Submitted: 23 May, 2025 Accepted: 21 July, 2025 Published: 03 January, 2026 DOI:10.22514/jocpd.2026.024

Journal of Clinical Pediatric Dentistry

ORIGINAL RESEARCH

Association of snoring with malocclusion in primary dentition: a cross sectional comparative study

Özlem Beren Satılmış[1,*], Nurhan Özalp[1], Tülin Ufuk Toygar Memikoğlu[2]

[1]Department of Pediatric Dentistry, Ankara University, 06500 Ankara, Turkey
[2]Department of Orthodontics, Ankara University, 06500 Ankara, Turkey

***Correspondence**
obsatilmis@ankara.edu.tr
(Özlem Beren Satılmış)

Abstract

Background: This study aimed to determine whether snoring is associated with occlusal parameters in children. **Methods**: In this cross-sectional comparative study, between January and July 2023, 126 children who were registered at the clinic were evaluated. Parents were asked whether their children snored. A total of 63 children who met the inclusion criteria were included in the study (case: snoring 32, control: non-snoring 31). A digital model was obtained from 63 children using a three-dimensional scanning method and occlusal parameters—including overjet, overbite, molar and canine relationships, arch length, inter-canine and inter-molar width, crowding, and crossbite—were measured and compared. Data were analyzed using the Chi-Square Test and Independent Samples *T*-Test, with statistical significance set at 5%. **Results**: Maxillary intercanine width was significantly lower in the snoring group (difference of 1.2 mm) (p = 0.028). Maxillary crowding was significantly higher in the snoring group (p = 0.048), and it was detected in 68% of snorers. Other occlusal parameter values were also lower, although not statistically significant. **Conclusions**: Snoring may adversely influence occlusal development during the late period of primary dentition. Notably, crowding in the maxillary arch is not typically a characteristic of primary dentition. Therefore, pediatric dentists should assess the underlying etiology during clinical examination or treatment.

Keywords

Snoring; Malocclusion; Primary dentition; Intraoral scanner; Digital model

1. Introduction

Pediatric dentistry focuses on managing oral health for children and adolescents from early childhood to prevent and treat various oral diseases and ensure normal tooth development from the eruption of the first primary tooth until the establishment of final occlusion. The developing dentition and occlusion should be followed throughout the teeth eruption with regular clinical examinations [1]. Malocclusion, which can occur due to many reasons, is defined as a deviation from ideal occlusion; therefore, there is an imbalance in the size and position of the teeth, facial bones, and soft tissues (lips, cheeks, and tongue) [2]. Sleep is defined as an important physiological behavior in which consciousness is suspended normally and temporarily. Some changes can occur in every healthy individual during sleep and the respiratory system is the most affected by these changes [3]. Sleep respiratory disorders are defined as disruption of normal breathing patterns and ventilation during sleep [4]. Sleep-related respiratory disorders mainly include obstructive sleep apnea syndrome (OSAS), central sleep apnea syndrome, sleep-related hypoventilation, and hypoxemia disorders. However, snoring is one of the most common symptoms of sleep disordered breathing (SDB) [5]. SDB; hypertrophy of adenoid tonsils is associated with various oral conditions such as narrow dentoalveolar width, increased overjet, and decreased overbite, and is also one of the factors that can cause malocclusion [6]. Studies are reporting a relationship between sleep-disordered breathing and malocclusion [7–9]. Niemi *et al.* [7] (2019) conducted a study in the 2–3 age group to investigate the potential effect of snoring on malocclusion and found that snoring did not affect occlusion. However, it has been reported that this result is too early to see the effect of snoring due to the newly completed primary dentition in this age group. Hultcrantz and Tideström (2009) reported that children who snored had a narrower upper jaw than those who did not snore. Esteller Moré *et al.* [9] (2001) found to be at a higher rate of narrow palate, and crossbite than the control group in children with sleep-related breathing disorders. As a result of these studies conducted during mixed dentition and permanent dentition, malocclusions have been reported to occur.

When the literature was reviewed, no study was found to have evaluated the effect of snoring on occlusion in the late period of primary dentition, specifically utilizing a digital model with a three-dimensional scanning method. This study, therefore, aimed to determine whether snoring is associated with malocclusion in children in the late period of primary dentition. The null hypothesis of this study was that snoring is not associated with malocclusion in children in the late period of primary dentition.

2. Material and methods

2.1 Sample size determination

When the effect size of the relationship between snoring and occlusion was taken as 0.50 and the sample calculation was made using the Chi-Square Test with a power of 80% at a significance level of 0.05, a minimum of 55 participants was found sufficient for the study.

2.2 Study design

This cross-sectional comparative study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [10]. The study protocol comprised 63 children, with the case (snoring) and the control group (non-snoring) including 32 and 31 children, respectively. The detailed data included in the study procedures were collected from the digital models obtained using a three-dimensional intraoral scanner.

2.3 Eligibility criteria

Between January and July 2023, 126 children who were registered at Ankara University, Faculty of Dentistry, Pediatric Dentistry Clinic were evaluated for eligibility criteria. The inclusion criteria were as follows:

- Systemically healthy patients.
- Patients not undergoing adenoidectomy.
- Patients aged 4–6 years who have not erupted permanent first molars and who do not have a premature primary molar loss.
- No oral habits such as thumb sucking, nail biting, pacifier use, lip biting, or tongue thrusting.

Detailed medical anamnesis was taken from the parents of the children. Parents were asked whether their children snore. The Sleep Disturbance Scale for Children, a Likert-type scale comprising 26 items and 6 subscales, is used to investigate sleep disturbances in school-age children [11]. The Turkish version, which was identified to meet the validity and reliability tests at an acceptable level, was used to assess the frequency of snoring [12]. Snoring frequency was classified as 1–2 nights/week, 3–5 nights/week and every night. Parents were asked to observe their children sleeping for at least two weeks. Children who snored at least three nights a week were included in the study group. The control group consisted of children who did not snore. Children who snored only during respiratory tract infections were excluded. At the end of the two weeks, telephone interviews were conducted with the children's parents to verify the occurrence of snoring/non-snoring. 63 children (snoring (n = 32), non-snoring (n = 31)) who met the inclusion criteria were included in the study (Fig. 1).

2.4 Intraoral scanning

All children were scanned using an intraoral scanner (3Shape, TRIOS 4, Copenhagen, Denmark), starting with the lower jaw, then the upper jaw, and finally the occlusion. The digital models obtained using an intraoral scanner were recorded in the system and transferred to the 3Shape OrthoAnalyzer™ (2015, Copenhagen, Denmark) programme in the "Standard Mosaic Language/stereolithography/Standard Triangle Language (.stl)" format, which is the most commonly used digital format or file format for digital measurement, to make the necessary measurements.

2.5 Measurement of parameters

Measurements of standard parameters used in the evaluation of occlusion in the primary dentition period were made and recorded in the Anamnesis/Examination/Measurement Form (Fig. 2).

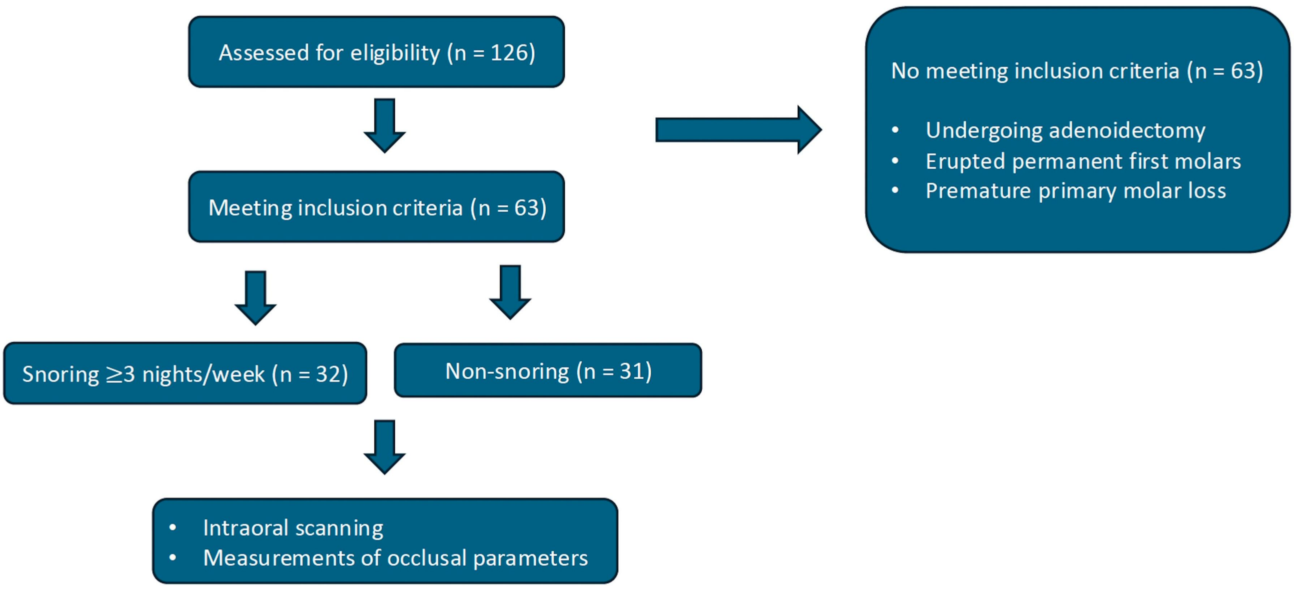

FIGURE 1. Flow diagram for study protocol and patient recruitment.

…../……/……

Anamnesis/Examination/Measurement Form

Patient Name/Surname : ……………………………………………….
Patient File Number : ………………………………………………
Birth Date : ___/___/______
Gender : M ( ) F ( )
Parent/Caregiver's Name/Surname : ……………………………………………….
Contact Number : 0 (5__) ______
Medical anamnesis :………………………………………………..

Does your child snore in her/his sleep?

Yes ( ) No ( )

If your child snores, how often does she/he snore?

Every night ( ) 3–5 nights/week ( ) 1–2 nights/week ( )

Intraoral Measurements	
Overjet (mm) : …… Overbite (mm): …...	Occlusion relationship of primary molar teeth (left) Flush terminal plane ( ) Mesial terminal plane ( ) Distal terminal plane ( )
Arch length (mm) maxilla ….. mandibula ….	
Intercanine width (mm) maxilla ….. mandibula ….	Occlusion relationship of primary molar teeth (right) Flush terminal plane ( ) Mesial terminal plane ( ) Distal terminal plane ( )
Intermolar width (mm) maxilla ….. mandibula ….	
Crowding (P/A) maxilla ….. mandibula ….	Occlusion relationship of primary canine teeth (left) Class I ( ) Class II ( ) Class III ( )
Primate spaces (P/A) maxilla ….. mandibula ….	Occlusion relationship of primary canine teeth (right) Class I ( ) Class II ( ) Class III ( )
Crossbite (P/A) anterior ( ) posterior ( )	
	(P:presence, A:absence)

FIGURE 2. Anamnesis/examination/measurement form.

Overjet value measurements were made from the horizontal distance between the palatal surface of the incisal edge of the primary maxillary right central teeth and the vestibule surface of the incisal edge of the primary mandibular right central teeth during occlusion. Overbite value measurements were made from the vertical distance between the incisal edge of the primary maxillary right central teeth and the incisal edge of the primary mandibular right central teeth during occlusion. The same teeth were used as a reference in each digital model to ensure standardization (Fig. 3).

Inter-canine width values were measured as the distance between the crown apex of primary canine teeth for both jaws and the values were recorded (Fig. 4a,b).

Inter-molar width values were measured as the distance between the mesiopalatal cusps of primary second molars for both jaws and the values were recorded (Fig. 4a,b).

Arch length values were obtained by measuring the line formed by the reference points placed on the most distal surface of the primary second molar, the crown apex of the primary canine, the midpoint of the central incisors, the crown apex of the contralateral primary canine tooth, and the most distal surfaces of the contralateral primary second molar tooth for both jaws (Fig. 4c,d).

Occlusion relationship of primary canine teeth was classified as;

Class I, the crown apex of the primary maxillary canine was in the same vertical plane as the distal surface of the primary mandibular canine;

Class II, the crown apex of the primary maxillary canine was mesial to the distal surface of the primary mandibular canine;

Class III, the crown apex of the primary maxillary canine was distal to the distal surface of the primary mandibular canine (Fig. 4e).

Occlusion relationship of primary molar teeth was classified as;

Flush terminal plane, distal surfaces of primary maxillary and mandibular second molars were in the same plane.

Mesial terminal plane, the distal surface of the primary mandibular second molar tooth was more anterior than the distal surface of the primary maxillary second molar.

Distal terminal plane, the distal surface of the primary mandibular second molar tooth was more posterior than the distal surface of the primary maxillary second molar (Fig. 4e).

The presence/absence of crowding, physiological and primate spaces and crossbite were determined visually on the models and recorded (Fig. 4f).

In order to minimize the margin of error and ensure the reliability of the data, all measurements were made three times at different periods and in a single-blind technique by the same researcher who was trained by an experienced person who knew how to use the program, and the mean values were calculated.

2.6 Statistical analysis

The data obtained in this study were analyzed through the SPSS 22 (IBM Corporation., Armonk, NY, USA) package program. The normality of continuous variables was assessed using the

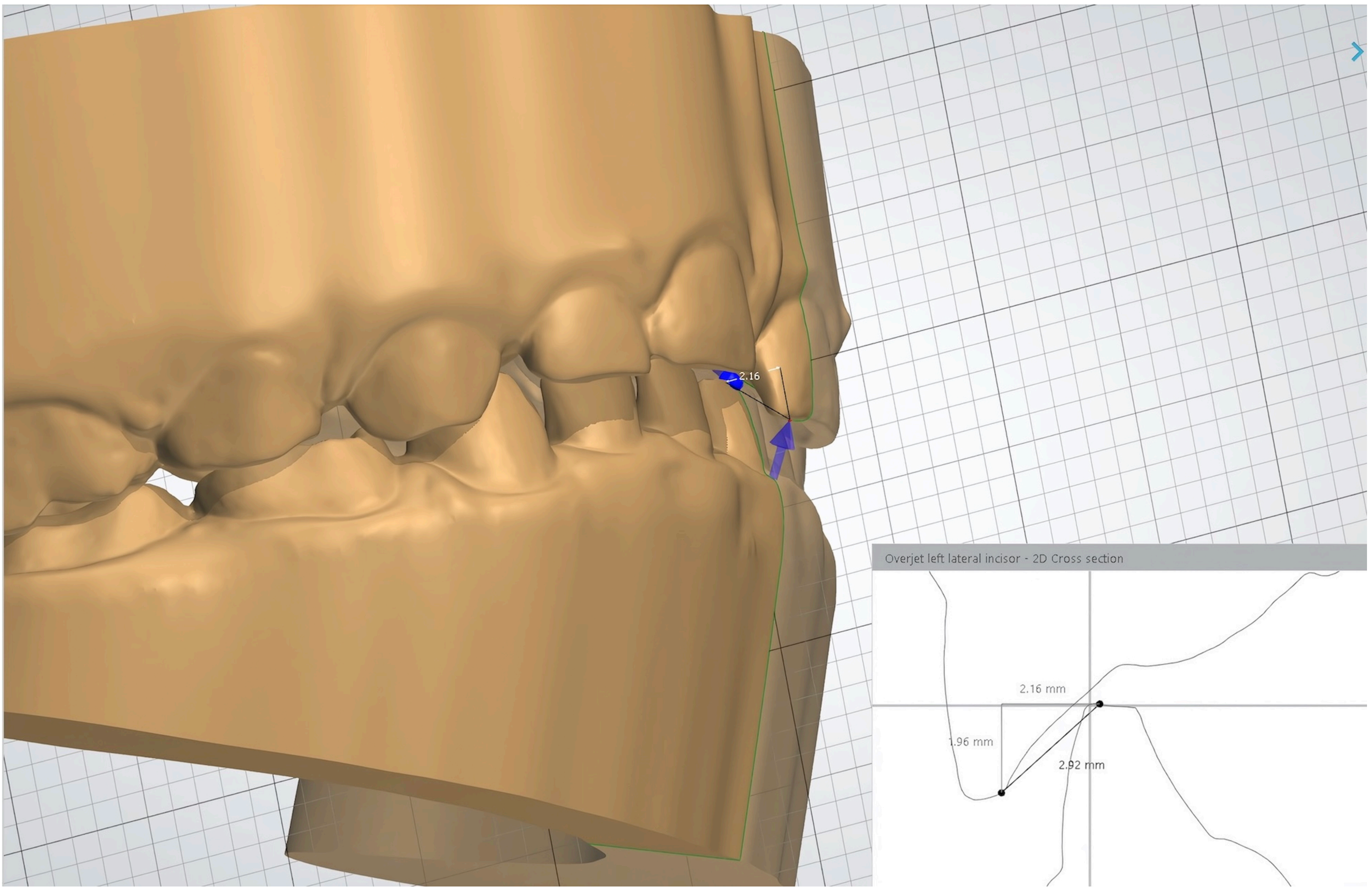

FIGURE 3. Measurement of overjet-overbite values on the digital model (2D: two-dimensional).

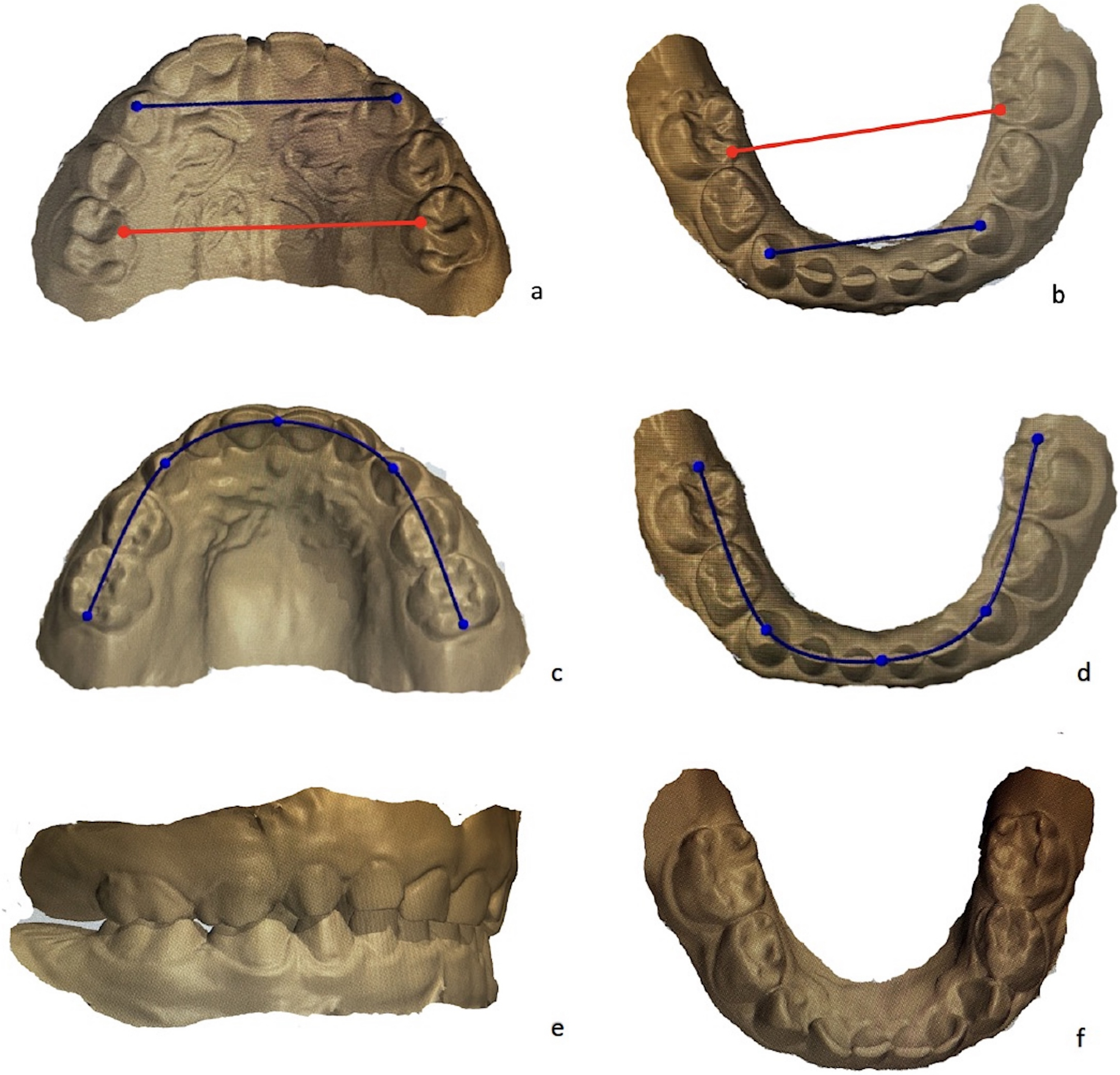

FIGURE 4. Measurement of inter-canine width (a,b (blue arrow)), inter-molar width (a,b (red arrow)) and arch length (c,d) values on the digital model. Determining the occlusion relationships of primary molar and canine teeth (e) and presence/absence of crowding, physiological and primate spaces (f) on the digital model.

Kolmogorov-Smirnov test, as the sample size in each group exceeded 30. For normally distributed variables, comparisons between two groups were conducted using the Independent Samples *T*-Test. The relationship between categorical variables was analyzed using the Chi-Square Test with the Monte Carlo simulation technique to ensure robustness in cases with small expected frequencies. A significance level of 0.05 was used for all statistical analyses; *p*-values less than 0.05 were considered statistically significant, while *p*-values greater than 0.05 were regarded as not statistically significant.

3. Results

126 children were assessed for eligibility criteria. 63 children who met the inclusion criteria were included in the study, with 32 snoring and 31 non-snoring (Fig. 1).

The study sample comprised 63 children, 31 boys (49.2%) and 32 girls (50.8%). The mean age was 5.09 (±0.6) years old.

There was no significant difference between the overjet and overbite values of the snoring and non-snoring pediatric patients participating in the study ($p = 0.899$ and $p = 0.895$, respectively) (Table 1).

There were no statistically significant differences found between the groups in the distribution of primary molar and canine relationships of the snoring and non-snoring pediatric patients participating in the study ($p = 1$ (left and right) and $p = 0.871$ (left), $p = 1$ (right), respectively). Flush terminal plane molar relationship and Class I canine relationship were found to be at the highest rates in both groups (Table 1).

There were no statistically significant differences between

TABLE 1. Overjet and overbite values, maxillary and mandibular jaw arch lengths, inter-canine width and inter-molar width values (mm).

Tested Parameters (mm)	Groups	n	Mean	SD (±)	Min	Max	Independent Samples *T*-Test *p*-value
Overjet							
	Snoring	32	2.17	1.09	0.64	6.11	0.899
	Non-snoring	31	2.13	1.15	–0.52	4.79	
Overbite							
	Snoring	32	0.88	1.20	–1.68	4.66	0.895
	Non-snoring	31	0.91	0.92	–0.55	3.24	
Maxillary arch lenghts							
	Snoring	32	69.86	3.93	64.09	78.16	0.091
	Non-snoring	31	71.51	3.65	62.83	76.85	
Mandibular arch lenghts							
	Snoring	32	62.38	3.92	56.60	72.80	0.061
	Non-snoring	31	64.04	2.84	57.00	68.50	
Maxillary inter-canine width							
	Snoring	32	28.16	2.26	24.90	32.20	0.028*
	Non-snoring	31	29.42	2.17	22.30	32.30	
Mandibular inter-canine width							
	Snoring	32	22.58	1.83	19.50	27.22	0.076
	Non-snoring	31	23.34	1.47	20.60	26.90	
Maxillary inter-molar width							
	Snoring	32	33.63	2.70	28.11	39.24	0.111
	Non-snoring	31	34.63	2.20	29.35	39.67	
Mandibular inter-molar width							
	Snoring	32	29.35	2.82	19.54	33.89	0.102
	Non-snoring	31	30.35	1.85	27.11	35.22	

n: number; SD: Standard Deviation; Min: minimum; Max: Maximum.
**indicates statistically difference.*

the snoring and non-snoring groups in terms of maxillary and mandibular arch lengths, maxillary and mandibular inter-molar width values, and mandibular inter-canine width values of the pediatric patients participating in the study (p = 0.091, p = 0.061, p = 0.111, p = 0.102 and p = 0.076, respectively). However, it was noteworthy that in all groups these values were lower in the snoring group (Table 1).

Among the pediatric patients participating in the study, it was determined that the upper jaw inter-canine width values of the snoring group were statistically significantly less than the non-snoring group (difference of 1.2 mm) (p = 0.028) (Table 1).

Among the children participating in the study, it was observed that the percentage of maxillary crowding of the children in the snoring group was significantly higher than in the non-snoring group (p = 0.048) (Table 2). Maxillary crowding was detected in 68% of snorers.

There was no significant relationship between mandibular crowding and snoring (p = 0.321) (Table 2).

There were no statistically significant differences between snoring and the non-snoring groups in the status (presence/absence) of primate spacing in the maxillary and mandibular jaws (p = 0.545 and p = 0.508, respectively). However, it was noteworthy that the absence of primate spacing in the maxillary jaws of the children in the snoring group was more than in the children in the non-snoring group (Table 2).

Crossbite was detected in two of the snoring children (1 anterior, and 1 posterior crossbite), and four of the non-snoring children (two anterior and two posterior). There was no significant relationship between the snoring status of the pediatric patients participating in the study and crossbite (p = 0.551) (Table 2).

4. Discussion

The completion of the primary dentition is around 2.5–3 years of age. Then, there is a stable period until the permanent first molar erupts [1]. Therefore, in this stable period, if snoring

TABLE 2. Molar and canine relationship, crowding, primate spaces, and crossbite according to the snoring status.

Parameters	Snoring		Non-snoring		Chi-Square Analysis	
	n	%	n	%	Chi-Square	*p*-value
Molar relationship (left)						
Flush	26	51.0	25	49.0		
Distal	4	57.1	3	42.9	0.351*	1.000
Mesial	2	40.0	3	60.0		
Molar relationship (right)						
Flush	25	50.0	25	50.0		
Distal	5	50.0	5	50.0	0.333*	1.000
Mesial	2	66.7	1	33.3		
Canine relationship (left)						
Class I	24	49.0	25	51.0		
Class II	7	58.3	5	41.7	0.341*	0.871
Class III	1	50.0	1	50.0		
Canine relationship (right)						
Class I	23	50.0	23	50.0		
Class II	8	53.3	7	46.7	0.151*	1.000
Class III	1	50.0	1	50.0		
Maxillary crowding						
Absence	15	39.5	23	60.5	3.830	0.048**
Presence	17	68.0	8	32.0		
Mandibular crowding						
Absence	19	45.2	23	54.8	0.961	0.321
Presence	13	61.9	8	38.1		
Maxillary primate space						
Absence	7	63.6	4	36.4	0.367	0.545
Presence	25	48.1	27	51.9		
Mandibular primate space						
Absence	15	57.7	11	42.3	0.438	0.508
Presence	17	45.9	20	54.1		
Crossbite						
Absence	30	52.6	27	47.4		
Presence (anterior)	1	33.3	2	66.7	0.809*	0.551
Presence (posterior)	1	33.3	2	66.7		

n: number; p: probability value.
**Monte Carlo simulation technique.*
***indicates statistically difference.*

affects occlusion, it is predicted that this effect can be evaluated more clearly at the age of 4–6 years.

In the literature review, no study was found to have evaluated the effect of snoring on occlusion in the 4–6-year-old group by creating a digital model using the three-dimensional scanning method. Since premature loss of primary teeth will negatively affect occlusal parameters in children in this age group, these patients were excluded from the study. Children whose permanent first molars did not erupt were included in the study, as, with the effect of the eruption forces of these teeth, the possibility of closing the physiological diastemas on the distal surface of the primary first molar tooth and the mesial surface of the primary second molar tooth may affect some measurement results in occlusal parameters.

Larger than normal adenoids are associated with snoring symptoms [13, 14]. Since the present study only aimed to evaluate the effect of snoring on occlusion, pediatric patients undergoing adenoidectomy were also excluded as it could not be possible to eliminate the effects of the previous period. In addition, bad oral habits such as thumb sucking, pacifier use, nail biting, and lip biting were excluded from the study because their possible effects on occlusion are known [15]. It has been reported that tooth structure loss due to caries can cause a decrease in arch length even without early loss of primary teeth. However, only caries with extensive loss of tooth structure have significant effects on the dental arch circumference. In one study, although the incidence of caries was high, there was no statistically significant relationship between caries and clinical orthodontic abnormalities, except for teeth with extensive loss of tooth structure requiring midline deviation or extraction [16]. For this reason, care was taken to ensure that caries in children included in this study did not cause much tooth structure loss to affect the arch length.

Traditional impression taking methods are widely used to record the hard and soft tissues of the oral cavity. Conventional impression methods have been reported by patients as uncomfortable and even described as the worst treatment phase they have ever experienced. The reason for this is that patient comfort can often be impaired by stimulating the gag reflex in conventional measurement methods, whereas digital measurement methods have a significant capacity to prevent the gag reflex [17, 18]. While in traditional impressions, differences may occur in the model obtained due to the contraction and expansion properties of the impression material, this problem does not occur in intraoral scanner systems [18]. The process of digital models only requires a few minutes. Even when the child's cooperation is impaired, the process can be stopped, continued, or repeated, and missing parts can be completed without having to start over. The child and parent can watch the process on the screen. Three-dimensional, true-to-life colors and shapes can be perceived as a video game, and this increases the child's and parent's acceptance of the treatment [19]. In the present study, digital models were obtained from all children using an intraoral scanner (3Shape, TRIOS 4). None of the children scanned with a three-dimensional digital intraoral scanner developed a gag reflex, and the scanning process was completed in a very short time.

Studies have shown that snoring and SDB are associated with increased overjet and decreased overbite and openbite [7, 20, 21]. However, there was no statistically significant difference between the groups in terms of snoring status and overjet and overbite values of the pediatric patients participating in this study. Even though in some studies, the prevalence of Angle class II molar relationship or asymmetric molar relationship was found to be statistically higher in children with snoring and OSAS than in the control group [20, 22, 23], no significant relationship was found in other studies [24, 25]. No statistically significant differences were found between the snoring and non-snoring groups in terms of primary molar and primary canine relations (both right and left) of the pediatric patients participating in this study. The age group in the studies in which increased overjet and decreased overbite, openbite and asymmetric molar relationship were detected was older than the age group in this study. The no statistical difference in these parameters between the two groups can be explained by the fact that snoring has not yet affected occlusion due to the smaller age group. Studies have concluded that maxillary inter-canine and inter-molar widths decrease in children with sleep-disordered breathing such as snoring and OSAS [9, 20]. Respiratory function associated with chewing and swallowing, correct muscular movement of the lips and tongue promotes adequate facial development and growth. Upper airway obstruction associated with mouth breathing can be damaging when present during the development of the face, orofacial skeleton and teeth [26, 27]. In this case, it has been stated that the position of the tongue may change, the muscular balance between the tongue and cheeks may be disturbed, maxillary intercanine/intermolar widths may decrease, and occlusal disorders such as crossbite may occur [20].

It has also been found that the mandibular arch length was reduced in children with sleep-related breathing disorders such as snoring and OSAS [14, 20, 28]. Although there was no statistically significant difference between the groups in terms of maxillary and mandibular arch lengths, inter-molar width values, and mandibular inter-canine width values of the pediatric patients participating in this study, it was noteworthy that these values were less in the snoring group. It was determined that the maxillary inter-canine width values of the snoring participants were statistically significantly less than the non-snoring counterparts. The observed reduction in maxillary intercanine width, although seemingly minimal at 1.2 mm, may carry significant clinical implications when evaluated in the context of early craniofacial development. In some studies, maxillary and mandibular crowding were found to be associated with SDB [22, 25]. It is thought that this malocclusion may be related to decreased dental arch widths and dental arch lengths, and it may also be a result of impaired lip-tongue balance due to mouth breathing. Among the pediatric patients in this study, it was observed that the percentage of maxillary crowding in the snoring group was statistically significantly higher compared to the non-snoring group. As demonstrated in the present study, while reduced maxillary intercanine width and increased maxillary crowding have been documented in both mixed and permanent dentition stages, it is suggested that these occlusal deviations may first become apparent in the late primary dentition period. This suggests that the adverse effects of snoring on craniofacial development may commence at an earlier stage than previously recognised. Early detection of these changes is of paramount importance, as it enables paediatric dentists to identify patients at risk and implement interceptive orthodontic or functional interventions before more severe skeletal discrepancies develop. Such early recognition has the potential to facilitate better long-term occlusal outcomes and contribute to overall craniofacial and airway health. It is important to consider that occlusal anomalies, such as crowding, may not exclusively result from snoring but could also act as predisposing factors for the development of sleep-disordered breathing. For instance, reduced arch dimensions and increased dental crowding may result in diminished oral cavity space, thereby promoting tongue displacement and airway narrowing during sleep [24]. This, in turn, may exacerbate snoring. Furthermore, factors such as temporomandibular joint (TMJ) disorders, alterations in cervical spine posture, and the absence of teeth can also influence craniofacial and airway morphology, thereby creating a complex interplay [29]. These bidirectional interactions underscore the necessity of a holistic and multidisciplinary diagnostic approach.

According to obtained data, the null hypothesis "Snoring is not associated with malocclusions in children in the late period of primary dentition." was partially rejected. Significant differences were observed in only two variables in the intra-group comparison. Maxillary crowding was assessed using the Chi-Square Test; thus, the statistical power of this finding was weaker. The more common maxillary crowding and shorter arch lengths observed in the snoring group indicate early changes in occlusal parameters and emphasize the clinical significance of these findings. These results suggest that pediatric dentists who frequently evaluate children during the primary dentition period should consider snoring and SDB as potential etiological factors when deviations in normal occlusal development are observed. The definitive diagnosis of SDB is made by methods such as polysomnography performed by otolaryngologists. Orthodontists can use cephalometric analyses as a diagnostic tool. Patients should be referred to the relevant physicians to definitively confirm the diagnosis and parents should be informed. The secondary aim of the study was to recognise and question the changes in occlusal parameters, which are still at a preventable and correctable stage, in this age group and to increase the awareness of pediatric dentists. Since snoring and SDB will continue to adversely affect occlusion development if left untreated, early detection and prevention of the etiology are essential.

It is imperative to acknowledge that snoring is a multifactorial phenomenon influenced by variables such as tongue posture, nasal and pharyngeal airway dimensions, craniofacial skeletal growth, and even genetic predispositions [30]. The present study did not directly evaluate these factors, and their absence represents a significant limitation. Consequently, the association observed between snoring and early occlusal deviations should be interpreted with caution, as unmeasured confounders may contribute to or mediate this relationship. It is imperative that future investigations be conducted in order to validate these findings and clarify underlying mechanisms. Furthermore, longitudinal follow-up studies would assist in determining the causality and directional sequence of these interactions.

5. Conclusions

The study found that maxillary intercanine width was significantly lower in the snoring group (difference of 1.2 mm). Maxillary crowding was significantly higher in the snoring group, and it was detected in 68% of snorers. The results imply that pediatric dentists should question the etiology of crowding in the maxillary jaw, which is not included in the normal physiology of primary dentition when they observe it during examination/treatment. In addition to known etiological factors such as bad oral habits and genetics, snoring associated with SDB may also be evaluated.

AVAILABILITY OF DATA AND MATERIALS

The data are not publicly available due to privacy or ethical restrictions.

AUTHOR CONTRIBUTIONS

NÖ and TUTM—conceived the study and analyzed the data. ÖBS—collected the data and wrote the article. All the authors approved the final version of the article.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethics committee approval was obtained before the study was conducted by Ankara University Faculty of Dentistry Clinical Research Ethics Committee (Approval date: 05 January 2022; Number: 01/03). The study consists of children in the primary dentition period, whose first permanent molar teeth have not erupted, an average 4–6 year-old, who agreed to participate in this study and signed the consent form, and their parents. All the study procedures were performed in accordance with the Declaration of Helsinki.

ACKNOWLEDGMENT

The authors wish to thank Otolaryngologist Süleyman Boynueğri for his contribution to data collection, and Orthodontic Research Assistant Kutluhan Yılmaz for his contribution to measurements.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] American Academy of Pediatric Dentistry (AAPD). Management of the developing dentition and occlusion in pediatric dentistry. American Academy of Pediatric Dentistry: Chicago. 2024.

[2] Kenza K, Ghina N, Farid B. Malocclusions risk factors: a systematic review. Open Access Library Journal. 2025; 12: 1–14.

[3] Hoxha S, Eser EG, Toygar Memikoğlu TU. A survey study on sleep breathing in individuals with malocclusion characterized by maxillary transversal deficiency and snoring problem. European Annals of Dental Sciences. 2022; 49: 53–57.

[4] Popevic M. Occupational sleep medicine: the sleep-related breathing disorders in high-risk occupations. In Gül H, Mirón Canelo JA (eds.) Protection and prevention approaches in occupational health and safety (pp. 87–122). 3rd edn. IntechOpen: Rijeka. 2024.

[5] Alshaikh AA, Alalyani RT, Aoun Alshahrani MA, Alshehri RM, Alasmari NS, Alshahrani SAA, *et al*. Prevalence of sleep-disordered breathing and its association with orofacial symptoms among primary school children in the aseer region, Saudi Arabia. Cureus. 2023; 15: e45466.

[6] Grillo C, La Mantia I, Zappala G, Cocuzza S, Ciprandi G, Andaloro C. Oral health in children with sleep-disordered breathing: a cross-sectional study. Acta Biomedica. 2019; 90: 52–59.

[7] Niemi P, Markkanen S, Helminen M, Rautiainen M, Katila MK, Saarenpää-Heikkilä O, *et al*. Association between snoring and deciduous dental development and soft tissue profile in 3-year-old children. American Journal of Orthodontics and Dentofacial Orthopedics. 2019; 156: 840–845.

[8] Hultcrantz E, Löfstrand Tideström B. The development of sleep disordered breathing from 4 to 12 years and dental arch morphology.

International Journal of Pediatric Otorhinolaryngology. 2009; 73: 1234–1241.

[9] Esteller Moré E, Pons Calabuig N, Romero Vilariño E, Puigdollers Pérez A, Segarra Isern F, Matiñó Soler E, *et al*. Dentofacial development abnormalities in paediatric sleep-related breathing disorders. Acta Otorhinolaryngologica Española. 2011; 62: 132–139.

[10] von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. Strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. The BMJ. 2007; 335: 806–808.

[11] Bruni O, Ottaviano S, Guidetti V, Romoli M, Innocenzi M, Cortesi F, *et al*. The Sleep Disturbance Scale for Children (SDSC). Construction and validation of an instrument to evaluate sleep disturbances in childhood and adolescence. Journal of Sleep Research. 1996; 5: 251–261.

[12] Ağca S, Görker I, Turan FN, Öztürk L. Validity and reliability of the Turkish version of Sleep Disturbance Scale for Children. Sleep Medicine. 2021; 84: 56–62.

[13] Redline S, Cook K, Chervin RD, Ishman S, Baldassari CM, Mitchell RB, *et al*. Adenotonsillectomy for snoring and mild sleep apnea in children: a randomized clinical trial. JAMA. 2023; 330: 2084–2095.

[14] Li Y, Tong X, Wang S, Yu L, Yang G, Feng J, *et al*. Pediatric sleep-disordered breathing in Shanghai: characteristics, independent risk factors and its association with malocclusion. BMC Oral Health. 2023; 23: 130.

[15] Eltager T, Bardissy AE, Abdelgawad F. Cessation of thumb/finger sucking habit in children using electronic habit reminder versus palatal crib: a randomized clinical pilot study. BMC Oral Health. 2025; 25: 27.

[16] Luzzi V, Fabbrizi M, Coloni C, Mastrantoni C, Mirra C, Bossù M, *et al*. Experience of dental caries and its effects on early dental occlusion: a descriptive study. Annals of Stomatology. 2011; 2: 13–18.

[17] Bosoni C, Nieri M, Franceschi D, Souki BQ, Franchi L, Giuntini V. Comparison between digital and conventional impression techniques in children on preference, time and comfort: a crossover randomized controlled trial. Orthodontics & Craniofacial Research. 2023; 26: 585–590.

[18] Serrano-Velasco D, Martín-Vacas A, Cintora-López P, Paz-Cortés MM, Aragoneses JM. Comparative analysis of the comfort of children and adolescents in digital and conventional full-arch impression methods: a crossover randomized trial. Children. 2024; 11: 190.

[19] Serrano-Velasco D, Martín-Vacas A, Paz-Cortés MM, Giovannini G, Cintora-López P, Aragoneses JM. Intraoral scanners in children: evaluation of the patient perception, reliability and reproducibility, and chairside time—a systematic review. Frontiers in Pediatrics. 2023; 11: 1213072.

[20] Ikävalko T, Närhi M, Eloranta AM, Lintu N, Myllykangas R, Vierola A, *et al*. Predictors of sleep disordered breathing in children: the PANIC study. European Journal of Orthodontics. 2018; 40: 268–272.

[21] Meer Z, Fahad M, Oudhah A, Alasmari A, Asiri M, Alzahrani E, *et al*. Malocclusion and its association with pediatric obstructive sleep apnoea in Saudi Arabia. Journal of Research in Medical and Dental Science. 2022; 10: 1–5.

[22] Pirilä-Parkkinen K, Pirttiniemi P, Nieminen P, Tolonen U, Pelttari U, Löppönen H. Dental arch morphology in children with sleep-disordered breathing. European Journal of Orthodontics. 2009; 31: 160–167.

[23] Shirke SR, Katre AN. Association of sleep-disordered breathing and developing malocclusion in children: a cross-sectional study. Cureus. 2023; 15: e39813.

[24] Aroucha Lyra MC, Aguiar D, Paiva M, Arnaud M, Filho AA, Rosenblatt A, *et al*. Prevalence of sleep-disordered breathing and associations with malocclusion in children. Journal of Clinical Sleep Medicine. 2020; 16: 1007–1012.

[25] Carvalho FR, Lentini-Oliveira DA, Carvalho GM, Prado LB, Prado GF, Carvalho LB. Sleep-disordered breathing and orthodontic variables in children—pilot study. International Journal of Pediatric Otorhinolaryngology. 2014; 78: 1965–1969.

[26] Habumugisha J, Cheng B, Ma SY, Zhao MY, Bu WQ, Wang GL, *et al*. A non-randomized concurrent controlled trial of myofunctional treatment in the mixed dentition children with functional mouth breathing assessed by cephalometric radiographs and study models. BMC Pediatrics. 2022; 22: 506.

[27] Lin L, Zhao T, Qin D, Hua F, He H. The impact of mouth breathing on dentofacial development: a concise review. Frontiers in Public Health. 2022; 10: 929165.

[28] Galeotti A, Festa P, Viarani V, D'Antò V, Sitzia E, Piga S, *et al*. Prevalence of malocclusion in children with obstructive sleep apnoea. Orthodontics & Craniofacial Research. 2018; 21: 242–247.

[29] Pirilä-Parkkinen K, Pirttiniemi P, Pääkkö E, Tolonen U, Nieminen P, Löppönen H. Pharyngeal airway in children with sleep-disordered breathing in relation to head posture. Sleep and Breathing. 2012; 16: 737–746.

[30] Kim KA, Kim SJ, Yoon A. Craniofacial anatomical determinants of pediatric sleep-disordered breathing: a comprehensive review. Journal of Prosthodontics. 2025; 34: 26–34.

How to cite this article: Özlem Beren Satılmış, Nurhan Özalp, Tülin Ufuk Toygar Memikoğlu. Association of snoring with malocclusion in primary dentition: a cross sectional comparative study. Journal of Clinical Pediatric Dentistry. 2026; 50(1): 255-264. doi: 10.22514/jocpd.2026.024.