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ORIGINAL ARTICLE

Association between breastfeeding and the development of breathing patterns in children

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Abstract The aims of the present study were to evaluate the association between breastfeeding and breathing development and to investigate associations between breastfeeding duration and the breathing patterns in children. A cross-sectional study was carried out at the Institute of Integrative Medicine Professor Fernando Figueira, Recife, Brazil, with a random sample of 732 children aged between 6 and 9 years. Breastfeeding and breathing patterns were identified using a questionnaire that was filled out by mothers or guardians, and a clinical examination of the children. Data were analyzed statistically by Pearson's chi-square test at 5 % significance level. The prevalence of mouth breathing was 48 %, whereas 52 % of the children were nasal breathers. Six hundred-forty children were breastfed; 46.2 % of them were mouth breathers and 53.8 % were nasal breathers. Ninety-two children were not breastfed; 59.8 % of them were mouth breathers and 40.2 % were nasal breathers. Breastfeeding for 24 months or more, as well as exclusive breastfeeding in the first 6 months, was associated with the development of nasal breathing. *Conclusions* Extended breastfeeding was associated with correct development of the breathing pattern.

Keywords Breastfeeding · Breastfeeding duration · Breathing patterns · Mouth breathing

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Introduction

A mother's milk provides an infant with all the essential nutrients during the first months of life. Exclusive breastfeeding is recommended for the first 6 months whereas non-exclusive breastfeeding should continue for at least 24 months [28, 29].

The benefits of mother's milk include the following: its nutritional content, a greater capacity of internal absorption, it prevents allergies and respiratory problems, it assists psychological development, better immunological defenses, it plays an important role in reducing infant mortality rates, and emotional bonding between the mother and child [1, 3, 11, 13, 14, 26]. Exclusive breastfeeding is associated with reduced irritability/colic and a tendency toward longer nocturnal sleep [6]. Breastfeeding can provide a feeling of well-being, security, and warmth, which reduces the possibility of children resorting to non-nutritive sucking habits to satisfy their needs [19].

The mechanics of breastfeeding require efficient coordination of suction, swallowing, and breathing [9]. This is a decisive and primordial factor of correct craniofacial maturity and growth at bone, muscle, and functional levels and in the ability of these structures to develop the orofacial muscles. These muscles will guide and stimulate the development of the physiological functions, thus guaranteeing survival and an improved quality of life [17, 27].

Children who are exclusively breastfed exhibit different nutritive sucking patterns from those who are exclusively fed with a baby's bottle [20]. Muscle stimulation, which leads to the development of nasal breathing, occurs during the breastfeeding process [17, 25]. Early weaning endangers the correct breathing pattern and commonly leads to a parted lips posture, which favors mouth breathing. Therefore, early weaning could explain the high prevalence of mouth breathers [10].

Breathing patterns alter craniofacial development [15]. Mouth breathers may experience respiratory infections, allergic rhinitis, asthma, hypertrophy of the adenoids and tonsils, deviated septum, parted lips, narrow nostrils, hypertonicity, elongation of the lower face, gummy smile, malocclusions, sleeping with the mouth open, slobbering, snoring, and sleep apnea [4, 7, 8, 16, 18].

The aim of the present study was to evaluate the association between breastfeeding and breathing development and to investigate associations between breastfeeding duration and the breathing patterns in children.

Methods

A cross-sectional study was carried out with patients attending the outpatient clinic of pediatrics at the Instituto de Medicina Integral Professor Fernando Figueira—IMIP (Institute of Integrative Medicine Professor Fernando Figueira), which is a reference hospital for maternal and infantile health in the city of Recife, Pernambuco, Brazil. This study received approval from the Human Research Ethics Committee of IMIP under process number 2322-11 in June 2011.

The sample size calculation was performed to demonstrate the association between exposure and outcome and the prevalence of this disease (mouth breathing) in patients presenting equal to 60 % with 95 % confidence, error of 2.5 %, and a power of 80 %. The Epi Info version 6 software was used.

The sample consisted of 732 children from 6 to 9 years who sought the service of pediatrics at IMIP. After their proper identification, parents or guardians were informed about the objectives, risks, and benefits of the research, and after signing the consent form, a questionnaire was initialized with them (Table 1); then, a clinical examination to detect the normal breathing pattern of the child was performed.

Children with the following criteria were excluded from the study: neurological disorders or syndromes, influenza, a cold or infection on the date of the examination, absence of permission from the parents/guardians, and those who refused to participate.

Three tests were used to analyze breathing patterns. Children who exhibited a positive response in two of the three tests were considered to be mouth breathers whereas those who were positive in only one test or negative in all three were considered to be nasal breathers. The tests were the following:

- Glatzel mirror: the mirror was placed below the child's nose to identify the presence of steam on the upper section, thereby indicating nasal breathing. Steam on the lower section or on both sections simultaneously indicated mouth breathing.
- Water test: the child was requested to pour some water into the mouth from a 50-mL disposable cup and to keep the lips closed, without swallowing, for a period of 3 min. Children who could not keep their lips in contact

Table 1 Questionnaire used in the study

Type of feeding
1. Has the child been breastfed? () yes () no
2. For how long has the child been breastfed?
() 1 month () 2 months () 3 months () 4 months () 5 months () 6 months () 7 months () 8 months () 9 months () 10 months () 11 months () 12 months () 13 to 23 months () 24 or more than 24 months
3. For how long has the child been exclusively breastfed?
() 1 month () 2 months () 3 months () 4 months () 5 months () 6 months () more than 6 months
4. Did the child use a baby's bottle? () yes () no
5. If so, when did the child start to use a baby's bottle?
() 1° month () 2° month () 3° month () 4° month () 5° month () 6° month
6. If so, how long did the child use a baby's bottle?
() until year () until 2 years () until 3 years () more than 3 years

Table 2 Association between breastfeeding and breathing pattern

Breastfeeding	Breathing pattern						*p* value	PR (95% CI)
	Mouth		Nasal		Total			
	n	%	*n*	%	*n*	%		
Yes	296	46.2	344	53.8	640	100.0	0.015[a]	1.00
No	55	59.8	37	40.2	92	100.0		1.29 (1.07–1.56)
Total	351	48.0	381	52.0	732	100.0		

PR prevalence rate, *CI* confidence interval

[a]Pearson's chi-square test

for 3 min with the water in their mouths were diagnosed as mouth breathers.

– Lip closure: an assessment was conducted to determine if there was a harmonious relationship between the upper and lower lips while in soft contact without the active participation of the perioral musculature. This test was performed without the child's knowledge in order to prevent the child from influencing the diagnosis.

The researcher was calibrated by an orthodontist and a speech therapist for a clinical examination. The results were statistically analyzed using Pearson's chi-square test with the confidence interval set at 95 %. A level of significance of 0.05 was adopted. The Statistical Package for the Social Sciences, version 13 (SPSS, Chicago, IL), was used.

Results

The study included a sample of 732 children aged from 6 to 9 years (median age, 7.5±1.2). The prevalence of mouth breathing was 48 %, whereas 52 % of the children were nasal breathers (Table 2). 640 children were breastfed, 46.2 % of them were mouth breathers, and 53.8 % were nasal breathers. Ninety-two children were not breastfed, 59.8 % were mouth breathers, and 40.2 % were nasal breathers. In order to evaluate the association of breastfeeding on breathing patterns, Pearson's chi-square test was carried out across the data of these two factors. The results indicate a positive association between breastfeeding and the development of mouth breathing (p=0.015).

Table 3 shows the prevalence of mouth breathing according to gender and year. There was no statistically significant association between the independent variables of gender (p=0.058) and age (p=0.078) and the dependant variable of breathing.

Exclusive breastfeeding in the first 6 months was related to decreased mouth breathing (p<0.001) (Table 4). It was also noted that the breastfeeding duration period influences respiration development. The possibility of exhibiting nasal breathing increased with an increase in the breastfeeding duration period (p=0.007), and the probability of developing mouth breathing decreases as the length of the breastfeeding period increases (Table 5).

Discussion

As a precautionary measure, three different tests were used to diagnose mouth breathing in the present study. In this way, the possible limitations of each test were balanced by the other tests. A diagnosis of mouth breathing was given when the child recorded positive results in at least two of the tests. This methodology resulted in a mouth breathing prevalence of 48.0 %, which is similar to the results found by Menezes et al. [3] which observed in a study conducted in Recife, PE (Brazil), a prevalence of 53.3 % of mouth breathers in the age group from 8 to 10 years. Gender and age were not statistically significant for the development of mouth breathing.

The literature about breastfeeding reveals that there is no longer any doubt about the benefits that breastfeeding can bring to the health of both mother and child [5, 14, 17, 19, 21, 24, 27]. As stated by Trawitzki et al. [24], breastfeeding promotes nasal breathing by requiring the adequate use of suction in newborns. During breastfeeding, the lips remain in complete contact with the breast, and the nose is stimulated to begin inspiration and expiration. This may explain

Table 3 Prevalence of mouth breathing according to gender and age group

Variable	Number	Percent	*p* value
Gender			0.058[a]
Male	197	51.0	
Female	154	44.5	
Years			0.078[a]
6	107	48.2	
7	86	47.5	
8	94	55.3	
9	64	40.3	

[a] Pearson's chi-square test

Table 4 Association between exclusive breastfeeding and breathing pattern

Exclusive breastfeeding (months)	Breathing pattern						*p* value	PR (95 % CI)
	Mouth		Nasal		Total			
	n	%	*n*	%	*n*	%		
Null	98	59.8	66	40.2	164	100.0	<0.001[a]	1.49 (1.23–1.82)
<6	153	48.1	165	51.9	318	100.0		1.20 (0.99–1.45)
≥6	100	40.0	150	60.0	250	100.0		1.00
Total	351	48.0	381	52.0	732	100.0		

Null children that were not breastfed or were non-exclusively breastfed, *PR* prevalence rate, *CI* confidence interval

[a] Pearson's chi-square test

why many children that were not breastfed, or were breastfed for a short period of time, exhibit mouth breathing.

The American Academy of Pediatrics [1] recommends exclusive breastfeeding for about 6 months, with continuation of breastfeeding for 1 year or longer as mutually desired by mother and infant, a recommendation concurred to by the World Health Organization (WHO) [29]. Support for this recommendation of exclusive breastfeeding is found in the differences in health outcomes of infants breastfed exclusively for 4 vs 6 months, for gastrointestinal disease, otitis media, respiratory illnesses, and atopic disease, as well as differences in maternal outcomes of delayed menses and postpartum weight loss [2, 23]. Compared with infants who never breastfed, infants who were exclusively breastfed for 4 months had significantly greater incidence of lower respiratory tract illnesses, otitis media, and diarrheal disease than infants exclusively breastfed for 6 months or longer. When compared with infants who exclusively breastfed for longer than 6 months, those exclusively breastfed for 4 to 6 months had a fourfold increase in the risk of pneumonia. Furthermore, exclusively breastfeeding for 6 months extends the period of lactational amenorrhea and thus improves child spacing, which reduces the risk of birth of a preterm infant [22]. Jedrychowski et al. [12] also complement that even a shorter duration of exclusive breastfeeding in early infancy produces beneficial effects on the cognitive development of children.

The present research observed that the breastfeeding period recommended by the WHO [28, 29], exclusive breastfeeding for the first 6 months followed by non-exclusive breastfeeding until at least 24 months of age, is essential to the development of the correct breathing pattern. This finding is in agreement with previous studies [17, 20] that highlighted breastfeeding as a stimulus to the musculature which favors the development of nasal breathing.

The present study compared children who were exclusively breastfed for the first 6 months of their life to children who were non-exclusively breastfed in the same period and observed that those who were exclusively breastfed showed less probability of developing mouth breathing. This finding confirms that newborns who are nourished with non-exclusive breastfeeding have less developed suction abilities than those who are exclusively breastfed [20].

Table 5 Association between the duration of breastfeeding in months and breathing pattern

Duration of breastfeeding (months)	Breathing pattern						*p* value	PR (95 % CI)
	Mouth		Nasal		Total			
	n	%	*n*	%	*n*	%		
Zero	55	59.8	37	40.2	92	100.0	0.007[a]	1.59 (1.23–2.05)
1–6	161	50.6	157	49.4	318	100.0		1.35 (1.08–1.68)
7–12	52	48.6	55	51.4	107	100.0		1.29 (0.98–1.70)
13–23	18	42.9	24	57.1	42	100.0		1.14 (0.77–1.70)
24 or more	65	37.6	108	62.4	173	100.0		1.00
Total	351	48.0	381	52.0	732	100.0		

PR prevalence rate, *CI* confidence interval

[a] Pearson's chi-square test

According to the present study and the study of Hatamleh et al. [10], early weaning is a possible explanation for the high numbers of mouth breathers. The results of this study demonstrate that a longer period of breastfeeding leads to a lower likelihood of mouth breathing: among children who were not breastfed, 59.8 % were mouth breathers, whereas among children who were breastfed for at least 24 months, only 37.6 % exhibited mouth breathing.

Due to the high percentage of mouth breathers and the implications of this disease [4], public action should be well defined in its aim to prevent this problem from occurring. Promoting breastfeeding can be one manner of preventing mouth breathing, as it had a positive impact on the correct development of breathing patterns. This will provide children with all the benefits of breastfeeding [1, 14, 17, 19, 21, 27] and decrease the likelihood of developing mouth breathing, thus leading to an improvement in their quality of life.

Conclusions

Based on this study's results, extended breastfeeding was associated with the correct development of breathing pattern.

Conflict of interest The authors deny any conflict of interest.

References

1. American Academy of Pediatrics (2012) Breastfeeding and the use of human milk. Pediatr 129:e827–e841
2. Chantry CJ, Howard CR, Auinger P (2006) Full breastfeeding duration and associated decrease in respiratory tract infection in US children. Pediatr 117:425–432
3. de Menezes VA, Leal RB, Pessoa RS, Pontes RM (2006) Prevalence and factors related to mouth breathing in school children at the Santo Amaro project—Recife, 2005. Braz J Otorhinolaryngol 72:394–399
4. Defabjanis P (2003) Impact of nasal airway obstruction on dentofacial development and sleep disturbances in children: preliminary notes. J Clin Pediatr Dent 27:95–100
5. Dewey KG, Heinig J, Nommsen-Rivers LA (1995) Differences in morbidity between breast-fed and formula-fed infants. J Pediatr 126:696–702
6. Engler AC, Hadash A, Shehadeh N, Pillar G (2012) Breastfeeding may improve nocturnal sleep and reduce infantile colic: potential role of breast milk melatonin. Eur J Pediatr 171:729–732
7. Faria PT, de Oliveira RAC, Matsumoto MA, Anselmo-Lima WT, Pereira FC (2002) Dentofacial morphology of mouth breathing children. Braz Dent J 13:129–132
8. Fujimoto S, Yamaguchi K, Gunjigake K (2009) Clinical estimation of mouth breathing. Am J Orthod Dentofacial Orthop 136:630.e1–630.e7
9. Goldfield EC, Richardson MJ, Lee KG, Margetts S (2006) Coordination of sucking, swallowing, and breathing and oxygen saturation during early infant breast-feeding and bottle-feeding. Pediatr Res 60:450–455
10. Hatamleh W (2012) Prenatal breastfeeding intervention program to increase breastfeeding duration among low income women. Health 4:143–149
11. Hylander MA, Strobino DM, Dhanireddy R (1998) Human milk feedings and infection among very low birth weight infants. Pediatr 102:38–43
12. Jedrychowski W, Perera F, Jankowski J, Butscher M, Mroz E, Flak E, Kaim I, Lisowska-Miszczyk I, Skarupa A, Sowa A (2012) Effect of exclusive breastfeeding on the development of children's cognitive function in the Krakow prospective birth cohort study. Eur J Pediatr 171:151–158
13. Kobayashi HM, Scavone Júnior H, Ferreira RI, Garib DG (2010) Relationship between breastfeeding duration and prevalence of posterior crossbite in the deciduous dentition. Am J Orthod Dentofacial Orthop 137:54–58
14. Kramer MS, McGill J, Matush L, Vanilovich I, Platt R, Bogdanovich N, Sevkovskaya Z, Dzikovich I, Shishko G, Mazer B (2007) Effect of prolonged and exclusive breast feeding on risk of allergy and asthma: cluster randomised trial. BMJ 335:815
15. Lessa FC, Enoki C, Feres MF, Valera FC, Lima WT, Matsumoto MA (2005) Breathing mode influence in craniofacial development. Braz J Otorhinolaryngol 71:156–160
16. Luz CLF, Garib DG, Arouca R (2006) Association between breastfeeding duration and mandibular retrusion: a cross-sectional study of children in the mixed dentition. Am J Orthod Dentofacial Orthop 130:531–534
17. Malandris M, Mahoney EK (2004) Aetiology, diagnosis and treatment of posterior cross-bites in the primary dentition. Int J Paediatr Dent 14:155–166
18. Mattar SEM, Valera FCP, Faria G, Matsumoto MAN, Anselmo-Lima WT (2011) Changes in facial morphology after adenotonsillectomy in mouth-breathing children. Int J Paediatr Dent 21:389–396
19. Montaldo L, Montaldo P, Cuccaro P, Caramico N, Minervini G (2011) Effects of feeding on non-nutritive sucking habits and implications on occlusion in mixed dentition. Int J Paediatr Dent 21:68–73
20. Moral A, Bolibar I, Seguranyes G, Ustrell JM, Sebastiá G, Martínez-Barba C, Ríos J (2010) Mechanics of sucking: comparison between bottle feeding and breastfeeding. BMC Pediatr 10:6
21. Oddy WH, Sherriff JL, Klerk NH, deKendall GE, Sly PD, Beilin LJ, Blake KB, Landau LI, Stanley FJ (2004) The relation of breastfeeding and body mass index to asthma and atopy in children: a prospective cohort study to age 6 years. Am J Public Health 94:1531–1537
22. Peterson AE, Peréz-Escamilla R, Labbok MH, Hight V, Von Hertzen H, Van Look P (2000) Multicenter study of the lactational amenorrhea method (LAM) III: effectiveness, duration, and satisfaction with reduced client–provider contact. Contracept 62:221–230
23. Quigley MA, Kelly YJ, Sacker A (2007) Breastfeeding and hospitalization for diarrheal and respiratory infection in the United Kingdom Millennium Cohort Study. Pediatr 119:e837–e842
24. Schubiger G, Schwarz U, Tönz O (1997) UNICEF/WHO baby-friendly hospital initiative: does the use of bottles and pacifiers in the neonatal nursery prevent successful breastfeeding? Eur J Pediatr 156:874–877
25. Trawitzk LV, Anselmo-Lima WT, Melchior MO, Grechi TH, Valera FC (2005) Breast-feeding and deleterious oral habits in

mouth and nose breathers. Braz J Otorhinolaryngol 71:747–751
26. Van Gysel M, Cossey V, Fieuws S, Schuermans A (2012) Impact of pasteurization on the antibacterial properties of human milk. Eur J Pediatr 171:1231–1237
27. Viggiano D, Fasano D, Monaco G, Strohmenger L (2004) Breast feeding, bottle feeding and non-nutritive sucking habits; effects on occlusion in deciduous dentition. Arch Dis Child 89:1121–1123
28. World Health Organization, Division of child health and development (1991) Indicators for assessing breastfeeding practices. WHO, Geneva
29. World Health Organization (2001) The optimal duration of exclusive breastfeeding: systematic review. WHO, Geneva