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Use of Sleep Evaluations and Treatments in Children with Down Syndrome

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Abstract

Objective—To characterize practice patterns regarding sleep evaluation and intervention among children with Down syndrome (DS).

Method—Data were obtained from electronic health records from 2009–2013 for a retrospective cohort of 954 children with DS, ages 5–21 years during the time sampled. ICD-9 diagnoses were used to identify children with obstructive sleep apnea and/or behavioral sleep disturbances. Primary outcomes were confirmed by participation in an overnight diagnostic polysomnography (PSG) and/or documented provision of specified sleep interventions including positive airway pressure, otolaryngology (ENT) surgery, sleep medication and behavioral sleep therapy.

Results—Overall, 47.7% of children with DS had undergone PSG, 39.1% had diagnosed sleep problems, and of those diagnosed with sleep problems, 81.2% had received sleep intervention. Consistent with best practice clinical care, sleep treatments matched the diagnosed sleep problems. Age, gender, and race, but not body mass index, were associated with PSG completion rate and occurrence rates for ENT surgery and sleep medication usage. Body mass index was associated with obstructive sleep apnea.

Conclusion—Despite high rates of reported sleep problems in children with DS, less than half underwent PSG. Children diagnosed with sleep problems received treatment consistent with their sleep diagnosis. However, age and gender were associated with differential rates of treatment delivery that was incongruous with prevalence rates for diagnosed sleep problems. These findings underscore the importance of screening for sleep problems in children with DS, and referring for and providing appropriate targeted sleep interventions.

Keywords

Down syndrome; trisomy 21; sleep

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Poor sleep is a significant clinical concern among individuals with Down syndrome (DS). Obstructive sleep apnea (OSA) and behavioral sleep disturbances (BSD; i.e. behavioral insomnia) are common and often co-exist. OSA is difficult for parents to identify, and may negatively impact cognitive functioning and daytime behaviors[1,2]. OSA is linked with lower verbal IQ scores and poorer performance on tests of cognitive flexibility among children with DS, and a higher number of apneas per hour is related to difficulties with visuo-perceptual skills, such as orientation, among young adults with DS[1,3]. BSD also negatively impacts daytime behaviors and language[4]. Among youth with DS, rates of OSA range from 31–63%[2,5–7], and rates of BSD range from 52–69%[8–11]. Given this, published health supervision for children with DS calls for routine screening for sleep problems[12]. The 2011 "Health Supervision for Children with Down Syndrome" clinical report by Bull and the American Academy of Pediatrics Committee on Genetics recommends discussing with parents symptoms of sleep difficulties during early childhood, and that all children receive a referral for an overnight diagnostic polysomnography (PSG, sleep study) by 4 years of age[12]. Beyond the age of 5 years, the guidelines recommend ongoing discussion of symptoms and referral to a sleep specialist for persistent sleep problems. Little is known about clinical practice patterns with respect to screening, identification, and treatment of sleep problems among children with DS, which leaves open the possibility of inadequate care.

The existence of guidelines for sleep screening highlights the importance of identifying OSA and determining the most appropriate intervention(s) in children with DS. Bilevel and continuous positive airway pressure (PAP) and otolaryngology (ENT) surgery (e.g, tonsillectomy, adenoidectomy) are common treatments for OSA. PAP has demonstrated efficacy for treating OSA among typically developing children[13]. Preliminary small studies have demonstrated the clinical benefits of PAP through improvements in measures of sleep and daytime functioning for children with OSA and cerebral palsy[14]. Tonsillectomy and adenoidectomy have demonstrated efficacy among typically developing children. ENT surgery may be less effective among children with DS; there is some evidence of efficacy[15–17], but that evidence was classified by the Cochrane report as low-quality due to small sample size, and in need of replication[18].

Sleep medication, including prescription sedative hypnotics and melatonin, may be used to treat sleep onset and sleep maintenance insomnia. However, pharmacological sleep treatments have limited safety and efficacy data for all pediatric patients, including children with DS[19–22]. In addition, associated side effect profiles may lead to parental reluctance to use prescription medication for treating sleep problems[10,23].

Behavioral treatments for insomnia may target modification of specific sleep hygiene practices, bedtime routines, sleep-wake schedules, and parent-child interactions at bedtime and after night wakening. Children dependent on PAP for treatment of OSA may require behavioral desensitization treatment if there is poor tolerance or suboptimal adherence to PAP. In typically developing children, behavioral sleep intervention has demonstrated efficacy and effectiveness in treating BSD[24,25]. In addition, a number of preliminary small sample studies have demonstrated that behavioral interventions are promising among

children with intellectual and developmental disabilities (IDD)[26–28]. To date, however, there is a lack of empirical support for use of behavioral insomnia treatment among children with DS[29–31].

Despite preliminary evidence to support the effectiveness of various sleep interventions among children with IDD or specifically children with DS, practice patterns regarding the use of sleep interventions in children with DS have not been reported in the literature. Large scale investigations of practice patterns related to sleep intervention in applied settings among children with DS are needed to better understand current clinical practice and inform future clinical care recommendations. Since it has been recommended that all children with DS undergo formal sleep screening by the age of 4 years, it would be expected that post-2011 many young children with DS may have completed a PSG by the age of 5 years.

Given the lack of data about clinical practice patterns for sleep evaluation and treatment for children with DS, the objective of this study was to explore the frequency of diagnosed sleep problems, use of diagnostic PSG and sleep interventions provided to children with DS. This was accomplished via outpatient chart reviews of children with DS. The site for the study was a large, regional medical center network with extensive satellite facilities that serve over 1000 children with DS each year within a mixed urban, suburban, and rural region. First, we examined the occurrence of obstructive sleep OSA and BSD based on ICD-9 diagnoses documented in electronic medical records. Second, we quantified the number of patients with DS that had undergone diagnostic PSG and/or received sleep treatment. The sample was stratified according to sleep diagnoses. Four patient groups were identified as follows: (1) children with no documented sleep problems, (2) children with a diagnosis of OSA, (3) children with a diagnosis of BSD, and (4) children with comorbid OSA and BSD. After stratification we examined how often children's sleep problems were treated with PAP, ENT surgery, sleep medication, and/or behavioral sleep treatment. Third, we examined the associations between demographic factors, sleep diagnoses, PSG, and sleep treatment.

METHODS

Design and Participants

This study was approved by the institutional review board of the medical center and the requirement for informed consent was waived. Electronic medical records were reviewed on a retrospective cohort of children and adolescents with DS seen for outpatient care between May 2009 and March 2013 at a large academic pediatric medical center. The pediatric medical center includes a specialty clinic for children with DS, an upper airway center (multidisciplinary program including pulmonary medicine, general surgery, ENT, plastic surgery, psychology, developmental pediatrics, and genetics) supporting children with DS, an accredited sleep disorders center, and various other specialties. The DS specialty clinic serves approximately 400 children, and the larger medical center serves over 1000 children, with DS each year.

The study site maintains a research data warehouse that abstracts electronic health records for the purposes of cohort identification and data collection. The data warehouse was used to identify subjects for inclusion in the study based upon specified discrete variables. Children

were included in the retrospective cohort if they were between the ages of 5 and 21 during the time sampled, and had a diagnosis of Down syndrome (ICD-9 code of 758.0) in the billing diagnosis list for any visit during the time sampled, problem list, or medical history. Manual chart review confirmed the diagnostic codes. Information on a total of 954 unique children with DS was extracted from medical records.

Variables extracted

Demographic data obtained for each child included age at most recent visit during the time sampled, gender, race, ethnicity, zip code, and county. Zip code was extracted to estimate socioeconomic status of the household. County was extracted to inform whether the child came from the immediate area serviced by the medical center. Weight status was dichotomized (normal vs. overweight) using height and weight at the most recent visit during the study period; for children, this classification was based upon age- and sex-adjusted standards for body mass index (BMI), and for adults this was based upon sex-adjusted BMI standards, both as set by the US Centers for Disease Control and Prevention. Individuals who were overweight included children whose BMI exceeded the 85th percentile, and adults whose BMI were higher than 25.

ICD-9 sleep diagnoses were extracted to identify sleep disorders, disturbances and symptoms. We identified children as having Obstructive Sleep Apnea (OSA; 327.2), or Behavioral Sleep Disturbances (BSD; Specific disorders of sleep of nonorganic origin [307.4], organic sleep disorders [327; excluding 327.2], insomnia unspecified [780.52], and hypersomnia unspecified [780.54]).

Determination regarding whether or not a child had undergone PSG was based on a manual chart review of each patient. Since the time frame for chart review spanned the 2011 publication of the health supervision clinical report, the date of the diagnostic PSG was also extracted for exploratory analyses. Medications that could have been prescribed for sleep disruption were also extracted. Medications queried included alpha agonists (Clonidine and Guanfacine), antidepressants (Trazadone), selective serotonin reuptake inhibitors (Mirtazapine), benzodiazepines (Diazepam, Lorazepam, and Temazepam), hypnotic agents (Zolpidem), and hormonal medications (Melatonin). Although it is possible that these medications could have been prescribed for other reasons (e.g., behavioral and mood disorders), they were included as possible sleep agents based on their known sedating properties and their common use as sleep medications. The most common sleep medications were melatonin (9.1%), Clonidine (5.1%), Diazepam (5.1%), Lorazepam (4.9%), and 5.5% were prescribed other sleep medications. There were no marked differences in findings when medications were broken down by subtype. Thus, the use of sleep medication was scored dichotomously (yes/no) and a summed score was calculated for the number of different sleep medications documented per patient.

The ENT sleep surgeries extracted from medical records included tonsillectomy and adenoidectomy. The number of surgical interventions was summed as several children had surgical revision or subsequent surgery, such as a lingual tonsillectomy. Frequency of behavioral sleep treatment provided within the context of clinic visits was also extracted

from medical records. Behavioral sleep treatment was identified by treatment visits with a certified behavioral sleep medicine clinician.

RESULTS

Sample Demographics

The overall sample of 954 children with DS was 55% male, with a mean age at the end of 2013 of 12.6 years (SD = 5.4, range 5–25 years). As a child visiting the medical center in 2009 could have been 21 years of age, their age in 2013 would be 25. Children were primarily non-Hispanic Caucasian (81.0%), and overweight (55.4%). The median household income, calculated using zip-code based census data, was $59,344. Most (63.2%) of the children lived within the 8 county primary catchment area of the medical center, and 75.4% of children lived within 100 miles of the medical center.

Frequency of Sleep Problems

Four groups of children were identified based on queried diagnoses; 258 (27.0%) children had a diagnosis of OSA only, 33 (3.5%) children had a diagnosis of BSD only, 82 (8.6%) had a diagnosis of both OSA and BSD, and 581 (60.9%) had no sleep diagnoses in their medical records. Demographics of the overall sample and by specific sleep group are presented in Table 1.

One-way analyses of variance and chi-square analyses were used to examine differences in demographics and obesity across the four sleep diagnosis groups. Statistically significant differences were identified between the sleep groups for weight status, $\chi^2(3) = 15.07$, $p < 0.002$. Children diagnosed with OSA were more likely to be overweight than children with no sleep diagnoses, or BSD. No statistically significant differences were identified for age, gender, race, or median household income.

Frequency of PSG and Sleep Treatments

Less than half (n=455 or 47.7%) of the sample had undergone PSG according to medical records. For children receiving clinical care at the hospital prior to the publication of the health supervision clinical report (last visit prior to or during 2011; n=111), 29.7% had undergone PSG. For children continuing to receive care at the hospital after the publication of the health supervision clinical report (last visit during or after 2012; n=843), 31.1% had undergone PSG earlier than 2011, 9.7% underwent PSG after 2012, and 9.2% underwent PSG several times that spanned the publication of the clinical report. There was negligible difference in the rate of PSG following that publication.

We also examined the age of the child at their first PSG in relation to the 2011 health supervision clinical report. Children who had their first PSG prior to 2011 ($M = 7.80$, $SD = 5.14$) were significantly younger than children who had their first PSG after 2012 ($M = 10.67$, $SD = 5.53$), $t(453) = -4.51$, $p = < 0.0001$.

As expected, children with OSA or OSA+BSD were more likely to have had a documented PSG than children with BSD alone, who were in turn more likely to have had PSG than children with no sleep diagnosis, $\chi^2(3) = 293.21$, $p < 0.00001$ (see Table 2).

Nearly 60% of children were documented to have received some form of sleep treatment (n=569); most common was ENT surgery (50% of the total sample of children with DS), followed by sleep medication (19.6%) (see Table 2). Not surprisingly, children with at least one documented sleep diagnosis were more likely to be receiving some form of sleep intervention in comparison to children with no sleep problems, $\chi^2(3) = 136.42$, $p < 0.00001$. Children with no diagnosed sleep disorder also had a high rate of sleep treatment, with almost 45% receiving primarily ENT surgery or sleep medication.

Children with OSA or OSA+BSD were more likely to have been treated with PAP and to have had an ENT surgery (tonsillectomy, adenoidectomy, both) when compared to children with BSD or no sleep diagnosis, ($\chi^2(3) = 116.36$, $p < 0.00001$, $\chi^2(3) = 111.42$, $p < 0.00001$, respectively). In addition, children with OSA and OSA+BSD had the highest number of ENT surgeries (74.4% and 67.1%, respectively) in comparison to children with BSD (48.5%) and no sleep diagnoses (38.6%), $F(3,948) = 53.43$, $p < 0.00001$ (see Table 2).

Children with BSD were more likely to be on medication for sleep (57.6%) than children with OSA+BSD (32.9%), children with OSA (22.5%) or children with no sleep diagnoses (14.3%), $\chi^2(3) = 51.21$, $p < 0.00001$. In addition, children with BSD were on more sleep medications than children with OSA+BSD or OSA, who in turn were on more sleep medications than children with no sleep diagnoses, $F(3,950) = 22.38$, $p < 0.00001$. Although targeted behavioral treatment with a behavioral sleep medicine provider was rare overall (2.4%), children with OSA+BSD or only BSD were more likely to be receiving these interventions than children with OSA or no sleep diagnoses, $\chi^2(3) = 40.33$, $p < 0.00001$.

Predictors of PSG and Sleep Treatments

Five separate logistic regression analyses predicted whether the child (1) had PSG, (2) used PAP, (3) had ENT surgery, (4) took sleep medication, and (5) received behavioral sleep treatment. Separate regressions were conducted because of overlapping groups. Gender, age, race, BMI (overweight), and documented OSA and BSD were predictors in all 5 regression equations.

As shown in Table 3, PSGs were more common among younger children and among children identified as having OSA or BSD. The odds ratio of 0.93 for age implies that for each year older the child was, the odds of having a PSG decreased by 7–8%. Children with OSA were 14.7 times more likely to have had PSG at the medical center than those without OSA, and children with BSD were 2.1 times more likely to have had PSG at the medical center than those with no BSD. The only significant predictor of PAP use was the diagnosis of OSA. Surgical interventions to support sleep were more common among younger children, Caucasian children, and among children with OSA. For each year older the child was, the odds of having a surgical intervention decreased by 6%. Children with OSA were 4.5 times more likely to have had ENT surgery than those without OSA, and Caucasian non-Hispanic children were 1.5 times more likely to have had ENT surgery than children of other races and ethnicities.

The use of sleep medication was related to gender, age, and having a comorbid diagnosis of BSD (see Table 3). Males were 49% more likely to be taking sleep medication, and the

likelihood of taking sleep medication was 4% greater with each year of age. Children with BSD were 2.7 times more likely to be taking sleep medication than children with no BSD. Behavioral sleep interventions were more common among children with OSA and BSD (see Table 3). Children with OSA were 7.6 times more likely than children with no OSA to have received behavioral intervention, and children with BSD were 3.9 times more likely than children with no BSD to have received behavioral intervention.

DISCUSSION

The current study is the first to examine the use of PSG and sleep intervention in a large clinical sample of children with DS. Among children with DS, the type of sleep problems did not differ on most demographic variables, though children with DS and comorbid OSA were most likely to be obese. The observed association between obesity and OSA in children with DS is consistent with the relationship found in typically-developing children and adults, and is in line with the current health supervision for children with DS that recommend discussing obesity as a risk factor for OSA. Overall, among children with DS between the ages of 5 to 21, 47.7% had undergone diagnostic PSG, 39.1% were diagnosed with a sleep disorder, and 81.2% of patients diagnosed with a sleep disorder had received some type of sleep treatment. The rates of OSA within this sample lends credence to reported rates in smaller samples in the literature. In contrast, rates of BSD were substantially smaller than those reported in the literature. This discrepancy is likely due to differences in how BSD are classified, whether from clinical diagnoses or from parental reports of areas of concern.

It appears that many children with DS were not receiving PSG. It is possible that children may have received a sleep study prior to the initiation of our electronic medical record in 2009 and prior data not being accurately captured, which would be consistent for the small but statistically significant inverse relationship between age and presence of PSG documentation. They may also have undergone PSG at another center, which would fit with observation that a small minority (1 in 10) of children with a diagnosis of OSA did not have PSG documentation in their records. However, it seems unlikely that no documentation of a PSG in the study site’s electronic medical record could explain why over half of our sample of children with DS had no evidence of having undergone PSG. Of interest, the mean age of children receiving their first PSG was older after the publication of the health supervision clinical report. While one may have assumed that the mean age would be younger given the recommendation to refer for PSG by 4 years of age, this finding could also reflect referral rates increasing across childhood with better physician identification of sleep concerns. Most likely, the rate of PSG in the current sample mirrors the rate of OSA in children with DS, and referrals based on physician concerns. However, the contribution of barriers to receiving PSG cannot be ignored. General barriers to receiving PSG may include parental reluctance to have their child complete a study that often requires hospitalization and/or lack of access to a sleep specialist that has competency for working with children with DS. The barriers to recommended sleep screening for children with DS are in need of additional study. In particular, we recommend that future studies provide a better understanding of the availability of PSG resources and sleep specialists that are experienced in working with children who have DS, as well as any bias from practitioners (e.g., not referring at risk

patients) or families (e.g. not following through with referral) that are associated with lower rates of diagnostic PSG. If sleep problems are identified, ideally, children with DS would receive appropriate sleep interventions. Under-utilization or lack of availability of appropriate sleep interventions has significant implications for optimal health outcomes for children with DS.

In terms of sleep intervention, ENT surgery (e.g., tonsillectomy, adenoidectomy) was most common for all children with DS, and especially so for children with OSA or OSA+BSD. The high rate of ENT surgery is not surprising, given that such intervention has some success in treating OSA, and that PAP is poorly tolerated in this population, with only about 1/3 of adults with DS who are prescribed PAP using it regularly[32]. However, ENT surgery currently has a relatively weak evidence base in treating OSA among children with DS, and previously was found to be less successful in children with DS than among typically developing children[15–17]. It may be that even a moderate surgical success rate is viewed as better than suboptimal or minimal use of PAP. Given the concerns for the effectiveness of such surgeries for improving sleep in children with DS, it is encouraging that research continues to assess, refine and improve surgical procedures for children with DS and OSA, using refined surgical procedures or novel tools, such as a hypoglossal nerve stimulator[33,34]. These research efforts are needed to continue to assess and improve surgical outcomes, as are research to improve PAP tolerance and adherence in this population.

For children with BSD, medication was the most common intervention, with 6 in 10 receiving sedating medication, compared to 1 in 20 receiving behavioral interventions at the medical center. It is possible that more children were receiving behavioral treatments outside of the medical center, or within the medical center but sleep was not labeled as a target within medical records, and that our current numbers reflect *where* a child receives behavioral treatment and not *whether* they are receiving behavioral treatment. Medication is reviewed at each hospital encounter, and recorded regardless of the prescribing physician. Thus, there is more accuracy in the data on the presence of medication interventions. However, our center housed the only pediatric behavioral sleep medicine program in the region, so it is unlikely that many children will have received specialized behavioral sleep services elsewhere. While many children were receiving medication that may have been targeting their sleep problems, there remains a large portion of children with BSD who were not receiving any documented treatments with known efficacy in addressing behavioral sleep problems. The lack of clinical trials on the use of medications in children with DS may contribute to prescriber reluctance to use medication in this population. Similarly, the lack of efficacy studies on the use of behavioral sleep treatments may contribute to its minimal use in children with DS and BSD.

Older children and boys were more likely to be receiving medication for sleep. The rates of general medication use are also increasing among adolescents with developmental disabilities[35,36]. Yet, neither age nor sex predicted the presence of either OSA or BSD. In other words, medication was being used more often in older children, even though sleep disorder rates did not differ by age. We speculate that this may relate to increased challenges managing sleep problems as children become older and larger, especially amongst males. Higher rates of behavior and conduct problems in males with DS[37,38] may drive increased

use of sleep medication in children with DS who have psychiatric comorbidity. Although, that remains to be tested in future research, which is also needed to better understand differential effectiveness of specific intervention across different ages and gender.

Race was associated with the rate of surgical intervention, with Caucasian non-Hispanic children undergoing surgical intervention at a higher rate. This finding is consistent with disparities in access to health care for non-Caucasians[39]. However, there were no significant differences by race on the frequency of other sleep interventions, or the rates of detecting sleep problems. Ongoing work on understanding health disparities at different levels of health care (access, referral for treatment, quality of care) continues to be needed, and is particularly limited in the specialty population of individuals with DS.

Children with DS without any diagnosed sleep disorder had a high rate of sleep-related treatments. To some degree, this may reflect an inherent limitation in chart reviews; medically complex children may receive treatment focused on comorbid diagnoses, or on specific symptoms and behaviors without an explicit diagnosis. In a post-hoc review of data, of children with no diagnosed sleep disorder taking alpha agonists (Clonidine, Guanfacine), 41.3% had a comorbid diagnosis of ADHD, which would corroborate the notion of medication prescription for comorbid diagnoses. However, only 6.5% of children with no diagnosed sleep disorders taking benzodiazepines had a comorbid diagnosis of anxiety. Nonetheless, it is also worth noting that by far the most common treatments in these instances were ENT surgeries and medication, which could have been legitimately undertaken for reasons other than sleep.

As noted, although our center has a very wide catchment area and includes the only accredited pediatric sleep disorders center that includes pediatric behavioral sleep medicine services, a limitation of this study is its focus on records from a single center. Similarly, we were only able to report on *current use* of PAP; more children may have been trialed (and failed) on PAP than we are able to identify in the current data. Another limitation is that we are unable to assess the success of the sleep interventions or the target problem for the prescribed medications assessed with our surveillance study. The DS health supervision clinical report was published in 2011, at the mid-point of our chart capture of patients. While we have tried to capture any potential difference before and after the report in regards to PSG, it is possible that these recommendations may have impacted our representation of sleep evaluations.

Despite these limitations, our study characterizes sleep problems and sleep interventions at a large pediatric hospital which has specialty clinics for DS, upper airway and behavioral sleep medicine. As a result of these specialty clinics, we are able to report on a large number of children with DS with access to the interventions needed when sleep problems are identified. To our knowledge, such an opportunity is unprecedented in the literature, which has focused on small samples in more limited catchment areas and with more limited access to specialty care, and/or those recruited specifically for research (rather than the broader group of those receiving outpatient care).

Overall, our study findings indicate that, despite high rates of reported sleep problems in children with DS, less than half of children with DS underwent PSG. Children diagnosed with sleep problems received treatment consistent with their sleep diagnosis, which is encouraging given the impact sleep problems have on language, cognition and behavior [1,4]. But, age and gender were associated with differential rates of treatment delivery that was incongruous with prevalence rates for diagnosed sleep problems. Thus, while many but not all children with DS are undergoing formal sleep screening, demographic disparities exist in who is receiving necessary sleep intervention. Further, only a small percentage of children with BSD were receiving targeted behavioral sleep intervention with a behavioral sleep medicine provider, and over 1/5 of children with OSA only were prescribed medication that does not address OSA. These findings underscore the importance of screening for sleep problems in children with DS, and referring for and providing appropriate targeted sleep interventions.

In addition our findings have implications for educating families about the purpose and need for formal sleep screening, including diagnostic PSG, and for research to assess when PSGs are recommended by clinical providers but not obtained, or are not successful with a particular child. As not all children were receiving treatment for diagnosed sleep problems, future research is needed to better understand how this finding is impacted by sleep treatment effectiveness and/or by poor adherence to sleep treatment. Finally, these findings provide a better understanding of age-related changes in medication use, surgical intervention, and rates at which patients with DS are undergoing PSG.

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Table 1

Demographics by sleep group.

	No Diagnosed Sleep Disorder (n=581, 60.9%)	**Diagnosed Sleep Disorder (n=373, 39.1%)**			**All (n=954)**
		BSD	**OSA**	**OSA+BSD**	
		(n=33, 3.5%)	**(n=258, 27.0%)**	**(n=82, 8.6%)**	
Age in 2013	M=12.31 (SD=5.17)	M=13.61 (SD=5.88)	M=12.78 (SD=5.62)	M=13.46 (SD=5.46)	M=12.58 (SD=5.36)
Household income	M=$59,662 (SD=$19,299); range $12,534–$115,357	M=$57,133 (SD=$13,965); range $37,376–$95,101	M=$59,810 (SD=$18,436); range $9,475–$135,641	M=$56,528 (SD=$17,532); range $15,413–$94,868	M=$59,344 (SD=$18,759); range $9,475–$135,641
Gender (male)	52.8%	48.5%	60.5%	56.1%	55.0%
Race (white, nonHispanic)	79.9%	81.8%	84.8%	76.8%	81.0%
BMI (overweight)	51.1%	48.5%	65.7%	53.1%	55.4%
Location (within 8 county area)	64.4%	66.7%	57.0%	73.2%	63.2%
Location (within 60 miles)	75.9%	90.9%	69.8%	82.9%	75.4%

M = mean, SD = standard deviation

BSD = Behavioral Sleep Disorder; BMI = Body Mass Index; OSA = Obstructive Sleep Apnea

Table 2

Frequency of PSGs and treatments by sleep condition.

	No Diagnosed Sleep Disorder (n=581)	BSD (n=33)	OSA (n=258)	OSA+BSD (n=82)	All (n=954)
PSG	26.2%	48.5%	82.6%	90.2%	47.7%
Any sleep treatment	44.9%	78.8%	83.5%	75.6%	59.6%
PAP	0.3%	0.0%	18.6%	19.5%	6.9%
Surgery	38.6%	48.5%	74.4%	67.1%	50.0%
Tonsillectomy only	2.6%	3.0%	9.7%	6.1%	4.8%
Adenoidectomy only	6.0%	3.0%	7.0%	11.0%	6.6%
T&A	28.2%	42.4%	57.8%	50.0%	38.6%
Medication	14.3%	57.6%	22.5%	32.9%	19.6%
Behavioral	0.3%	6.1%	3.9%	11.0%	2.4%
Number of medications	M=0.14 (SD=0.35)	M=0.58 (SD=0.50)	M=0.22 (SD=0.42)	M=0.33 (SD=0.47)	M=0.20 (SD=0.40)
Number of surgeries	M=0.42 (SD=0.60)	M=0.67 (SD=0.78)	M=1.03 (SD=0.80)	M=0.99 SD=0.84)	M=0.64 (SD=0.74)

M = mean, SD = standard deviation

BSD = Behavioral Sleep Disorder; OSA = Obstructive Sleep Apnea; PAP = Positive Airway Pressure; PSG = Polysomnography; T&A = Tonsillectomy and Adenoidectomy

Table 3

Logistic regression predicting PSGs or sleep interventions.

	PSG			PAP			Surgery			Medication			Behavioral		
	Exp(B)	**Wald(1)**	**p**	**Exp(B)**	**Wald(1)**	**p**	**Exp(B)**	**Wald(1)**	**p**	**Exp(B)**	**Wald(1)**	**p**	**Exp(B)**	**Wald(1)**	**p**
Gender	1.04	0.04	.84	1.15	0.24	.62	1.19	1.35	.25	**0.67**	**5.08**	**.02**	0.62	1.01	.31
Age	**0.93**	**18.07**	**.00**	1.04	2.59	.11	**0.94**	**20.14**	**.00**	**1.04**	**4.55**	**.03**	1.03	0.60	.44
Race	1.24	1.01	.32	1.06	0.02	.88	**1.52**	**4.81**	**.03**	1.39	1.93	.16	1.37	0.24	.63
BMI	1.02	0.02	.89	1.77	3.22	.07	1.16	0.94	.33	0.75	2.72	.10	0.55	1.66	.20
OSA	**14.67**	**177.01**	**.00**	**60.01**	**31.78**	**.00**	**4.53**	**82.27**	**.00**	1.21	1.05	.30	**7.64**	**9.81**	**.00**
BSD	**2.12**	**6.80**	**.01**	1.05	0.02	.88	0.90	0.12	.73	**2.74**	**19.85**	**.00**	**3.87**	**8.54**	**.00**
Nagelkerke R^2	.39			.32			.17			.07			.19		

BSD = Behavioral Sleep Disorder; BMI = Body Mass Index; OSA = Obstructive Sleep Apnea; PAP = Positive Airway Pressure; PSG = Polysomnography