

Sleep Difficulties and Symptoms of Attention-deficit Hyperactivity Disorder in Children with Mouth Breathing

Ritesh Kalaskar¹, Priyanka Bhaje², Ashita Kalaskar³, Abhijeet Faye⁴

ABSTRACT

Aims and objectives: Persistent mouth breathing affects stomatognathic functions along with effects on the academics and social life of a child. Sleep-related problems and behavioral symptoms similar to that found in attention-deficit hyperactivity disorder (ADHD) can be present in mouth breathers. This study aims at assessing the sleep disturbances and pattern of symptoms of ADHD in children with mouth breathing.

Materials and methods: A cross-sectional study was carried out on 100 children of mouth breathing (consecutively selected) in 7–12 years of age using semi-structured proforma, children's sleep habit questionnaire (CSHQ), and diagnostic and statistical manual of mental disorders, version 5 (DSM 5). Statistical analysis was done using SPSS software version 21. Mean, standard deviation, Chi-square, and Pearson's correlation coefficient test were utilized during the analysis. p value of <0.05 was considered significant.

Results: Out of 100 children, 70 were males and 30 were females. On the CSHQ scale, the highest score was found on sleep-disordered breathing followed by sleep onset delay and daytime sleepiness. The commonest symptom of inattention was "failing to give close attention in school" (73%) whereas the commonest symptom of hyperactivity was "trouble waiting for his/her turn" (66%). Seven participants satisfied complete criteria for ADHD. Sleep duration and daytime sleepiness had a significant negative correlation with hyperactivity ($p < 0.05$). A positive correlation was observed between daytime sleepiness and inattention ($p < 0.01$).

Conclusion: Children with sleep disturbances or ADHD should be assessed for the presence of mouth breathing, as early identification and correction of mouth breathing may help to prevent unnecessary exposure to the medication.

Clinical significance: Children with ADHD or sleep disturbances should always be assessed for the presence of mouth breathing. Early identification and correction of mouth breathing may help in preventing unnecessary exposure to medication for treating ADHD.

Keywords: Attention-deficit hyperactivity disorder, Mouth breathing, Sleep disturbances.

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INTRODUCTION

Respiration is a vital physiologic function of the body which is usually of nasal type.¹ Oral or mouth breathing is found in children having increased nasal resistance which is usually caused by mechanical factors like tonsils hyperplasia, hypertrophy of turbinates, rhinitis, nasopharyngeal tumors, infectious diseases or inflammations, and structural changes in the architecture of the nose. It has been documented that, despite correction of these factors mouth breathing persists in the majority of cases due to habituation of such breathing. This may lead to an imbalance in facial musculature and craniofacial structure which may jeopardize the balance of stomatognathic functions.²⁻⁴

Studies have shown that altered sleep patterns and sleep apnea are common in children with persistent mouth breathing. Such children also suffer from problems such as difficulty in sustaining attention in school, easy fatigability, lethargy, and behavioral problems. These symptoms are similar to the symptoms in attention-deficit hyperactivity disorder (ADHD) leading to misdiagnosis of ADHD in many children with sleep disorders⁵⁻⁹ in mouth breathers. Literature also shows that children with breathing problems like snoring, mouth breathing, or apnea are 40–100 times more likely to develop behavioral problems resembling ADHD.⁸

As per the data of the National Sleep Foundation, ADHD may be associated with a variety of sleep problems. Parents of 25–50% ADHD children complain of sleep difficulties in these children. Inadequate sleep can affect thinking, functioning, and behavior. Sleeping problems have also been shown to induce ADHD symptoms (hyperactivity, impulsivity, and inattention).

^{1,2}Department of Pediatric and Preventive Dentistry, Government Dental College and Hospital, Nagpur, Maharashtra, India

³Department of Oral Medicine and Radiology, Government Dental College, Nagpur, Maharashtra, India

⁴Department of Psychiatry, NKP Salve Institute of Medical Sciences, Nagpur, Maharashtra, India

Corresponding Author: Priyanka Bhaje, Department of Pediatric and Preventive Dentistry, Government Dental College and Hospital, Nagpur, Maharashtra, India, Phone: +91 7709505116, e-mail: priyanka22bhaje@gmail.com

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Various reasons causing sleep disturbances in ADHD children are bedtime resistance, stimulant agents, and coexisting illnesses like primary sleep disorders, anxiety, depression, and substance abuse. Because of this, sometimes, sleep deprivation can create confusion in diagnosing ADHD in these children. Children can also show symptoms like moodiness, frequent emotional outbursts, and/or aggressiveness due to sleepiness.^{9,10}

Attention-deficit hyperactivity disorder is a common diagnosis of behavioral disturbances in children; but, many among these can have sleep-related problems due to mouth breathing and may have been misdiagnosed as ADHD. These children may therefore

receive medicinal treatment for ADHD which has cardiovascular and other side effects on the growth of children (reduction in weight or height).¹¹

The confusion may result in a significant number of ADHD cases in children, and the drugs used to treat them may only exacerbate the problem. Mouth breathing therefore should be considered in the differential diagnosis of ADHD so that appropriate or ideal treatment of mouth breathing can be considered to avoid medicinal exposure if it is a cause for ADHD symptoms. This in turn may help reduce the overall disease burden and cost of treatment in these children. It is therefore important for the dentists dealing with pediatric patients to screen, assess, and diagnose mouth breathing at the earliest, as, if treated early, the negative consequences affecting face and dental development can be avoided. It will also help in improving the medical or social problems associated with it.

The present study was planned with the aims of assessing the sleep disturbances and ADHD symptoms in children having mouth breathing along with finding the relation between them.

MATERIALS AND METHODS

This study was of the cross-sectional type carried out in a tertiary care center. After the institutional ethics committee approval, 100 children with mouth breathing in the age-group of 7–12 years were selected for participation in the study. Children visiting the department of pedodontics and preventive dentistry of a tertiary care center for various dental problems were screened for mouth breathing. Primary diagnosis of mouth breathing was done with the Water holding test, Butterfly test, Mirror test, and Rosenthal test. Out of 210 children (between 7 and 12 years of age) screened, 100 children showed a positive result for mouth breathing and were then interviewed after taking consent (assent) from their parent/family member who has accompanied the child to the hospital. Children with an already diagnosed psychiatric or neuropsychiatric disorder affecting attention and behavior were excluded from the study after the assessment by a psychiatrist. This study aimed to assess the sleep disturbances and the pattern of ADHD symptoms in children with mouth breathing along with finding the correlation between symptoms of ADHD and sleep disturbances.

The sample size was estimated based on the prevalence of sleep disturbances among mouth breathers reported in the literature which is around 50%. Calculated sample size to estimate this prevalence with 10% absolute error and 95% confidence level is 100 by using formula $n = 4pq/d^2$, where p is prevalence, q is 100 - prevalence, and d is an absolute error.

The assessment was done across the following tools.

Semi-structured Proforma

This was a self-prepared proforma including sociodemographic details, detailed case history (dental and medical) along with intraoral and extraoral examination.

Children's Sleep Habits Questionnaire

Children's sleep habits questionnaire (CSHQ) was used for assessing sleep disturbances and quality of sleep. Children's sleep habit questionnaire is a 45-item parent questionnaire (retrospective assessment) utilized for examining sleep behavior in children (young).^{12,13} It includes questions related to various sleep domains that are usually the presenting sleep complaints found in children. Sleep problems assessed are sleep onset and bedtime behavior;

duration of sleep; anxiety around sleeping; behavior observed in sleep and night waking; sleep-disordered breathing; daytime sleepiness and parasomnias. Parents are interviewed and asked to recall the sleep behaviors they observed over a "typical" recent day or week. Questions are rated on a 3-point scoring:

- "usually"—when sleep behavior occurred 5–7 times in a week.
- "sometimes"—when 2–4 times per week.
- "rarely"—0–1 time in a week.

Some items were scored in a reverse order to create a higher score consistently that would be indicative of higher sleep disturbances. For appropriate psychometric evaluation analysis, some of the items were eliminated. The remaining 35 items were then grouped into eight subscales as following sleep domains:

(1) Bedtime resistance, (2) sleep onset delay, (3) sleep duration, (4) sleep anxiety, (5) night wakings, (6) parasomnias, (7) sleep-disordered breathing, and (8) daytime sleepiness.

The total score sleep disturbance score included all 8 domains, but consisted of only 33 items as two of the items on bedtime resistance and sleep anxiety subscales are similar.¹⁴ The cut-off score of 41 has a sensitivity of 0.80 and up to 0.72 specificity.

Diagnostic and Statistical Manual of Mental Disorder 5

Diagnostic and Statistical Manual of Mental Disorder 5 (DSM V) was utilized for the assessment of ADHD symptoms like hyperactivity, inattention, and impulsivity. It is a diagnostic manual used to diagnose ADHD. It consists of nine symptoms of inattention and nine features of hyperactivity and impulsivity.

Symptoms of Inattention

- Inability to give close attention to details, makes careless mistakes in activities.
- Having trouble sustaining attention.
- Often does not seem to listen when spoken to directly.
- Frequently fails to follow through on instructions, fails to finish the schoolwork, chores, etc.
- Trouble organizing tasks and activities.
- Often avoids, dislikes, or is reluctant to do tasks that require mental effort.
- Often loses things (e.g., school materials).
- Get easily distracted.
- Is often forgetful in daily activities.

Symptoms of Hyperactivity and Impulsivity

- Fidgetiness.
- Frequently leaves the seat when remaining seated is expected.
- Runs about or climbs in situations where it is inappropriate.
- Unable to play or participate in leisure activities quietly.
- Often "on the go" acting as if "driven by a motor".
- Talking excessively.
- Often blurts out an answer before a question being completed.
- Has trouble waiting his/her turn.
- Interrupts or intrudes on others.

The study was conducted over 3 months period. Each interview required around 20 minutes. Children's sleep habit questionnaire was applied based on information from the parents. Children with difficulty in interacting because of severe dental or medical problems were excluded from the study.

Statistical Analysis

Data collected were statistically analyzed with the Statistical Package for the Social Science (SPSS version 22). Along with derivation of mean and standard deviation, Chi-square and Pearson’s correlation coefficient test were used for analysis. *p* value of <0.05 was considered statistically significant.

RESULTS

Sociodemographic profile

Out of 100 children, 70 were males and 30 were females with a mean age of 10.12 (SD ± 1.81). Class I malocclusion was found in 79% of the participants, whereas 21 % had class II malocclusion. Forty-seven percent of the mouth breather had a relevant medical history of which 32% had allergic rhinitis, 10% had tonsillitis, and 5% had other significant histories like deviated nasal septum (Table 1).

On CSHQ subscales, the mean score was highest for sleep-disordered breathing followed by sleep onset delay and daytime sleepiness. The lowest mean score was found for parasomnia (Table 2).

Among the symptoms of inattention on DSM V criteria, 73% of the children had symptoms of failing to give close attention in school, 50% of the children had trouble sustaining attention on any tasks or game activities, whereas 47% had forgetfulness in daily activities. Similarly, among the symptoms of hyperactivity in mouth breathers, 66% had trouble waiting for his/her turn, 53% had a symptom of interrupting or intruding on others, whereas 50% had a history of blurting out answers before the completion of question. The mean symptom score for inattention was 3.37 whereas that for hyperactivity was 2.86. Seven percent of the children with mouth breathing were diagnosed with ADHD as they satisfied the complete

criteria for ADHD (six out of nine features of inattention and six out of nine features of hyperactivity/impulsivity).

Symptoms of inattention were significantly lower in mouth breathers with class I malocclusion (*p* value 0.01), whereas other dentofacial factors did not have any significant correlation with symptoms of inattention (Table 3).

A statistically significant correlation was found between hyperactivity and various dentofacial factors. Hyperactivity symptoms were significantly higher in mouth breathers with increased overjet (*p* = 0.04) followed by short upper lip length (*p* = 0.02) and hypotonicity of the upper lip (*p* = 0.05) (Table 4).

On Pearson’s correlation test, a statistically significant negative association was found between the CSHQ subscale of sleep duration and daytime sleepiness with hyperactivity. More the sleep duration less were the symptoms of hyperactivity (*p* < 0.05). Similarly, more the daytime sleepiness lower was the score on hyperactivity (*p* < 0.01).

A statistically significant (positive) correlation was also found between daytime sleepiness and inattention (*p* < 0.01). That means

Table 2: Mean score of sleep disturbances, on CSHQ subscales

CSHQ parameters	Mean	SD
Bedtime resistance (BR)	1.03	0.51
Sleep onset delay (SOD)	1.39	0.69
Sleep duration (SD)	1.02	0.56
Parasomnia (PARA)	0.69	0.3
Night walking (NW)	0.9	0.7
Sleep anxiety (SA)	0.85	0.56
Sleep-disordered breathing (SDB)	1.42	0.73
Daytime sleepiness (DTS)	1.32	0.69

Table 1: Sociodemographic and dentofacial profile of mouth breather

Sociodemographic and dentofacial factors		
	Mean	SD
Age	10.12	1.81
Gender	Male	Female
	70	30
Malocclusion	Class 1	Class 2
	79	21
Facial profile	Convex	Straight
	65	35
Overjet	Normal	Increased
	42	58
Overbite	Normal	Increased
	50	50
Upper lip length	Normal	Short
	23	77
Upper lip tonicity	Normal	Hypotonic
	40	60
Lower lip tonicity	Hypertrophic	Hyperactive mentalis
	4	21
Lip competency	Competent	Incompetent
	27	71
Tongue thrust	Present	Absent
	23	77

Table 3: Correlation between the mean of symptoms of inattention and dentofacial factors

Mean of symptoms of inattention	Facial profile—convex	Facial profile—straight	<i>p</i> value
<3.37	39	22	0.77
>3.37	26	13	
	Malocclusion—class 1	Malocclusion—class 2	
<3.37	53	8	0.01
>3.37	26	13	
	Overjet—normal	Overjet—increased	
<3.37	22	39	0.13
>3.37	20	19	
	Overbite—normal	Overbite—increased	
<3.37	28	33	0.3
>3.37	22	17	
	Upper lip length—normal	Upper lip length—short	
<3.37	11	50	0.13
>3.37	12	27	
	Upper lip tonicity—normal	Hypotonicity	
<3.37	28	33	0.13
>3.37	12	27	



Table 4: Correlation between the mean of symptoms of hyperactivity and dentofacial factors

Mean of symptoms of hyperactivity	Facial profile—convex	Facial profile—straight	p value
<2.86	35	21	0.55
>2.86	30	14	
	Malocclusion—class 1	Malocclusion—class 2	0.17
<2.86	47	9	
>2.86	32	12	
	Overjet—normal	Overjet—increased	0.04
<2.86	36	20	
>2.86	6	38	
	Overbite—normal	Overbite—increased	0.68
<2.86	27	29	
>2.86	23	21	
	Upper lip length—normal	Upper lip length—short	0.02
<2.86	20	36	
>2.86	7	37	
	Upper lip tonicity—normal	Hypotonicity	0.05
<2.86	27	29	
>2.86	13	31	

the more the daytime sleepiness, the higher was the inattention (Table 5).

DISCUSSION

This study is among the very few studies in the literature that assess the relationship between sleep disturbances and ADHD in children with mouth breathing. This study showed a significant relationship between various sleep disturbances and ADHD symptoms, in children of 7–12 years. This group was considered in the present study because behavioral symptoms like inattention and hyperactivity are more evident in this age-group when children start going to school and are unable to concentrate on their studies. At the same time, sleep difficulties can also be better understood in children of this age-group as they, themselves can report sleep-related problems.

Mouth breathing, a spectrum of symptoms identified in growing children is a matter of concern for many parents. These children often suffer from learning difficulties and poor academic performance because of sleep-related obstructive breathing, altered pattern of sleeping, frequent awakening at night, and daytime sleepiness.¹⁵ In the current study, sleep-disordered breathing was the most commonly noted symptom followed by sleep onset delay, daytime sleepiness, and bedtime resistance. These findings from this study are in accordance with the reported literature which also documented dysfunction in academics and social life in these children besides having sleep difficulties.^{15–17} Persistent sleep disturbances can lead to various behavioral problems including irritability, difficulty in concentration, forgetfulness, etc. So, it can be said that mouth breathing is

Table 5: Correlation between sleep disturbances and mean of symptoms of ADHD

		Pearson's correlation	
Subscales of CSHQ		Total symptoms of inattention	Total symptoms of hyperactivity
BR	Pearson correlation	−0.077	−0.041
	p value	0.445	0.689
	N	100	100
SOD	Pearson correlation	0.051	0.033
	p value	0.611	0.744
	N	100	100
SD	Pearson correlation	−0.103	−0.227*
	p value	0.309	0.023
	N	100	100
SA	Pearson correlation	0.091	0.163
	p value	0.367	0.105
	N	100	100
NW	Pearson correlation	0.154	0.038
	Sig. (two-tailed)	0.126	0.710
	N	100	100
PARA	Pearson correlation	−0.008	−0.184
	p value	0.940	0.075
	N	95	95
SDB	Pearson correlation	−0.190	−0.005
	p value	0.059	0.957
	N	100	100
DTS	Pearson correlation	0.264**	−0.404**
	p value	0.008	0.000
	N	100	100

**Correlation is significant at the 0.01 level (two-tailed)

*Correlation is significant at the 0.05 level (two-tailed)

indirectly related to behavioral problems and many of these behavioral problems are similar to those found in ADHD, which is a common behavioral disorder in childhood. A recent study also reported impairments in reading, comprehension, arithmetic, and working memory in mouth-breathing children.¹

Mouth breathing results in non-restorative sleep due to disruptions in sleep patterns. It may lead to repeated, complete, or partial obstruction in the upper respiratory tract and cause frequent arousal during sleep. Children having frequent awakenings cannot maintain the deeper stages of sleep. This may result in persistent sleep deprivation and symptoms similar to that in ADHD, behavioral and mood problems, fatigue, daytime sedation, and worsening of scholastic performance.¹⁸ On the other hand, ADHD can cause sleep-related obstructive breathing, altered pattern of sleeping, and daytime sleepiness which has a negative impact on school performance and social life.^{19–21} In community studies with different cultures, mouth breathing and ADHD are observed together in 54 and 5–13% of children in different studies.^{1,17,22} In the current study, 7% of the mouth-breathing children full filled the complete DSM V criteria of ADHD which accurately diagnoses ADHD.^{23,24} This means there is every possibility of misdiagnosing mouth breathing as ADHD because of the similarity in behavioral symptoms. However, elimination of cause, if found, might help in managing the condition. Significant improvement in ADHD

symptoms was observed in some studies, after adenotonsillectomy which was attributed to improved oxy-hemoglobin desaturation and breathing²⁴ as mouth breathing was the possible cause for ADHD symptoms in these cases.

There is an association between sleep-related obstructive breathing, daytime sleepiness, and poor academic and social life.^{25,26} Dryness of mouth is usually observed in mouth breathing children leading to hypoxia, sleep fragmentation, frequent nocturnal arousal at night which in turn leads to behavioral problems and impacts on neurocognitive function. Other studies conducted by O'Brien et al.²⁷ and Chervin et al.²⁶ revealed that snoring and sleep apnea may cause mild inattention and daytime hyperactivity but may not be associated with the diagnosis of ADHD.

Periodic leg movements are usually observed in ADHD children.²⁶ In the current study, none of the patients found to have periodic leg movement, whereas parasomnias (type of sleep disorders involving abnormal movements, emotions, behaviors, perceptions, and dreams occurring while falling asleep, sleeping or during arousal from sleep) were least commonly found in the present study. This observation is in accordance with the reported literature.²⁷⁻²⁹

Sleep-disordered breathing is a clinical condition encompassing the problems like resistance in the upper airway, frequent snoring, and obstructive sleep apnea (OSA).³⁰ It is well-researched fact that mouth breathing is associated with adenotonsillar hypertrophy, which is the main cause of OSA among children. And many authors have documented the association of OSA with mouth breathing.

In this study, a significant correlation was noticed between sleep duration and hyperactivity. It means children with better sleep duration (total) had less symptoms of hyperactivity. This is self-explanatory, as an adequate amount of sleep without much disturbances during night sleep results in good physical and psychological relaxation. Daytime sleepiness was correlated negatively with hyperactivity which is obvious as a sleepy child cannot be hyperactive. On the contrary, daytime sleepiness was positively correlated with inattention, which means more the daytime sleepiness more was the inattention. Daytime sleepiness usually occur secondary to sleep disturbances at night. Obstructive sleep apnea, as one of the components of SDB, is a common reason for the same. Poor sleep at night can affect cognitive functions including memory and attention. Studies have shown that OSA is associated with impairments in neurocognitive functions like attention, concentration, memory, problem-solving, and behavior.³¹

A cross-sectional study on the general population done by Gottlieb et al. in 2003 found that children having SDB symptoms had significantly more daytime sleepiness along with behavioral problems like inattention, hyperactivity, and aggressiveness compared with children without symptoms of SDB.³² Huang et al. in their study done on 120 children between 6 and 12 years of age in an ADHD clinic found that a significant number of children had mild OSA.⁷ Some studies have mentioned that prepubertal children with disturbed nocturnal sleep show predominant symptoms of hyperactivity than daytime sleepiness. One study also found that both mouth breathing and ADHD can aggravate SDB, which, along with daytime sleepiness, can impair performance in school.³³

In this study, malocclusion of class I malocclusion, convex facial profile, increased overjet, hypotonic upper lip, and incompetency of lip were found as common facial/oral cavity features in participants. Literature mentions that persistent mouth breathing brings about changes in lip, tooth, and tongue position. The majority

of the studies reported class I malocclusion, convex facial profile, increased overjet, hypotonic upper lip, and incompetent lips.¹¹ The observation from the current study is in accordance with the reported literature. However, a recent study conducted by Felcar et al.³⁴ reported that persistent mouth breathing can lead to lifetime respiratory problems, skeletal class II, III malocclusion, high vault, long face syndrome, vertical and sagittal face discrepancies. The author further mentioned that jaws and palate adjust themselves to counterbalance new breathing patterns.

Many children with mouth breathing syndrome may be misdiagnosed as ADHD and are medicinally treated by a psychiatrist/pediatrician. Children may have to suffer from long-term adverse effects associated with the medication. Therefore, we suggest that children with sleep-disordered breathing, sleep disturbances, daytime sleepiness, and symptoms of ADHD should be screened for mouth breathing before diagnosing as ADHD. Early diagnosis and treatment of mouth breathing would have a positive impact on the quality of life, academic performance, and overall growth and development of a child. Besides this, the associated negative consequences on face and teeth development and social problems related to it can be prevented/reduced.

The few limitations of the study are, being a cross-sectional study carried out in a single-center, findings cannot be generalized. Follow-up study assessing the effect of alleviation of the cause of mouth breathing on sleep disturbances and behavior symptoms would yield a better result.

CONCLUSION

It can be concluded from the study that sleep-disordered breathing was commonest sleep disorder in mouth breathers, followed by daytime sleepiness and sleep onset delay whereas parasomnias were the least common. Attention-deficit hyperactivity disorder symptoms are common in children with mouth breathing. Seven children satisfied the complete criteria for ADHD. Children with better sleep duration had significantly lower hyperactivity whereas higher inattention and lower hyperactivity were associated with increased daytime sedation.

CLINICAL SIGNIFICANCE

Children with ADHD or sleep disturbances should always be assessed for the presence of mouth breathing. Early identification and correction of mouth breathing may help in preventing unnecessary exposure to medication for treating ADHD.

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