*Original Article*

# Influence of Nonnutritive Sucking Habits, Breathing Pattern and Adenoid Size on the Development of Malocclusion

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**ABSTRACT**

**Objective:** To investigate the association of finger and pacifier-sucking habits, breathing pattern, and adenoid size with the development of malocclusion in primary dentition.

**Materials and Methods:** A case-control study was carried out involving 300 preschool children, ages 3 to 6 years, randomly selected from 10 public and 10 private preschools from a large representative sample of 745 children. The study was developed to identify risk factors associated with the development of malocclusion. The case group (n = 150) was composed of individuals with at least one of the following malocclusions: anterior open bite, posterior crossbite, or overjet of more than 3 mm. The control group (n = 150) was made up of individuals without malocclusions. Other variables were assessed through questionnaires about oral habits, including the use of a dummy, finger sucking, duration of these habits; mouth-breathing analysis; and a lateral cephalometric radiograph to evaluate the airway obstruction related to the adenoids. Multiple logistic regression analyses were performed. Statistical significance was $P < .05$.

**Results:** The risk factors for the occurrence of malocclusion in preschool children were duration of pacifier-sucking after 2 years of age (OR = 14.7) and mouth-breathing pattern (OR = 10.9). No significant associations were found between hypertrophied adenoids or finger-sucking habits and the occurrence of malocclusion.

**Conclusions:** The malocclusion in the primary dentition in preschool children was directly related to the duration of pacifier-sucking after 2 years of age and the mouth-breathing pattern.

**KEY WORDS:** Digit sucking; Pacifier sucking; Mouth-breathing; Adenoids; Malocclusion; Primary dentition

## INTRODUCTION

Occlusal relations in the primary dentition have been considered an important factor in many research studies due to their key role as a guide to permanent dentition development. Thus, a large number of studies have included the identification of alterations in the normality pattern among the possible etiologic factors.[1–21] Sucking behavior has long been recognized as affecting occlusion and dental arch characteristics.[1–6] Studies have found that nonnutritive sucking habits are associated with certain malocclusions in the primary dentition.[1–5] Several studies have also reported the effects of prolonged nonnutritive sucking habits on certain dental arch measurements with a correspondingly higher prevalence of posterior cross-

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bite.[2,3,5,6] Few investigators have shown no significant association between nonnutritive sucking habits and some types of malocclusions.[7,8]

Even though causal associations between respiration and growth patterns remain as yet to be clarified, assumptions continue to be made.[9–15] The breathing pattern depends on the interaction between genetic and environmental factors and may influence the development of the transverse relationship, resulting in the development of crossbite.[9,13,15] Others have disagreed that mouth-breathing can affect the form of the jaw or create malocclusions.[16,17]

Enlarged adenoids may be associated with the presence of a posterior crossbite and mouth-breathing in children.[7] A number of studies in the literature associate nasopharyngeal airway obstruction with adenoid enlargement and the development of skeletal and dental abnormalities.[7,11,18,19] Other authors have stated that the adenoids have no direct cause-and-effect relationship with malocclusion or mouth-breathing.[17,20,21] Hence, the etiologic role of hypertrophied adenoids is as yet unclear. The purpose of the present investigation was to assess the relationship between nonnutritive sucking habits, mouth-breathing, hypertrophied adenoids, and the occurrence of malocclusions in preschool children through a case-control study.

## MATERIALS AND METHODS

This study was performed in the city of Juiz de Fora, in southeastern Brazil, and was developed in two distinct phases from March 2004 to September 2004. A pilot-study was first developed using a convenience sample of 94 preschool children from a public school. The aim was to estimate the prevalence and etiology of malocclusions in the primary dentition of such children. Next, a cross-sectional study was carried out on a large sample of 745 children, ages 3 to 6 years (mean age 4.52 years), randomly selected from 10 public and 10 private preschools. Sample distribution was proportional to the total population enrolled in these two types of schools for each region of the city (Table 1).

In the second phase, a case-control study (n = 300) was developed to identify associated risk factors. This sample size was based on a table estimating an odds ratio of 4.25 (posterior crossbite) with an anticipated probability of 75% for harmful oral habits among children without malocclusion,[22] with a confidence interval of 95% and a relative precision of 50%.[23] The children were separated into two groups (case and control), with 150 individuals in each and matched according to age, gender, and economic status (Table 2). None of the children had previously undergone orthodontic treatment or adenoidectomy. None showed the presence of permanent teeth or the loss of any primary tooth. All primary teeth had no dental caries that affected the integrity of the mesiodistal diameter.

**Table 1.** Sample Distribution in Relation to Regions and Types of Preschool

| | Frequency of Children by Preschool Types, According to ESS/MG[a] | | Sample Distribution | |
|---|---|---|---|---|
| Region | Public n (%) | Private n (%) | Public n (%) | Private n (%) |
| North 1 | 1495 (8.7) | 237 (1.4) | 46 (15.3) | 8 (2.6) |
| North 2 | 1215 (7.1) | 644 (3.7) | 15 (5.0) | 3 (1.0) |
| Northeast | 648 (3.8) | 723 (4.2) | 9 (3.0) | 15 (5.0) |
| Downtown | 1410 (8.2) | 2849 (16.6) | 26 (8.7) | 28 (9.3) |
| East | 2257 (13.1) | 1047 (6.1) | 15 (5.0) | 29 (9.7) |
| West | 757 (4.4) | 235 (1.4) | 10 (3.3) | 9 (3.0) |
| South | 1636 (9.5) | 506 (2.9) | 38 (12.7) | 6 (2.0) |
| Southeast | 1218 (7.1) | 315 (1.8) | 26 (8.7) | 17 (5.7) |
| Partial total | 10,636 (61.9) | 6556 (38.1) | 185 (61.7) | 115 (38.3) |
| Total | 17,192 (100.0) | | 300 (100.0) | |

[a] ESS/MG indicates Education State Superintendence of Minas Gerais.

The preschool children from the case group had at least one of the following: anterior open bite, posterior crossbite, or overjet more than 3 mm. The eligibility criteria for the control group were positive overjet and overbite no more than 3 mm,[2] distal terminal plane of primary second molars in the mesial step or vertical plane,[24] primary canine relation in normal occlusion (Class I),[25] and absence of malocclusions such as anterior open bite, or posterior and anterior crossbite (Table 3). The participants' rights were protected, and informed consent and assent were obtained according to the Ethics Committee of the Federal University of Minas Gerais.

### Dental Arch Evaluation

All children received a clinical examination by a unique previously calibrated orthodontist in their own schools while seated in front of the examiner who assessed their malocclusions. Assessments included measurements of overjet and overbite, classification of primary canine and second molar relationships, and presence or absence of anterior crossbite, posterior crossbite, and anterior open bite in centric occlusion. Measurements were then made directly using a tongue blade and a mechanical pencil to record the amount of overjet and overbite in millimeters, using the Warren and Bishara criteria.[2]

Criteria for the evaluation of the canine and second primary molar relationships in Class I, Class II, or Class III and for posterior and anterior crossbite were based on a method previously described by Foster and Hamilton.[25]

**Table 2.** Association Between the Matching Variables, Preschool Types, and Study Group

| Variable | Study Group | | | $\chi^2$ | *P* Value |
|---|---|---|---|---|---|
| | Case n (%) | Control n (%) | Total n (%) | | |
| Age, years | | | | | |
| 3 | 12 (4.0) | 12 (4.0) | 24 (8.0) | 0.719 | .869* |
| 4 | 59 (19.7) | 65 (21.6) | 124 (41.3) | | |
| 5 | 66 (22.0) | 59 (19.7) | 125 (41.7) | | |
| 6 | 13 (4.3) | 14 (4.7) | 27 (9.0) | | |
| Gender | | | | | |
| Male | 75 (25.0) | 75 (25.0) | 150 (50.0) | 0.000 | 1.000* |
| Female | 75 (25.0) | 75 (25.0) | 150 (50.0) | | |
| Economical class | | | | | |
| Less favorable | 50 (16.7) | 43 (14.3) | 93 (31.0) | 1.968 | .374* |
| Intermediary | 59 (19.7) | 55 (18.4) | 114 (38.0) | | |
| More favorable | 41 (13.6) | 52 (17.3) | 93 (31.0) | | |
| Preschool | | | | | |
| Public | 99 (33.0) | 86 (28.7) | 185 (61.7) | 2.283 | .123* |
| Private | 51 (17.0) | 64 (21.3) | 115 (38.3) | | |
| Total | 150 (50.0) | 150 (50.0) | 300 (100.0) | | |

* $P > .05$.

### Evaluation of Nonnutritive Sucking Habits

All information regarding the history and duration of existing pacifier or digit-sucking habits came from the questionnaire answered by the parents or guardians.

### Mouth-Breathing Analysis

During the exam by the same orthodontist, the following factors were determined: lip incompetence, dry lips, and fogging on the lower side of a double-faced mirror. These factors were considered for the diagnosis of mouth-breathing in agreement with Moyers' criteria,[24] later used by Bresolin and associates,[15] and Hartgerink and Vig.[26]

### Upper Airway Analysis

The assessment of the severity of upper respiratory airway obstruction with respect to the adenoids was based on a radiograph. All children who participated in the study were asked to go to the same radiology clinic so that a standard lateral cephalometric radiograph for the assessment of the degree of nasopharyngeal obstruction could be obtained.[12,27,28]

In order to radiographically assess the obstruction, measurements regarding the size of the adenoids, as well as the width of the nasopharynx, were taken using anatomic landmarks identified on the lateral cephalometric radiograph.

The following four measurements were used to examine the possibility of airway impairment[12,27] (Table 4):

Airway percent: Percentage of nasopharynx occupied by adenoid tissue.

D-AD1 : PNS: Distance from PNS to the nearest adenoid tissue measured along the line through PNS-BA (posterior nasal spine-basion).

D-AD2 : PNS: Distance from PNS to the nearest adenoid tissue measured along a line through PNS perpendicular to S-BA (sella-basion).

D-PTV : AD: Distance to the nearest adenoid tissue from a point on PTV (pterygoid vertical) 5 mm superior to PNS.

Norms were preestablished for each of the four variables and all radiographs were scanned and evaluated by computerized cephalometric tracing using the Radiocef 4 program by the same radiologist (Table 4).[29]

For each case to be classified, four variables were measured through the Radiocef 4 program and compared to the norms.[29] For each participant, the number of measurements fulfilling more than one standard deviation below the norm was counted, and the classification scheme was assigned to the degree of the adenoid problem (Table 5; Figures 1 and 2).

### Statistical Analysis

The results were submitted to the following statistical tests: chi-square, simple and multiple conditional logistic regression analyses, using SPSS for Windows (version 10.0; SPSS Inc, Chicago, Ill). The first and second of these tests assessed the association between variables. Multivariate analysis was used to find the interaction among the main variables. A linear logistic model was adjusted to determine the effects of nonnutritive sucking habits, breathing pattern, and hy-

**Table 3.** Sample Distribution in Relation to Occlusal Variables

| Variable | N | % |
|---|---|---|
| Overjet | | |
| Normal | 198 | 66.0 |
| Increased | 91 | 30.3 |
| Edge-to-edge | 7 | 2.3 |
| Negative (anterior crossbite) | 4 | 1.4 |
| Overbite | | |
| Normal | 200 | 66.7 |
| Increased | 8 | 2.7 |
| Edge-to-edge | 5 | 1.6 |
| Negative (anterior open bite) | 87 | 29.0 |
| Anterior open bite | | |
| No | 213 | 71.0 |
| Yes | 87 | 29.0 |
| Posterior crossbite | | |
| No | 246 | 82.0 |
| Left unilateral | 17 | 5.7 |
| Right unilateral | 25 | 8.3 |
| Bilateral | 12 | 4.0 |
| Right deciduous canine | | |
| Neutroclusion (Class I) | 192 | 64.0 |
| Mesioclusion (Class III) | 13 | 4.3 |
| Distoclusion (Class II) | 95 | 31.7 |
| Left deciduous canine | | |
| Neutroclusion (Class I) | 203 | 67.7 |
| Mesioclusion (Class III) | 18 | 6.0 |
| Distoclusion (Class II) | 79 | 26.3 |
| Right distal terminal plane | | |
| Straight | 134 | 44.7 |
| Mesial step | 130 | 43.3 |
| Distal step | 36 | 12.0 |
| Left distal terminal plane | | |
| Straight | 121 | 40.3 |
| Mesial step | 142 | 47.3 |
| Distal step | 37 | 12.3 |
| Total | 300 | 100.0 |

**Table 4.** Norms for Airway Measurements*

| Measurement | Mean (± Standard Deviation) |
|---|---|
| Airway percent, % | 50.60 (± 14.00) |
| D-AD1:PNS, mm | 24.20 (± 5.50) |
| D-AD2:PNS, mm | 19.00 (± 4.00) |
| D-PTV:AD, mm | 11.60 (± 5.20) |

* PNS indicates posterior nasal spine; PTV, pterygoid vertical; AD, adenoid tissue.

pertrophied adenoids on the development of malocclusion. The level of significance was set at 5%.

### Assessment of Intraobserver Consistency

The reliability of the cephalometric and clinical measures of 30 children was determined by calculating the intraexaminer kappa concordance index (κ) between the first and the second measurements. All variables presented high degrees of reliability, with κ values ranging from 0.78 (anterior open bite and overbite) to 1.00 (posterior crossbite, overjet, and adenoid tracing).

**Table 5.** Classifications: Degree of Adenoid Problem

| Number of Measurements More Than One Standard Deviation Below Norm | Classification |
|---|---|
| 0–1 | No adenoid problem |
| 2 | Possible adenoid problem |
| 3 | Probable adenoid problem |
| 4 | Definite adenoid problem |

## RESULTS

### Association between Nonnutritive Sucking Habits, Breathing Pattern, Adenoids, and Malocclusion

In the simple logistic regression analyses, the nonnutritive sucking habits and the pacifier-sucking showed significant associations with the presence of malocclusion ($P < .001$). However, digit-sucking was not statistically significant ($P > .05$). Children with nonnutritive sucking habits and pacifier-sucking had 5.9 and 6.0 times greater chances of having malocclusion in comparison with the children without such habits (Table 6).

An increase of malocclusion was verified only when children stopped the pacifier-sucking habit after 2 years of age. Such children had 13.6 times greater chances of having malocclusion in comparison with children with no pacifier-sucking habits. There was no statistical association to the development of malocclusion with regard to pacifier-sucking habits that ended before 2 years of age and the duration of digit-sucking ($P > .05$) (Table 6).

Children with mouth-breathing had a 10 times greater chance of having malocclusion in comparison with those with nose breathing ($P < .001$). Hypertrophied adenoids were not directly associated with the presence of malocclusion ($P > .05$) (Table 6).

### Multivariate Analysis

Initially, variables with a $P$ value equal to or less than 0.25 were included in this stage, with the exception of the adenoid variable due to its importance in the present research study.

On the basis of information obtained from statistical tests, a procedure was developed to determine when nonnutritive sucking habits, mouth-breathing, and hypertrophied adenoids could develop a malocclusion. For this purpose the final model was adjusted with a

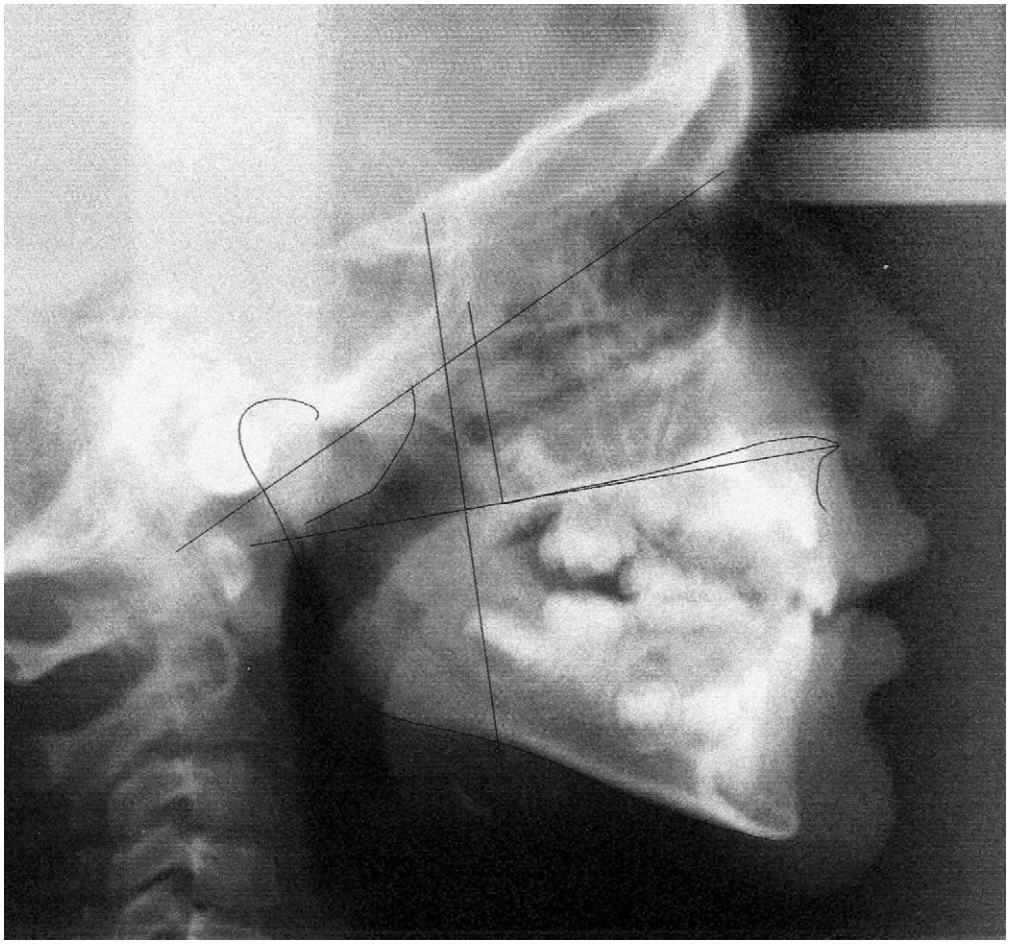

**Figure 1.** A lateral cephalometric radiograph of the nasopharyngeal area reveals no adenoid problem.

minimum significance level of 0.05 for these measurements in all cases.

A tendency toward an increase in malocclusions was observed with an increase in age. Children with a duration of pacifier-sucking after 2 years of age (OR [CI 95%] = 14.7 [7.1–30.5]) and those who were mouth breathers (OR [CI 95%] = 10.9 [5.5–21.4]) had greater chances of having malocclusion than children without such habits ($P < .001$) (Table 7).

## DISCUSSION

The study design adopted was appropriate for the research proposal because it offered a number of advantages, such as enabling the researcher to identify individuals with and without malocclusion and investigate risk factors instead of having to wait for the manifestation of the event as in a cohort study. This conferred greater efficiency to the study in temporal and financial terms.

Logistic regression analysis showed that among the variables studied, the most significant predictors for the development of malocclusion in the case group were pacifier-sucking habits and mouth-breathing. There was a significantly higher prevalence of malocclusion in the primary dentition associated with prolonged pacifier-sucking habit (beyond the age of 2 years). The frequency, duration of a use cycle, and the intensity of the habit were not measured by this retrospective design of a case-control study; however, memory bias was minimized considering that children were at a very young age and that the time elapsed between the parents' reports and cessation of the habit was short.

A previous study has implicated continued nonnutritive sucking habits beyond the age of 4 years in development of certain malocclusions, such as anterior open bite, posterior crossbite, or increased overjet.[16] The present study reports the importance of stopping the pacifier-sucking habit by the age of 2 years in order to reduce the risk of malocclusions, with or without an association to mouth-breathing.

Other investigators have also agreed with our results.[1–6] Farsi and Salama[4] found that children with existing pacifier and digit-sucking habits had significantly

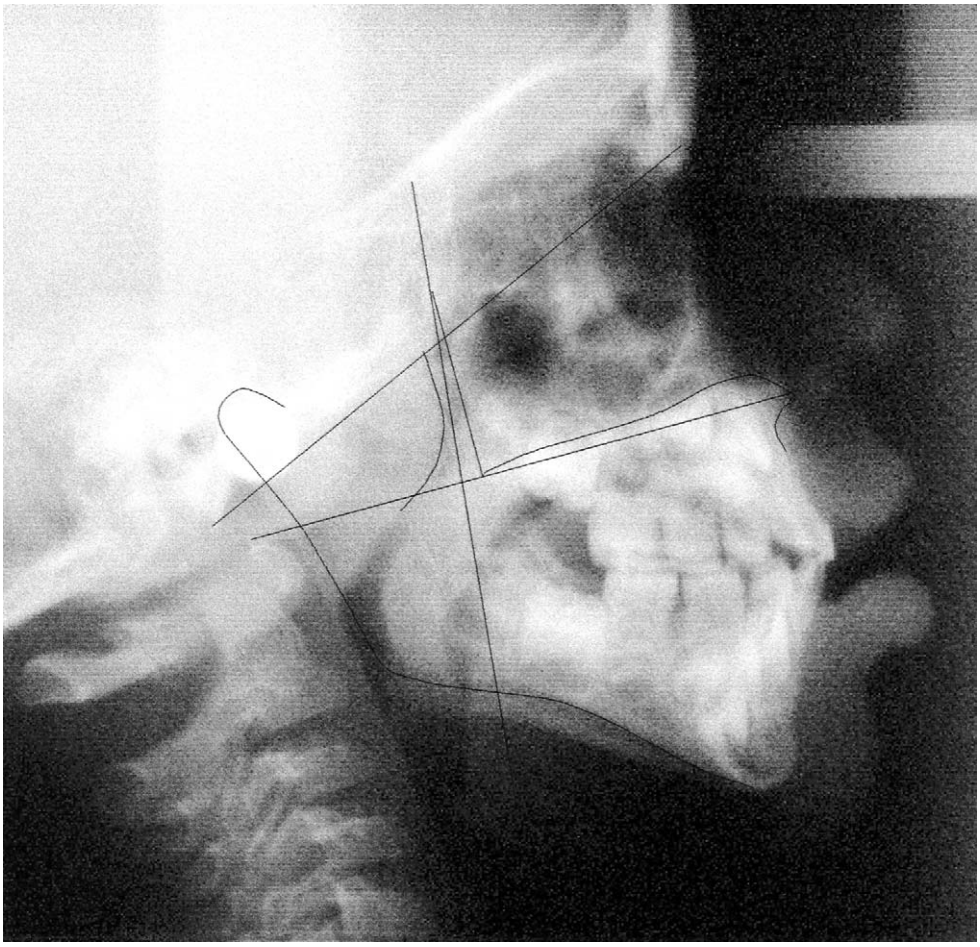

**Figure 2.** A lateral cephalometric radiograph of the nasopharyngeal area reveals definitive adenoid problem.

more distal molar and Class II canine relationships, larger overjets and open bites than children without sucking habits. It is therefore important to observe not only the presence of the pacifier-sucking habit, but also when it ceased. Oulis and associates[7] found no relationship between a history of pacifier and finger-sucking and posterior crossbite. However, their sample was composed only of children with hypertrophied adenoids, which probably interfered with their results. Meyers and Hertzberg[8] also found no association, but did not directly examine the subjects, implying the possibility of misclassification of exposure variables.

In our study, finger-sucking appeared to have no effect on the development of malocclusion in preschool children, which is in agreement with Ögaard et al,[6] Oulis et al,[7] and Meyers and Hertzberg.[8] This association was not observed probably because it could be related to the small number of children with this habit ($n = 18$) or to the different methodologies employed in the present study and others that observed such association. However, this effect is clearly demonstrated in some studies in the literature.[1,2,4,5] Warren and Bishara[2] found that digit-sucking habits were associated with an increased prevalence of anterior open bite and reduced overbite, greater overjet, greater maxillary arch depths, and smaller maxillary arch widths. It would therefore appear that the effect of such habits depends on the direction of force, duration, and intensity of the habit as well as the resistance of the jaws to displacement.[1]

The multivariate analysis found that mouth-breathing children had 10.9 times greater chances of having malocclusion than children who breathe through the nose. This evaluation substantiates the existence of an association, as documented in the literature, between mouth-breathing and the presence of anterior open bite, posterior crossbite, increased overjet, and the development of the long face syndrome.[10–15] However, Sillman[16] and Hartsook[17] disagreed with these results in their research studies.

In the present study, hypertrophied adenoids did not contribute toward an increased risk of children having malocclusion. However, a number of both deep and peripheral conditions enter into respiratory problems. Other etiologic factors might be involved, but were not evaluated in the present research, such as genetic

**Table 6.** Association Between Nonnutritive Sucking Habits, Breathing Pattern, Adenoids, and Malocclusion

| Variable | Study Group | | | *P* Value | OR − CI (95%) |
|---|---|---|---|---|---|
| | Case n (%) | Control n (%) | Total n (%) | | |
| Nonnutritive sucking habits | | | | | |
| Yes | 131 (43.7) | 81 (27.0) | 212 (70.7) | .000* | 5.9 (3.3–10.5) |
| No | 19 (6.3) | 69 (23.0) | 88 (29.3) | | 1 |
| Pacifier sucking | | | | | |
| Yes | 127 (42.3) | 74 (24.7) | 201 (67.0) | .000* | 6.0 (3.4–10.4) |
| No | 23 (7.7) | 76 (25.3) | 99 (33.0) | | 1 |
| Pacifier sucking time | | | | | |
| More than 2 years old | 107 (35.6) | 26 (8.7) | 133 (44.3) | .000* | 13.6 (7.2–25.6) |
| Up to 2 years old | 20 (6.7) | 48 (16.0) | 68 (22.7) | | 1.4 (0.7–2.8) |
| No | 23 (7.7) | 76 (25.3) | 99 (33.0) | | 1 |
| Digit sucking | | | | | |
| Yes | 8 (2.7) | 9 (3.0) | 17 (5.7) | 1.000** | 1.0 (0.4–2.6) |
| No | 142 (47.3) | 141 (47.0) | 283 (94.3) | | 1 |
| Digit sucking time | | | | | |
| More than 2 years old | 5 (1.7) | 3 (1.0) | 8 (2.7) | .472** | 1.7 (0.4–7.1) |
| Up to 2 years old | 3 (1.0) | 6 (2.0) | 9 (3.0) | | 0.5 (0.1–2.0) |
| No | 142 (47.3) | 141 (47.0) | 283 (94.3) | | 1 |
| Breathing pattern | | | | | |
| Mouth | 91 (30.3) | 20 (6.7) | 111 (37.0) | .000* | 10.0 (5.7–17.8) |
| Nasal | 59 (19.7) | 130 (43.3) | 189 (63.0) | | 1 |
| Size of adenoids | | | | | |
| Definitive hypertrophy | 18 (6.0) | 16 (5.3) | 34 (11.3) | .904** | 1.0 (0.5–2.3) |
| Probable hypertrophy | 44 (14.7) | 49 (16.3) | 93 (31.0) | | 0.8 (0.5–1.5) |
| Possible hypertrophy | 38 (12.7) | 39 (13.0) | 77 (25.7) | | 0.9 (0.5–1.6) |
| No hypertrophy | 50 (16.6) | 46 (15.4) | 96 (32.0) | | 1 |
| Total | 150 (50.0) | 150 (50.0) | 300 (100.0) | | |

* $P < .001$; ** $P > .05$.

**Table 7.** Multiple Conditional Logistic Regression Analyses Between Independent Variables and Study Group, Case or Control of Preschool Children from Juiz de Fora – Representative Sample

| Variable | Adjusted OR (CI, 95%) | *P* Value |
|---|---|---|
| Pacifier sucking time | | |
| More than 2 years old | 14.7 (7.1–30.5) | .000* |
| Up to 2 years old | 1.4 (0.6–3.1) | .419** |
| No | 1 | |
| Breathing pattern | | |
| Mouth | 10.9 (5.5–21.4) | |
| Nasal | 1 | .000* |

* $P < .001$; ** $P > .05$.

tendencies,[11,14] allergic and chronic rhinitis, sinusitis, asthmas, hypertrophied palatine tonsils, polyps, engorged turbinates, and a deviated nasal septum.[9,11] Such association between hypertrophic adenoids and malocclusion probably was not observed because it could be related to the small number of children with definitive hypertrophic adenoids (n = 34) or to the difference in the age of children between this study and other investigations because it is known that adenoids tend to reduce with age. These results also agree with findings by Oulis et al,[7] which showed through statistical analysis that only obstruction by the palatine tonsils and the number of children with crossbite were dependent variables. Other investigators are of the same opinion.[17,20,21] The results of our study contradict these reports that show that hypertrophied adenoids have an appreciable influence on the development of malocclusion.[11,18,19]

Identifying factors associated with malocclusion in preschool children may help to target interventions and counseling regarding prolonged nonnutritive sucking habits and mouth-breathing. One recommendation is that children visit the dentist during the first 2 years of life so that parents can act before habits become prolonged and adversely affect the children's occlusion.

This study was unique in that the sample represented a defined population of preschool children from Juiz de Fora and included the same number of children of both genders in the case and control group. All children were examined directly, and proportionally and randomly selected from each region of the city.

The upper airway analysis was based on a lateral cephalometric radiograph, which provided a satisfactory means of evaluating the dimension of the nasopharynx in agreement with other authors,[7,11,12,15,18,27,28] and according to a method previously described by Schulhof[12] and Poole et al.[27]

Although the study design was strong, it did have some limitations. The sample had a relatively small number of subjects engaged in certain behaviors such as digit-sucking. Sucking behavior data were reported by parents and could not be directly validated, and the mouth-breathing children were selected on the basis of visual rather than functional criteria. Moreover, limitations involved assessing something three-dimensional (airway obstruction/adenoid size) based on lateral cephalometric radiographs (two-dimensional).

## CONCLUSIONS

- The presence of nonnutritive sucking habits and pacifier-sucking were directly associated with the presence of malocclusion.
- Children with duration of pacifier-sucking after 2 years of age and those who presented the mouth-breathing pattern had greater chances of having malocclusion.
- It is difficult to draw inferences about the effects of digit-sucking habits and hypertrophied adenoids on malocclusion given the small number of children in both groups.

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