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Sleep Profiles in Children with Down Syndrome

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Abstract

Down syndrome (DS) is the most common genetic cause of intellectual disability and results from an extra chromosome 21 (Trisomy 21). Sleep issues and/or obstructive sleep apnea (OSA) are assumed to be part of the DS phenotype with a high prevalence but are often under recognized. This cross-sectional study of children with DS examines the caregiver reported sleep behaviors of 108 children with DS, ranging in age from 1.50 to 13.40 years (mean = 5.18 years) utilizing a standardized assessment tool, the Children's Sleep Habit Questionnaire (CSHQ). The CSHQ revealed 76% of children with DS had sleep problems, which began at a young age, and continue to persist and may recur with increasing age. Furthermore, children with DS who undergone adenoid and tonsillectomy for OSA continued to have sleep problems suggesting that ongoing monitoring of sleep issues is needed in this population. Implications of sleep problems and recommended anticipatory guidance and intervention are discussed.

Keywords

Down syndrome; obstructive sleep apnea; health screening

INTRODUCTION

Down syndrome (DS, OMIM #190685) is the most common genetic cause of intellectual disability, with an incidence of 1 in 691 live births [Parker et al., 2010]. In general, sleep problems occur more frequently in children with intellectual disability compared to typically developing population [Didden et al., 2002; Harvey & Kennedy, 2002; Krakowiak et al., 2008]. In children with intellectual disability, sleep issues commonly noted are disturbances initiating and maintaining sleep, night awaking, excessive daytime sleepiness, and sleep disordered breathing. In addition to the intellectual disability, children with DS have craniofacial findings, including midfacial hypoplasia, narrow nasopharynx, micrognathia, small larynx, and hypotonia leading to floppiness of the upper airways, that increase their risk of having sleep disordered breathing issues, particularly obstructive sleep apnea (OSA)

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[Shott, 2006]. The prevalence of OSA is seen in only 1% to 4% of the general pediatric population, but increases to 30–63% among individuals with DS [Stebbens et al., 1991; Rosen et al., 2011].

Sleep is essential to the development in children and the parent-child dynamic. There is a link between sleep problems and/or OSA to health complications (e.g., obesity), parental stress, and neurocognitive, behavioral, and learning deficits in the typically developing population [Miano et al., 2011; Witmans et al., 2011]. These issues may become more pronounced for children with developmental and cognitive impairment such as DS. Yet, sleep issues are often under recognized by physicians and parents because they underestimate these problems and/or assume that they are part of the DS features. For instance, approximately 69% of parents reported that their child with DS did not have sleep issues, but 57% had an abnormal polysomnogram [Shott et al 2006]. For these reasons, the American Academy of Pediatrics Health Supervision for Children with DS currently recommends that physicians discuss symptoms of OSA that could be associated with poor sleep at every well-child visit, and all children with DS receive a polysomnogram by the age of 4 years [Bull, 2011].

Despite the high prevalence of sleep issues and/or OSA in children with DS, there have been limited studies examining the pattern of sleep problems in young children with DS. Furthermore, the extent of sleep problems and how they change with age have not been appropriately studied in children with DS due to small sample sizes, lack of standardized measures to evaluate sleep, and inadequate follow-up for children [Shott et al., 2006; Rosen, 2011; Rosen et al., 2011]. Our study examines the sleep profiles, across age groups as well as the impact of previous adenoid and tonsillectomy (AT) on sleep patterns in children with DS. Additionally, we also compare sleep problems in our DS cohort to a cohort of typically developing US children [Liu et al., 2005].

MATERIALS AND METHODS

Subjects

Subjects included 108 children with DS (52 boys, 56 girls) ranging in age from 1.50 to 13.40 years, with a mean age of 5.18 years (standard deviation [SD] = 2.47). Subjects consisted of 65% Caucasian, 25% African American, 6% Hispanic, and 4% Asian. No sleep medications were reported. The comparable cohort of typically developing US children is from the study by Liu et. al [2005].

Procedures

The study was a retrospective chart review of children with DS who were evaluated at the DS Clinic at Emory University from 2013–2014. As part of the clinic visit, parents typically complete the Children's Sleep Habit Questionnaire (CSHQ) [Owens et. al., 2000]. The abbreviated CSHQ consists of 33 questions that has been validated and widely used to assess sleep in children. The caregivers were instructed to reflect on the past week of sleep when completing the questionnaire. Eight subscales can be derived from the items: Bedtime Resistance, Sleep Onset Delay, Sleep Duration, Sleep Anxiety, Night Wakings,

Parasomnias, Sleep Disordered Breathing, and Daytime Sleepiness. The internal consistency for each of the subscales was high with all α coeifficients above 0.98.

Each of the 33 items on the questionnaire were rated on a 3 point Likert scale: If the behavior occurred 0–1 nights per week, “rarely” would be marked and a score of (1) would be given for that behavior. Similarly, if the behavior described occurred 2–4 nights per week, “sometimes” would be marked and a score of (2) would be given, and if the behavior occurred 5–7 nights per week, “usually” would be marked and a score of (3) would be given. The scores for each of the 33 questions would be summed to find the total CSHQ score with the higher scores representing more sleep problems. A cut off score of 41 yields the best diagnostic confidence for identifying clinically significant sleep problems. In addition, we considered any item on the scale clinically significant if greater than 20% of responders marked a (2) or (3).

Statistics

Data from the demographic information were analyzed using descriptive statistics. For the different variables as indicated in Tables 1 and 2, descriptive statistics, including mean, range, and standard deviations of each continuous variables, were computed using SAS, version 9.1 software (Cary, NC), allowing for inspection and direct comparison. Pearson chi-square test was used to compare sample characteristics.

RESULTS

Sleep Problems and Impact of adenoid and tonsillectomy (AT)

A total of 108 CSHQ questionnaires were completed by parents. With a clinically significant cut off score of 41, the average CSHQ score was 50, with a range of 34–73. Clinically significant sleep problems were noted in 76% of our cohort including restless sleep and constant movement during sleep.

In our sample, 53 subjects did not have a diagnosis of OSA (DS-OSA) and 55 subjects had undergone previous AT for OSA (DS+OSA). The diagnosis of OSA was confirmed by the polysomnogram, and parents completed the CSHQ after the AT for the DS+OSA group. The average CSHQ score for the DS-OSA (mean age 4.41 years) was 49 with a range of 34–73 compared to an average score of 50 with a range of 38–73 for the DS +OSA group (mean age 5.94 years).

By using 41 as the cut off score for identifying children with clinically significant sleep problems, 78% of the DS+OSA group and 74% of the DS-OSA group had clinically significant sleep problems. As indicated in Table 1, 29 items were found to be significant (>20% of caregivers marking (2) or (3)) in the DS+OSA group, and 23 items were found to be significant in the DS-OSA group. By using the Pearson chi-square analysis,”falling asleep while watching television” was significantly different between the two cohorts with a *p* value of .005; only 15% of the DS+OSA group caregivers considered this a significant problem, while 35% of the DS-OSA group considered this a significant problem.

Age progression Analysis in Children with DS

The 108 participants were divided by age into 3 groups: ages 1–3 (n=32), ages 4–7 (n=58), and ages 8–13 (n=18). Pearson chi-sqaure analysis identified that with increasing age, children with DS begin to fall asleep in their own bed, p=.026, less frequently awakening, screaming/sweating, p=.024, and less frequently fall asleep when riding in a car p=.043, but become more afraid to sleep in the dark p=.013 (Table 2).

Additionally, there were 5 items that improved with increasing age. For example, children had less trouble sleeping away, p= .047 (Age group 1 to 2), less frequently awakened screaming and sweating, p = .006 (Age group 1 to 2), less frequently fell asleep while riding in a car, p=.018 (Age group 1 to 3) and p=.022 (Age group 2 to 3), and less frequently had trouble falling asleep in their own bed, p=.012 (Age group 2 to 3). Although the problem of bed wetting did improve, p=.038 (Age group 1 to 2) and p= .018 (Age group 1 to 3), the highest age range of 8+ still had bed wetting listed as a significant problem in 28% of the population which still represents a significant sleep problem.

Some items that do not significantly change between age groups included: “needs parent in room to sleep”, “moves to other's bed in the night”, “awakes one or more than once during the night”, “seems tired during the day”, and “others wake the child” (Table 2). Notably, items related to OSA including, “snoring”, “snorts and gasps”, and “restess” remain to be a persistent sleep problems as reported by the caregiver.

Sleep problems in a typical pediatric population compared to DS population

Liu et. al. [2005] used the CSHQ to compare sleep patterns in school-age children in China (N=292) and the United States (N=415). Only 13 significant items were found in the United States population, while 26 items were found to be significant in our DS participants (N=108). When we compared the 13 significant items in the typical pediatric population from this study, 9 items were found to be statistically different (p <.01) with 6 of those items showing the higher prevalence in the DS population. It is also important to note that problems parallelling symptoms of OSA such as “snoring” and “snorts and gasps” were not prevalent in the typical pediatric population. The OSA related item of “restless and moves around a lot” does occur in 35% of the typical pediatric population and 84% our DS cohort which reinforces this significant discrepancy of sleep problems between the two populations.

DISCUSSION

Our study is the first to specifically examine sleep profiles across age groups of children with DS between the ages of 1.50 to 13.4 years. Based on the information from the 108 CSHQ questionnaires, caregivers reported 76% of their children with DS had sleep problems. 55/108 (51%) who had undergone AT for OSA continued to have sleep problems specifically in night awakenings (e.g., need parents in room to sleep), restless sleep, snoring, and daytime sleepiness. Interestingly, the AT group also reported more issues with falling asleep while watching television. Our results suggest that children with DS who undergone AT for OSA continue to have sleep problems suggesting that ongoing monitoring of sleep

issues is needed in this population. It is possible that AT is much less effective in treating OSA in DS compared to typically developing population [Merrell & Shott, 2007] possibly due to macroglossia, glossoptosis, recurrent enlargement of the adenoid tonsils, and enlarged lingual tonsils [Shott et al., 2004]. These surgical options are most often curative (95%) of sleep issues in the typically developing population [Nieminen et al., 2000; Schechter, 2002; Shott & Donnelly, 2004]. Furthermore, effective treatment of sleep issues or other underlying sleep disorders often will improve maladaptive behavior symptoms as suggested in studies with typically developing children [Chervin et al., 2005; Gozal et al., 2008; Biggs et al., 2014].

Sleep problems in children with DS begin at an early age and may continue to persist with increasing age. The prevalent items that do not resolve with age included the need to sleep with parents, moving to parent's bed in the middle of the night, sleep fragmentations with increased arousals during sleep, daytime fatigueness, and symptoms related to OSA (e.g., snoring, snorting and gasping, and constant movement during sleep). Between the age groups, the items that improved in the oldest group of 8–13 years are falling asleep in their own bed, less falling asleep in the car, and decrease noctural enuresis. However, 28% of parents still reported noctural enuresis in this age group. Our results identify that sleep problems begin early, and may persist.

When we compared the sleep profile of children with DS to the typically developing population from Liu et al study, the OSA related items of restless sleep, snoring, and gasping are more common in children with DS compared to typically developing children. This further highlights that children with DS have predisposing factors of midface and mandibular hypoplasia, small upper airway with relative large tonsils, small nasal passages, generalized hypotonia, obesity that contribute to the persistent and recurrence of sleep issues. Importantly, the sleep fragmentations and arousals have been reported to be associated with daytime somnolence and functioning, and may lead to learning and behavioral disorders [Marcus et al., 1991]. In the typically developing population, multiple studies have shown that untreated OSA can lead to impaired hippocampal function with deficits in spatial learning and memory [Feng et al., 2012; Lal et al., 2012]. Evidence also suggests a significant correlation between the extent of behavioral and neuropsychological deficits and the severity of OSA. Furthermore, IQ level decreases with the severity of the OSA [Ezzat et al., 2010; Feng et al., 2012] or with the severity of other sleep problems without OSA [Blunden et al., 2000; O'Brien et al., 2004; Miano et al., 2011]. In addition, improvement in cognitive function (e.g. attention capacity, ADHD like symptoms) after surgical treatment for OSA is noted in the typically developing population [Horiuchi et al., 2014]. Studies on the impact of sleep disturbances on neurocognitive and behavior in DS have been limited with most studies focusing on the importance for health care professionals to conduct sleep screening evaluations [Austeng et al., 2014; Hoffmire et al., 2014; Stores et al., 2014]. Studies have revealed that children with DS who have higher ratings of sleep disruption showed greater difficulties with executive function, and mean Verbal IQ is approximately 9 points lower in those with comorbid OSA than in those without OSA ($p=0.006$) [Chen et al., 2013]. These findings suggest a relation between OSA and cognitive outcomes in the DS population.

Significant sleep disturbances can have an impact on the child's overall academic and behavioral function. Sleep problems can contribute to a higher level of daytime somnolence, altered daytime learning, and increased behavioral issues. Based on our results, children with DS encounter sleep problems beginning at a young age, and continue to persist and may recur with increasing age. Importantly, OSA is not the only cause for sleep issues noted in children with DS. Persistent sleep problems after AT are likely to occur due to multiple anatomic causes and decreased airway tone related to reduced muscular tone in individuals with DS. Thus, children with DS who have persistent OSA despite AT should be monitored by an otolaryngologist to determine if additional surgical procedures (e.g., removal of recurrent adenoid tonsils, removal of enlarged lingual tonsils) might be beneficial.

Screening for sleep problems and anticipatory guidance regarding sleep should be discussed with parents at every well child care visit, and all children with DS should have a polysomnogram by age 4 as recommended by the American Academy of Pediatrics Health Supervision for Children with DS. Parents should be encouraged to set routine and consistency with their child's sleep schedule. Screen time is adversely associated with sleep outcomes; thus, limit or reduce screen time exposure, especially before or during bedtime hours to minimize any harmful effects of screen time on sleep and well-being [Magee et al., 2014].

If sleep problems are noted, referral to a physician with expertise in pediatric sleep should be considered. Behavioral intervention to reduce sleep problems may be needed, although studies have been limited in the DS population. In some cases, sleep medication such as melatonin or clonidine may be beneficial. Thus, health care providers should continue to discuss symptoms of OSA with families and monitor for recurrence of signs and symptoms sleep disordered breathing (e.g., snoring, restless sleep, night awakening). It is also important to emphasize to parents that poor sleep may present with daytime somnolence and/or behavior problems.

Limitations of this study include a convenience sample from the DS Clinic at Emory University. It is possible that their experiences differ from those who are unlikely to attend a DS specialty clinic and/or proactive in seeking specialty clinic care for their child. Additionally, there may be recall bias when parents complete the questionnaires. However, the parental sleep questionnaires were correlated with the polysomnogram results. We also did not collect parental socioeconomic status, which may contribute to factors in accessing medical care and education. Despite these limitations, our findings suggest that future research is needed in examining the impact of sleep on cognitive functioning in young children with DS since sleep problems emerge at a young age. Another important area of research would be an investigation of the efficacy of sleep medications and/or behavioral intervention in this population. Ongoing and frequent assessment of sleep in children with DS must remain part of routine clinical care.

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Table 1

Prevalence of Children's Sleep Habits Questionnaire (CSHQ) Subscales for Children with Down syndrome with and without Tonsillectomy/Adenoidectomy (AT)

CSHQ subscales	**AT (51%) n=55 Mean age 5.95 years**	**No AT (49%) n=53 Mean age 4.42 years**
Bedtime Resistance		
Doesn't go to bed at same time	8	9
Doesn't fall asleep in own bed	24	28
Falls asleep in others bed	21	30
Needs parent in room to sleep	47	39
Struggles at bedtime	25	22
Sleep Onset Delay		
Doesn't fall asleep in 20 min	28	36
Sleep Duration		
Sleep too little	32	28
Doesn't sleep the right amount	24	25
Doesn't sleep same amount each day	16	18
Sleep Anxiety		
Afraid of sleeping in the dark	15	11
Afraid of sleeping alone	14	18
Trouble of sleeping away	23	22
Night Wakings		
Moves to other's bed in the night	39	42
Awakes once during the night	58	58
Awakes more than once	36	27
Parasomnias		
Wets the bed at night	39	52
Talks during sleep	25	30
Restless and moves around a lot	85	87
Sleepwalks	9	4
Grinds teeth during sleep	38	36
Awakens screaming, sweating	7	16
Awakens alarmed by scary dream	8	12
Sleep Disordered Breathing		
Snores loudly	45	39
Stops breathing	15	18
Snorts and gasps	38	32
Daytime Sleepiness		
Doesn't wake by himself	43	28
Others wake child	26	16

CSHQ subscales	**AT (51%) n=55 Mean age 5.95 years**	**No AT (49%) n=53 Mean age 4.42 years**
Wakes up in a negative mood	45	37
Hard time getting out of bed	30	20
Takes long time to be alert	28	14
Seems tired	48	37
Watching TV	15*	35*
Riding in a car	57	56

* p value < 0.05

Table 2

Prevalence of Children's Sleep Habits Questionnaire (CSHQ) Subscales for Children with Down syndrome by age group

CSHQ subscales	Comp. (A) N=415	Ages 1–13 N=108	Ages 1–3 (30%) n=32	Ages 4–7 (53%) n=58	Ages 8–13 (17%) n=18
Bedtime Resistance					
Doesn't go to bed at same time	n/a	9	12	7	6
Doesn't fall asleep in own bed	n/a	26	19*	36*	6*
Falls asleep in others bed	n/a	26	22	31	11
Needs parent in room to sleep	n/a	43	35	48	33
Struggles at bedtime	n/a	24	22	24	17
Sleep Onset Delay					
Doesn't fall asleep in 20 min	21	32	41	28	33
Sleep Duration					
Sleep too little	20*	30*	25	32	33
Doesn't sleep the right amount	n/a	25	15	30	22
Doesn't sleep same amount each day	n/a	17	13	19	11
Sleep Anxiety					
Afraid of sleeping in the dark	26**	13**	0**	16**	28**
Afraid of sleeping alone	n/a	16	12	16	11
Trouble of sleeping away	n/a	23	31*	14*	33
Night Wakings					
Moves to other's bed in the night	n/a	41	28	43	44
Awakes once during the night	25**	58**	59	56	61
Awakes more than once	n/a	32	19	34	44
Parasomnias					
Wets the bed at night	n/a	46	63*	40*	28*
Talks during sleep	23	28	31	28	22
Restless and moves around a lot	35**	86**	81	84	89
Sleepwalks	n/a	7	9	7	6
Grinds teeth during sleep	21**	37**	47	33	33
Awakens screaming, sweating	21	12	25**	6**	17*
Awakens alarmed by scary dream	n/a	10	9	7	22
Sleep Disordered Breathing					
Snores loudly	n/a	42	50	38	39
Stops breathing	n/a	17	12	17	17
Snorts and gasps	n/a	35	41	31	39
Daytime Sleepiness					
Doesn't wake by himself	n/a	36	31	38	28

CSHQ subscales	Comp. (A) N=415	Ages 1–13 N=108	Ages 1–3 (30%) n=32	Ages 4–7 (53%) n=58	Ages 8–13 (17%) n=18
Others wake child	34**	21**	16	22	28
Wakes up in a negative mood	68**	41**	38	43	39
Hard time getting out of bed	39	25	19	28	28
Takes long time to be alert	24	21	16	22	28
Seems tired	24**	43**	41	42	44
Watching TV	24	25	12	16	28
Riding in a car	27**	57**	62*	58*	28*

a) Comparative sample Liu et. al. 2005

* p value <0.05

** p value <0.01