Original Article

Sleep-disordered breathing among Saudi children seeking orthodontic treatment

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Abstract

Aims: The aim of this research is to assess the prevalence of sleep disordered breathing (SDB) and evaluate the risks and symptoms in children seeking orthodontic treatment in a Saudi dental center. **Settings and Design:** It is a cross-sectional survey-based study. **Methods and Material:** Pediatric sleep questionnaire (PSQ) was used to survey 285 children and adolescents aged 5 to 18 years old who are undergoing orthodontic screening in a Saudi Dental Center. **Statistical Analysis Used:** PSQ scores were tested with multiple variables including gender, parents' education, academic performance using Mann-Whitney-U test. Correlation of study sample scores with age were calculated using the Spearman rank correlation coefficient (rho). **Results:** In this study 136 (47.7%) of the participants were deemed to be high risk for developing SDB and 149 (52.3%) were low risk, males were significantly at higher risk compared to females *($P \leq 0.05$).* Participants with previous adenoidectomy surgery were more likely to be identified as high-risk for SDB *(P-value = 0.000)* as well as participants with a family history of snoring *(P-value = 0.000).* **Conclusions:** Sleep disordered breathing was prevalent among Saudi children seeking orthodontic therapy, it is important to screen children and adolescents in dental pediatric and orthodontic clinics for SDB risk as this is a prevalent disorder among this population, early detection of SDB will improve patients' quality of life and prevent future complications associated to this disorder.

Keywords: Children, orthodontic treatment, pediatric sleep questionnaire, sleep disordered breathing

Introduction

Sleep is an important biological process that maintains humans' physical and mental health.[1] Normal sleep patterns might be affected by sleep-disordered breathing (SDB). Sleep-disordered breathing (SDB) is a general description of multiple respiratory patterns that result from either upper airway resistance or incomplete or complete airway obstruction (obstructive sleep apnea).[2] Epidemiological studies measured the prevalence of sleep-disordered breathing to be about 2% among children and about 2.5%-6% among adolescents.[3] Moreover, there are various symptoms associated with sleep-disordered breathing such as mouth breathing, snoring, daytime sleepiness, behavioral and cognitive symptoms, and nocturnal enuresis.[3-9] According to Al-Hammad *et al.*, multiple studies indicate that snoring, difficult sleep, nocturnal sweating, mouth breathing, poor school performance, and daytime sleepiness are symptoms that are highly associated with sleep-disordered breathing.[5]

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Based on the literature review done, snoring during sleep is abnormal in children, and it is considered to be a significant and underreported symptom of pediatric sleep-disordered breathing.[10] According to a technical report reviewing childhood obstructive sleep apnea syndromes, the prevalence of snoring among children and adolescents ranged between 3.2% and 12.1%.[11] A study was conducted by BaHammam *et al.* discovered that the prevalence of snoring among Saudi primary school children was 17.9%.[7]

A more recent study was done in 2019 by Baidas *et al.* to evaluate the prevalence of SDB symptoms among Saudi school children. It showed that about 21% of Saudi children are at risk of sleep-disordered breathing and the prevalence of snoring was 14.4%.[12] These two studies indicate that Saudi children, in general, have a higher risk of developing SDB symptoms.

Although children in intermediate school experience a phase of maximum daytime wakefulness, they have may have sleep deprivation, and it is often caused by SDB during the night time; this might lead to daytime sleepiness.[7] Daytime sleepiness is less common in children suffering from SDB compared to adults.[4–6] According to the literature, the symptom of daytime sleepiness among children with SDB varied, and its prevalence ranged between 7% and 10%.[5,13,14] In addition, Some researchers suggest that children have a different sleep architecture[15] also children may have a threshold for sleepiness that is different from adults.[16] However, no clear conclusion regarding daytime sleepiness and SDB, and it is considered to be a controversial matter among researchers. Moreover, behavioral and cognitive presentations of sleep deprivation during daytime in children differ from adults.[4-6] These behavioral and cognitive presentations involve hyperactivity, difficulties in concentrating\learning, memory impairment, poor academic performance, behavioral problems, aggressiveness, and moodiness.[4-6,8] Furthermore, other studies suggest that SDB in children can increase the risk of developing physical problems such as growth retardation, failure to thrive, and metabolic disorders.[5,6]

Sleep-disordered breathing is related to anatomical craniofacial factors. These include a narrow maxilla associated with narrow nasal walls, deep palatal height, decreased nasal volume, and increased upper airway resistance.[17] In order to compensate for the upper airway resistance, children tend to breathe through their mouths.[18] Huynh *et al.* found a significant association between mouth breathing and sleep-disordered breathing.[19] Al-Hammad *et al.* also reported that 85.2% of children with SDB breathe through their mouths during the night and 92.6% during the daytime.[5]

Pediatric sleep-disordered breathing is also associated with craniofacial morphology disharmonies. Macroglossia, midface hypoplasia, mandibular and maxillary retrognathia, maxillary constriction, short cranial base length, elevated total and lower anterior facial heights and a more anterior and inferior location of the hyoid bone are anatomical and craniofacial characteristics that have been correlated with upper airway narrowing and SDB in children.[20-23]

During a routine orthodontic examination, these anatomical characteristics are clinically and radiographically examined and, in most cases, may be the subject of orthodontic care.

The prevalence of pediatric sleep-disordered breathing among orthodontic population was evaluated by Rohra *et al.* his findings revealed that 7% of orthodontic patients were considered high risk for SDB.[4] Abtahi *et al.* findings showed that Pediatric SDB risk was higher in the orthodontic population than in a healthy population. They advised that SDB screening should be a routine part of dental practitioners' clinical practice.[24]

Although several studies[5,7,12] evaluated pediatric sleep-disordered breathing among the general Saudi population, our study was the first to evaluate SDB symptoms among Saudi orthodontic population.

In 2012, clinical guidelines for the diagnosis and management of obstructive sleep apnea were established by the American Academy of Pediatrics (AAP).[25] These guidelines confirmed the importance of screening to ensure that children and adolescents have enough oxygen saturation during sleep; otherwise, low oxygen saturation might lead to various complications.[25] unfortunately, the public and health care providers do not commonly identify Sleep Disorders in Saudi Arabia; therefore, lack of awareness might lead to comorbid conditions, risks, and complications.[26]

This study highlights the importance of SDB screening among children by evaluating the prevalence of symptoms and the risks of SDB in children seeking orthodontic treatment in a Saudi dental center.

Subjects and Methods

This study was approved by the Institutional Review Board (IRB) at King Abdullah International Medical Research Center (KAIMRC) (NCBE ethical approval registration No: H-01-R-005) date of approval was 27-6-2019. It is a cross-sectional survey-based study carried out in the department of orthodontics at King Abdulaziz Dental Center (KADC) in Riyadh. The study sample consisted of 285 children and adolescents receiving orthodontic treatment between 5 and 18 years old. Inclusion criteria were no previous orthodontic therapy, good health in general, the ability to read and write in Arabic and/or English to complete the pediatric sleep questionnaire (PSQ), medical and dental history forms. Patients with craniofacial deformities and syndromes, neuromuscular diseases, and congenital malformations or with psychiatric illness were excluded from this study. Subjects were selected to participate in the survey at the orthodontics department waiting areas. The willing participants' guardians were given informed written consent before participating.

Although overnight polysomnography is the gold slandered test to assess SDB, Pediatric Sleep Questionnaire (PSQ) was used in the study because of lack of access, time, and

staff.[3] Demographic data included in the questionnaire were participants' age, sex, and region; moreover, data about parents' education level and child school performance were also collected. The pediatric sleep questionnaire (PSQ) includes a 22-item questionnaire to assess participants' symptoms.[27] The questionnaire is divided into three categories to evaluate child snoring, sleepiness, and behavioral symptoms (mainly hyperactivity and inattention). After running Coefficient alpha and Cronbach alpha tests, the translated questionnaire was deemed to be valid and reliable.

For all questions in the questionnaire, the answer categories are "yes", "no", or "I don't know". A high risk of SDB was indicated by a percentage of "yes" responses equal to or greater than 33 percent; a lower rate indicated a low risk. When calculating the percentage for risk status, missing and "don't know" answers were omitted from the denominator. In previous studies, the PSQ showed a specificity of 0.87 and a sensitivity of 0.85 when compared with polysomnographic data.[27] In addition to the pediatric sleep questionnaire, two questions were added about obstructive sleep apnea (OSA) severity and frequency. Moreover, two questions about previous Adenoidectomy surgery and family history of snoring were also added. The questionnaire was translated into Arabic, and a pilot study was done to check the translated version validity and reliability. The translated questionnaire was deemed to be valid and reliable.

Descriptive statistics were presented in the form of means, standard deviations, and percentages. Pediatric sleep questionnaire (PSQ) scores were tested with multiple variables, including gender, parents' education, academic performance using Mann-Whitney-U test.

Adenoidectomy surgery, family history of snoring, and obstructive sleep apnea severity and frequency were also associated with PSQ scores using Mann-Whitney-U test. Correlation of pediatric sleep questionnaire results with age was calculated by using Spearman rank correlation coefficient (rho).

Statistical significance for all statistical tests is predetermined at P value < 0.05. and SPSS (Statistical Package for Social Sciences) software was used to analyze all data (version 23.0; IBM, Armonk, NY).

Results

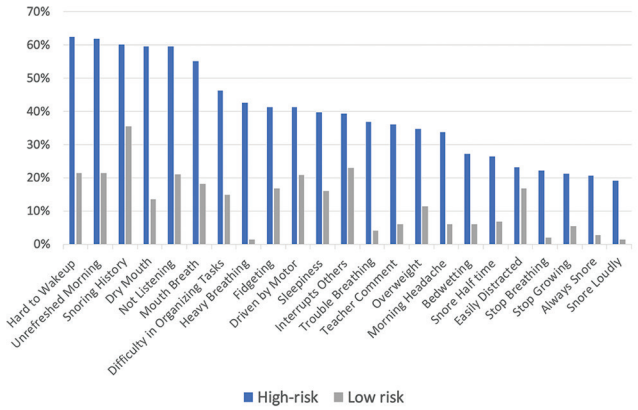
The mean age of the study participants was 14.14 years of age, 53.3% of them were females and 46.7% were males [Table 1].

In pediatric sleep questionnaire (PSQ) patients are considered either low or high risk for SDB PSQ identifies high risk patients as those who answered "yes" to 33% the questions or more.

Of the 285 participants, 149 (52.3%) were identified as low-risk patients and 136 (47.7%) were identified as high risk. among the 149 high-risk patients, multiple symptoms were highly common such as having difficulties waking up in the morning, being unrefreshed in the morning and the presence of family snoring history [Graph 1].

Gender was significantly related with SDB risk, with males being more affected than females *(P-value = 0.043)*. Participants with previous adenoidectomy surgery were more likely to be identified as high-risk for SDB *(P-value = 0.000)* as well as participants with a family history of snoring *(P-value = .000)* [Table 2].

Obstructive sleep apnea severity and frequency both were significantly associated with high SDB risk *(P-value = 0.000)*. However, age *(P-value = 0.132)* and academic performance *(P-value = .092)* were not correlated with SDB risk [Table 3].



Graph 1: Percentage of 'Yes' Responses Among High and Low Risk Group

Table 1: Characteristics of the sampled population

	Frequency	Valid percentage
Age	14.14±3.21	
Gender		
Male	133	46.7%
Female	152	53.3%

Table 2: Distribution and association of PSQ risk groups with gender, previous adenectomy surgery and family history

	Low risk group	High risk group	*P*
Gender			
Male	61 (46%)	72 (54%)	0.043
Female	88 (58%)	64 (42%)	
Previous Adenoidectomy surgery			
Yes	27 (18.1%)	53 (39.0%)	0.000
No	119 (79.9%)	81 (59.6%)	
I don't know	3 (2.0%)	2 (1.5%)	
Family history of snoring			
Yes	53 (35.5%)	82 (60.1%)	0.000
No	81 (54.3%)	47 (34.5%)	
I don't know	15 (10.0%)	7 (5.1%)	

Table 3: Distribution of PSQ risk categories by gender, academic performance and sleep apnea severity and frequency

	Low risk group	High risk group	*P*
Age			0.132
Academic performance			
Excellent	84 (56.4%)	63 (46.3%)	0.092
Advanced (very good)	50 (33.6%)	55 (40.4%)	
Capable (good)	15 (10.1%)	18 (13.2%)	
Did not pass	0	0	
Obstructive sleep apnea severity			
Loud snoring	2 (1.4%)	11 (8.1%)	0.000
Snorts and gasp	6 (4.0%)	30 (22.0%)	
Breathing pauses	2 (1.3%)	17 (12.5%)	
None	138 (92.6%)	77 (56.6%)	
Obstructive sleep apnea frequency			
Frequently	2 (1.3%)	12 (8.8%)	0.000
Sometimes	1 (0.6%)	37 (27.2%)	
Rarely	5 (3.3%)	7 (5.1%)	
Not Applicable (N/A)	141 (94.6%)	80 (58.8%)	

Table 4: Distribution of PSQ risk categories by parents' level of education

	Low risk group	High risk group	*P*
Mother's education			
Never attended school	4 (2.6%)	4 (2.9%)	0.046
Primary education	12 (8.0%)	13 (9.5%)	
Intermediate education	13 (8.7%)	21 (15.4%)	
Secondary education	47 (31.5%)	46 (33.8%)	
College graduate	65 (43.6%)	48 (35.2%)	
Advanced degree	8 (5.3%)	4 (2.9%)	
Father's education			
Never attended school	1 (0.6%)	1 (0.7%)	0.456
Primary education	7 (4.6%)	8 (5.8%)	
Intermediate education	18 (12.0%)	9 (6.6%)	
Secondary education	52 (34.8%)	47 (34.5%)	
College graduate	56 (37.5%)	58 (42.6%)	
Advanced degree	15 (10.0%)	13 (9.5%)	

Parents' education was correlated with patients' risk and exhibited that mothers' level of education was significantly correlated with child's risk of SDB *(P-value = 0.046)* while level of fathers' education showed no significant correlation *(P-value = 0.456)* [Table 4].

Discussion

Children with sleep-disordered breathing might show multiple symptoms such as snoring, mouth breathing, daytime sleepiness, behavioral and cognitive symptoms, and nocturnal enuresis.[3-9] The pediatric sleep questionnaire (PSQ) used in this study is considered a valid and efficient screening tool for SDB risk. PSQ is developed for patients aged between 2-18 years old. The PSQ contains twenty-two questions divided into three categories to evaluate snoring, sleepiness, and behavioral symptoms.[27] This study was the first to evaluate SDB symptoms using the PSQ among Saudi orthodontic population. Unlike in Rohra *et al.*[4], adolescents who are 18 years old were included in this study, as adolescents in this age group in Saudi Arabia usually live with their parents. Therefore, parents' lack of awareness regarding their child's sleep disorder did not affect parents' answers to the questionnaire. In this study, 136 (47.7%) of the participants are at high risk of sleep-disordered breathing, which is considered to be higher than Rohra's *et al.* study, where only 7% to 10% were at high risk.[4] This high result might be explained by the type of care the dental center provides since it is a tertiary center where the referred cases include moderate to severe malocclusions or orthodontic problems. Furthermore, these referred cases often present with craniofacial morphological defects similar to sleep-disordered breathing characteristics. This result is also consistent with the high prevalence of reported pediatric SDB symptoms among the general Saudi population.[7,12] where it reached 21% among School-children in Baidas study.[12] This study is the first study to report the prevalence of sleep-disordered breathing symptoms among the orthodontic population in Saudi Arabia.

Furthermore, in this study, 72 (54%) of males are at higher risk of SDB compared to 64 (42%) of females, and the difference was statistically significant *($P \leq 0.05$)*. The difference between genders in terms of risk was not found to be statistically significant in Rohra *et al.*, Krezki *et al.*, and Al-Hammad study.[4,5,8] However, our results are consistent with Baidas findings, which found Saudi boys are more affected by SDB than Saudi girls.[12] A systematic review by Lumeng and Chervin concluded that the prevalence of childhood SDB differs according to gender, with males being more commonly affected than females.[28]

According to previous studies, parents' frequent complaints regarding their child's SDB are snoring, trouble to breathe during sleep, and mouth breathing.[4,5,12] Snoring is a cardinal sign for SDB; however, the difference between primary snoring and snoring due to SDB should be recognized. Primary snoring is at the mild end of the SDB spectrum. Primary snoring is often characterized by normal snoring, but with few respiratory events (< 1 event/h), oxygen desaturation, or respiratory arousals that are formally described. Obstructive sleep apnea (OSA) is at the most extreme end of the continuum and is characterized by repeated episodes of full or partial airway obstruction resulting in oxygen desaturation and/or sleep arousal, if not full awakening.[29]

In this study, the prevalence of snoring and loud snoring was (16.2%) for snoring and (9.9%) for loud snoring among precipitants regardless of their risk assessment [Table 5]. Furthermore, there is a statistically significant difference in chronic snoring habits between the high-risk group where (20.6%) suffer from chronic snoring, and only (2.7%) of the low-risk group have chronic snoring [Table 6]. Similarly, in her study, Al-Hammad states that the percentage of chronic snoring was higher in the high-risk group compared to the control.[5] this is also consistent with previous studies that have examined snoring among Saudi

Table 5: PSQ response findings among the entire sample

Question	PSQ responses		
	Yes	No	I do not know
Snoring and apnea symptoms during sleeping			
Snores more than half time	46 (16.2%)	219 (77.1%)	19 (6.7%)
Always snores	32 (11.3%)	238 (83.8%)	14 (4.9%)
Snores loudly	28 (9.9%)	248 (87.3%)	8 (2.8%)
Have trouble breathing	56 (19.7%)	216 (67.1%)	12 (4.2%)
Heavy or loud breathing	60 (21.1%)	217 (76.4%)	7 (2.5%)
Stops Breathing	33 (11.6%)	245 (86.3%)	6 (2.1%)
Sleepiness symptoms during the day			
Mouth Breathing	102 (35.8%)	157 (55.1%)	26 (9.1%)
Dry mouth	101 (35.7%)	154 (54.4%)	28 (9.9%)
Bed wetting	46 (16.1%)	227 (79.6%)	12 (4.2%)
Unrefreshed in the morning	116 (40.7%)	156 (54.7%)	13 (4.6%)
Sleepiness during the day	77 (27.2%)	197 (69.6%)	9 (3.2%)
Teacher comments about sleepiness during class	58 (20.5%)	206 (72.8%)	19 (6.7%)
Child is hard to wake up in the morning	117 (41.21%)	168 (58.9%)	0 (0%)
Child wakes up with morning headaches	55 (19.4%)	222 (78.2%)	7 (2.5%)
Stop growing	37 (13.0%)	244 (85.6%)	4 (1.4%)
Child is overweight	64 (22.5%)	219 (76.8%)	2 (0.7%)
Behavioral symptoms			
Child is not listening when spoken to	112 (39.6%)	167 (59.0%)	4 (1.4%)
Child has difficulty in organizing tasks	85 (29.8%)	189 (66.3%)	11 (3.9%)
Child is easily distracted	91 (31.9%)	180 (63.2%)	14 (4.9%)
Child fidgets with hands	81 (28.4%)	192 (67.4%)	12 (4.2%)
Child is driven by motor	87 (30.5%)	187 (65.6%)	10 (3.5%)
Child interrupts others	87 (30.7%)	190 (67.1%)	6 (2.1%)

Table 6: PSQ response findings among high and low risk groups

Question	Groups					
	High risk group			Low risk group		
	Yes	No	I do not know	yes	no	I do not know
Snoring and apnea symptoms during sleeping						
Snores more than half time	36 (26.5%)	92 (67.6%)	8 (5.9%)	10 (6.8%)	127 (85.8%)	11 (7.4%)
Always snores	28 (20.6%)	103 (75.7%)	5 (3.7%)	4 (2.7%)	135 (91.2%)	9 (6.1%)
Snores loudly	26 (19.1%)	105 (77.2%)	5 (3.7%)	2 (1.4%)	143 (96.6%)	3 (2.0%)
Have trouble breathing	50 (36.8%)	78 (57.4%)	8 (5.9%)	6 (4.1%)	138 (93.2%)	4 (2.7%)
Heavy or loud breathing	58 (42.6%)	75 (55.1%)	3 (2.2%)	2 (1.4%)	142 (95.9%)	4 (2.7%)
Stops Breathing	30 (22.1%)	103 (75.7%)	3 (2.2%)	3 (2.0%)	142 (95.9%)	3 (2.0%)
Sleepiness symptoms during the day						
Mouth Breathing	75 (55.1%)	51 (37.5%)	10 (7.4%)	27 (18.1%)	106 (71.1%)	16 (10.7%)
Dry mouth	81 (59.6%)	45 (33.1%)	10 (7.4%)	20 (13.6%)	109 (74.1%)	18 (12.2%)
Bed wetting	37 (27.2%)	90 (66.2%)	9 (6.6%)	9 (6.0%)	137 (91.9%)	3 (2.0%)
Unrefreshed in the morning	84 (61.8%)	48 (35.3%)	4 (2.9%)	32 (21.5%)	108 (72.5%)	9 (6.0%)
Sleepiness during the day	53 (39.6%)	78 (58.2%)	3 (2.2%)	24 (16.1%)	119 (79.9%)	6 (4.0%)
Teacher comments about sleepiness during class	49 (36.0%)	72 (52.9%)	15 (11.0%)	9 (6.1%)	134 (91.2%)	4 (2.7%)
Child is hard to wake up in the morning	85 (62.5%)	51 (37.5%)	0	32 (21.5%)	117 (78.5%)	0
Child wakes up with morning headaches	46 (33.8%)	87 (64.0%)	3 (2.2%)	9 (6.1%)	135 (91.2%)	4 (2.7%)
Stop growing	29 (21.3%)	105 (77.2%)	2 (1.5%)	8 (5.4%)	139 (93.3%)	2 (1.3%)
Child is overweight	47 (34.6%)	88 (64.7%)	1 (0.7%)	17 (11.4%)	131 (87.9%)	1 (0.7%)
Behavioral symptoms						
Child is not listening when spoken to	81 (59.6%)	54 (39.7%)	1 (0.7%)	31 (21.1%)	113 (76.9%)	3 (2.0%)
Child has difficulty in organizing tasks	63 (46.3%)	65 (47.8%)	8 (5.9%)	22 (14.8%)	124 (83.2%)	3 (2.0%)
Child is easily distracted	66 (48.5%)	63 (46.3%)	7 (5.1%)	25 (16.8%)	117 (78.5%)	7 (4.7%)
Child fidgets with hands	56 (41.2%)	73 (53.7%)	7 (5.1%)	25 (16.8%)	119 (79.9%)	5 (3.4%)
Child is driven by motor	56 (41.2%)	71 (52.2%)	8 (5.9%)	31 (20.8%)	116 (77.9%)	2 (1.3%)
Child interrupts others	53 (39.3%)	77 (57.0%)	5 (3.7%)	34 (23.0%)	113 (76.4%)	1 (0.7%)

children, with Bahmmam[7] reporting the prevalence of habitual snoring being (17%) and Baidas[12] reporting (14%) prevalence among Saudi school children.

One common complaint by parents of children with SDB is trouble breathing during sleep. In this study, there is a statistically significant difference between low and high-risk groups regarding trouble breathing during sleep *($P \leq 0.05$),* where (36.8%) of the high-risk group face difficulty in breathing compared to (4.1%) of the low-risk group. The overall prevalence of troubled breathing among the two groups was (19.7%) This finding was higher than Baidas' findings, where only (8%) of the general Saudi pediatric population had trouble breathing during sleep.[12]

Huynh *et al.* found an association between mouth breathing and SDB where mouth breathing is a compensating mechanism for upper airway resistance that results from transverse skeletal discrepancies.[19] In this study, (55.1%) of the high-risk group tended to breathe from their mouth during the day, while in Al-Hammad study (92.6%) of the high-risk group tended to be mouth breathers.[5] Regardless of the risk group, sampled patients' tendency to breathe from their mouths during the day was (35.8%); this percentage was higher than the general Saudi population, with Baidas reporting a (21%) prevalence of mouth breathing tendency during the day.[12] Moreover, according to Angle, "the father of orthodontics: "mouth breathing is considered to be the most potent cause of malocclusion."[30] Therefore, early diagnosis of SDB is crucial as it allows dental physicians to prevent future malocclusion complications.[4] Transverse skeletal discrepancies resulting from maxillary constriction are associated with nasal airway resistance; therefore, maxillary expanders might reduce this resistance by widening the nasal base, improving airway volume, and enhancing nasal breathing.[31] This statement highlights the importance of general dentists and orthodontists' role where early detection and intervention improve patients' health and quality of life.

The percentage of patients that reported having dry mouth upon waking-up in our study regardless of their risk group was (35.7%), which was higher than the previous reporting (21.4%) by Baidas in the general pediatric population. In the present study, children in the high-risk group who are suffering from dry mouth were (59.6%); this percentage was higher than Al-Hammad study, which reported only (18.5%) prevalence among their study group.

Furthermore, a strong association between mouth breathing and dry mouth *($P \leq 0.05$)* was found, which was not extensively reviewed in other studies evaluating SDB among orthodontic populations.

Our result is consistent with previous literature linking xerostomia with habitual mouth breathing.[32] Dry mouth increases patients' susceptibility to developing dental decay, chronic gingivitis, and oral candidiasis because of the lack of cleansing and antimicrobial activity normally provided by saliva.[33]

Previous literature suggested that children with SDB might experience excessive day time sleepiness less than adults.[4-6] There are many reasons behind this, two of which are that children can maintain their sleep architecture with less frequent awakenings during sleep. Also, children might have a different sleepiness threshold than adults.[15,16] Remarkably, in this study (39.6%) of the high-risk group reported daytime sleepiness, which is significantly higher compared to the low-risk group. The general reporting among the two groups was (27.2%), which was slightly higher than the general pediatric population evaluated in Baidas *et al.* (24.4%).[12] However, there is a controversy regarding daytime sleepiness resulting from SDB among children and adolescents due to various survey methods used among studies.

In contrast to adults, children with SDB are hyperactive during the day when they have insufficient sleep at night. Therefore, a child might be misdiagnosed with attention deficit disorder and be treated accordingly.[10] On the other hand, other studies reported that children with attention deficit disorder had underlying SDB.[34] In this study, (30.5%) of parents of children with high SDB risk reported that their child is 'driven by a motor' or 'on the go'. Furthermore, attention deficit disorder and hyperactivity were linked to daytime sleepiness, and these symptoms depend on the type of sleep problem and the confounding factors.[3]

Some of the Sleep-disordered breathing symptoms that parents of children with SDB complain about are behavioral symptoms that might not be alarming symptoms when compared to night-time symptoms; therefore, SDB is sometimes underdiagnosed in children and teenagers.[3,5–8] Symptoms such as ease of distraction, difficulty organizing tasks and activities, and not listening when spoken to directly are signs of SDB.[3,5-7] In the present study, (59.6%) of parents of children within the high-risk group admit that their child does not listen when spoken to. Moreover, (46.3%) are having difficulty in organizing tasks, and (48.5%) are easily distracted.

When evaluating children regardless of their risk category, the percentages were lower (39.6%) of parents report that their child does not listen when spoken to, (29.8%) are having difficulty in organizing tasks. When compared to Baidas' study,[12] they reported lower percentages in their sampled population where (21.8%) Do not respond quickly when spoken to and (20.4%) are having difficulty in organizing tasks. Oddly Baidas' findings showed that children in the general population were more easily distracted (43.6%) than children in the orthodontic population in our study (31.9%).

Previous studies found an association between SDB and nocturnal anuresis.[3,5-8] Therefore, nocturnal enuresis is considered to be one of SDB symptoms. The prevalence of bedwetting in this study is (16.1%) among the entire sample. This result is comparable to BaHmmam *et al.*, where (12%) of participants experience nocturnal enuresis.[7] Surprisingly, (0%) of the high-risk group answered "yes" to bedwetting in Al-Hammad

study,[5] which contradicts the (27.2%) of "yes" responses in the high-risk group in this study.

Adenotonsillar hypertrophy is a significant determinant of sleep-disordered breathing in children.[35] Adenectomy is one of the treatment options to relieve the symptoms of patients with SDB.[36] Therefore, it is dentists' responsibility to examine their patients for Adenotonsillar hypertrophy to prevent further problems and complications.[3] In this study, Participants with previous adenoidectomy surgery were more likely to be identified as high-risk for SDB *(P-value = 0.000)* and (18.1%) of participants who undergone adenoidectomy procedure were at low risk of having SDB.

Moreover, obesity is a risk factor for SDB due to the accumulation of fat in the tongue tissue and upper airway muscles.[3,5-8] In the present study, the answer to a child's weight question depends on what parents' opinion regarding their child's weight and not on valid numeric weight measurements; therefore, 64 parents (22.5%) answered "yes" to this question, 34.6% of which were in the high-risk group. This was in contrast with Baidas' findings where only (10.5%) of parents reported that their child was overweight.[12] Dental physicians should play a role in advising parents to modify their child's eating habits and lifestyle in order to prevent serious complications and comorbidity.

Poor school achievement was linked to SDB risk where children and adolescents who are at high risk of SDB have lower academic performance than their healthy peers.[3,5-8] According to Maya *et al.* SDB might compromise the phenological process and neurocognitive abilities.[3] There was no significant difference between high and low-risk groups *(P > 0.05)* in their academic performance in the present study. This result is referred to as the fact that children have different compensatory mechanisms where they are affected differently by SDB.[37]

One of the limitations of this study is the possibility of recall-bias since this is a cross-sectional study. Also, patients who have had prior adenoidectomy surgery might present with mouth breathing habit, which would bias our findings. Therefore, they should be excluded to validate the findings.

Furthermore, there are no guidelines established yet to assess SDB in dental clinics in Saudi Arabia; hence, this study emphasizes the importance of SDB risk and complications associated with it among children seeking dental and in specific orthodontic care. We also urge the importance of implementation of SDB screening as a part of dental physicians' role in identifying high-risk patients, and proper management should be done accordingly.

We recommend a set of guidelines where patients are well screened at dental clinics and referred to sleep medicine clinics to avoid under-diagnosing and under-treating sleep disorders. For future research, polysomnography testing can be used along with PSQ to enhance clinical results' validity.

In conclusion, sleep-disordered breathing was prevalent among Saudi children seeking orthodontic therapy, it is important to screen children and adolescents in dental pediatric and orthodontic clinics for SDB risk as this is a prevalent disorder among this population, the symptoms were significantly higher in the high-risk group compared to the low-risk group. Besides clinical examination, PSQ can be an essential tool in initially recognizing patients that are high-risk during a dental examination. early detection of SDB by dental practitioners will improve patients' quality of life and prevent future complications associated to this disorder.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Key Messages

It is important to screen children and adolescents in dental pediatric and orthodontic clinics for SDB risk as this is a prevalent disorder among this population, early detection of SDB will improve patients' quality of life and prevent future complications associated with this disorder.

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Conflicts of interest

There are no conflicts of interest.

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