REVIEW ARTICLE

Sleep Disordered Breathing and Dentistry: Are Oral Health Practitioners Living Up to Their Clinical Role? A Narrative Review

Rama Krsna Rajandram[1], Kokila Subramaniam[1] and Lavanyah Ponnuthurai[2]

[1] Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, National University of Malaysia, 50300 Kuala Lumpur
[2] Department of Restorative Dentistry, Faculty of Dentistry, National University of Malaysia, 50300 Kuala Lumpur

ABSTRACT

Introduction: Sleep-disordered breathing (SDB) is a subgroup of sleep disorders. It can lead to cognitive and health morbidities in children as well as adults. The constant disruption of sleep and oxygenation causes fragmented sleep and significant health consequences. This narrative review analyses the current state of awareness within the dental community concerning their role in screening for SDB based on the publication pattern in dental journals. **Methods**: A narrative review using the search engine Pubmed review of papers focusing on SDB was conducted using specific terms from 2011 to 2021. **Results:** SDB constituted a significant part of the sleep disorder literature. A subgroup analysis revealed that 86% of publications focused on OSA, and only 1% on UARS. Dental-related publications were scant and mostly secondary to findings from other medical specialties. Few studies examined the causal relationship between oropharyngeal anatomy and sleep, and there was a lack of longitudinal studies from dental specialties. Our review highlights the need for the dental community to recognize their role in airway screening and SDB management, especially in the pediatric and young adult populations at risk of developing neurocognitive and behavioral issues due to undiagnosed SDB. **Conclusion and impact:** Dental professionals must integrate airway screening and sleep analysis into routine dental charting to prevent complications from chronic sleep fragmentation and undiagnosed breathing disorders as part of a holistic approach to patient management.

Malaysian Journal of Medicine and Health Sciences (2025) 21(SUPP9):165-180. doi:10.47836/mjmhs.21.s9.21

Keywords: Dental, Upper airway resistance syndrome, Obstructive sleep apnea, Sleep-disordered breathing, Oropharyngeal Crowding

Corresponding Author:
Rama Krsna Rajandram, MBBS,MDS-OMFS,DDS
Email: ramakrsna@ukm.edu.my
Tel : +603-92897799

BACKGROUND AND AIMS

Sleep changes in duration and pattern from the beginning of birth to adulthood, adapting to growth and development needs (1). It has a significant role in neuronal regenerative processes, positive behavioral patterns, and metabolic recovery through physiologic and cognitive factors (2). Sleep disorders represent issues related to either the quantity or quality of sleep (3). In children, it can impact their overall health, behavior, mood, and academic performance as it correlates with a time in life when there are rapid changes in physical development and emotional regulation (3). In adults, it leads to systemic morbidity and disrupts work performance. This is due to chronic poor sleep leading to adverse effects on neurocognition and the hypoxic/hypoxemia burden on the cardiovascular and metabolic systems (4).

The International Classification of Sleep Disorders has classified sleep disorders into six categories: insomnia, sleep-related breathing disorders, central disorders of hypersomnolence, circadian rhythm sleep-wake disorders, parasomnias, and sleep-related movement disorders (5). Out of these six classifications, sleep-related breathing disorders are the only ones where anatomical deficiency in the upper airways alters breathing and disrupts sleep patterns instead of vice versa. The upper airways, which consist of the oropharyngeal and nasopharyngeal airways, play a fundamental role in ensuring the function of breathing is maintained through sleep. To support this breathing circuit, a vacuum must be generated by the mouth being closed and the tongue's position behind the palatal region of

the maxillary central incisors. An oral seal is essential so air can overcome the normal nasal resistance at the anterior nasal valve before progressing to complete the lung circuit (6).

In sleep-disordered breathing, nasal obstruction is the most common cause of this circuit disruption (7). This disruption leads to a break in the oral seal, causing mouth breathing. Mouth breathing causes an altered tongue position(8). This will then alter craniofacial growth negatively, especially if it is present during the active period of facial growth (9). These anatomical deficiencies have been shown to lead to an increased risk for breathing disorders, especially during sleep, due to increased upper airway resistance (UAR)(10). In normal sleep, UAR increases from the transition of wake to sleep (11). Due to the nature of the upper airway being like a collapsible tube, any significant anatomical changes in the upper airway region can lead to an increased risk for sleep-related breathing disorders (10).

Sleep-disordered breathing (SDB) represents a spectrum of abnormal sleep-related breathing that impacts oxygenation. This leads to fragmented sleep due to frequent arousals (12). Clinically, the spectrum ranges from primary snoring, hypoventilation, and upper airway resistance syndrome (UARS) to the most severe form, which is obstructive sleep apnea (OSA) (12, 13). SDB leads to detrimental health effects in two ways. Firstly, systemic health effects are related to the constant cardiovascular and metabolic response to overcome hypoxemia and hypercapnia. Secondly, chronic sleep fragmentation leads to adverse neurocognitive, behavioral, and metabolic side effects due to chronic sleep deprivation(4).

Up to recent years, SDB was diagnosed and graded based on the apnea hyponea index (AHI) on polysomnography(12). However, of late, there have been some controversies relating to diagnosing SDB(14). Studies on children and young adults with sleep problems have shown that the development of OSA can also be a progressive problem in individuals who may already have an undiagnosed breathing disorder. This theory was strengthened by studies analyzing polysomnography (PSG) that challenged the conventional diagnosis of SDB grading using AHI(15). Recent studies have shown that abnormal breathing patterns may exist independent of AHI, and failure to recognize this early clinically will lead to misdiagnosis and delayed intervention (15).

Current evidence is that sleep-related breathing disorders exist as a continuum and can advance from the non-hypoxic form to the hypoxic form based on the individual risk of each patient. More importantly to clinicians, there is a considerable role in screening all individuals since it may present indolently, unlike the usual OSA. The shift away from diagnosing based on AHI from polysomnography has brought a whole new dimension to the role of dentists in respiratory sleep disorders.

The objective of this study was to conduct a narrative review of the literature to investigate the current evidence regarding whether the dental fraternity is doing enough regarding sleep-disordered breathing screening.

DESIGN

This study was a quantitative narrative review of the literature to assess the publication trend in sleep-disordered breathing (SDB) by the dental community to determine the adequacy of screening efforts. Inclusion criteria were papers published from 2011 to 2021 in English, with abstracts representing the spectrum of SDB (13) Exclusion criteria included conditions not related to the definition of screening, such as syndromic study populations, obstructive hypoventilation pertaining to obesity, SDB due to brain injury or pathology-induced injury, skeletal-related malocclusions (Class II, Class III), papers reporting craniofacial changes with SDB using radiographic materials, papers focusing on maxillomandibular advancement (MMA) outcomes, and review papers.

SEARCH METHOD

The database for the search was PubMed. In the first level of publication screening, we used the sleep disorder OR sleep disorders. The publication number was recorded as representative of the general publication trend for sleep disorders in the general literature. This was considered the initial screening. We then did a second-level screening using the specific classification of sleep disorder as stated in the AASM International Classification of Sleep Disorders – Third Edition, Text Revision (ICSD-3-TR) (16). This was done to ensure homogeneity of our search terms, as sleep disorders have often been presented in multiple different terms with much generalization. In the third level screening, we used Boolean operators to combine the search term in the initial screening with the second-level search terms to ensure we do not miss any papers from the first two screening levels. The number of publications for each classification of sleep disorders was then recorded. Subsequently, we focused on publications concerning the sleep-disordered breathing spectrum. We used Boolean operators to divide the literature into hypoxic (obstructive sleep apnea) and non-hypoxic (upper airway resistance syndrome) disorders.

Lastly, to identify dental-related publications to SDB , the search was combined with dental-related conditions, focusing on dental-related factors related to SDB. Terms that were used to highlight deficient craniofacial growth or oral pharyngeal crowding included ‘malocclusion,’ “tongue scalloping,” “ankyloglossia,”” posterior tongue tie” and signs of dysfunctional breathing, which will

represent nasal obstruction, “chronic mouth breathing.”

ETHICAL APPROVAL:

This review was approved by the University Kebangsaan Malaysia ethics committee (JEP-2023-599).

Data Extraction

Terms used for the dental-related search regarding SDB included “altered tongue position,” such as “transverse maxillary discrepancy,” “V-shape maxilla,” “high arch palate,” “posterior crossbite,” “narrow maxilla,” and “palatal expansion”; “altered tongue space,” such as oropharyngeal crowding signs, “dental crowding,” “malocclusion,” “torus palatinus,” and “torus mandibularis”; and “altered tongue mobility,” such as “ankyloglossia.

RESULTS

1.0 General Outlook of Publication Patterns Related to Sleep-Disordered Breathing (SDB) Among Other Sleep Disorders.

Analysis of the literature shows that sleep-related breathing disorder is the most researched sleep disorder in comparison to all other sleep disorders classified under the AASM International Classification of Sleep Disorders. It contributed to almost 52% of the literature when analyzed under the classification of the AASM. Figure 1 shows the breakdown of publication papers based on the classification. Figure 2 shows the publication trend across different sleep disorders, indicating that

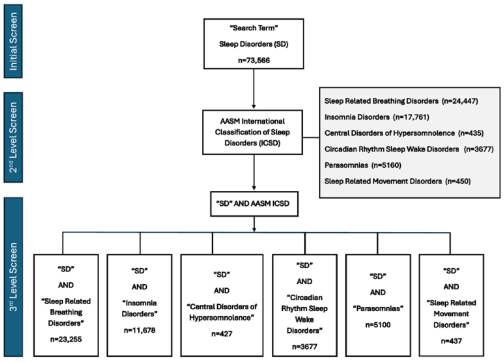

Figure 1 : General outlook of publication pattern related to sleep disordered breathing (SDB) compared to other sleep disorders.

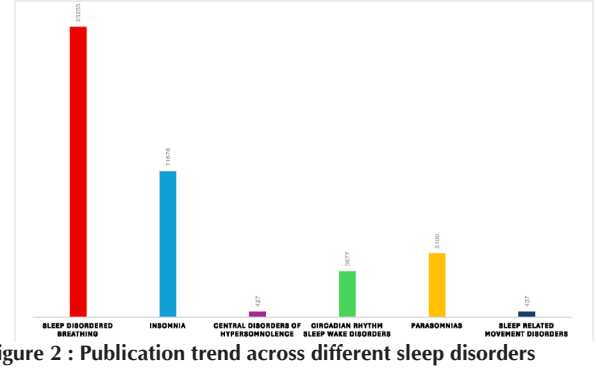

Figure 2 : Publication trend across different sleep disorders

sleep disordered breathing makes up most publications related to sleep disorders.

2.0 Publication Trends in Dentistry concerning risk factors for SDB

2.01: Upper Airway Resistance Syndrome (UARS) and dentistry

Figure 3 shows the lack of awareness regarding screening for sleep disordered breathing. Only two papers from dental journals highlighted interventions for upper airway resistance syndrome.

Publication	Title	Primary Finding
Corrêa Cde C, Berretin-Felix G(1).	Myofunctional therapy applied to upper airway resistance syndrome: a case report.	Myofunctional Therapy Positive Effects on sleep quality
Tay DKL, Pang KP.(2)	Clinical phenotype of Southeast Asian temporomandibular disorder patients with upper airway resistance syndrome	Somatic Pain related to repeated sleep arousals– Temporomandibular pain

Figure 3: Publication pattern related to UARS and dentistry

2.02 Chronic Mouth Breathing:

Only three papers addressed chronic mouth breathing as an outcome of craniofacial maldevelopment due to dysfunctional breathing, causing SDB. They all involved paediatric subjects and were published in orthodontic journals. Figure 4 shows that these studies agreed that chronic mouth breathing is associated with dental malocclusion and sleep issues, with one paper linking it to nasal obstruction.(17, 20, 24).

Publication	Title	Primary Indicator	Finding
Huynh NT, Morton PD, Rompré PH, Papadakis A, Remise C.(3)	Associations between sleep-disordered breathing symptoms and facial and dental morphometry, assessed with screening examinations.	Sleep quality and snoring	Chronic mouth breathing with dental morphological changes leading to anatomical narrowing of the oropharyngeal airway
Pacheco MC, Fiorott BS, Finck NS, Aratijo MT.(4).	Craniofacial changes and symptoms of sleep-disordered breathing in healthy children	Mouth breathing	Oropharyngeal crowding Sleep Quality Snoring Lip incompetence Nasal obstruction symptoms
Ikävalko T, Närhi M, Eloranta AM, Lintu N, Myllykangas R, Vierola A, Tuomilehto H, Lakka T, Pahkala R..(5)	Predictors of sleep-disordered breathing in children: the PANIC study	Sleep Quality	Chronic Mouth breathing Oropharyngeal crowding

Figure 4: Publication patterns on chronic mouth breathing and tongue position-related maldevelopment

2.02 Oral Pharyngeal Crowding

Altered tongue space usually stems from deficient transverse and anterior-posterior maxillary growth. There were 33 papers on the maxilla and SDB: however, only four focused on the relationship between maxillary form and SDB, as shown in Figure 5 (21, 25-27). These studies, mainly published in orthodontic journals, emphasized the benefits of palatal expansion for OSA patients, particularly in improving nasal architecture and reducing hypoxic symptoms. Notable interventions included surgically assisted rapid maxillary expansion and distraction osteogenesis maxillary expansion (DOME)(28). Only one paper explored the role of palatal expansion in addressing mood disorders linked to SDB. Tongue scalloping, a clinical indicator of limited tongue space, was mentioned in only two publications as a marker for sleep pathology as shown

in Figure 6 (29, 30). We found 71 papers that discussed ankyloglossia in a dental context, but as shown in Figure 7, only three focused on oropharyngeal morphometry changes leading to oropharyngeal crowding (28, 31, 32). Most dental publications centered on intervention techniques for improving breastfeeding and speech. Ankyloglossia was linked to altered maxillary form and chronic mouth breathing, with its severity affecting the degree of malocclusion. There were 87 publications on mandibular and palatal tori; however, only three indicated these anatomical features as risk factors for exacerbating OSA. These studies were not conducted in dental settings.

Publication	Title	Type of Journal	Population	Dental Finding
Kim JH, Guilleminault C. (6)	The nasomaxillary complex, the mandible, and sleep-disordered breathing	Non-Dental Study	Paediatric Population	Narrow maxillary complex leading to symptoms of sleep fragmentation
Rambaud C,Guilleminault C.(7)	Death, nasomaxillary complex, and sleep in young children	Non-Dental Study	Paediatric Population	Narrow nasomaxillary without mandibular retro position leading to OSA
Ito E, Tsuiki S, Maeda K, Okajima I, Inoue Y. (8)	Oropharyngeal Crowding Closely Relates to Aggravation of OSA	Non-Dental Study	Adult Population	Oropharyngeal crowding an anatomical contributor to severity of OSA
Katyal, Vandana et al. (9)	Craniofacial and upper airway morphology in pediatric sleep-disordered breathing and changes in quality of life with rapid maxillary expansion	Dental Related Study	Paediatric population	Maxillary deficiency led to sleep fragmentation

Figure 5: Publication pattern on the relationship between maxillary form and SDB

Publication	Title	Clinical Finding
Weiss TM, Atanasov S, Calhoun KH. (10)	The association of tongue scalloping with obstructive sleep apnea and related sleep pathology.	Tongue scalloping was associated with sleep pathology.
Tomooka K, Tanigawa T, Sakurai S, Maruyama K, Eguchi E, Nishioka S, Miyoshi N, Kakuto H, Shimizu G, Yamaoka D, Saito I. Study.(11)	Scalloped tongue is associated with nocturnal intermittent hypoxia among community-dwelling Japanese: the Toon Health.	Severity of tongue scalloping correlated with increased risk of intermittent nocturnal hypoxia

Figure 6: Publication pattern on tongue space and sleep pathology

Publication	Title	Clinical finding
Srinivasan B, Chitharanjan AB. Skeletal and dental characteristics in subjects with ankyloglossia.(12)	Skeletal and dental characteristics in subjects with ankyloglossia."	Reduced maxillary and mandibular width correlated to the severity of ankyloglossia.
Yoon AJ, Zaghi S, Ha S, Law CS, Guilleminault C, Liu SY. (13)	Ankyloglossia as a risk factor for maxillary hypoplasia and soft palate elongation: A functional-morphological study	Reduced Maxillary width correlated with the severity of ankyloglossia.
Vaz AC, Bai PM.(14)	Lingual frenulum and malocclusion: An overlooked tissue or a minor issue.	Dental malocclusion correlated to the severity of ankyloglossia.

Figure 7: Publication pattern on oropharyngeal morphometry changes leading to oropharyngeal crowding

3.0 Malocclusion and Sleep Disordered Breathing

Nine papers discussed the relationship between malocclusion and SDB, primarily involving paediatric populations. These studies were published in dental paediatric, medical paediatric, and otorhinolaryngology journals, confirming malocclusion as a predictor of underlying SDB.

DISCUSSION

Our narrative review indicates that sleep disordered breathing is the most researched sleep disorder, indicating the significant health morbidity it has globally. There is a substantial lack of awareness among oral health practitioners concerning their roles in screening for underlying sleep-disordered breathing (SDB). This is proven by the lack of publications involving the dental team as principal investigators and the involvement of dental patients as the patient population. Most publications came from dental involvement and were reported as a secondary outcome of investigation or findings from other non-dental related surgical or medical specialties, especially otorhinolaryngology. This is surprising considering that dentists deal with the airway daily and are exposed to all the anatomical structures that have been reported to play a role in contributing to sleep-disordered breathing.

This review reflects a paradoxical relationship between the clinical relationship and the publication and awareness pattern. The reason behind this can be extrinsic and intrinsic. Extrinsic factors relate to our medical counterparts, classifying oral health practitioners as adjuncts to airway management rather than front liners. Intrinsic factors pertain to oral health practitioners not knowing their role in airway management and having a separate understanding of SDB. There is also a combination of extrinsic and intrinsic factors concerning the view of the nasal and oral cavity as two separate entities; therefore, the failure to understand that the airway is shared between nasal and oral factors contributes equally to the rise of SDB.

The lack of early interceptive screening also probably arises from the lack of homogeneity in understanding the disease. Our analysis shows that sleep-disordered breathing was used interchangeably with obstructive sleep apnea (OSA), with the diagnosis always confirmed by polysomnography. The current definition of SDB mentions that it exists as a spectrum from non-hypoxic to hypoxic forms. The failure to understand this new definition has reduced the early screening of UARS, potentially involving oral health practitioners. Over the last 10 years, only 2% of publications focused on UARS, compared to 98% on OSA.

The more significant issue within the dental fraternity not living up to their potential role is likely intrinsic. The publication scenario in dental literature resembles a situation where the eyes do not see what the brain does not know. Less than 50 publications were found to have cumulatively involved chronic mouth breathing, oropharyngeal crowding, and tongue mobility issues when analyzing the significant associated dental findings with SDB. This poor publication ratio was not only in quantity but also quality, with no studies on sleep and dental-related factors examining causal relationships of oropharyngeal anatomy with breathing and sleep, despite the dental team having the most considerable exposure to the population in terms of time and quantity. The poor quality and quantity of research leads to poor interpretation of findings that indicate no causal relationship, further reducing research in this area by oral health practitioners. This problem exists in dentistry due to a fundamental misconception that only OSA exists, poor understanding of the spectrum of SDB,

and our roles in UARS patients. The analysis is supported by findings on oropharyngeal crowding, which indicate that most publications with a dental relationship to SDB were still from OSA-related publications. Ignorance in the broader picture has failed to realize that UARS patients are typically seen daily in a dental setting. These patients seek treatment for aesthetic or functional occlusion-related problems, which may be partly due to an underlying undiagnosed breathing disorder.

Notably missing from the publication trend were impactful sleep and breathing-oriented publications from pediatric dentistry, dental public health, and orthodontics. This is concerning as these dental specialties deal with children and school-related policies. Children and young adults stand to benefit the most from dental airway screening for undiagnosed breathing disorders, especially UARS. Undiagnosed UARS patients are at risk of developing significant behavioural and neurocognitive issues related to fragmented sleep.

Malocclusion, which showed the most publications involving dentistry in SDB, is also the most common complaint seen in a dental clinic. However, no longitudinal study originating from a primarily dental population with airway and sleep improvement as the bigger picture of management outcomes was found.

There is, therefore, a need to address intrinsic and extrinsic issues to ensure oral health practitioners fulfill their roles. The first step is for all dental and non-dental specialties to accept that the nose and mouth are symbiotic when breathing and should be treated as a breathing unit. Concurrent assessment in all screenings, whether by dental or medical professionals, is essential. Moving away from the standard OSA approach and standardizing terms to approach breathing as a unit will emphasize the need to manage breathing disorders as a team at all management points. Standardizing terms and managing breathing disorders with a multidisciplinary airway team, similar to the well-established cleft lip and palate team, ensures the whole breathing unit is ideal, with sleep quality as the outcome of success. By being part of this multidisciplinary team, embracing the dynamic relationship of breathing, growth, and interventions throughout all ages is crucial, as sleep requirements and breathing change with growth and are never static.

A primary limitation of the study is the reliance on existing publications, which might have inherent biases and variability in study quality. Furthermore, the focus on English-language studies may overlook significant contributions in other languages. Despite these limitations, the study provides a comprehensive overview of dental involvement in SDB and highlights crucial gaps and opportunities for future research.

The review's findings are likely generalizable to other regions with similar healthcare structures and dental education systems. However, specific contextual factors, such as local healthcare policies and interdisciplinary collaboration norms, might affect the applicability of these recommendations. Nonetheless, the overarching principles of integrated care and multidisciplinary approaches to SDB management have broad relevance and can inform global practices in dental and medical fields.

CONCLUSION

This review advocates reconceptualizing the dental role in SDB, promoting a unified airway unit perspective. By embracing this holistic approach, dental practitioners can significantly contribute to the early detection and management of SDB, ultimately improving patient outcomes and reducing the broader health and economic burdens associated with these disorders.

ACKNOWLEDGEMENT

There is no conflict of interest or financial support for this research project.

REFERENCES

1. Licis A. Sleep Disorders: Assessment and Treatment in Preschool-Aged Children. Child Adolesc Psychiatr Clin N Am. 2017;26(3):587-95. doi: 10.1016/j.chc.2017.02.009.
2. Siegel JM. Why we sleep. Sci Am. 2003;289(5):92-7. doi: 10.1038/scientificamerican1103-92.
3. Kansagra S. Sleep Disorders in Adolescents. Pediatrics. 2020;145(Suppl 2):S204-s9. doi: 10.1542/peds.2019-2056I.
4. Lowe CJ, Safati A, Hall PA. The neurocognitive consequences of sleep restriction: A meta-analytic review. Neurosci Biobehav Rev. 2017;80:586-604. doi: 10.1016/j.neubiorev.2017.07.010.
5. Santander P, Sievers D, Moser N. Sleep-related breathing disorders and dentistry: What is the relationship? Quintessence Int. 2016;47(7):617-21. doi: 10.3290/j.qi.a36172.
6. Brennan LC, Kirkham FJ, Gavlak JC. Sleep-disordered breathing and comorbidities: role of the upper airway and craniofacial skeleton. Nat Sci Sleep. 2020;12:907-36. doi: 10.2147/nss.S146608.
7. Magliulo G, Iannella G, Ciofalo A, Polimeni A, De Vincentiis M, Pasquariello B, et al. Nasal pathologies in patients with obstructive sleep apnoea. Acta Otorhinolaryngol Ital. 2019;39(4):250-6. doi: 10.14639/0392-100x-2173.
8. Yoon AJ, Zaghi S, Ha S, Law CS, Guilleminault C, Liu SY. Ankyloglossia as a risk factor for maxillary hypoplasia and soft palate elongation: A functional - morphological study. Orthod Craniofac Res. 2017;20(4):237-44. doi: 10.1111/ocr.12206.

9. Parada C, Chai Y. Mandible and Tongue Development. Curr Top Dev Biol. 2015;115:31-58. doi: 10.1016/bs.ctdb.2015.07.023.
10. Le TB, Moghaddam MG, Woodson BT, Garcia GJM. Airflow limitation in a collapsible model of the human pharynx: physical mechanisms studied with fluid-structure interaction simulations and experiments. Physiol Rep. 2019;7(10):e14099. doi: 10.14814/phy2.14099.
11. Wiegand L, Zwillich CW, White DP. Collapsibility of the human upper airway during normal sleep. J Appl Physiol (1985). 1989;66(4):1800-8. doi: 10.1152/jappl.1989.66.4.1800.
12. Foldvary-Schaefer NR, Waters TE. Sleep-Disordered Breathing. Continuum (Minneap Minn). 2017;23(4, Sleep Neurology):1093-116. doi: 10.1212/01.CON.0000522245.13784.f6.
13. Carroll JL. Obstructive sleep-disordered breathing in children: new controversies, new directions. Clin Chest Med. 2003;24(2):261-82. doi: 10.1016/s0272-5231(03)00024-8.
14. Guilleminault C, Chowdhuri S. Upper airway resistance syndrome is a distinct syndrome. Am J Respir Crit Care Med. 2000;161(5):1412-3. doi: 10.1164/ajrccm.161.5.16158a.
15. Guilleminault C, Huang YS, Chin WC, Okorie C. The nocturnal-polysomnogram and "non-hypoxic sleep-disordered-breathing" in children. Sleep Med. 2019;60:31-44. doi: 10.1016/j.sleep.2018.11.001.
16. Mohammadieh AM, Chan A, Cistulli PA. Sleep-disordered breathing - clinical spectrum. Aust Dent J. 2024;69 Suppl 1(Suppl 1):S45-s52. doi: 10.1111/adj.13043.
17. Huynh NT, Morton PD, Romprй PH, Papadakis A, Remise C. Associations between sleep-disordered breathing symptoms and facial and dental morphometry, assessed with screening examinations. Am J Orthod Dentofacial Orthop. 2011;140(6):762-70. doi: 10.1016/j.ajodo.2011.03.023.
18. Bixler EO, Vgontzas AN, Lin HM, Liao D, Calhoun S, Vela-Bueno A, et al. Sleep disordered breathing in children in a general population sample: prevalence and risk factors. Sleep. 2009;32(6):731-6. doi: 10.1093/sleep/32.6.731.
19. Schumacher GH, Becker R, Ньbner A, Pommerenke F. Stimulating effect of tongue on craniofacial growth. Proc Finn Dent Soc. 1991;87(1):69-83.
20. Ikдvalko T, Nдrhi M, Eloranta AM, Lintu N, Myllykangas R, Vierola A, et al. Predictors of sleep disordered breathing in children: the PANIC study. Eur J Orthod. 2018;40(3):268-72. doi: 10.1093/ejo/cjx056.
21. Ito E, Tsuiki S, Maeda K, Okajima I, Inoue Y. Oropharyngeal Crowding Closely Relates to Aggravation of OSA. Chest. 2016;150(2):346-52. doi: 10.1016/j.chest.2016.03.005.
22. Corrĸa Cde C, Berretin-Felix G. Myofunctional therapy applied to upper airway resistance syndrome: a case report. Codas. 2015;27(6):604-9. doi: 10.1590/2317-1782/20152014228.
23. Tay DKL, Pang KP. Clinical phenotype of South-East Asian temporomandibular disorder patients with upper airway resistance syndrome. J Oral Rehabil. 2018;45(1):25-33. doi: 10.1111/joor.12551.
24. Pacheco MC, Fiorott BS, Finck NS, Araьjo MT. Craniofacial changes and symptoms of sleep-disordered breathing in healthy children. Dental Press J Orthod. 2015;20(3):80-7. doi: 10.1590/2176-9451.20.3.080-087.oar.
25. Kim JH, Guilleminault C. The nasomaxillary complex, the mandible, and sleep-disordered breathing. Sleep and Breathing. 2011;15(2):185-93. doi: 10.1007/s11325-011-0504-2.
26. Rambaud C, Guilleminault C. Death, nasomaxillary complex, and sleep in young children. Eur J Pediatr. 2012;171(9):1349-58. doi: 10.1007/s00431-012-1727-3.
27. Katyal V, Pamula Y, Daynes CN, Martin J, Dreyer CW, Kennedy D, et al. Craniofacial and upper airway morphology in pediatric sleep-disordered breathing and changes in quality of life with rapid maxillary expansion. Am J Orthod Dentofacial Orthop. 2013;144(6):860-71. doi: 10.1016/j.ajodo.2013.08.015.
28. Yoon A, Guilleminault C, Zaghi S, Liu SY. Distraction Osteogenesis Maxillary Expansion (DOME) for adult obstructive sleep apnea patients with narrow maxilla and nasal floor. Sleep Med. 2020;65:172-6. doi: 10.1016/j.sleep.2019.06.002.
29. Weiss TM, Atanasov S, Calhoun KH. The association of tongue scalloping with obstructive sleep apnea and related sleep pathology. Otolaryngol Head Neck Surg. 2005;133(6):966-71. doi: 10.1016/j.otohns.2005.07.018.
30. Tomooka K, Tanigawa T, Sakurai S, Maruyama K, Eguchi E, Nishioka S, et al. Scalloped tongue is associated with nocturnal intermittent hypoxia among community-dwelling Japanese: the Toon Health Study. J Oral Rehabil. 2017;44(8):602-9. doi: 10.1111/joor.12526.
31. Srinivasan B, Chitharanjan AB. Skeletal and dental characteristics in subjects with ankyloglossia. Prog Orthod. 2013;14:44. doi: 10.1186/2196-1042-14-44.
32. Vaz AC, Bai PM. Lingual frenulum and malocclusion: An overlooked tissue or a minor issue. Indian J Dent Res. 2015;26(5):488-92. doi: 10.4103/0970-9290.172044.