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Development and psychometric evaluation of the Children's Sleep-Wake Scale[☆,☆☆]

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ABSTRACT

Objective: To describe the development and psychometric evaluation of the Children's Sleep-Wake Scale (CSWS), a caregiver-report measure of behavioral sleep quality in 2- to 8-year-old children.
Design: Five studies using independent samples were completed to generate, refine, and finalize the item pool, as well as to confirm the factor structure and to assess the reliability and validity of the CSWS.
Setting: Field.
Measures: CSWS, sleep diary, and actigraphy.
Results: Confirmatory factor analysis supported the theoretically proposed 5-factor structure (Going to Bed, Falling Asleep, Maintaining Sleep, Reinitiating Sleep, Returning to Wakefulness). The final questionnaire included 25 items, with items rated on a 6-point scale (Never, Once in Awhile, Sometimes, Quite Often, Frequently-if not Always, and Always); higher scores indicate better sleep quality. We found excellent internal consistency reliability for subscales and the total scale ($\alpha = .81$–$\alpha = .91$), strong test-retest reliability ($r = 0.67$–$r = 0.84$; all P values < .001), moderate-to-strong correlations between CSWS subscale scores and corresponding parental diary ratings ($r = 0.58$–$r = 0.72$; all P values < .001), and weak-to-moderate correlations between CSWS subscales and actigraphic measures ($r = 0.38$–$r = 0.61$; all P values < .001). CSWS subscale scores discriminated 4 extreme groups, thus supporting the construct validity of the scale.
Conclusion: These collective findings indicate that the CSWS has adequate reliability and validity for research instruments and suggest that it is a convenient tool for assessing behavioral sleep quality in preschool-aged and school-aged children.

Introduction

This article describes the development and psychometric evaluation of the Children's Sleep-Wake Scale (CSWS), a caregiver-report measure of behavioral sleep quality in 2- to 8-year-old children. The CSWS differs from existing questionnaires designed to screen for pediatric sleep disorders or to assess childhood sleep disturbances[1,2]: (*a*) it is a research instrument; (*b*) it provides data on the full range of sleep quality, from very good to very poor; and (c) it quantitatively assesses 5 distinct behavioral dimensions of sleep quality, including Going to Bed, Falling Asleep, Maintaining Sleep, Reinitiating Sleep, and Returning to Wakefulness.

A comprehensive understanding of sleep health necessitates complementary behavioral and physiological approaches.[3] Polysomnography is the gold standard for quantifying multiple aspects of sleep physiology, and actigraphy provides ambulatory estimation of continuous sleep states via motor activity.[4] Both, however, are costly and time/labor intensive, and do not capture all behavioral aspects of children's sleep health, such as bedtime resistance or difficulties awakening in the morning. Given the high prevalence of childhood behavioral sleep problems[5–8] and the need to better understand their etiology, consequences, and treatment course, questionnaires with established reliability and validity are needed.

Development of the CSWS was based on a theoretical framework (Fig. 1) that was informed by published models of infant sleep regulation and disturbance[9,10] and empirical data. This framework proposes that children's behavioral sleep quality (middle oval) occurs within the broad context (outer oval) of 2 extrinsic domains (ie, culture and physical environment) and 2 intrinsic child domains (ie,

Abbreviations: CSWS, Children's Sleep-Wake Scale.
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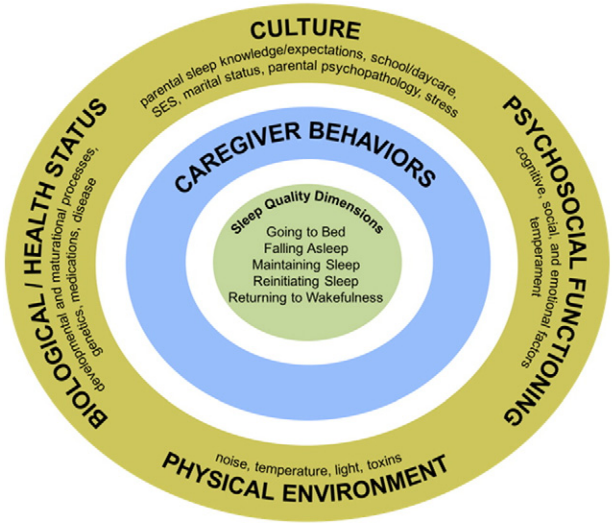

Fig. 1. Transactional model for the study of children's sleep and the development of the Children's Sleep-Wake Scale (CSWS).

psychosocial functioning and biological/health status). Caregiver behaviors (middle oval), including sleep hygiene practices and behavioral change strategies, can mediate or moderate relationships between sleep quality and contextual domain variables. Similar to other transactional models,[11] this framework assumes interactions between domains and differences in relationships between domain variables and sleep. Domain variables can also have a direct impact upon sleep quality and vice versa. Individual combinations of the domain variables influence each behavioral dimension of sleep quality. Difficulties with one or more of these behavioral dimensions can directly impact caregivers' behaviors and, thus, children's psychosocial functioning, development, and health status.

This project utilized conventional and rigorous procedures for scale development and psychometric evaluation.[12,13] Five studies with independent samples were completed. After establishing content validity of generated items, we evaluated internal consistency and refined and/or deleted items (studies 1 and 2). Study 3 examined the factor structure of the CSWS with confirmatory factor analysis (CFA), evaluated subscale-to-subscale correlations, and then reassessed internal consistency. Study 4 examined the 1-month temporal stability (test-retest reliability) of the CSWS. Finally, study 5 evaluated the construct validity of the CSWS via extreme-groups discrimination.

General analysis

Data were analyzed with SPSS version 11.0 (SPSS Inc, Chicago, IL) or version 20.0 (IBM Corp, Armonk, NY). Summary measures include range, %, or M ± SD. Univariate distributions of variables were evaluated for normality, and correlations were computed following inspection of scatterplots to confirm linearity and to identify potential outliers. For all analyses, the significance level was $\alpha = .05$.

Preliminary CSWS development: item generation and content validity

Seep medicine and child psychology experts generated a pool of 79 items written below a sixth grade reading level (1-month reference period; 3-point response set: Rarely, Sometimes, Usually). As a first step, primary caregivers (n = 30) of 2- to 5-year-olds attending a community daycare/preschool provided qualitative feedback on the clarity of directions and items, suitability of the scaling method, and approximate time to complete administration.

Following scale revisions, 9 pediatric sleep experts participated in a quantitative assessment of the scale's content validity.[13] Reviewers evaluated (*a*) the clarity and conciseness of the administration directions and items, (*b*) the content relevance of each item for the 5 proposed sleep quality domains, and (*c*) the comprehensiveness of the entire scale as a measure of children's behavioral sleep quality. Items were rated using a four-point scale (1 = not relevant, 2 = unable to assess relevance without item revision, 3 = relevant, but needs minor revision, 4 = very relevant and succinct). The index of content validity (CVI; range 0-1) for each item was the proportion of experts who gave the item a rating of at least 3 or 4, and the CVI for the entire instrument was the proportion of total items judged to be content valid. Based upon the approach of Lynn,[13] items with CVI < 0.78 were eliminated from the item pool ($\alpha = .05$). Expert review resulted in a total of 77 items with total CVI of 0.93 for the entire instrument.

Study 1: Item refinement

Participants were recruited via flyers, personal contact at community events, daycares, and schools (contact information obtained on-site for subsequent follow-up by researchers), and/or snowball sampling[14] from a tri-county area of southern Mississippi, as guided by the 1990 Census of Population and Housing.[15] The CSWS and a general demographics and health questionnaire were completed by the primary caregiver for only one child per family using a controlled selection method.[16] As approved by the University of Southern Mississippi institutional review board, researchers obtained verbal informed consent from caregivers to participate via telephone. There were no exclusionary criteria.

Researchers contacted 174 caregivers of 2- to 5-year-old children (3.4 ± 1.1 years; Supplemental Data, Table S1) and completed administration of the 77-item CSWS preliminary version with 161 (93% response rate). Subscale items were identified for exclusion if they had corrected item-total correlation coefficients less than $r = 0.30$[17] or a high inter-item correlation ($r = 0.70$) with a more internally consistent item (to avoid redundancy). Inspection of item means and standard deviations served as a secondary criterion for elimination. Items with a high, moderate, and low chance of being endorsed were all desired to facilitate differentiating among varying levels of sleep quality in children. The least discriminating items were deleted if their removal improved the subscale's internal consistency. This analysis resulted in elimination of 35 items and the addition of 8 items (ie, combined highly redundant original items), resulting in a 50-item scale.

Corrected item-total correlations ranged from $r = 0.03$ to $r = 0.80$, and 13 items were considered for elimination due to low values ($r < 0.30$). Subscale inter-item correlations varied widely ($r = 0.00$ to $r = 0.83$); 20 items with high inter-item correlations ($r > 0.70$) were examined for redundancy. Of these items, 2 with item-total correlations lower than the respective redundant item were marked for deletion. The remaining 18 items were retained for the following analysis.

Study 2: Item analysis

We used the same recruitment strategy and approach for obtaining informed consent as described above for study 1. In a new sample of 543 primary caregivers of 2- to 8-year-old children (4.9 ± 2.0 years; Supplemental Data, Table S1) contacted by telephone, 485 responded to the 50-item scale (response rate = 89%). Item analysis and selection followed the same procedure as in study 1, resulting in a total of 39 items. Cronbach α (internal consistency) for the 5 subscales was as follows: Going to Bed (10 items; $\alpha = .83$), Falling Asleep (9 items; $\alpha = 0.72$), Maintaining Sleep (7 items; $\alpha = .73$), Reinitiating Sleep (8 items; $\alpha = .74$), and Returning to Wakefulness (5 items; $\alpha = .85$). Internal consistency reliability for the total scale was $\alpha = .89$.

Table 1
Characteristics of the Children's Sleep-Wake Scale (CSWS) subscale and total scale scores (n = 751; ages 2-12 years).

	Obtained range	M	SD	α	Item-total (r) range
Going To Bed	1-6	3.47	1.2	0.88	0.67-0.77
Falling Asleep	1-6	4.25	1.0	0.83	0.49-0.70
Maintaining Sleep	1-6	4.60	1.0	0.81	0.54-0.68
Reinitiating Sleep	1-6	4.14	1.2	0.81	0.49-0.70
Returning To Wakefulness	1-6	4.01	1.3	0.91	0.71-0.81
CSWS Total Scale	1.25-5.92	4.09	0.8	0.89	0.31-0.63

Based on participants' feedback and data from Bass and colleagues,[18] the 3-point response set was revised to a 6-point scale (Never, Once in Awhile, Sometimes, Quite Often, Frequently-if not Always, and Always), which represents approximately equal quantitative intervals.

Study 3: CFA and scale characteristics

Participants were recruited face-to-face at community events, shopping malls, daycares, and schools, where they signed an institutional review board–approved consent form and completed the CSWS and a general demographics and health questionnaire. A total of 751 of 843 primary caregivers (response rate, 89%) of children aged 2 to 12 years (6.1 ± 3.1 years; Supplemental Data, Table S1) completed the 39-item CSWS.

As described in study 1, item analysis (ie, inter-item correlations and item subscale-total correlations) resulted in the deletion of 14 additional items. We then examined the scale's structure with CFA (AMOS version 5.0; SPSS Inc, Chicago, IL). Principle components analysis with oblimin rotation of the remaining 25 items (Supplemental Data, Table S2) yielded a 5-factor solution with eigenvalues >1.00, accounting for 64.2% of the variance. No items had factor loadings <0.40 or >0.40 for more than one scale. The factor structure was as expected, based on our theoretical framework (Fig. 1). Factor 1, Going to Bed, accounted for 29.9% of the variance and included 5 items; the item, "Child 'puts off' or delays going to bed" was most closely associated with the subscale score. Factor 2, Returning to Wakefulness, explained 13.4% of the variance and included 5 items, with the item "In the morning, child wakes up and is ready to get up for the day" most strongly associated with the subscale score. Factor 3, Reinitiating Sleep, explained 9.4% of the variance, with the item "After arousing or awakening, child awakens others" most closely associated with the subscale score. Factor 4, Maintaining sleep, explained 6.9% of the variance and included 5 items; the item, "During the night, child is very restless" was most highly correlated with the relevant subscale score. Finally, factor 5, Falling Asleep, accounted for 4.5% of the variance and also included 5 items, with the item "Child has trouble going to sleep'" most strongly associated with the relevant subscale.

Descriptive statistics (range, M, SD) and coefficient α values for the 5 subscales and the total scale are presented in Table 1. We observed weak-to-strong Pearson correlations among the subscale scores (Table 2). The Going to Bed and Falling Asleep subscale scores were the most closely related ($r = 0.69$), followed by Maintaining Sleep and Reinitiating Sleep ($r = 0.41$), and then Falling Asleep and Maintaining Sleep ($r = 0.40$). Correlations between Returning to Wakefulness and other subscales were either relatively weak ($r = 0.17$–$r = 0.30$) or showed subscale independence (ie, with Reinitiating Sleep, $r = 0.07$). The final scale and scoring (higher scores = better sleep quality) are presented in the Appendix.

Table 2
Pearson correlations (r) between Children's Sleep-Wake Scale (CSWS) subscales and total scale scores (n = 751; ages 2-12 years).

	GTB	FA	MS	RS	RTW
Going to Bed (GTB)	–	0.69**	0.33**	0.33**	0.30**
Falling Asleep (FA)		–	0.40**	0.33**	0.26**
Maintaining Sleep (MS)			–	0.41**	0.17**
Reinitiating Sleep (RS)				–	0.07
Returning to Wakefulness (RTW)					–
CSWS Total Scale	0.78**	0.77**	0.65**	0.63**	0.57**

** $P < .001$.

Study 4: Test-retest reliability

A total of 55 undergraduate primary caregivers with 2- to 8-year-old children were recruited from psychology classes and administered the 25-item pencil-and-paper version of the CSWS in the research laboratory. Of these, 36 (4.4 ± 2.1 years; Supplemental Data, Table S1) completed the 1-month retest assessment (65% completion rate). The temporal stability assessment of the CSWS showed a reliability coefficient of $r = 0.85$ ($P < .001$) for the CSWS total scale and the following subscale coefficients (all P values < .001): GTB ($r = 0.84$), FA ($r = 0.78$), MS, ($r = 0.75$), RS ($r = 0.67$), and RTW ($r = 0.70$).

Study 5: Construct validity

As a final step, we examined the extent to which CSWS subscale and total scale scores (*a*) converged with other assessments of sleep quality (ie, sleep diary and actigraphy) and (*b*) discriminated groups of children expected to differ on multiple behavioral dimensions of behavioral sleep quality.

Participants recruited via flyers at daycares, schools, and pediatric clinics made direct contact with the research team, who then provided an explanation of the study and obtained informed consent by telephone. Screening involved a structured interview and completion of the Behavior Assessment System for Children (BASC[19]), also administered by telephone (n = 108). For all groups, children aged 2 to 8 years were excluded for major developmental, medical, genetic, learning, or psychiatric problems (eg, autism, chronic pain, developmental delay, attention deficit hyperactivity disorder, obstructive sleep apnea) or for medications affecting sleep or alertness. Specific group criteria included the following:

Exceptionally Good Sleepers (GS). Primary caregivers' rated their child's success for each of the 5 behavioral dimensions of sleep quality on a 10-point analog scale (1 = very poor success, 10 = very good success). Inclusion in the GS group necessitated a rating of at least 8 on all 5 sleep quality domains. Exclusion criteria included the following: (*a*) history of a diagnosed sleep disorder or mental health problem, (*b*) diagnosed mental health problems in first-degree relatives, (*c*) caffeine consumption exceeding 200 mg/d, (d) a variable sleep-wake schedule (ie, >120-minute difference in weekday to weekend bedtimes or wake times), or (*e*) clinically significant scores on the BASC Internalizing or Externalizing scales.

Children with Behavior Problems (BP). Children in the BP group had a reported problematic behavior (eg, noncompliance, anger, hyperactivity, sadness, worry) with no prior/active treatment and scored in the at-risk (*t* score 60-70) or clinically significant range (*t* score >70) on the BASC Externalizing or Internalizing scales.

Children with Sleep-Onset Association Problems (SOA). These children met the minimal criteria established in the International Classification of Sleep Disorders[20] for sleep-onset association disorder during a structured telephone interview with a certified professional counselor with >3 years experience in clinical sleep medicine: (*a*) a complaint of insomnia; (*b*) the complaint is associated with the absence of specific conditions; (*c*) the disorder is present for at least 3 weeks; (*d*) when the associated condition

Table 3
Sample characteristics of discriminant study groups (n = 85).

	GS (n = 17)	BP (n = 20)	SOA (n = 13)	CC (n = 35)	Statistics
Age (y)	5.0 (2.0)	4.9 (1.8)	4.0 (1.6)	5.5 (2.0)	NS
Age range (y)	2-8	2-8	2-6	2-8	NS
Sex (% male)	35.5	50.0	46.2	65.7	NS
Race (% white)	100.0	60.0	61.5	80.0	$\chi^2 = 15.0, p < .05$
Sleep alone (%)	94.1	70.0	00.0	60.0	$\chi^2 = 25.8, p < .001$
4-Factor SES Index	51.5 (9.0)	49.2 (14.0)	45.7 (8.2)	46.7 (13.9)	NS
BASC Externalizing	43.7 (6.1)	66.7 (5.1)	51.0 (13.3)	45.1 (6.8)	$F = 51.2, p < .001$
BASC Internalizing	43.5 (6.2)	52.9 (4.7)	54.8 (10.7)	44.3 (9.2)	$F = 10.3, p < .001$

One-way analysis of variance, *df*(3,81); $P < .05$.
GS, good sleep; BP, behavior problem; SOA, sleep onset association; CC, community control; SES, socioeconomic status; NS, not significant; 4-Factor SES Index, Hollingshead[27]; M (SD).

is present, sleep is normal in onset, duration, and quality; and (*e*) the complaint is not accounted for by an underlying medical or psychiatric disorder or any other sleep disorder.
Community Controls (CC). Children in this group were healthy and did not meet the criteria for any other study group.

The final sample included 83 children (54% boys) aged 2 to 8 years (5.1 ± 1.9 years). Descriptive statistics for group characteristics are presented in Table 3. We found no between-group differences in age or sex; however, the SOA group did not include any children aged 7 to 8-years. The proportion of children who always slept alone differed significantly across groups. All children in the GS group were white; race was significantly different between groups. As expected, children in the BP group had higher BASC Externalizing scores than did children in the other groups ($P < .001$). We also found group differences in Internalizing *t* scores. Post hoc comparisons revealed that the mean Internalizing composite for the SOA and BP groups were significantly higher than the CC and GS groups ($P < .001$).

Measures

Sleep diary

This 7-day diary documented children's bedtimes, wake times, and any intervals the actigraph was not worn. Caregivers' also rated their child's success on each CSWS behavioral sleep quality domain and their child's overall sleep quality on an analog scale from 1 to 10 (1 = very poor success and 10 = very good success). Analysis of sleep diary data included 83 of the 85 participants (n = 2 excluded for acute illness), with 3 to 7 nights aggregated per child (5.7 ± 1.4 nights; 473 nights total).

Actigraphy

Children wore a model AW64 actigraph (Mini Mitter Company; Bend, OR) on their nondominant wrist. One-minute epochs at medium sensitivity were scored as sleep or wakefulness with Actiware-Sleep V 2.53 software using published standard laboratory procedures.[21,22] Caregivers pressed an event marker at bedtime (lights-off) and morning wake time. Sleep episodes were defined as usable if (*a*) the child was not sick or taking medications; (*b*) the caregiver reported no daytime or nighttime atypical events (eg, resistance to wearing watch, spending the night away from home, bedwetting); (*c*) sleep was influenced by external motion (eg, sleeping in a car); (*d*) the actigraph was attached to the child during the entire sleep episode; (*e*) diary data were available; and (*f*) data from the actogram corresponded with the that from the sleep diary. Sleep start time was the first of 3 consecutive epochs of sleep after lights-off time, and sleep end was the time of the last of 5 consecutive epochs of sleep before reported wake time. Sleep summary variables included the following: *sleep latency*, min from lights-off to sleep start; *sleep %*, proportion of sleep min from sleep start to sleep end times[23]; *sleep efficiency (%)*, proportion of sleep min from lights-off to wake time; *wake bouts*, number of continuous blocks of wake (>1 minute) between sleep start and sleep end; and *average wake bout (min)*, mean min of continuous wake bouts between sleep start and sleep end. This analysis included actigraphy data from 69 children. Excluded cases were due to technical problems (n = 7) and an insufficient number of usable nights (n = 9; eg, caretaker noncompliance, illness, medications). The number of usable nights was 3 to 7 (5.6 ± 1.2 nights; 390 total nights).

Procedure

Participants visited the laboratory, where researchers obtained written assent to participate from children (aged ≥6 years), administered the CSWS, and provided a demonstration on actigraph use and sleep diary completion. For the next 7 days, children's sleep was monitored daily with caretaker ratings (sleep diary) and actigraphy. Caregivers returned study materials to the laboratory after the home monitoring period. Actigraphy data were reviewed on-site with families to resolve discrepancies with sleep diaries.[4,21] Children were given a $20 gift card to a local toy store.

Hypotheses

We hypothesized that CSWS subscale and total scale scores would be moderately correlated with relevant sleep diary ratings. We also hypothesized moderate correspondence between CSWS scores and actigraphic measures, including the following: (*a*) Falling Asleep subscale scores would be correlated with sleep latency; (*b*) Maintaining Sleep subscale scores would be correlated with sleep minutes (%) and sleep efficiency; and (*c*) Reinitiating Sleep subscale scores would be correlated with wake bout number and average wake bout length.

We then tested the following hypotheses with our discriminant group approach: (*a*) GS group subscale and total CSWS scores would be higher than those of the CC, BP, and SOA groups; (*b*) BP group Going to Bed subscale scores would be lower than the GS, CC, and SOA groups; (*c*) BP and SOA groups Falling Asleep subscale scores would be lower than the GS and CC groups; (*d*) SOA group Maintaining Sleep and Reinitiating Sleep subscale scores would be lower than those of the GS, CC, and BP groups; and (*e*) BP and SOA total CSWS total scores would be lower than the GS and CC groups.

Analysis

Sleep diary and actigraphy data were aggregated across multiple days. Comparisons of continuous variables were performed with independent-samples *t* tests (2-tailed) or 1-way analysis of variance, and the χ^2 statistic was used for categorical data analysis. Planned comparisons (1-tailed *t* tests) were utilized for discriminant group analyses.

Table 4
Pearson correlations (r) between Children's Sleep-Wake Scale (CSWS) subscale scores and sleep diary ratings (n = 83) and actigraphy measures (n = 69).

	CSWS subscales					CSWS Total
	GTB	FA	MS	RS	RTW	
Sleep diary						
Going to Bed (GTB)	**0.59****	0.51**	0.27*	0.26*	0.22*	0.52**
Falling Asleep (FA)	0.55**	**0.58****	0.39**	0.44**	0.18	0.59**
Maintaining Sleep (MS)	0.32**	0.40**	**0.72****	0.68**	0.14	0.62**
Reinitiating Sleep (RS)	0.28*	0.34**	0.65**	**0.66****	0.05	0.56**
Returning to Wakefulness (RTW)	0.44**	0.35**	0.31**	0.30**	**0.60****	0.54**
CSWS Total	0.48**	0.49**	0.64**	0.65**	0.22*	**0.66****
Actigraphy						
Sleep Latency (min)	−0.45**	**−0.61****	−0.16*	-.036**	−0.05	−0.46**
Sleep Minutes (%)	0.22	0.23	**0.54****	0.51**	−0.01	0.40**
Sleep Efficiency (%)	0.25*	0.30*	**0.49****	0.43**	−0.01	0.41**
Wake Bouts (#)	−0.14	−0.18	−0.37**	**−0.38****	−0.05	−0.29*
Mean Wake Bouts (min)	−0.14	−0.17	−0.25**	**−0.49****	0.03	−0.27*

Bold text indicates hypothesized concordance between measures.
* $P < .01$.
** $P < .001$.

Results

Correspondence between CSWS and sleep diary and actigraphy measures

As hypothesized, we found moderate correlations between CSWS subscale/total scale scores and corresponding analog diary sleep quality ratings ($r = 0.58$ to $r = 0.72$; Table 4). With regard to concordance between CSWS scores and actigraphy measures (Table 4), children with poorer success in Falling Asleep were more likely to have longer sleep onset latencies ($r = 0.61$). Relationships between Maintaining Sleep subscale and actigraphic sleep minutes (%) and sleep efficiency variables were positive and moderate in strength ($r = 0.54$ and $r = 0.49$, respectively). Likewise, correlations between Reinitiating Sleep subscale scores and actigraphic wake bouts (#) and wake bout average (min) were negative and weak-to-moderate in strength ($r = -0.38$ and $r = -0.49$, respectively). CSWS total scores were associated with all actigraphic variables: the strongest correlations were with sleep latency, sleep minutes (%), and sleep efficiency (%).

Discriminant-group analysis

As shown in Table 5, each of our discriminant-group hypotheses was confirmed. Children in the GS group had higher mean scores (better sleep quality) on all CSWS subscales and total scale score relative to the other study groups. We also confirmed that children in the BP group had the lowest mean Going to Bed subscale scores (poorer success in going to bed at night), which was different from the average score of the next lowest group (SOA). Furthermore, Falling Asleep subscale scores were lowest for both the BP and SOA groups; the CC group had the next lowest scores. Two planned contrasts were conducted to evaluate these mean differences. Analyses showed that the mean Falling Asleep score of the CC group was higher (better success in falling asleep at night) than those of children in both the BP or SOA groups. Finally, Maintaining Sleep and Reinitiating Sleep subscale scores for children in the SOA group were lower than those of children in the other study groups.

General discussion

Collectively, these data provide support for the psychometric soundness of the CSWS, a 25-item caregiver-report measure of children's behavioral sleep quality. The range of subscale and total scale scores indicate wide variability in caregiver reports, suggesting that the scale is able to produce scores spanning the full range of sleep quality. The high internal consistency reliabilities and test-retest coefficients of the each of the subscales and the CSWS total scale suggest that it is more than adequate for use in the research settings.[17] CFA results provide strong validation of the proposed model of children's sleep focusing on 5 behavioral dimensions. Furthermore, the appreciable subscale to total scale correlations evidence the convergence

Table 5
Descriptive statistics, M (SD), for the Children's Sleep-Wake Scale (CSWS) subscale and total scale scores for discriminant study groups (n = 85).

	GS (n = 17)	BP (n = 20)	SOA (n = 13)	CC (n = 35)	Planned contrasts	Statistics
Going to Bed	5.0 (0.7)	2.1 (1.1)	2.9 (0.9)	4.0 (0.9)	GS > CC	$t(50) = 7.21, p < .001$
					BP < SOA	$t(31) = -2.46, p < .05$
Falling Asleep	5.3 (0.4)	3.3 (1.4)	3.3 (0.9)	4.6 (0.6)	GS > CC	$t(50) = 4.54, p < .001$
					BP < CC	$t(53) = -3.91, p < .01$
					SOA < CC	$t(46) = -4.55, p < .001$
Maintaining Sleep	5.4 (0.4)	4.6 (0.9)	3.3 (1.0)	4.8 (0.7)	GS > CC	$t(50) = 3.34, p < .01$
					SOA < BP	$t(31) = 3.85, p < .01$
Reinitiating Sleep	5.4 (0.6)	4.0 (1.1)	2.5 (0.8)	4.4 (1.1)	GS > CC	$t(50) = 7.09, p < .001$
					SOA < BP	$t(31) = 4.11, p < .001$
Returning to Wakefulness	5.0 (0.9)	3.6 (1.1)	3.6 (1.2)	3.9 (1.1)	GS > CC	$t(50) = 9.26, p < .001$
CSWS Total	5.2 (.43)	3.5 (0.8)	3.2 (0.5)	4.3 (0.4)	GS > CC	$t(50) = 7.12, p < .001$
					BP < CC	$t(53) = -4.48, p < .001$
					SOA < CC	$t(46) = -7.82, p < .001$

Independent-samples t tests ($P < .05$, 1-tailed).
GS, good sleeper; BP, behavior problem; SOA, sleep onset association; CC, community control.

of the latent construct, behavioral sleep quality, and provide an empirical basis for averaging subscale scores to produce a total scale score for use as an outcome measure.

Additional evidence supporting the construct validity of the CSWS is provided by the confirmation of predicted CSWS profiles for distinct groups of children. As hypothesized, GS children had higher scores on all 5 CSWS subscales than did other study group participants. These findings are especially important because they support the CSWS' ability to discriminate between not only good and poor sleepers, but also *very good* sleepers and *average* sleepers, such as children in the community control group. We also found that children in the BP group had poorer Going to Bed subscale scores than did other group participants, and that both the BP and SOA groups had lower scores on the Falling Asleep subscale than did GS and CC children. These results suggest that the CSWS could be a valuable tool in general pediatric clinics, where behavioral sleep complaints, especially evening settling problems, are common.[5–8] Finally, as predicted, analysis of scores on the Maintaining Sleep and Reinitiating Sleep subscales showed that children with SOA difficulties had lower scores than other group participants. These findings suggest that the CSWS successfully discriminates between children who do and do not exhibit nighttime awakens and/or difficulties getting back to sleep.

With regard to concordance between the CSWS and other measures, caregiver reports from the CSWS were moderately correlated with related sleep diary assessments. Even greater correspondence might have been obtained if the number of days a sleep diary was kept (1 week) had been equal to the reporting interval for the CSWS (1 month). The CSWS subscale scores also showed significant correspondence with specific objective actigraphic estimates of sleep quality. For example, Falling Asleep subscale scores were moderately associated with the actigraphic measure of sleep onset latency. As anticipated, the other actigraphic measures (ie, sleep minutes %, sleep efficiency, wake bouts, mean wake bout minutes) were more closely associated with the Maintaining Sleep and Reinitiating Sleep subscales (assessing sleep during the night) than the Going to Bed, Falling Asleep, and Returning to Wakefulness subscales (beginning and end-of-the-night assessments). The modest strength of our observed associations, although similar to previous published data of correspondence between different sleep assessments (ie, questionnaires, sleep logs, and actigraphy[24,25]) has several potential explanations. Actigraphy provides assessment of movement and, thus, is an appropriate criterion measure for the Maintaining Sleep subscale. It does not, however, assess the full content evaluated by the Falling Asleep and Reinitiating Sleep subscales (eg, needs help getting or going back to sleep, awakens other family members). Furthermore, caregivers of children who do not signal during the night (eg, call out, wake others) and reinitiate sleep independently are most likely unaware of the number and duration of their children's nocturnal awakenings.[26] Because school-aged children tend to signal to their parents during the night less often than preschoolers,[25] validity coefficients for these subscales may differ as a function of children's age and sleep problem status.

This collective work is based on multiple independent studies and rigorous procedures, which are strengths in scale development and psychometric evaluation. Several limitations, however, should be noted. First, we collected data with children living strictly in southern Mississippi, which poses a threat to external validity. Further research with children living in other geographical areas and cultural contexts is needed to determine the generalizability of our findings. Second, it is uncertain whether the children included in the GS group were actually "exceptionally" good sleepers, which may have influenced our discriminant group analysis. Because there is a lack of normative data on children's sleep, defining exceptionally good or adequate sleep in childhood is problematic. Such understanding will require future experimental studies investigating the relationship between nighttime sleep quality and daytime functioning. Third, although we examined the internal consistency and factor structure of the CSWS in children aged 2 to 12 years, the collective and most comprehensive psychometric evaluation of the scale (including test-retest reliability and construct validity) was performed on a more restricted age range. Thus, investigators should use the CSWS in children aged 9 to 12 years with some caution, as this marks a period of decreased parental involvement in sleep routines and the transition to puberty. Finally, selection of the 6-point response set for the final version of the CSWS was based on rigorous investigation of the statistical properties of various scales of frequency[18]; however, it is possible that this approach resulted in perceptual bias between different participants, which could be improved by objective quantification of categories (eg, "Once in Awhile" = 2-3 times per week).

In summary, the CSWS quantitatively assesses 5 distinct behavioral dimensions of sleep quality in 2- to 8-year-old children. The catalyst for developing the CSWS was the need for a convenient instrument with acceptable reliability and validity that assesses the full range of children's behavioral sleep quality. The present results are consistent with a multidimensional model of sleep quality and suggest that the CSWS has adequate-to-excellent content validity, internal consistency, and test-retest reliability, as well as good construct validity. Although subjective sleep instruments have unavoidable weaknesses (eg, caregivers' restricted and biased knowledge about their children's sleep), the CSWS holds promise as a tool for (*a*) describing normal developmental changes in children's sleep quality, (*b*) identifying children at risk for sleep disturbance, (*c*) studying protective factors associated with healthy sleep and risk factors for poor sleep health, and (*d*) examining the role of sleep in child development.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.sleh.2016.04.001.

References

1. Bruni O, Ottaviano S, Guidetti V, et al. The Sleep Disturbance Scale for Children (SDSC). Construction and validation of an instrument to evaluate sleep disturbances in childhood and adolescence. *J Sleep Res*. 1996;5(4):251–261.
2. Owens JA, Spirito A, McGuinn M. The Children's Sleep Habits Questionnaire (CSHQ): psychometric properties of a survey instrument for school-aged children. *Sleep*. 2000;23(8):1043–1051.
3. Buysse DJ. Sleep health: can we define it? Does it matter? *Sleep*. 2014;37(1):9–17.
4. Acebo C, LeBourgeois MK. Actigraphy. *Respir Care Clin N Am*. 2006;12(1):23–30.
5. Beltramini AU, Hertzig ME. Sleep and bedtime behavior in preschool-aged children. *Pediatrics*. 1983;71(2):153–158.
6. Bruni O, Lo Reto F, Miano S, Ottaviano S. Daytime behavioral correlates of awakenings and bedtime resistance in preschool children. *Suppl Clin Neurophysiol*. 2000; 53:358–361.
7. Jenni OG, Fuhrer HZ, Iglowstein I, Molinari L, Largo RH. A longitudinal study of bed sharing and sleep problems among Swiss children in the first 10 years of life. *Pediatrics*. 2005;115(1 Suppl):233–240.
8. Lozoff B, Wolf AW, Davis NS. Sleep problems seen in pediatric practice. *Pediatrics*. 1985;75(3):477–483.
9. Blampied NM, France KG. A behavioral model of infant sleep disturbance. *J Appl Behav Anal*. 1993;26:477–492.
10. Sadeh A, Anders TF. Infant sleep problems: origins, assessment, interventions. *Infant Ment Health J*. 1993;14:17–34.

11. Sameroff AJ. The Transactional Model of Development: How children and contexts shape each other. In: Sameroff AJ, editor. Washington, DC: American Psychological Association; 2009.
12. DeVellis RF. Scale development: theory and applications. Newbury Park: Sage Publications; 1991.
13. Lynn MR. Determination and quantification of content validity. *Nurs Res*. 1986;35:382–385.
14. Goodman LA. Snowball sampling. *Annals of Mathematical Statistics*. 1961;32(1):148–170.
15. Bureau USC. 1990 Census of population and housing: population and housing unit counts, Mississippi. Washington D.C.: U.S. Government Printing Office; 1993
16. Kish L. Survey sampling. New York: John Wiley & Sons, Inc.; 1965.
17. Nunnally JC, Bernstein IR. Psychometric theory. 3rd. ed. New York: McGraw-Hill Book Company; 1994.
18. Bass BM, Wayne FC, Edward JO. Magnitude estimates of expressions of frequency and amount. *J Appl Psychol*. 1974;59(3):313–320.
19. Reynolds C, Kamphaus RW. Behavior Assessment System for Children (BASC). Circle Pines, MN: AGS Publishing; 1992.
20. Association A.S.D.. The International Classification of Sleep Disorders Diagnostic and Coding Manual. Lawrence, Kansas: Allen Press; 1990.
21. Acebo C, Sadeh A, Seifer R, Tzischinsky O, Hafer A, Carskadon MA. Sleep/wake patterns derived from activity monitoring and maternal report for healthy 1- to 5-year-old children. *Sleep*. 2005;28(12):1568–1577.
22. Berger RH, Miller AL, Seifer R, Cares SR, LeBourgeois MK. Acute sleep restriction effects on emotion responses in 30- to 36-month-old children. *J Sleep Res*. 2012;21(3):235–246.
23. Craven HJ, Seifer R, LeBourgeois MK. Correspondence between actigraphy and PSG measures of sleep onset latency in young children. *Sleep*. 2012;35:A127.
24. Wolfson AR, Carskadon MA, Acebo C, et al. Evidence for the validity of a sleep habits survey for adolescents. *Sleep*. 2003;26(2):213–216.
25. Tikotzky L, Sadeh A. Sleep patterns and sleep disruptions in kindergarten children. *J Clin Child Psychol*. 2001;30(4):581–591.
26. Mindell JA. Sleep disorders in children. *Health Psychol*. 1993;12(2):151–162.
27. Hollingshead AA. Four-factor index of social status. *Yale J Socio*. 2000;8:21–52.