An Analysis of Pediatric Obstructive Sleep Apnea Questionnaires

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INTRODUCTION

Obstructive Sleep Apnea (OSA) and other Sleep-Related Breathing Disorders (SRBD) frequently gets undiagnosed (13) and can affect the development as well as manifest as behavioral problems in children (13). Screening of patients that may be at risk of SRBDs is important as it can aid in appropriate referral for the establishment of a diagnosis. According to the AAPD "Policy on Obstructive Sleep Apnea", biomarkers and questionnaires are recommended tools for POSA screening. In the UOP pediatric clinic at present, there is no qualified questionnaire that faculty has yet determined to be of utility in our teaching clinical environment. So in search, we compared potential questionnaires with their strengths, limitations, and utility in hopes of finding one to serve as an initial questionnaire in a pediatric clinic teaching setting.

METHODS

In a literature review, we evaluated four well-researched POSA questionnaires. The comparison criteria was limited to the following criteria: questionnaires with objectively the most research behind them, recognition by the AAPD, and/or sensitivity for detecting OSA. Using key terms such as pediatric obstructive sleep apnea, screening of, and questionnaire in PubMed and Google Scholar search engines, pertinent literature sources were obtained. The questionnaires that showed the most promise were the I'M SLEEPY, BEARS, STOP-BANG, and the Michigan PSQ. To analyze the effectiveness of various POSA questionnaires, analytical measures such as sensitivity, sensibility, kappa correlation coefficient, Cronbachs alpha correlation coefficient, McNemar test, and Student's T-test were included in our selection. The criteria for utility in the clinical educational setting was the number of questions in the questionnaire and its subsequent implications for the ease of memorization.

RESULTS

I'M SLEEPY:

The I'M SLEEPY questionnaire is a series of quick and precise questions to serve as a screening tool for obstructive sleep apnea in children. Kadmon et al. performed a study on 150 children who were referred to a pediatric sleep clinic in which both the I'M SLEEPY questionnaire and polysomnography were utilized (5). Polysomnography is the gold standard for obstructive sleep apnea diagnosis and was used to assess the sensitivity and sensibility of the I'M SLEEPY questionnaire (5)(Table 5). The researchers found that the parent version had a sensitivity of 82% and specificity of 50% while the child version had a sensitivity of 47% and a specificity of 58% (5)(Table 5).

The researchers also utilized a modified version of the STOP-BANG questionnaire in which they removed the A criteria (A = Age over 50 years old?). The modified STOP-BNG questionnaire was tested on 69 children and yielded a sensitivity of 12% and specificity of 90% (5)(Table 5).

I'M SLEEPY questionnaire.

Parent version:
I – Is your child often Irritated or angry during the day?
M – Body Mass index above 85%?
S – Does your child usually Snore?
L – Does your child sometimes have Labored breathing at night?
E – Ever noticed a stop in your child's breathing at night?
E – Does your child have Enlarged tonsils and/or adenoids?
P – Does your child have Problems with concentration?
Y – Does your child often Yawn or is often tired/sleepy during the day?

Child version:
I – Are you angry a lot?
M – Filled in by the doctor: body mass index above 85%?
S – Do you snore at night?
L – Did your parents or a friend tell you that your breathing is "difficult" at night?
E – Did your parents or a friend tell you that you stop breathing at night?
E – Do you have problems with your tonsils or adenoids (glands inside your mouth)?
P – Is it difficult for you to focus (at school or at home)?
Y – Do you feel tired or sleepy a lot?

Table 1. I'M SLEEPY Questionnaire

STOP-BANG:

The STOP-BANG questionnaire is a series of 8 questions designed to identify patients at high risk of OSA, where the number of "yes" answers given indicates the risk-level. A meta-analysis by Nagappa et al. reviewed 17 studies and included 9,206 patients. Sensitivity was high within a sleep clinic population: 90% to detect any OSA (AHI>5), 94% to detect moderate-to-severe OSA (AHI>15), and 96% to detect severe OSA (AHI>30) (9). Probability of severe OSA also increased proportionally with increased STOP-BANG scores: probability was 25% (score of 3), 35% (score of 4), 45% (score of 5), 55% (score of 6), and 75% (score of 7-8) (9).

Another study by Chung et al. corroborated these results. 746 patients had a polysomnography test after taking the questionnaire. The odds-ratio (OR) was then compared for both moderate/severe and severe OSA at different STOP-BANG scores. For a score of 5, the OR was 4.8 (moderate/severe) and 10.4 (severe). For a score of 6, the OR was 6.3 and 11.6. For a score of 7 & 8, the OR was 6.9 and 14.9 (4).

STOP		
Do you SNORE loudly (louder than talking or loud enough to be heard through closed doors)?	Yes	No
Do you often feel TIRED, fatigued, or sleepy during daytime?	Yes	No
Has anyone OBSERVED you stop breathing during your sleep?	Yes	No
Do you have or are you being treated for high blood PRESSURE?	Yes	No
BANG		
BMI more than 35kg/m2?	Yes	No
AGE over 50 years old?	Yes	No
NECK circumference > 16 inches (40cm)?	Yes	No
GENDER: Male?	Yes	No
TOTAL SCORE		

High risk of OSA: Yes 5 - 8
Intermediate risk of OSA: Yes 3 - 4
Low risk of OSA: Yes 0 - 2

Table 2. STOP BANG Questionnaire

Michigan PSQ:

The Michigan Pediatric Sleep Questionnaire (PSQ) is a 22-item questionnaire relating to the symptoms of POSA. A study by Chervin et al. compared questionnaire scores with PSG and found that a score 1 standard deviation above the mean predicted a 3x increased risk of POSA (OR of 2.8) (1). The study randomly assigned subjects into 2 groups. Sensitivity was found to be 0.85 and 0.81, and specificity was 0.87 and 0.87. Classification was correct for 86% and 85% (1).

Please answer the following questions as they pertain to your child in the past month.

1. While sleeping, does your child:	
Snore more than half the time?	Y N DK
Always snore?	Y N DK
Snore loudly?	Y N DK
Have "heavy" or loud breathing?	Y N DK
Have trouble breathing, or struggle to breathe?	Y N DK
2. Have you ever seen your child stop breathing during the night?	Y N DK
3. Does your child:	
Tend to breathe through the mouth during the day?	Y N DK
Have a dry mouth on waking up in the morning?	Y N DK
Occasionally wet the bed?	Y N DK
4. Does your child:	
Wake up feeling unrefreshed in the morning	Y N DK
Have a problem with sleepiness during the day	Y N DK
5. Has a teacher or other supervisor commented that your child appears sleepy during the day?	Y N DK
6. Is it hard to wake your child up in the morning?	Y N DK
7. Does your child wake up with headaches in the morning?	Y N DK
8. Did your child stop growing at a normal rate at any time since birth?	Y N DK
9. Is your child overweight?	Y N DK
10. This child often:	
Does not seem to listen when spoken to directly	Y N DK
Has difficulty organizing tasks and activities	Y N DK
Is easily distracted by extraneous stimuli	Y N DK
Fidgets with hands or feet or squirms in seat	Y N DK
Is "on the go" or often acts as if "driven by a motor."	Y N DK
Interrupts or intrudes on others (e.g., butts into conversations or games)	Y N DK

Scoring: Score = (number of positive responses) / (number of items answered with Yes or No).
Score ≥0.33 suggest high risk for pediatric obstructive sleep apnea.[1]

Table 3. Michigan (PSQ) Questionnaire

BEARS:

In a pilot study done by Owens et al., 195 patients between the ages of 2 and 12 years were recruited through a convenience sample (10). Sleep-related information recorded in the BEARS visit was compared to the pre-BEARS visit (subject's most recent previous well child check (WCC)). The researchers found that the BEARS visits were significantly more likely than the pre-BEARS visits to have any sleep information recorded (98.5% vs. 87.7%, p<0.001), and to have information recorded about bedtime issues (93.3% vs. 7.7%, p<0.001), excessive daytime sleepiness (93.9% vs. 5.6%, p<0.001), snoring (92.8% vs. 7.2%, p<0.001), nighttime awakenings (91.3% vs. 29.2%, p<0.001), and regularity and duration of sleep (65.3% vs. 31.5%, p<0.001) (10). Furthermore significantly more sleep problems were identified during the BEARS visits in the domains of bedtime issues (16.3% vs. 4.1%, p<0.001), nighttime awakenings (18.4% vs. 6.8%, p<0.001) and snoring (10.7% vs. 4.6%, p=0.012) (10). Finally, almost twice as many BEARS charts had sleep mentioned in the Impression and Plan (13.1% vs. 7.3%), which approached significance (p=0.07) (10). Another study by Mohammadi et al. found similar results in which 215 children ages 2-12 recruited through a convenience sample. It was found that the BEARS is a reliable and relatively valid sleep screening tool for children (8). In determining test-retest reliability, the assumptions of kappa coefficient >0.6 and Cronbachs alpha>0.8 were used (8). The researchers found that there was good to excellent agreement in all of the BEARS items in the preschool age group (makes BEARS an appropriate screening tool) (8).

	TODDLER/PRESCHOOL (2-5 YEARS)	SCHOOL-AGED (6-12 YEARS)	ADOLESCENT (13-18 YEARS)
Bedtime problems	Does your child have any problems going to bed? Falling asleep? (C)	Does your child have any problems at bedtime? (P) Do you have any problems going to bed? (C)	Do you have any problems falling asleep at bedtime? (C)
Excessive daytime sleepiness	Does your child seem overtired or sleepy a lot during the day? Does he/she still take naps?	Does your child have difficulty waking in the morning, seem sleepy during the day or take naps? (P) Do you feel tired a lot? (C)	Do you feel sleepy a lot during the day? In school? While driving? (C)
Awakening during the night	Does your child wake up a lot at night?	Does your child seem to wake up a lot at night? Any sleepwalking or nightmares? (P) Do you wake up a lot at night? Have trouble getting back to sleep? (C)	Do you wake up a lot at night? Have trouble getting back to sleep? (C)
Regularity and duration of sleep	Does your child have a regular bedtime and wake time? What are they?	What time does your child go to bed and get up on school days? Weekends? Do you think he/she is getting enough sleep? (P)	What time do you usually go to bed on school nights? Weekends? How much sleep do you usually get? (C)
Snoring	Does your child snore a lot or have difficulty breathing at night? (P)	Does your child have loud or nightly snoring or any breathing difficulties at night? (P)	Does your teenager snore loudly or nightly? (P)

(P) Parent-directed question / (C) Child-directed question

Table 4. BEARS Questionnaire

Feature	STOP-BANG	STOP-BNG	Michigan PSQ	I'M SLEEPY	BEARS
Population	Any	Pediatric	Pediatric	Pediatric	Pediatric
Sensitivity (any OSA)	94%	12%	81-85%	Parent: 82% Child: 47%	n/a
Sensitivity (moderate-severe OSA)	94.1%	n/a	n/a	n/a	n/a
Sensitivity (severe OSA)	95.3%	n/a	n/a	n/a	n/a
Specificity	32-52% (cutoff score: 3+) 100% (cutoff score: 8+)	90%	87%	Parent: 50% Child: 58%	n/a
# of questions	8	7	22	8	5

Table 5. Summary of validity indices of included questionnaire assessments

DISCUSSION

I'M SLEEPY:

Kadmon et al. stated that although several pediatric OSA screening questionnaires such as Sleep Related Breathing Disorder Scale (SRBD scale), Children's Sleep Habits Questionnaire (CSHQ), and Sleep Disorders Inventory for Students (SDIS) have good sensitivity and specificity for the diagnosis of OSA, those questionnaires are mainly used for research or in sleep clinics due to their difficult application and high number of questions (5). This suggests that such questionnaires would not be as useful for the screening of children in a primary care clinic setting due to their complexity and high question count.

The significant difference in sensitivity and specificity between the STOP-BNG and I'M SLEEPY can be accounted for by the differing etiologies and clinical presentations of OSA in children and adults (5) (Table 5). The STOP-BNG seems to be more catered towards adults while the I'M SLEEPY is geared towards children. The researchers concluded the I'M SLEEPY questionnaire is better utilized in a primary care setting since it takes less than 1 minute to complete and the catchy mnemonic makes it easier for practitioners to memorize and use when OSA is suspected in a pediatric patient (5). Since the sensibility and sensitivity of the child version of the I'M SLEEPY was significantly lower than those of the parent version, we deduced that it's better to utilize solely the parent version to save time without any net loss of sleep information (Table 5).

BEARS:

The results of the study by Owens et al. suggests that use of the BEARS questionnaire for pediatric sleep problems is significantly more likely than a standard single chart prompt to yield sleep information and information about specific sleep domains (8). We also found that it was hard to compare the BEARS to the other questionnaires because the researchers for both BEARS studies used different statistical tools than those who used sensibility and sensitivity in the other studies (I'M SLEEPY, STOP-BANG, PSQ). A further avenue of research is performing a study that evaluates the sensibility and sensitivity of the BEARS in order to compare it to the other questionnaires we researched. Given the small number of questions in the BEARS questionnaire, we believe the BEARS questionnaire would be effective in the initial process of referring a patient who potentially has POSA in a pediatric instructional clinic setting.

STOP-BANG:

Nagappa et al. identifies the STOP-BANG questionnaire as a tool useful in identifying patients at high risk of OSA. The questionnaire has high specificity for the diagnosis of OSA and has increased probability with higher scores. Because there is no defined cut-off point and it only predicts the likelihood of OSA, it is up to the clinician to interpret the results and decide the next steps.

STOP-BANG is not specific to a particular population. Different studies have effectively used the questionnaire for various groups including sleep clinic patients (6), patients needing surgery (9), obese patients (7), women, men, and Down Syndrome patients (2). The short length and high accuracy make STOP-BANG a valuable clinical tool, however it is not generally used for pediatric patients without modifications to the questions (ie,. STOP-BNG). Other questionnaires, such as the IMSLEEPY or BEARS questionnaires, may be preferable for children since their questions are tailored to them.

Michigan PSQ:

The studies by Chervin et al. suggest that the PSQ is effective in identifying sleep-related breathing disorders in children. But at 22 questions long, the PSQ is significantly longer and more detailed than the other questionnaires evaluated here, potentially limiting its clinical usefulness. As a screening tool, ease of use and efficiency are important considering clinic time is often limited. A short, easy-to-remember series of questions is easier for both the clinician and parent/patient, and shorter questionnaire length has been associated with higher response rate (11). The PSQ is by far the longest questionnaire, and has no easy mnemonic for remembering the questions. However, the specificity of the questions could be diagnostically helpful, so the questionnaire would likely be more useful in the later stages of the diagnosis, rather than in a pediatric teaching clinic such as UoP.

CONCLUSION

The STOP-BANG, Michigan (PSQ), I'M SLEEPY, and BEARS questionnaires were selected by our research to assess the feasibility of their use in a pediatric dental teaching clinic. Factors which were considered included sensitivity, sensibility, ease of memorization, questionnaire duration, and results of statistical analysis to determine effectiveness. Implementing a short, easy to memorize, and effective POSA questionnaire will help students in identifying young patients potentially suffering from obstructive sleep apnea and allows for referral for further sleep apnea testing. Based on our research, the I'M SLEEPY and BEARS questionnaires show the most promise for implementation. This takes into consideration these questionnaires effectiveness (i.e. sensitivity), ease of utilization as determined by number of questions, catchy mnemonic, and short duration when utilized. Further research should be conducted in order to analyze the usability and utility of the I'M SLEEPY and BEARS questionnaires when utilized by dental students in a pediatric instructional dental clinic.

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