Original Article

Association of pediatric obstructive sleep apnea with poor academic performance: A school-based study from India

Abhishek Goyal, Abhijit P Pakhare[1], Girish C Bhatt[2], Bharat Choudhary[2], Rajesh Patil[2]

Departments of Pulmonology and Sleep Medicine, [1]Community and Family Medicine and [2]Pediatrics, All India Institute of Medical Sciences, Bhopal, Madhya Pradesh, India

ABSTRACT

Background: Pediatric obstructive sleep apnea (OSA) is a highly prevalent but often neglected disorder. There is paucity of reports on the prevalence of pediatric OSA from India. This study was done to estimate the prevalence of OSA in school children aged 5–10 years and its association with academic performance. **Methodology:** This school-based cross-sectional epidemiological study was conducted from July 2015 to November 2015. A questionnaire seeking information on sociodemographic variables, school performance, sleeping pattern, and a validated 22-item pediatrics sleep-related breathing disorder (SRBD) scale was distributed to 1820 pupils in three primary schools. The prevalence of OSA (defined as SRBD score >33%) was reported as proportion and its 95% confidence interval (CI). **Results:** We received 1520 questionnaires out of 1820 distributed and of which 1346 were complete and were analyzed. The prevalence of OSA among children in our study was 9.6% (95% CI: 8.1%–11.7%). On multivariate analysis, working mother (adjusted odds ratio [OR]: 1.8; 95% CI: 1.2–2.7), sleep bruxism (adjusted OR: 1.7; 95% CI: 1.1–2.6), and sleep talking (adjusted OR: 3.0; 95% CI: 1.9–4.7) were found to be independently associated with OSA. Students with positive SRBD were more prone to nocturnal enuresis (NE) (OR 3.48; 95% CI 2.27–5.26) and poor academic performance in all subjects. **Conclusion:** OSA is highly prevalent (9.6%) in Indian children. OSA is associated with NE and poor academic performance in all subjects. This study found association of maternal occupation and OSA which needs to be confirmed in larger studies.

KEY WORDS: Academic grade, nocturnal enuresis, pediatric obstructive sleep apnea, sleep-related breathing disorder

Address for correspondence: Dr. Abhishek Goyal, Department of Pulmonology and Sleep Medicine, All India Institute of Medical Sciences, Bhopal, Madhya Pradesh, India. E-mail: abhishek.pulmed@aiimsbhopal.edu.in

INTRODUCTION

Pediatric obstructive sleep apnea (OSA) is a highly prevalent but often neglected disorder due to ignorance among general physicians and pediatricians. The prevalence in children is estimated in the range of 2%–4% from western countries but data from India are lacking.[1] The prevalence is increasing and is probably underrepresented in view of pediatric obesity epidemic. Pediatric OSA is usually due to combination of anatomic factors such as adenotonsillar hypertrophy, decreased oropharyngeal dimensions, and/or obesity. Pediatric OSA has different presentation from adult OSA; it can present with hyperactivity, attention deficit, fatigability, growth retardation, enuresis, obesity, hypertension, impaired fasting glucose, and even metabolic syndrome.[2] Recently, pediatric OSA has been associated with poor academic grades.[3]

Till date, no study has been done from Indian subcontinent for prevalence and complications of OSA in children. Hence, we devised this study to find the prevalence of pediatric OSA and its association with enuresis, obesity,

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socioeconomic factors, and school grades in schoolgoing children of Central India, aged 5–10 years.

METHODOLOGY

Study type and setup

This study is part of a primary study conducted to investigate prevalence of nocturnal enuresis (NE) among school children, results of which are published elsewhere.[4] It was a school-based cross-sectional study, done in children aged between 5 and 10 years at three purposively selected schools of Bhopal, India, from July 2015 to November 2015. This study has been approved by the Institutional Human Ethics Committee AIIMS Bhopal.

Sampling procedure and data collection

We have utilized same participants of the study mentioned earlier. Sample size of that study was 1820 individuals. Reported prevalence of OSA by questionnaire method lies between 4% and 11%.[1] Required samples size to estimate prevalence of 11% with 20% relative error and design effect of 2 was 1553 participants. Thus, sample size of 1820 was sufficient for this analysis.

Class teachers were explained about study objectives, and procedures were detailed to them before initiation of the study. Anthropometry was done by teachers of the respective schools. Students were given questionnaire during their class and were instructed to get it filled by their parents. Along with questionnaire, an informed consent and participant information sheet were also provided. Questionnaire had sought information regarding sociodemographic variables, NE frequency, sleeping habits, and a 22-item pediatrics sleep-related breathing disorder (SRBD) scale. Grades in various subjects (Mathematics, Science, English, Hindi, Drawing, and Physical education) of last semester examinations were filled by parents and were checked by teachers before submission. Retrieval of the questionnaire from the students was done within 5–7 days.

Translation of sleep-related breathing disorder scale

SRBD scale was adopted from University of Michigan after permission. This scale has been validated with polysomnography for sleep-disordered breathing. Hindi translation was done after due permission. For Hindi translation, English version of questionnaire was given to five bilingual pediatricians and they were asked to translate in Hindi. The Hindi version was further backtranslated into English by another bilingual pediatrician. Any discrepancy in the two versions was then resolved by consensus. The questionnaire was then given to parents of 30 children attending pediatric OPD. They were asked to fill in questionnaire and report any ambiguity or confusion in questions. Subsequently, a final Hindi version of the scale was contrived after getting due feedback from parents. Cronbach's alpha for 22-item translated questionnaire was found to be 0.70 indicating optimal reliability.

Interpretation of sleep-related breathing disorder scale

SRBD scale contains 22 symptom items about snoring frequency, loud snoring, difficulty in breathing during sleeping, observed apneas, daytime sleepiness, inattentive, or hyperactive behavior. Each of these items was shown to correlate with OSA in children confirmed by polysomnography.[5] There are three options to answer each question in the scale – yes = 1, no = 0, or don't know = missing. The number of symptom-items endorsed positively ("yes") is divided by the number of items answered positively or negatively; the denominator therefore excludes items with missing responses and items answered as don't know. The result is a proportion that ranges from 0.0 to 1.0. Scores >0.33 are considered positive and suggestive of high risk for a pediatric SRBD and it was taken as indicator of OSA.

Statistical analyses

Data were analyzed using SPSS (version 21.0; IBM, New York, NY, USA). The prevalence is reported as a proportion with 95% confidence interval (CI). Comparison of different sociodemographic and other variables among children with and without OSA was done by Chi-square test. Univariate logistic regression analysis was performed to test association of various risk factors with OSA. Statistically significant and biologically important variables were then entered in logistic regression model to identify independent predictors of OSA. All variables were entered at the same time using ENTER model in SPSS. Hosmer–Lemeshow goodness of fit test was used for testing fit of model. $P < 0.05$ was considered as statistically significant. The results of the multivariable analysis are reported as adjusted odds ratios (ORs) with 95% CI.

RESULTS

Out of 1820 questionnaires distributed, 1528 were retrieved back, resulting in response rate of 83.95%. Out of 1528 forms, 182 (11.9%) forms were incomplete for requested information, and hence, 1346 (74%) questionnaires were finally analyzed.

Demographic characterization

Table 1 depicts association of various demographic and clinical factors with OSA.

The prevalence of OSA was 9.6% (129 out of 1346) (95% CI: 8.1% to 11.7%). OSA was more common in males (11.2% vs. 6.9%) which was significant on univariate analysis, and when multivariate analysis was done on gender as risk factor, it was borderline significant ($P = 0.052$).

Information of some variables was missing for some participants, and number of participants with information is shown in Table 1 for these variables. Since a lot of anthropometric data regarding height was missing in the received questionnaires, we could not calculate body mass index (BMI).

Literacy level of father or mother had no association with positive SRBD questionnaire (8.3% vs. 9.6%; $P = 0.796$ and 15.9 vs. 9.2%; $P = 0.065$, respectively). Although employment of father had no association with positive SRBD questionnaire (8.2% vs. 9.7%; $P = 0.663$), if mother was working, it was significantly associated with positive SRBD compared to if mother was homemaker (13.5% vs. 8.1%; $P = 0.003$, adjusted odds ratio (OR): 1.8; 95% CI: 1.2–2.7) [Table 2 and 3].

Students with positive SRBD had higher chances of sleep talking (31.7% vs. 11.2%; $P < 0.0001$, adjusted OR: 3.0; 95% CI: 1.9-4.7). Similarly, this group had higher chances of having bruxism (29% vs. 15.4%; $P < 0.0001$, adjusted OR: 1.7; 95% CI: 1.1–2.6), respectively. However, sleep walking was not found to be statistically different in individuals with positive SRBD and negative SRBD [Table 2].

Association of obstructive sleep apnea with sleep duration

Total sleep time was calculated by adding sleep time during night plus duration of naps during day (if any). Sleeping less can lead to obesity in adults and obesity leads to OSA. American Academy of Sleep Medicine has recently recommended that children from 6 to 12 years should sleep 9–12 h (including naps) in 24 h.[6] Hence, to evaluate effect of sleep duration, individuals were clubbed into two groups: who were sleeping <9 h and those sleeping more than 9 h. Individuals with positive SRBD were not statistically different in these two groups (10% vs. 8.3%; $P = 0.391$).

To find association between late sleepers and OSA, students were clubbed on the basis of their sleeping times into two groups: who sleep before 10 P.M. and those who sleep later. This time period was selected on convenient basis. Individuals with positive SRBD were not statistically different in these two groups (8.2% vs. 10.5%; $P = 0.186$).

Association of obstructive sleep apnea with academic performance and nocturnal enuresis

In children with positive SRBD, NE was seen in 30.5% (39/128) which was significantly higher than children with negative SRBD (11.2%; 132/1180; $P < 0.001$, OR 3.48; 95% CI 2.27–5.26).

When academic performance of individuals with positive SRBD was compared with those with negative SRBD, it was found to be significantly and consistently poor in the former group [Table 4]. In all subjects, students with positive SRBD questionnaire were more probable to have poorer grades than their counterparts with negative SRBD.

DISCUSSION

This study showed high prevalence (9.6%) of OSA among Indian children in age group of 5–10 years. In

Table 1: Distribution of sleep-related breathing disorder score by various sociodemographic factors

Variables	SRBD score			P
	Positive (>33%), n (%)	Negative (≤33%), n (%)	Total (n)	
All	129 (9.6)	1217 (90.4)	1346	
Age (years)				
<6	20 (8.0)	231 (92.0)	251	0.343
6-7	25 (11.3)	197 (88.7)	222	
7-8	33 (11.3)	258 (88.7)	291	
8-9	23 (8.9)	236 (91.1)	259	
9 and above	20 (13.8)	125 (86.2)	145	
Gender (n=1346)				
Male	94 (11.2)	742 (88.8)	836	0.080
Female	35 (6.9)	475 (93.1)	510	
Sleep duration (h) (n=963)				
≤9.00	41 (10.0)	371 (90.0)	412	0.391
9.01+	46 (8.3)	505 (91.7)	551	
Sleeping time (h) (n=1294)				
<22.00	37 (8.2)	412 (91.8)	449	0.186
22.00+	89 (10.5)	756 (89.5)	845	
Father (n=1346)				
Illiterate	3 (8.3)	33 (91.7)	36	0.796
Literate	126 (9.6)	1184 (90.4)	1310	
Unemployed	7 (8.2)	78 (91.8)	85	0.663
Employed	122 (9.7)	1139 (90.3)	1261	
Mother (n=1346)				
Illiterate	11 (15.9)	58 (84.1)	69	0.065
Literate	118 (9.2)	1159 (90.8)	1277	
Unemployed or Homemaker	80 (8.1)	902 (91.9)	982	0.003
Employed	49 (13.5)	315 (86.5)	364	

SRBD: Sleep-related breathing disorder

Table 2: Association of other sleep disorders with sleep-related breathing disorder

Associated sleep abnormalities	SRBD_33			P
	>33.0%, n (%)	≤33.0%, n (%)	Total, n (%)	
Sleep talking				
Yes	39 (31.7)	130 (11.2)	169 (13.2)	<0.001
No	84 (68.3)	1032 (88.8)	1116 (86.8)	
Total	123 (100.0)	1162 (100.0)	1285 (100.0)	
Sleep bruxism				
Yes	36 (29.0)	178 (15.4)	214 (16.7)	<0.001
No	88 (71.0)	976 (84.6)	1064 (83.3)	
Total	124 (100.0)	1154 (100.0)	1278 (100.0)	
Sleep walking				
Yes	3 (2.5)	23 (2.0)	26 (2.1)	0.736
No	118 (97.5)	1115 (98.0)	1233 (97.9)	
Total	121 (100.0)	1138 (100.0)	1259 (100.0)	

SRBD: Sleep-related breathing disorder

Table 3: Logistic regression analysis; dependent variable – sleep-related breathing disorder >33.0%

Variables	Univariate (unadjusted)		Multivariate (adjusted)	
	OR (95% CI)	P	OR (95% CI)	P
Male gender	1.7 (1.1-2.6)	0.008	1.5 (1.0-2.3)	0.052
Working mother	1.8 (1.2-2.6)	0.003	1.8 (1.2-2.7)	0.004
Illiterate mother	1.9 (1.0-3.6)	0.065	1.9 (0.9-3.9)	0.080
Sleep bruxism	2.2 (1.5-3.4)	<0.001	1.7 (1.1-2.6)	0.027
Sleep talking	3.7 (2.4-5.6)	<0.001	3.0 (1.9-4.7)	<0.001

OR: Odds ratio, CI: Confidence interval

Table 4: Association of obstructive sleep apnea with nocturnal enuresis and school grades

Variables	SRBD score		P
	Positive (>33%), n (%)	Negative (≤33%), n (%)	
Nocturnal enuresis			
No	89 (69.5)	1048 (88.8)	<0.001
Yes	39 (30.5)	132 (11.2)	
Total	128 (100.0)	1180 (100.0)	
Overall school grade			
A	39 (31.5)	506 (43.9)	<0.001
B	49 (39.5)	446 (38.7)	
C	24 (19.4)	168 (14.6)	
D	12 (9.7)	33 (2.9)	
Total	124 (100.0)	1153 (100.0)	
Mathematics			
A	47 (41.2)	593 (56.7)	0.003
B	42 (36.8)	324 (31.0)	
C	19 (16.7)	107 (10.2)	
D	6 (5.3)	22 (2.1)	
Total	114 (100.0)	1046 (100.0)	
Science			
A	31 (31.0)	450 (48.1)	<0.001
B	33 (33.0)	310 (33.1)	
C	24 (24.0)	151 (16.1)	
D	12 (12.0)	25 (2.7)	
Total	100 (100.0)	936 (100.0)	
Hindi			
A	42 (39.3)	551 (54.5)	<0.001
B	37 (34.6)	370 (36.6)	
C	24 (22.4)	78 (7.7)	
D	4 (3.7)	12 (1.2)	
Total	107 (100.0)	1011 (100.0)	
English			
A	47 (41.2)	604 (58.2)	0.006
B	47 (41.2)	313 (30.2)	
C	17 (14.9)	101 (9.7)	
D	3 (2.6)	19 (1.8)	
Total	114 (100.0)	1037 (100.0)	
Drawing			
A	32 (28.8)	486 (47.0)	<0.001
B	39 (35.1)	355 (34.3)	
C	31 (27.9)	158 (15.3)	
D	9 (8.1)	36 (3.5)	
Total	111 (100.0)	1035 (100.0)	
Physical education			
A	34 (35.8)	498 (56.5)	<0.001
B	43 (45.3)	295 (33.4)	
C	10 (10.5)	72 (8.2)	
D	8 (8.4)	17 (1.9)	
Total	95 (100.0)	882 (100.0)	

SRBD: Sleep-related breathing disorder

this study, boys were only marginally more prone to develop OSA compared to girls. Boys were statistically at more risk than girls for OSA on univariate analysis, although on multivariate analysis, risk reduced to near significant (*P* = 0.052). Since this study was done in school population of different strata, i.e., public and private, it was near representative of community prevalence of pediatric OSA. In various studies, the prevalence of pediatric OSA has been found to be around 2%–11%.[1] OSA has been seen to be equal in boys and girls in preadolescent children, but after puberty, there is a male predominance.

Literacy levels or occupation of parents has never been studied in relation to OSA. In our study, there was no statistically significant difference in terms of employment of father or literacy level of either parents; but interestingly, if mother was employed, it was a significant risk factor for OSA. This study is probably the first one in which association of working mother and OSA has been found. Whether this is cultural effect or it is consistent throughout world, it needs to be further confirmed in larger studies in different parts of the world.

Sleep talking is highly prevalent in children. In our study, children with positive SRBD were more probable for sleep talking. This could be effect of recurrent arousals occurring due to OSA. Whether this is occurrence of two common disorders or there is any significant association needs to be verified in larger studies.

Bruxism is stereotypical rhythmic movement of mastication muscles which leads to grinding of teeth. It is commonly aggravated by stress, gastroesophageal reflux disease, and medications; it is also now increasingly recognized to be associated with OSA. Studies have shown a positive correlation between sleep-disordered breathing and tooth grinding.[7,8] It is hypothesized that bruxism could be manifestation of increased stress level due to effect of recurrent arousals in OSA. If a child snores and history of bruxism is positive, OSA should be the first disease to rule out until proven otherwise. Sleep walking was not associated with OSA in our study although in few studies, association was found between these two diseases in children.

Nocturia is a significant complication of OSA in adults, and NE has been shown to be a complication in young children.[9-11] In our study, NE was found to be very high in students with positive SRBD (OR 3.48; 95%CI 2.27–5.26). Enuresis is postulated to be due to increased urine formation due to excess release of atrial natriuretic peptide by cardiac myocytes in response to distension. Thus, all patients of suspected OSA should be asked about history of NE and vice versa. If enuresis is due to OSA, it can be treated simply by doing adenotonsillectomy (AT). Some patients who do not respond to AT will require CPAP. In a meta-analysis of 14 studies, strong association of OSA and NE was seen; also, significant improvement in enuresis was seen in these children who underwent AT.[12]

Poor academic performance is an important complication of OSA and this could be due to cortical and sympathetic arousals and hypoxemia which affects memory consolidation.[3,13-15] In fact, academic performance has now been incorporated as a risk factor in modified version of STOP BANG-modified teen STOP-BANG questionnaire for pediatric patients.[16]

In our study, school grades were consistently poor in all subjects including Mathematics, Science, Hindi, English, Drawing, and Physical education in children with

suspected OSA (*P* < 0.01). This shows OSA's overall effect on learning, analytical, and calculating abilities, as well as on speech, language, and physical development. If a child's academic performance is going downhill, OSA should be one of the differentials, and merely asking about snoring, witnessed apnea, and sleepiness/hyperactivity can reveal the possible diagnosis.

The biggest strength of this study is that it is a school-based study, and considering higher school enrollment rates in Bhopal, it is proxy of community-based study. To the best of our knowledge, it is the first study depicting the prevalence of OSA in Indian children. Furthermore, this is the first study in which maternal occupation has been found to be associated with OSA.

The study is limited by the following:
1. Since performing polysomnography is not practical in community studies, we used SRBD questionnaire for the identifications of OSA in this study. SRBD subscale of the Pediatric Sleep Questionnaire has been shown to be both reliable and valid in identifying SDB in children in clinical research[17]
2. Although we have translated and piloted the study instrument in Hindi, there was no direct interface between parent and investigator which implies theoretical possibility of miscomprehension of some items in questionnaire
3. Since a lot of height data were missing, we could not calculate BMI, which is one of the important factors for OSA.

CONCLUSION

OSA is highly prevalent (9.8%) in Indian children. OSA leads to NE and poor academic performance in all subjects. This study found association of maternal occupation and OSA which needs to be confirmed in larger studies.

Informed consent
Informed consent was obtained from all individual participants included in the study.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) have given their consent for 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.

Conflicts of interest
There are no conflicts of interest.

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