking habits were more likely to have a total malocclusion score of >0 than those who had current sucking habits (OR=3.0, OR=1.3-6.7).

Table 6. Open bite regressed on swallowing, speech problem (adjusted for age, gender, parental education and sucking habits).

Malocclusion	Normal swallowing % (n)	Thrust swallowing % (n)	Adjusted Model OR (95% CI)	No speech problem % (n)	Speech problem % (n)	Adjusted model OR (95% CI)
Open bite	13.4 (31)	72.7 (16) ***	20.3 (7.1-58.6)	14.5 (34)	68.4 (13) **	16.6 (5.5-49.6)

***= $p=0.000$, **= $p<0.01$; OR=Odds Ratio; CI= Confidence interval.

It was shown in Table 6 that children who had an open bite were more likely to thrust while swallowing and to have speech problems than their counterparts who did not have an

open bite (OR=20.3; CI=7.1-58.6 and OR=16.6; CI=5.5-49.6, respectively) ($p=0.000$ and $p<0.01$, respectively).

Discussion

Socio-demographic characteristics of the participants, breastfeeding, and bottle-feeding practices

A cross-sectional survey was used to collect data from a sample of 3-5-year-old pre-schoolchildren (and their parents), from two districts of the Dar es Salaam region in Tanzania. At this age, most of the children would be having fully erupted primary dentition (Proffit and Fields, 2000). Regarding the parents' education, few parents (14.2%) in the present study had an education of above primary school level. One of the importance of enquiring about the parents' level of education is that it could reflect on the mothers' breastfeeding practices (Heck et al., 2006.; Tang et al., 2019). Hence, considering the parents' breastfeeding practices, in this study the majority (82.5%) of the mothers reported breastfeeding their children for less than two years.

In one Chinese study, the rate of exclusive breastfeeding practice was higher since the parents involved in the study were highly educated (Chen et al., 2015), but it was lower in a lesser educated group of participants in another study among rural Chinese residents (Qu et al., 2015). This implies that the rate of exclusive breast feeding may improve with advancement of the parents' education level. Furthermore, a substantial proportion (64.8%) of parents in the present study reported to have used a bottle-feeding method to feed their infants.

Chen et al., (2015) documented that a shorter duration or lack of breastfeeding, may be associated with a longer duration of bottle-feeding.

Thus, past studies have recommended interventions to promote breastfeeding to increase its duration (Marks et al., 2018). This encourages parents to prolong breastfeeding and shorten bottle-feeding duration as much as possible (Orengul et al., 2018). The recommendations are essential for children's correct growth and development.

Malocclusion is related to feeding modalities and duration.

Angle's Class II or III was currently recorded in a significant proportion of bottle-fed children compared to breastfed children (12.2% versus 3.4%, respectively). This finding is comparable to that reported in an earlier study, where bottle-fed children were found to have a high risk of developing a nonmesial step occlusion (Chen et al., 2015). Breastfeeding was further reported to be protective against developing skeletal Class II and distocclusion in children (Abate et al., 2020).

Moreover, breastfeeding has been considered a factor for proper oro-facial development by promoting muscle exercise, which stimulates oro-facial structures (Ling et al., 2018). On the other hand, bottle-feeding practices have been reported to have lesser muscular activities (Cotrim et al., 2002) to promote harmonious orofacial growth. Regarding breastfeeding duration, as it

relates to Angle's Class II or III malocclusion, this study found an altered molar relationship in most children who were breastfed for a lesser duration (below two years) compared with those who were breastfed for a longer duration (2 years and above).

The observation supports what was concluded in a systematic review by Boronat-Catalá et al. (2017), who indicated that breastfeeding for longer duration decreases the risk of being found with Class II malocclusion. In addition, Sánchez-Molins et al. (2010) indicated that breastfed children are likely to have a more correct sagittal mandibular relationship with maxilla and the cranial base. As regards a transverse jaw relationship, scissors bite was currently found in most of those who were breastfed compared with those who were bottle-fed (23.6% versus 14.0%, respectively).

Contrary to this finding, previous workers documented that artificial teat (as those used to bottle-feed) may cause malalignment of teeth by restricting transverse growth of the palate (Viggiano et al., 2004; Peres et al., 2007). This is because the teats usually have a specific shape and rigidity, which is different from the human breast tissue (Peres et al., 2007). Generally, a combined presence of various malocclusion was higher among children who were breastfed for less than 2 years, compared with those who were breastfed for a longer duration (48.5% versus 27.3%, respectively). This finding supports what was reported by previous studies, that breastfeeding determines proper craniofacial development, which may counteract occlusal deviations (Sánchez-Molins et al., 2010).

Regression analysis of the relationship between malocclusion and feeding methods

In a regression analysis between presence of malocclusion and the feeding methods, it was presently found that children who were breastfed were less likely to be found with Angle's Class II or III malocclusion, compared with those who were bottle-fed. The finding is in concordance with earlier reports which found a greater distocclusion among children who were breastfed for a shorter duration

(Feldens et al., 2016), and more mesial occlusion among bottlefed children (Wójcik et al., 2011). Other reports found longer breastfeeding duration associated with recording less Class II incisor or molar relationship (Boronat-Catalá et al., 2017; Sum et al., 2015, respectively).

Besides, the regression analysis in this study showed that children who were breastfed for less than two years were about thrice as likely to have various malocclusion than their counterparts (who were breastfed for two years or greater). Suggestions were made by Labbok and Hendershot (1987) that increased breastfeeding duration is associated with a drop in the proportion of malocclusion in children. However, the current study showed that breastfed children were more likely to be seen with scissors bites than bottle-fed children. In contrast to this finding, a study by Moimaz et al. (2014) showed a higher prevalence of transverse malocclusion among bottle-fed children.

Relationship between malocclusion and past/present non-nutritive sucking habits

The present research found an open bite in a more significant number of children who had a history of non-nutritive sucking habits, compared with those who never had the habits. Similarly, open bite was currently found in most children with active non-nutritive-sucking habits, compared with those who did not have the habits. The findings conform to that reported in a study of Chen et al. (2015), who found digit sucking habit to be associated with anterior open bite. The mechanism through which an open bite occurs in people with non-nutritive sucking habits has been explained earlier (Bishara et al., 2006; Dawood, 2004; Fukuta et al., 1996).

The explanation includes that thumb/pacifier pressure prevents the downward maxillary base growth and delays the eruption of anterior teeth while allowing the posterior teeth to erupt. This causes an overeruption of posterior teeth and the formation of an anterior open bite (Chen et al., 2015). Also, this study found a more significant percentage (65.9%) of various

malocclusion in children who ever performed non-nutritive sucking habits, compared with a lesser percentage (38.6%) of various malocclusion in children who never had the habits. This finding is in line with the findings of former researchers who reported an association between the presence of malocclusion in children and non-nutritive sucking habits. (Capsi Pires et al., 2012; Peres et al., 2007).

Regression analysis of the relationship between sucking habits, open bite and other malocclusion

In the present regressing analysis, it was shown that an open bite was less likely to be found in children who never performed non-nutritive sucking habits, compared with those who ever performed the habits. Also, children who did not have active non-nutritive sucking habits were less likely to have an open bite, compared with those who were actively performing the habits. The findings agree with those of Ling et al. (2018) and Belitz et al. (2022), who found the presence of non-nutritive sucking habits to be associated with a higher prevalence of anterior open bite.

In this study reported overall presence of malocclusion (other malocclusion than an open bite) in a higher proportion of children who did not have active sucking habits, compared to those who had active sucking habits. This could be explained by the fact that some of those who were actively performing the habits might have just recently started to perform the habits. Hence, it could have been too early for them to present with some other dental-alveolar alteration/s. On the contrary, other past studies (Montaldo et al., 2011; Viggiano et al., 2004; Warren & Bishara, 2002) reported differently, where they reported that pacifier and digit-sucking are associated with the occurrence of various malocclusion in children.

Relationship between malocclusion (open bite), swallowing pattern and speech problem.

Because of having an open bite, the current study revealed an association between

presence of the condition (open bite) and observing swallowing by thrusting and speech problems among the participants (children). Specifically, children who had an open bite were many times more likely to thrust while swallowing and to have speech problems than their counterparts who did not have the condition. This finding agrees with what was earlier reported, where atypical swallowing was found to have a significant relationship with the presence of anterior open bite (Sahad et al., 2008).

Moreover, a study by Amr-Rey et al. (2022) found a significant association between an anterior open bite and an alteration of the fricative phonemes (s,ch,z) and the affricate (ch). The study further explained that the alteration could be due to a defective air outlet since the anterior teeth do not occlude. Another explanation for the presence of swallowing and speech problems among the present participants is that, since most of the children were breastfed for a shorter duration, they might have been subjected to early weaning. A previous study explained the possibility of early weaning to cause negative consequences such as swallowing, breathing, speaking and malocclusion development (Neiva et al., 2003). Therefore, the appropriate children's feeding modalities should be encouraged and supported.

Study limitations: Few parents might have been unable to provide accurate answers, causing a recall bias. Additionally, this was a cross-sectional study, where it is possible only to establish associations between the predictors and the outcomes, but no causal relations could be determined. Issues like effects of heredity and other detrimental habits as aetiological factors for malocclusion, were beyond the reach of this study.

Conclusion and recommendations

Most of the children who were breastfed for a shorter duration and children who had non-nutritive sucking habits were found with various malocclusion, compared with those who were breastfed for a longer duration and

those who had no non-nutritive sucking habits. Exclusive breastfeeding for up to 6 months and continuing breastfeeding practice for possibly up to 2 years of age is recommended due to its nutritional, immunological, and stomato-gnathic system developmental benefits. It is also important to develop public health programs to encourage good behaviours related to oral health and to discourage prolonged children's deleterious habits.

Competing interests

The authors declare that they have no competing interests. The authors' contributions MM conceived the idea, designed the study, collected data, carried out statistical analysis and wrote the first

draft of the manuscript. PB participated in the study of design, methodology and manuscript writing. AA designed the study, carried out statistical analysis. All read and approved the final version of the manuscript.

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