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The Children's Report of Sleep Patterns – Sleepiness Scale: A Self-Report Measure for School-Aged Children

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Abstract

Objective—To establish the psychometric properties of a self-report measure of daytime sleepiness for school-aged children.

Methods—Three-hundred eighty-eight children ages 8–12 years (inclusive) from pediatrician's offices, sleep clinic/labs, children's hospitals, schools, and the general population. A multi-method approach was used to validate the Children's Report of Sleep Patterns – Sleepiness Scale (CRSP-S), including self-report measures (questions about typical sleep), parent-report measures (CSHQ, proxy version of CRSP-S, CSHS, Morningness-Eveningness), and objective measures (actigraphy and PSG).

Results—The CRSP-S was shown to be internally consistent (Cronbach's alpha = .77) and the scale's unidimensionality was supported by a one-factor confirmatory factor analysis. A Rasch-Masters Partial Credit model demonstrated that items cover a broad range of sleepiness experiences with minimal redundancy, gaps in coverage, or bias against age, gender, or clinical groups. Test-retest reliability was .82. Construct and convergent validity were demonstrated with actigraphy, parental reports of children's sleepiness, sleep disturbances, sleep hygiene, circadian

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preference, as well as comparison of groups of children (e.g., sleep clinic/lab versus school children).

Conclusions—The CRSP-S is a reliable and valid self-report measure of sleepiness for school-aged children. As an adjunct to parental report measures and objective measures of sleep, the CRSP-S provides a brief and psychometrically robust measure of children's sleepiness. Children who endorse sleepiness should have a more detailed screening for underlying sleep disruptors or causes of insufficient sleep.

Keywords

children; sleepiness; validation; measurement; self-report

INTRODUCTION

In school-aged children, insufficient or disrupted sleep can result in significant daytime sleepiness, impacting attention, learning, and mood(1). In both clinical settings and research studies, sleepiness is most commonly reported by parents. The lack of multiple reporters for children's sleepiness can be problematic, with poor concordance rates between parent and child report as children reach school-age(2;3). As children get older, parents become less aware of a child's sleep onset latency and the frequency and duration of night wakings, each of which may contribute to daytime sleepiness. Further, unless a teacher reports a child falling asleep in class, or the child complains of excessive fatigue, parents may be unaware of the level of daytime sleepiness children experience. Thus it is important to query children directly about their level of sleepiness.

Self-report measures of daytime sleepiness have been validated among middle-school children(4) and adolescents(5;6). However, few studies have examined the self-report of sleepiness in younger school-aged children (8–12 years). There is sufficient evidence that children as young as 8 years of age can provide meaningful information about their own health(7). While child report alone may not be sufficient for research or in a clinical setting, children can provide information above and beyond that of parent report alone. In a study of 8–9 year old children, Paavonen et al. reported that one-third of sleep problems may go unnoticed if a child report is not included(3).

For both clinical and research purposes, there is a need for a validated, brief self-report measure of daytime sleepiness for school-aged children (8–12 years). The objective of this study was to examine the psychometric properties of a new self-report measure of sleepiness for school-aged children, demonstrating the reliability and validity of this scale using both classical and modern psychometric methods. In addition, we utilized multi-method (i.e., objective and subjective) and multi-reporter (i.e., parent and child) approaches for validation.

METHODS

Participants

As seen in Table 1, a total of 600 participants were recruited from multiple settings. Participants were recruited (1) while waiting for a well-child visit in two primary care pediatrician's offices, (2) while waiting for an evaluation in the Sleep Clinic at the Children's Hospital of Philadelphia (CHOP), (3) through community flyers and advertisements in the Delaware Valley, (4) through two independent schools in Adelaide, South Australia, (5) while waiting for an overnight polysomnography at CHOP or the Children's Hospital of Alabama (AL), or (6) during outpatient clinic visits or on the inpatient unit at St. Jude Children's Research Hospital.

A total of 388 children completed the Children's Report of Sleep Patterns – Sleepiness Scale (CRSP-S). With the exception of the Australian school sample (where local ethical requirements prevented the collection of reasons for non-participation or demographic information from refusers), reasons for declining participation were most commonly not enough time or not interested. The overall participation rate was 64.7%. Demographic information was available for 73% of the refusers (excluding the Australian sample). No significant differences were found in age, sex, or race between children who participated and children who did not participate. The final sample was 49.7% male with an average age of 10.1 years (SD=1.4 years, range 8–12 years inclusive). Demographic information by group is seen in Table 1. Information about race was not collected for the Australian sample.

Measures

While all participants completed the CRSP-S, other measures were not uniformly collected across sites. Table 1 shows the different measures completed by each group of participants.

Child Self-Report Measures

Children's Report of Sleep Patterns – Sleepiness Scale: The Children's Report of Sleep Patterns – Sleepiness Scale (CRSP-S) is a 5-item self-report scale for school-aged children. The CRSP-S asks about five different situations where school-aged children should not feel sleepy. While the wording of these items was written specifically for the CRSP-S, the situations were chosen based on the clinical experience of the investigators, as well as a review of other measures of sleepiness (4;8;9). Children were asked to recall a recent typical week when they were not sick or on vacation, and to answer the following question: "How often do you feel sleepy or fall asleep when you are..." for the five situations: eating, talking with someone else, at school, playing, and riding in the car or bus for a short time (less than 20 minutes). The answer choices were Never, Not very often (if it happened less than once a week), Sometimes (if it happened once or twice a week), Usually (if it happened 3–5 times a week), and Always (if it happened every day). Scores ranged from 1=Never to 5=Always, with higher scores indicating more sleepiness. All 388 children completed the CRSP-S

In addition to the CRSP-S, children were asked to provide information about their typical sleep habits. Questions focused on their sleep quantity (whether they thought on most nights they got enough/not enough/too much sleep) and napping behaviors (whether they never napped/napped only when sick/napped sometimes/napped almost every day). These questions were used to examine construct validity. All 388 children completed the questions related to typical sleep habits.

Morningness/Eveningness Scale for Children: The Morningness/Eveningness Scale for Children (M/E) is a child self-report measure that identifies circadian preference(10). Higher scores indicate a morning preference. This scale has shown good reliability (Cronbach's alphas 0.68 to 0.82) and validity compared to objective measures of sleep in children(11;12). The M/E Scale was used as a measure of construct validity in this study, with the expectation that children with an evening preference would be more sleepy (due to later sleep onset times).

Objective Measures of Child Sleep

Actigraphy: To provide an objective measure of child sleep-wake patterns, the Micro Motionlogger Sleep Watch (Ambulatory Monitoring Inc., Ardsley, NY) was worn by a subsample of children for one week on their non-dominant wrist. Compared to polysomnography, actigraphy has been shown to have accuracy of 88–93% and sensitivity to detect sleep of 90–95% in school-aged children(13–15). Data were collected in 1-minute epochs using the zero crossing mode and the Sadeh algorithm(15). Sleep onset and sleep

offset were scored using the 3/5 Minute Rule (3 consecutive minutes of sleep for sleep onset, 5 consecutive minutes of sleep for sleep offset)(16). Participants pressed an event marker to indicate the time they attempted to fall asleep at night and the time they woke in the morning. In addition, participants kept a concurrent daily sleep diary which was used to facilitate the scoring of sleep intervals and identify artifact. Measures derived for this study were total sleep time (greater than or less than 8 hours) and sleep onset time (before or after 10 pm).

Polysomnography (PSG): As the gold standard measure of sleep staging and sleep disordered breathing, overnight PSG was included in this study. PSG was performed in the CHOP Sleep Lab using the Rembrandt polysomnography system (Embla, Broomfield, CO) and in the AL Sleep Lab using the Sandman 9.2 PSG system (Embla, Broomfield, CO). Recorded parameters included: electroencephalography (F3-M2, F4-M1, C3-M2, C4-M1, O1-M2, O2-M1); left and right electrooculogram; submental electromyogram; bilateral tibial electromyogram; electrocardiogram; oronasal airflow with 3-pronged thermistor; nasal pressure with pressure transducer; rib cage and abdominal wall motion via respiratory impedance plethysmography; and end-tidal capnometry. Arterial oxygen saturation with pulse waveform was also recorded, as well as digital video and audio. Studies were scored based on American Academy of Sleep Medicine (AASM) pediatric criteria(17). Variables of interest for the current study included the apnea-hypopnea index (AHI) and sleep efficiency (SE), with the expectation that children who had a higher AHI (and thus greater sleep disordered breathing) would report more sleepiness.

Parent-Report Measures of Child Sleep

Children's Report of Sleep Patterns – Sleepiness Scale, Parent Proxy: A parent proxy version of the CRSP-S was created for this study and used to measure convergent validity. With this parent proxy measure, parents were asked to identify how often their child felt sleepy in the same 5 situations as the CRSP-S.

Children's Sleep Habits Questionnaire: The Children's Sleep Habits Questionnaire is a 45-item parent-report measure of children's sleep(9). Parents are asked to recall sleep behaviors during a typical recent week. The CSHQ has demonstrated adequate reliability (coefficient alpha 0.68 to 0.78, test-retest reliability 0.62 to 0.79) and validity(2;9). Further, a cutoff score of 41 to identify children with significant sleep disruptions produced a sensitivity of 0.80 and a specificity of 0.72. As the CSHQ is one of the most widely used measures of child sleep, the Daytime Sleepiness subscale and the Total Sleep Disruptions scores from this legacy measure were selected to examine construct validity.

Children's Sleep Hygiene Scale—The Children's Sleep Hygiene Scale (CSHS) is one of the only measures of sleep hygiene that has been used in the literature. The CSHS is a 22-item parent-report measure that has demonstrated adequate reliability (coefficient alpha = 0.76) in studies of children (18;19). In the current study the CSHS Sleep Stability and Total Sleep Hygiene scores were used to examine construct validity, as children with inconsistent sleep schedules and poor sleep hygiene are likely to be more sleepy.

Data Analysis

CRSP-S Development—Advanced psychometric methods including both traditional (i.e., classical) and modern (i.e., item response theory) procedures were used throughout instrument development and validation. The general characteristics of each item were assessed using response frequencies, mean, standard deviation, and skewness. We evaluated the unidimensionality of the scale by estimating internal consistency reliability (Cronbach's alpha) and fitting the data to a one-factor confirmatory factor model (CFA) using MPlus

software(20). Goodness of fit to the one-factor model was evaluated using the standardized root mean square residual (SRMR), root mean square error of approximation (RMSEA) and its 90% confidence interval (90% CI), comparative fit index (CFI), and the Tucker-Lewis index (TLI). Guided by suggestions provided in Hu and Bentler (1999), acceptable model fit was defined by the following criteria: RMSEA $\leq .10$, SRMR $\leq .05$, CFI $\geq .95$ and TLI $\geq .95$. Multiple fit indices were used because they provide different information about model fit (e.g., absolute fit, fit adjusted for model parsimony). Used together, the indices provide a conservative and reliable evaluation of fit to the single factor model. Local independence of items was evaluated by examining residual correlations among items in the one-factor model.

A Rasch-Masters Partial Credit model was fit to the data, and model and item fit determined using Winsteps(21). We established item fit to the model through inspection of the infit and outfit statistics and post hoc estimated empirical discrimination parameters. Item scores were used to calibrate item difficulty on a logit scale with a midpoint of 0. Difficulty parameters were inspected to determine whether items supported the comprehensive measurement of sleepiness with minimal gaps and item redundancy. Tests of uniform differential item functioning (DIF) were conducted to identify systematic errors due to group bias based on age [8–10 years ($n = 234$) vs. 11–12 years ($n = 154$)], gender [male ($n = 193$) vs. female ($n = 195$)], and sub-sample [school/community ($n = 87$) vs. clinical ($n = 129$)]. A significant DIF contrast value as evidenced by the Mantel-Haenszel significance test indicates that after adjusting for overall sleepiness, children in one subgroup score higher or lower on an item than those in another group(21;22).

Once the scale composition was established based on results of the aforementioned psychometric analyses, a scale score was calculated by averaging constituent items, with a score ranging from 1 to 5, with higher values indicating greater sleepiness.

Reliability and Validity—Test-retest reliability of the individual items and overall scale was examined using Pearson's correlation, as well as a paired t-test for the overall scale. Construct validity was examined using Pearson's correlation for the CSHQ, CSHS, and M/E Scale, and one-way ANOVA with Tukey's post-hoc analysis to examine children's self-report of typical sleep quantity and napping. In addition, mean CRSP-S scores were compared for children scoring above and below the CSHQ cutoff of 41 (higher scores indicating more sleep problems)(9). Convergent validity was examined using actigraphy and PSG. Discriminative validity was evaluated by comparing sleepiness between children recruited from the community/school and from clinical (sleep) settings using a t-test.

RESULTS

Item descriptive statistics are presented in Table 2. Missing data rates for all items was less than 2%. As is typical of most child health outcome measures(23;24), items were negatively skewed. However, all response options were endorsed for every item. The largest floor effect was observed for 'sleepy while eating' (69.6% endorsed 'never') and the largest ceiling effect was observed for 'sleepy at school' (8.8% endorsed 'always').

Scale dimensionality

Item responses were found to be internally consistent (Cronbach's alpha = .77). The scale's unidimensionality was further supported by the one-factor CFA model. Each of the overall goodness-of-fit indices suggested that the single factor model fit the data well: SRMR = .04; RMSEA = .09, (90% CI = 0.08 – 0.10); CFI = .95; TLI = .96. Item-to-item residual correlations from the one-factor CFA model were examined to test for local independence, which is the assumption that observed items are independent of each other given an

individual score on the underlying trait (sleepiness). Residual correlations were $< .20$ for all item pairs, indicating local independence.

Estimated Rasch parameters and model fit

After determining that the scale met the assumptions of unidimensionality and item local independence, data were fit to the Rasch-Masters partial credit model. As shown in Table 3, all items fit the model according to infit/oufit statistics (within 0.7–1.4 range) and post-hoc estimated discrimination parameters (> 0.7). The scale covered a broad range of estimated level of sleepiness (theta); coverage was 4.0 logits (ranging from -3.1 to 1.0). On average, item difficulties (deltas) covered 3.2 logits with the largest coverage observed for “sleepy while playing” (3.5 logits) and the smallest coverage observed for “sleepy in the car during a short ride” (3.0 logits). No significant differential item functioning was observed by age, gender, or sub-sample.

Test-Retest Reliability

Test-retest was evaluated in 122 subjects 7–28 days after the first administration (mean days between administration = 19.2, median = 22.0). The Pearson’s correlation for the CRSP-S was $.82$, $p < .001$. The Pearson’s correlations for the individual items ranged from $.64$ to $.75$. A paired t-test between the CRSP-S two administrations was non-significant.

Construct Validity

Significant associations were found between the CRSP-S and parent reported sleep measures ($n=159$). More child reported sleepiness was associated with more parent reported daytime sleepiness (CSHQ), $r = .20$, $p = .01$, more parent reported sleep disturbances (CSHQ), $r = .19$, $p = .02$, less parent reported sleep stability (CSHS), $r = -.19$, $p = .02$, and poorer sleep hygiene, $r = -.17$, $p = .03$. Children identified on the CSHQ as having significant sleep disruptions ($n=112$) had significantly higher sleepiness on the CRSP-S (mean=2.0) compared to children without significant sleep disruptions ($n=47$, mean=1.7), $t(157) = -2.28$, $p = .02$. Finally, a significant difference in daytime sleepiness scores was found between children who were reported to “never” nap or “nap only when sick” ($n=71$, mean=1.7) and children who were reported to nap “sometimes” or “almost every day” ($n=37$, mean=2.2), $t(106) = -3.33$, $p = .001$.

For child reported measures, a significant association was found between child reported sleepiness on the CRSP-S and circadian preference, $r = -.27$, $p < .001$, with children who reported a morning preference reporting less daytime sleepiness. A significant difference in sleepiness was found for child reported typical sleep quantity, $F(2,382) = 7.88$, $p < .001$, with post-hoc analyses showing a significant difference between children who reported getting enough sleep ($n=251$, mean = 1.7) and children who reported getting not enough sleep ($n=121$, mean = 2.0). Although not a significant difference, children who reported getting too much sleep ($n=13$) also reported more sleepiness than the other two groups (mean = 2.2). Similarly, children who reported that they “never” napped or “napped only when sick” ($n=250$) also reported significantly less sleepiness (mean=1.6) than children who reported that they napped “sometimes” or “almost every day” ($n=137$, mean=2.2), $t(385) = -6.47$, $p < .001$.

Convergent Validity

Convergent validity was examined using both objective and subjective measures of sleep. Children who averaged less than 8 hours of sleep by actigraphy reported more sleepiness (2.04) than children who averaged more than 8 hours of sleep by actigraphy (1.60). Although this difference was not statistically significant ($p = .08$), a medium effect size was

found (Cohen's $d = 0.57$). Children whose average sleep onset time was later than 10 pm by actigraphy reported significantly more sleepiness (2.01) than children whose average sleep onset time was before 10 pm (mean = 1.42, $sd = .40$), $p = .006$, Cohen's $d = 0.88$. No significant associations were found between child reported sleepiness on the CRSP-S and PSG SE and PSG AHI (r 's less than 0.10).

Discriminative Validity

A significant difference in child reported sleepiness on the CRSP-S was found between children surveyed in the schools ($n=87$, mean = 1.5) and children surveyed in a pediatric sleep clinic or sleep lab ($n=129$, mean = 1.9), $t(214) = 3.45$, $p < .001$, suggesting greater sleepiness in the sleep clinic/lab population.

DISCUSSION

The results of this study demonstrate the reliability and validity of the Children's Report of Sleep Patterns – Sleepiness Scale (CRSP-S) as a brief screener for daytime sleepiness in school-aged children. To our knowledge, this is one of the first self-report measures of sleepiness for 8–12 year old children. The 5-item CRSP-S scale was found to have good internal consistency and to measure a unidimensional trait through confirmatory factor analysis. Modern psychometric methods demonstrated that CRSP-S items cover a full range of the underlying sleepiness construct with few gaps in coverage and minimal redundancies. After controlling for sleepiness, item responses did not differ by age, gender, or sub-sample. Thus, the CRSP-S is a reliable, efficient, unbiased and sensitive screener for moderate to severe levels of sleepiness.

More traditional psychometric methods also demonstrated the reliability and validity of the CRSP-S. As would be expected without intervention, sleepiness was stable over time (test-retest). Construct validity for the CRSP-S was demonstrated with actigraphy and both parent and child reported measures. Children with later bedtimes and shorter total sleep time by actigraphy also reported more sleepiness on the CRSP-S. However, as sleepiness can be a subjective feeling, it was not surprising that the associations between the CRSP-S and parent reported sleep disturbances, sleep stability, and sleep hygiene were low. With the observable behavior of napping frequency, significant differences were found in sleepiness between children who did and did not nap regularly.

The lack of associations between self-reported sleepiness (a subjective feeling) and PSG was consistent with other self-report measures of sleepiness in youth (e.g., CASQ)(5). Statistical differences were not found between children with no OSA, mild OSA, and moderate to severe OSA. However, daytime sleepiness was a presenting concern for the majority of children, thus the sleepiness may be due to poor sleep hygiene, insufficient sleep or other underlying disorders. This is further supported by the significant differences found for sleepiness between children seen in a sleep clinic or sleep lab and children surveyed in the schools, suggesting that children presenting to a sleep clinic are sleepier than school children.

There are limitations to this study that must be noted. Beyond the CRSP-S, not all children or parents completed the same measures. In some cases this may have limited the ability to detect significant associations or differences. Further, the objective measures used (actigraphy and PSG) are not measures of daytime sleepiness, thus future validation studies should include the multiple sleep latency test to provide an objective measure of children's sleepiness.

It should be noted that the CRSP-S was designed as a screening tool (as opposed to a diagnostic tool) that has utility in both clinical settings and research studies. In addition, the CRSP-S is intended to provide information in conjunction with parent report, and is not intended to be used in isolation. This 5-item scale can easily be completed in a primary care or sleep clinic setting, providing additional information (beyond parent report) to clinicians. Elevated scores on the CRSP-S would alert clinicians to provide additional screening for underlying sleep disorders, insufficient sleep, and/or sleep hygiene. Further, the CRSP-S could be used to monitor treatment responses in patients. Similarly in research studies the CRSP-S can provide a brief way to provide information about child daytime functioning.

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Table 1

Demographic Information about Study Participants and Inclusion in Psychometric Analyses

Sample	# Recruited	# Declined	# Participants	% Male	%Caucasian/Black	Age Mean (SD)	IRT	Test-Retest	Convergent Validity	Construct Validity	Actig.	PSG
Primary Care Provider	145	42	103	49.5	64.1/24.3	10.2 (1.5)	✓			✓		
CHOP Sleep Clinic	82	26	56	57.1	62.5/32.1	9.8 (1.4)	✓	✓ (n=29)		✓		✓ (n=37)
Community	48	8	40	50.0	77.5/20.0	9.9 (1.4)	✓	✓ (n=37)	✓		✓	
Australia School	213	126	87	44.8	---	10.1 (1.3)	✓	✓ (n=56)				
CHOP Sleep Lab	30	1	29	44.8	48.3/44.8	10.1 (1.3)	✓		✓			✓
AL Sleep Lab	49	5	44	47.7	31.8/65.9	9.9 (1.4)	✓		✓			✓
St. Jude's	33	4	29	58.6	72.4/33.6	9.9 (1.4)	✓					
Total	600	212	388	49.6		10.1 (1.4)	388	122	107	159	40	110

Note. CHOP = Children's Hospital of Philadelphia, AL = Children's Hospital of Alabama, IRT = Item Response Theory, Actig. = Actigraphy, PSG = Polysomnography, Convergent Validity included parent proxy report of the CRSP-S, Construct Validity included parent-report Children's Sleep Habits Questionnaire and Children's Sleep Hygiene Scale. "✓" indicates inclusion in that type of psychometric analysis.

Table 2

Item descriptive statistics

<i>How often do you feel sleepy or fall asleep when you are...</i>	Never % (N)	Not Very Often (< once/wk) % (N)	Sometimes (1–2 times/wk) % (N)	Usually (3–5 times/wk) % (N)	Always (every day) % (N)	Item Mean (SD)	CFA
At school	41.5 (161)	18.1 (70)	23.2 (90)	8.5 (33)	8.8 (34)	2.25 (1.3)	0.72
Riding in a car or bus for a short time (less than 20 min)	46.1 (179)	23.2 (90)	18.3 (71)	7.5 (29)	4.9 (19)	2.02 (1.2)	0.72
Playing	65.2 (253)	18.3 (71)	10.1 (39)	3.1 (12)	3.4 (13)	1.61 (1.0)	0.69
Eating	69.6 (270)	15.5 (60)	8.2 (32)	3.6 (14)	3.1 (12)	1.55 (1.0)	0.51
Talking with someone else	65.7 (255)	18.6 (72)	10.8 (42)	2.8 (11)	2.1 (8)	1.57 (1.0)	0.56

Notes: Higher mean score indicates more sleepiness.

Table 3

Rasch item fit statistics and parameters

	Infit (Outfit)	Discrimination	Difficulty	Response category difficulties				
				1	2	3	4	5
At school	1.14 (1.11)	0.84	-0.75	-3.08	-1.71	-0.86	-0.21	0.06
Riding in a car or bus for a short time (less than 20 min)	1.20 (1.19)	0.76	-0.27	-2.87	-1.29	-0.67	0.08	0.09
Playing	0.89 (0.80)	1.13	0.25	-2.52	-0.78	-0.30	-0.02	0.96
Eating	0.87 (0.90)	1.06	0.33	-2.34	-0.89	-0.31	0.44	0.82
Talking with someone else	0.85 (0.86)	1.11	0.44	-2.48	-0.84	-0.26	0.50	0.93