Sleep-disordered breathing and neurobehavioral symptoms in children in a Southeast Nigerian city

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ABSTRACT

Introduction: Sleep-related breathing difficulties can lead to neurobehavioral symptoms in children. They can be assessed through validated screening questionnaires. **Objective:** This study aims to determine the prevalence of sleep-disordered breathing (SDB) among children, as well as neurobehavioral symptoms and associated risk factors. **Materials and Methods:** Descriptive cross-sectional study was conducted using the pediatric sleep questionnaire to assess sleep habits such as snoring and sleep apnea; neurobehavioral symptoms such as easy distractibility and disruptive behavior. The sample size of the study was 400 participants consecutively enrolled from consenting households in the enumeration areas in Enugu, Southeast Nigeria. Percentage prevalence of neurobehavioral symptoms was calculated, and SDB scores assigned with the determining cutoff score of >0.33. Analyses for an association of SDB score with socio-economic class (SEC), age, and gender, were performed using relevant statistics. **Results:** Of the 338 children aged between 2 and 18 years, 47% (158) were males. Children between 2 and 5 years represented 30% (101), while 59% (110) and 11% (46) were children 5–10 years and >10 years, respectively. The mean age of all participants was 6.4±3.1 years, 10% (34) belonged to SEC one while 49% (164) and 41% (139) belonged to middle and lower classes, respectively. At least one of SDB symptoms was present in 73% (248) of participants, but the SDB criteria score was met by 45 participants giving a prevalence of 13.3%. The most prevalent neurobehavioral symptoms were bed wetting in 56.8% (192), easy distractibility in 50.9% (167), and excessive day time sleepiness in 41.3% (139) cases. SDB was more likely in children with up to seven neurobehavioral symptoms, with an odds ratio of 8.27 (CI 3.48–19.66). **Conclusions:** SDB prevalence rate was found to be high in the present estimated pediatric population. The presence of seven or more neurobehavioral symptoms was associated with SDB and was predominant in children aged between 5 and 10 years.

Key words: *Children, Neurobehavioral symptoms, Nigeria, pediatric sleep questionnaire extract, polysomnography, sleep-disordered breathing*

Sleep disorders associated with difficulty in breathing during sleep are classified as sleep-related breathing disorders (SRBD) [1,2]. It can range from frequent loud snoring to obstructive sleep apnea (OSA). Reports show that snoring and OSA are frequent in children [3-5].

A standard tool for the assessment of SRBD such as polysomnography (PSG) is a time-consuming, expensive, labor-intensive, and requires technical expertise [6]. Furthermore, the SRBD scale can predict OSA-associated neurobehavioral symptoms better than PSG [7,8]. With the emergence of questionnaires, which have been validated with PSG for their efficiency and can predict the existence of sleep-disordered breathing (SDB), these SDB symptoms can be easily perceived in children. The use of tools such as the pediatric-sleep questionnaire (PSQ) as a screening methodology, which is comparable to PSG [7], is still low even in a resource-poor setting where there PSG may not be available. SDB is considered in any child whose symptoms include frequent loud snoring, gasping, snorting, and thrashing during sleep or unexplained bedwetting [9-11], increase in total sleep time with difficulty in arousal in the mornings and non-specific neurobehavioral symptoms such as hyperactivity, irritability, morning headaches, mood swings, misbehavior, and poor school performance [10]. These features ultimately affect a child's growth, development, and school performance if not identified on time and managed appropriately.

Data on the prevalence of SDB are particularly scarce in African children. Findings from a study done in a Southeastern

Nigerian city indicate that poor sleep hygiene was a regular phenomenon among children in this environment [12]. Given the related comorbidities such as neurobehavioral characteristics, early detection, and intervention are therefore essential before the attainment of school age.

This study aims to determine the prevalence of SDB among the included population, as well as to assess the neurobehavioral symptoms and associated risk factors among children in Enugu. Findings may show the need and ease of the use of validated questionnaires to quantify SDB, symptoms in the absence of formal PSG in sub-Saharan Africa, as early detection and intervention will reduce morbidity from SRBD in children.

MATERIALS AND METHODS

This was a descriptive, cross-sectional study of children aged 2–18 years, residing in Enugu urban (Southeast Nigeria). Based on a stratified multi-stage random sampling, households were selected consecutively by trained research assistants and face-to-face interviews conducted. Sampling involved all the enumeration areas (EAs) in Enugu. The sample size was determined using the formula for a limited population (i.e., EAs in Enugu) and assumed precision of 80% and ability to detect a 10% prevalence of SRBD. Using the geographically stratified sample of households, proportionate to the Enugu population (based on the Nigeria 2006 census and projected data from the National Population Commission), the EAs (with an average of about 37 households) were calculated for urban areas using a population of 722,664 in Enugu urban. The families in Enugu EAs became the primary sampling unit for this study, and from them, individual families were randomly selected.

The initial sample size calculation of 400 included all children below the age of 18 years. The eventual analyses excluded children <2 years as specified by the validated questionnaire design. Enrolment was based on parental consent for every healthy child <18 years of age. Households that refused permission were excluded, as well as children with parent-reported neurological problems which could affect general sleep quality such as children with cerebral palsy. Following permission from the developers, the pre-tested, interviewer-administered and validated extract from the PSQ (SRBD subscale-070129) were used. Following a pre-testing, its Cronbach's alpha coefficient (coefficient of reliability/consistency) was determined to be 0.73; thus, internal consistency was in keeping with that stipulated by the designers for its accuracy (0.47–0.68).

The SRBD questionnaire consists of 22 closed response question-items, a validated segment of the PSQ. The questions comprised information on disorders of breathing occurring during sleep and how this may affect day-to-day home and school activities, and inquiry about snoring history, breathing difficulties while asleep, witnessed sleep apnea, mouth breathing, post-sleep dry mouth, enuresis, insomnia, daytime somnolence, poor sleep quality, morning headaches, growth problems, attentiveness, self-organization, distractibility, fidgetiness, hyperactivity, and interruptive behavior.

To capture specific symptoms, the components/symptom groups studied (from the questionnaire) were grouped into severity levels using total number of symptoms present in each child and thus presence of 0 symptoms, 1–3 symptoms/components, 4–6, and 7 or more SDB symptoms were categorized as no SDB, mild SDB, moderate SDB, or severe SDB. Furthermore, the 22 items in the questionnaire are each answered "yes" = 1, "no" = 0. The number of symptom-items endorsed positively ("yes") was divided by the number of items answered positively or negatively. A result is a number or a proportion that ranges from 0.0 to 1.0. The validated cutoff score was 0.33 (composite score criteria), and thus scores >0.33 were considered positive and suggestive of high risk for a pediatric SRBD. This cutoff was used in this study to decide which child had enough symptoms to qualify for the diagnosis of SDB [13-20]. Socio-economic class (SEC), age, and gender were also obtained to ascertain any effects on sleep hygiene and the various components of SDB.

Ethical approval was obtained from the Health Research and Ethics Committee of the Enugu State University Teaching Hospital (ESUTH) Enugu (NHREC identification number: ESUTHP/CMAC/RA/034/158), before the commencement of the study. Individual consent from caregiver/assent from children older than 7 years was obtained. The enrolled children's ages were grouped into 2–<5 years (preschool), 5–10 years (school age), and above 10 years (adolescent) to help in interpreting the age-appropriate responses to the reported SDB symptoms. Socio-economic status was determined by modified validated methods described by Ogunlesi *et al*. [21] using parental level of education and type of current job used to earn a living [21], and these were categorized into lower Class 3 (SEC 4 and 5), middle Class 2 (SEC 2 and 3), and upper Class 1 (SEC 1).

Statistical Analysis

Data collected were entered and analyzed using IBM®SPSS version 20.0 (SPSS Inc., Chicago, IL). Chi-square goodness of fit was used to determine the relationship of the variables to the normal population dispersion. Inferential statistics were conducted using Chi-square/Fisher's exact tests, and Spearman correlation statistics were applied as appropriate to determine the association between the presence of SDB, and severity (outcome variables), and predictor variables: SEC, gender, age, and age group. Correlation analysis and cross tabulation were done between total SDB score and all composite components assessed. Student *t*-test for independent samples was used to determine between-group differences in total and subscale sleep scores. Multivariate logistic regression was used to analyze the extent to which socio-demographic parameters predicted SDB in the children surveyed. Measures of association were presented as odds ratios (OR) and 95% confidence intervals (95% CI). Statistically, the significant value was set at $p \leq 0.05$.

RESULTS

A total of 338 children from consenting household were recruited; ages between 2 years and 18 years, 47% (158) of whom were males (Table 1). By age categorization, there were 30% (101) aged between 2 and 5 years; while 59% (110) and 11% (46) were between 5 and 10 years and >10 years, respectively. The mean age of all participants was 6.4±3.1 years, while 10% (34) belonged to SEC 1 while 49% (164) and 41% (139) belonged to middle and lower SEC classes, respectively. Of all participants, a minimum of one of the SDB symptoms was present in 73% (248) of children (Table 1). The mean of reported neurobehavioral symptoms was 7.5±2. The mean SDB score for children who met the 0.33 criteria was 1.29±0.29 (Table 2).

The SDB composite criteria score required for the diagnosis of SDB was met by 45 participants giving a prevalence rate of 13.3%. Using the component severity scoring, 57.1% (193) had no or mild SDB symptoms, while 29.6% (100) and 13.3% (45) had moderate and severe symptoms, respectively. Table 3 represents the prevalence of SDB and its various components. The most prevalent neurobehavioral symptoms were enuresis in 56.8% (192), easily distractibility 50.9% (167), excessive day time sleepiness 41.3% (139), dry mouth 28.4% (96), mouth breathing 27.8% (94), disruptiveness 23.1% (78), and snoring 19.2% (65).

The age bracket with a higher proportion of neurobehavioral symptoms was observed in children between 5 and 10 years old; the higher the age, the more severe, the SDB symptoms (χ^2 39.76, p=0.01). Being female was an important but not significant factor associated with positive SDB symptoms, (p=0.07). Furthermore, the age of the child, the gender and SEC were not significantly different between those positive for SRDB (score >0.33) and those who did not have SRDB (Table 4). Multivariate regression, however, showed those children who had seven SDB components and those with ≥8 SDB components were respectively eight times and 325 times more likely to develop SRDB, compared to those with fewer symptoms (Table 5). This retained significance after adjustments were made for other study variables.

DISCUSSION

In the present study, the prevalence of SDB was estimated to be 13.3%. This prevalence is comparable to the pediatric SDB prevalence of 11.0% reported by Archbold *et al*. in the United States. In the same study, a higher prevalence rate of 29% and

Table 1: Demographic characteristics of study participants

Characteristic	Variable	Number of participants (n)	Percentage (%)
Age (years) (n=338)	2 to <5	101	30
	5 to 10	110	59
	>10	46	11
Gender (n=338)	Male	158	47
	Female	180	53
Socio-economic class (n=338)	High	34	10
	Middle	164	49
	Low	139	41
Presence of clinical parameters of SDB* (n=338)	Yes	248	73
	No	88	27
Total clinical parameters encountered in study participants with SDB* (n=248)	1	34	14
	2	29	12
	3	37	15
	4	37	15
	5	39	16
	6	25	10
	7	24	10
	8	14	6
	>8	9	2

***Sleep-disordered breathing, SDB: Sleep-disordered breathing, SEC: Socio-economic class**

Table 2: Age and SDB scores of children with SDB

Parameters	Mean±SD	Standard error	Minimum value	Maximum value	Skewness statistics
Age (years)	6.4±3.1	0.48	2.00	17.0	1.3
Number of SDB parameters	7.5±2.0	0.30	1.00	11.0	–1.1
Total SDB Score	1.13±0.33	0.02	0.00	1.00	2.2
Children with the criteria cutoff ≤0.33	1.16±0.37	0.03	0.00	0.33	1.9
Children with the criteria cut off >0.33	1.29±0.29	0.02	0.35	1.00	2.8

SDB: Sleep-disordered breathing, SD: Standard deviation

Table 3: Prevalence of various clinical parameters of SDB in study participants

Clinical parameters of SDB assessed	Frequency(n)	Total (n)	Prevalence (%)
Snores half of the time in the night	65	338	19.2
Snores always during sleep	19	338	5.6
Loud snores while sleeping	16	338	4.7
Deep breath while sleeping	21	338	6.2
Breathes with mouth during sleep	94	338	27.8
Breathes with difficulty during sleep	12	338	3.6
Stops breathing sometimes while sleeping	1	338	0.03
Difficulty to wake up from sleep	28	338	8.3
Wakes from sleep with dry mouth	96	338	28.4
Wakes up from sleep unrefreshed	26	332	7.8
Wakes up from sleep with a headache	8	321	2.5
Wets bed during sleep	192	338	56.8
Sleeps excessively during the day	139	337	41.3
The teacher complains of daytime sleep	11	335	3.3
Non-attentiveness	53	338	15.7
Always on the go	1	333	0.03
Easily distracted	167	328	50.9
Fidgets	4	338	1.2
Disruptiveness	78	338	23.1
Un-organized	28	338	8.2
Overweight	4	338	1.2
Poor growth	5	338	1.5

SDB: Sleep-disordered breathing

Table 4: Assessment for predictors of SDB

Characteristic	Variable	Participants with SDB criteria score			$\chi 2$
		≤0.33 n (%)	>0.33 n (%)	Total n (%)	p-value*
Age (years)	2–<5	86 (29)	15 (36)	101	0.768
	5–10	174 (59)	23 (55)	197	0.681
	>10	34 (12)	4 (9)	38	
Gender	Male	132 (45)	25 (60)	157	3.158
	Female	162 (55)	17 (40)	179	0.076
Socio-economic class	High	30 (10)	5 (12)	35	0.529
	Middle	142 (48)	22 (52)	164	0.768
	Low	122 (42)	15 (36)	137	
Number of SBD parameters encountered	1–3	97 (47)	3 (7)	100	146.7
	4–6	98 (48)	3 (7)	101	0.001
	≥7	11 (5)	36 (86)	47	

***Yates correction applied where appropriate, SDB: Sleep-disordered breathing, SEC: Socio-economic class**

Table 5: SDB diagnosis and its association with total number of clinical parameters obtained

Number of SDB parameters	Frequency	Presence of SDB		Likelihood ratio
	Total (n)	No (n)	Yes (n)	OR (95% CI)
0	88	88	0	0.04 (0.002–0.64)
1	34	33	1	0.21 (0.03–1.60)
2	29	29	0	0.12 (0.07–1.96)
3	37	36	1	0.19 (0.03–1.46)
4	37	35	1	0.20 (0.03–1.50)
5	39	38	1	0.18 (0.02–1.37)
6	25	23	2	0.61 (0.14–2.68)
7	24	11	13	8.27 (3.48–19.66)
≥8	23	0	23	325.68 (19.42–546.1)

SDB: Sleep-disordered breathing, OR: Odds ratios, CI: Confidence intervals

21% was documented among children with neurologic diseases (such as cerebral palsy) and non-infectious respiratory disorders, respectively [22]. The high prevalence of SDB in children with neurologic diseases may be due to multifactorial etiology related to their dysfunctional airway breathing and impaired cerebral control [23-26]. Children with neurological disorders were however not included in the current study.

Another study which used the interviewer-administered PSQ on children of age between 2 and 6 years reported a comparable but lower SDB prevalence rate of 9.4% [27]. The current study, however, used the SRDB subscale (an extract of the PSQ) as the investigative tool for a study population whose age range spanned from 2 years to adolescence: thus, incorporating those who were most at risk of SDB. More importantly, the current study-population consisted of indigenous black subjects. In general, the black race is a risk factor for SDB [28].

Factors reported in blacks that place them at higher risk include increased body mass index, higher obesity risk and increased neck circumference [29]. In another work by Rudnick *et al*., demographic variables in children confirmed that African-American children in the SDB group were more likely to be obese [30]. Perhaps, these factors may account for our finding of a slightly higher SDB prevalence rate. In comparison to the current study, a much lower SDB prevalence rate of 1.3% was reported among only primary school children in another region of the United States [31]. This wide disparity may be because the study population comprised older children whose age group meant less susceptibility to SDB. Furthermore, ethnic variations could be a contributory factor, as Negroid and Hispanic children constituted only a small percentage of that study population [31].

Preschool-aged children are generally more susceptible to SDB. Another study in Kentucky, United States further confirmed this observation; the authors reported that as many as 22% of preschoolers were at risk for SDB [32]. In a more extensive study on sleep-related habits which included infants (mean age 64.27±9.3 months), SDB prevalence was 36%. This comparatively higher prevalence may be due to the inclusion of infants and the authors' use of a more comprehensive questionnaire (children's sleep habits questionnaire) [33]. Confounding factors to that study may include natural sleep habits of infants which may overlap with some symptoms of SBD.

Nocturnal enuresis was the most prevalent symptom experienced by the present study population. The high number of cases of nocturnal enuresis may be related to the increased night-time urine production associated with SDB, and the resultant bed-wetting [17,18]. Enuresis is prevalent in up to 15% of healthy children [19], but when it occurs in addition with other comorbidities such as snoring or restless sleep, in a child older than 5 years when most children have achieved dryness, it can be considered as a vital indicator for SDB [19,20].

Other prevalent symptoms were easily distractibility, drowsiness, dry mouth, mouth breathing, disruptiveness, and snoring and this was in tandem with the findings of previous studies [16,17]. Interestingly, loud snoring was reported to be the most apparent symptom-component of SDB by the American Academy of Otolaryngology [18]. On the contrary, a lower snoring prevalence of 13.9% was reported in Brooklyn, the United States among preschool-aged children (Caucasians, Hispanics, and Blacks) using a similar investigative tool [28]. Nevertheless, the black race as an independent predictor of snoring may have accounted for the higher snoring prevalence documented in the current study. Within the West African sub-region, Ofovwe *et al*. also reported a snoring incidence of 16.0% among children with inattention and hyperactivity who were aged 2–13.9 years [24]. Growth parameters, comorbid attention-deficit/hyperactivity disorder or autism spectrum disorder are also predictors of sleep disorders, which vary according to developmental age group [34].

Sleep apnea was the least frequent component of sleep disorders in the current study. Caregivers were required to be observant to report this component in a questionnaire-based survey, mainly if it occurs during night sleep. Thus, poor parental vigilance, which was not explicitly investigated in this study, may have accounted for the low prevalence of sleep apnea in the study population. A previous study in the mid-western part of Nigeria documented snoring; daytime sleepiness and restlessness during sleep as the common sleep disorders in children with neurologic disorders, although there was no report of SDB prevalence in these children [24]. However, Ram *et al*. in the United States reported higher sleep apnea prevalence of 4.2% among the study population which included Hispanics and Blacks [17].

Among the SDB behavioral symptoms observed in the current study, inattention and disruptive behavior were significantly prevalent in school-age children. The high prevalence of these symptoms is not surprising as poor sleep hygiene leads to lack of concentration with resultant poor school performance [35]. The finding of difficulty in waking up from sleep, seen in children <5 years, is probably more physiologic as the toddler sleep-cycle may still be in the transition phase from infancy, and thus may not be related to SDB.

The present study also evaluated the possible risk factors for SDB in the subjects. Socio-demographic variables such as age, gender, school grade, and the SEC had no significant association with SDB when those with SDB score >0.33 were compared with those <0.33. In contrast, other authors found a meaningful relationship with the male gender [28]. Besides, low socio-economic status was noted as a risk factor by other investigators [36]. We, however, indicated that the presence of seven or more SDB symptom was consistently indicative of having SRDB. The use of this amalgamated scoring can thus be useful in places without the PSG equipment.

The current study depended on a face-to-face interview as it was questionnaire-based, and this may have introduced bias to the reported outcomes. Using formal PSG to validate, the obtained scores would have strengthened the conclusions of the present study. PSG was however not available in the locality and was

cumbersome for a community-based survey which was the present study design. Furthermore, the validated SDB questionnaire was comparable to findings using the standard PSG, and as a screening tool, it helps to identify children who will eventually require a full PSG study.

CONCLUSIONS

Sleep-related behavioral symptoms are prevalent in the present study population and children with higher SDB scores. Use of the SRBD questionnaire remains a veritable tool to diagnose SDB where PSG is not available. Further studies are also needed to differentiate the respiratory symptoms peculiar to the different pediatric age groups.

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REFERENCES

1. Jennum P, Riha RL. Epidemiology of sleep apnoea/hypopnoea syndrome and sleep-disordered breathing. Eur Respir J 2009;33:907-14.
2. White DP. The pathogenesis of obstructive sleep apnoea: advances in the past 100 years. Am J Respir Cell Mol Biol 2006;34:1-6.
3. Franklin KA, Lindberg E. Obstructive sleep apnea is a common disorder in the population-a review on the epidemiology of sleep apnea. J Thorac Dis 2015;7:1311-22.
4. Abdullah AA, Jamalludin AR, Norrashidah AW, Norzila MZ, Kassim KA, Anida AR, *et al.* Prevalence of sleep disordered breathing symptoms among malay school children in a primary school in Malaysia. Med J Malaysia 2012;67:181-5.
5. Gislason T, Benediktsdottir B. Snoring, apneic episodes, and nocturnal hypoxemia among children six months to 6 years old: An epidemiologic study of the lower limit of prevalence. Chest 1995;107:963-6.
6. Agarwal R, Gotman J. Digital tools in polysomnography. J Clin Neurophysiol 2002;19:136-43.
7. Chervin RD, Hedger K, Dillon JE, Pituch KJ. Pediatric sleep questionnaire (PSQ): Validity and reliability of scales for sleep-disordered breathing, snoring, sleepiness, and behavioral problems. Sleep Med 2000;1:21-32.
8. Chervin RD, Weatherly RA, Garetz SL, Ruzicka DL, Giordani BJ, Hodges EK, *et al.* Pediatric sleep questionnaire: Prediction of sleep apnea and outcomes. Arch Otolaryngol Head Neck Surg 2007;133:216-22.
9. DeHaan KL, Seton C, Fitzgerald DA, Waters KA, MacLean JE. Polysomnography for the diagnosis of sleep disordered breathing in children under 2 years of age. Pediatr Pulmonol 2015;50:1346-53.
10. Flemons WW, Douglas NJ, Kuna ST, Rodenstein DO, Wheatley J. Access to diagnosis and treatment of patients with suspected sleep apnea. Am J Respir Crit Care Med 2004;169:668-72.
11. Verhulst SL, Aerts L, Jacobs S, Schrauwen N, Haentjens D, Claes R, *et al.* Sleep-disordered breathing, obesity, and airway inflammation in children and adolescents. Chest 2008;134:1169-75.
12. Orji ML, Anyanwu OU, Ibekwe R, Onyire NB. Sleep hygiene of children in Abakaliki, Ebonyi state, Southeast Nigeria. Sahel Med J 2017;20:98-101.
13. Athayi S, Omidi R, Athari SS. The effect of using raw and cooked garlic in daily food on sleeping of asthmatic patients. Am Eurasian J Toxicol Sci 2015;7:43-6.
14. Alnaji F, Zemek R, Barrowman N, Plint A. PRAM score as predictor of pediatric asthma hospitalization. Acad Emerg Med 2014;21:872-8.
15. Barnes K. Genetics of Asthma; 2014. Available from: http://www.uptodate.com. [Last accessed on 2018 Aug 15].
16. Kheirandish-Gozal L, Gozal D. Obesity, asthma, and sleep-disordered breathing. J Pediatr 2012;160:713-4.
17. Ram S, Seirawan H, Kumar SK, Clark GT. Prevalence and impact of sleep disorders and sleep habits in the United States. Sleep Breath 2010;14:63-70.
18. American Academy of Otolaryngology-Head and Neck Surgery. Pediatric Sleep Disordered Breathing/Obstructive Sleep Apnea; 2017. Available from: http://www.entnet.org/content/pediatric-sleep-disordered-breathingobstructive-sleep-apnea. [Last accessed on 2017 Oct 20].
19. Bascom A, Penney T, Metcalfe M, Knox A, Witmans M, Uweira T, *et al.* High risk of sleep disordered breathing in the enuresis population. J Urol 2011;186:1710-3.
20. Stone J, Malone PS, Atwill D, McGrigor V, Hill CM. Symptoms of sleep-disordered breathing in children with nocturnal enuresis. J Pediatr Urol 2008;4:197-202.
21. Ogunlesi AT, Dedeke IO, Kuponiyi OT. Socio-economic classification of children attending specialist pediatric centers in Ogun state, Nigeria. Nig Med Pract 2008;54:21-5.
22. Archbold KH, Pituch KJ, Panahi P, Chervin RD. Symptoms of sleep disturbances among children at two general pediatric clinics. J Pediatr 2002;140:97-102.
23. Sinha D, Guilleminault C. Sleep disordered breathing in children. Indian J Med Res 2010;131:311-20.
24. Ofovwe GE, Ofovwe CE, Okunola P. Prevalence and pattern of sleep disorder among children with neurological diseases in university of Benin teaching hospital, Benin city, Nigeria. Nig J Paediatr 2012;39:14-7.
25. Quine L. Sleep problems in children with mental handicap. J Ment Defic Res 1991;35:269-90.
26. Zucconi M, Bruni O. Sleep disorders in children with neurologic diseases. Semin Pediatr Neurol 2001;8:258-75.
27. Rajna P, Veres J. Correlations between night sleep duration and seizure frequency in temporal lobe epilepsy. Epilepsia 1993;34:574-9.
28. Goldstein NA, Abramowitz T, Weedon J, Koliskor B, Turner S, Taioli E, *et al.* Racial/ethnic differences in the prevalence of snoring and sleep disordered breathing in young children. J Clin Sleep Med 2011;7:163-71.
29. Blondet M, Yapor P, Latalladi-Ortega G, Alicea E, Torres-Palacios A, Rodríguez-Cintrón W, *et al.* Prevalence and risk factors for sleep disordered breathing in a Puerto Rican middle-aged population. Sleep Breath 2009;13:175-80.
30. Rudnick EF, Walsh JS, Hampton MC, Mitchell RB. Prevalence and ethnicity of sleep-disordered breathing and obesity in children. Otolaryngol Head Neck Surg 2007;137:878-82.
31. Rosen CL, Larkin EK, Kirchner HL, Emancipator JL, Bivins SF, Surovec SA, *et al.* Prevalence and risk factors for sleep-disordered breathing in 8 to 11-year-old children: Association with race and prematurity. J Pediatr 2003;142:383-9.
32. Montgomery-Downs HE, Gozal D. Sleep habits and risk factors for sleep-disordered breathing in infants and young toddlers in Louisville, Kentucky. Sleep Med 2006;7:211-9.
33. Ozgoli G, Sheikhan Z, Soleimani F, Nasiri M, Amiri S. Prevalence of sleep disorders among children 4-6 years old in Tehran province, Iran. Iran Red Crescent Med J 2016;18:e22-52.
34. Chervin RD, Archbold KH, Dillon JE, Panahi P, Pituch KJ, Dahl RE, *et al.* Inattention, hyperactivity, and symptoms of sleep-disordered breathing. Pediatrics 2002;109:449-56.
35. Mirghani HO, Mohammed OS, Almurtadha YM, Ahmed MS. Good sleep quality is associated with better academic performance among sudanese medical students. BMC Res Notes 2015;8:706.
36. Chervin RD, Clarke DF, Huffman JL, Szymanski E, Ruzicka DL, Miller V, *et al.* School performance, race, and other correlates of sleep-disordered breathing in children. Sleep Med 2003;4:21-7.

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