A CONFIRMATORY FACTOR ANALYSIS OF THE CHILDREN'S REPORT OF SLEEP PATTERNS

BY

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Abstract

Sleep is essential for learning, memory, neurobehavioral functioning, and emotion regulation. The importance of sleep in children has led to the creation of numerous sleep assessment instruments. However, there is a dearth of validated self-report measures. In an attempt to fill the gap, the Children's Report of Sleep Patterns (CRSP) was developed for children ages 8-12. Despite its apparent strengths, the initial validation of the complete CRSP in this age group reported a number of scales and indices that were not empirically evaluated and only Cronbach alphas were reported. To further explore the psychometric properties of the CRSP in school-aged children, factor analysis is necessary to understand the latent structure, as well as the relationships among the constructs. The purpose of this study was to examine the first-order factor structure of the Sleepiness Scale and the Sleep Disturbances Scales of the CRSP in a sample of preadolescent children. As an exploratory aim, the degree to which the five scales contributed to a higher-order Sleep Problems Total Score was examined. Participants were 3rd-5th grade children recruited from two elementary schools (N = 109). Results of the current study revealed that the hypothesized first-order factor structure is not supported and several modifications are necessary to achieve acceptable model fit. Based on modifications from the first-order model, the Sleep Problems Total Score was derived, achieving high internal consistency. Therefore, it is recommended that the Sleep Problems Total Score be calculated and used in conjunction with other scales obtained from the CRSP. Despite promising findings, researchers and clinicians interested in using the CRSP should continue to assess its validity by exploring the relationship between the measure and objective measures of sleep patterns and behavior.

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Introduction

Sleep is a multifaceted, iterative experience critical for learning, memory, neurobehavioral functioning, and emotion regulation (Curcio, Ferrara, & De Gernnaro, 2006; Gruber, Laviolette, Deluca, Monson, Cornish, & Carrier, 2010; Hobson & Pace-Schott, 2002, Pilcher & Huffcut, 1996; Wolfson & Carskadon, 1998). On average, sleep consumes approximately 40% of a child's day (Mindell & Owens, 2009). In a national survey, parents indicated that school-aged children averaged 9-9.5 hours of sleep per night (Mindell, Meltzer, Carskadon, & Chervin, 2009), despite recommendations of 10-11 hours for children in this age range (Meltzer & Mindell, 2006). Inadequate sleep in elementary school-aged children has been linked to numerous daytime impairments including behavioral problems, deficits in attention, anxiety, irritability, hyperactivity, depression, and academic performance, including diminished learning capacity (e.g., Buckhalt, El-Sheikh, Keller, & Kelly, 2009; Curcio et al., 2006; El-Sheikh, Kelly, Buckhalt, & Hinnant, 2010; Gruber, Laviolette, Deluca, Monson, Cornish, & Carrier, 2010; Stein, Mendelsohn, Obermeyer, Amromin, & Benca, 2001; Wolfson & Carskadon, 1998).

When asked about children's sleep duration in the previous week, nearly one-third of parents reported that their child experienced at least one night of inadequate sleep (Smaldone, Honig, & Byrne, 2007). Among typically developing children, shorter sleep duration may be attributed to increasingly later bedtimes (after 9 p.m.), televisions in bedrooms, and consumption of caffeinated beverages during the day (Mindell et al., 2009). Beyond poor sleep hygiene routines, approximately 25% of typically developing children experience inadequate sleep due to assorted sleep problems (Mindell & Owens, 2009), including difficulty with sleep onset latency, bedtime resistance, complaining of uncomfortable feelings in their legs, and increased nighttime fears (Mindell, Carskadon, Chervin, & Meltzer, 2004; Smaldone, Honig, & Byrne, 2007).

The discrepancy between needed and obtained sleep most often results in daytime sleepiness, which subsequently affects behavior, academic performance, and other facets of daily living. According to Dement (1993), sleepiness is defined as "an awake condition that is associated with an increased tendency for an animal or person to fall asleep" (p. 554), and results in a limitation in functional capacity. Generally viewed as a subjective experience, sleepiness is quantified for children by using measures containing adjectives such as "sleepy" or "fuzzy," and contains possible scenarios in which the child may fall asleep (e.g., "*How often do you feel sleepy or fall asleep while you are eating?*"). Increased sleepiness among children has negative implications for attention, learning, and mood (Beebe, 2011; Chorney, Detweiler, Morris, & Kuhn, 2008; Gregory & Sadeh, 2012). Researchers have noted significant impairments in parent-reported behavioral difficulties, positive affect, and higher-order cognitive processes in the presence of increased sleepiness (Fallone, Owens, & Deane, 2002). Inadequate sleep and daytime sleepiness have also been linked to increased risk of unintentional injury among children and adolescents (Koulouglioti, Cole, & Kitzman, 2008; Owens, Fernando, & McGuinn, 2005; Valent, Brusaferro, & Barbone, 2001).

Within the field of pediatrics, failing to inquire about sleep patterns is common practice among professionals. Data suggest that less than 8% of general practitioners discuss sleep problems with their patients (Blunden, Lushington, Lorenzen, Ooi, Fung, & Kennedy, 2004). Of additional concern is that parents tend to underreport their children's sleep problems, with only 13.9% of parents mentioning sleep problems to the child's doctor and 11.4% actually seeking advice. These results are striking, as nearly 25% of parents reported sleep disturbances in the clinical range when completing a questionnaire during a “sick” visit at their child’s general practitioner office (Blunden et al., 2004). Frequently, questions about sleep duration and disruptions only receive attention once children begin displaying problem behavior, impaired mood, and declining academic performance (Chervin, Archbold, Panahi, & Pituch, 2001; Smaldone et al., 2007). Sleep problems are then typically addressed with an intervention only after children present to sleep clinics or after they receive a diagnosis of a chronic illness. The minimal dialogue between parents and pediatric care professionals may be the result of an under recognition of sleep disorders in children, as well as a lack of understanding and identification of important symptoms (Chervin et al., 2001).

The importance and relevance of sleep in children has led to the creation of numerous sleep assessment instruments. To date, two reviews have been published summarizing the strengths and weaknesses of existing measures. In 2007, Lewandowski, Toliver-Sokol, and Palermo published a review of 21 existing sleep measures. Of the 21 identified measures, six measures (see Table 1) met criteria for a classification of “well-established,” based on the recommendations put forth by the American Psychological Association Division 54 Evidence-Based Assessment Task Force (Cohen et al., 2008). Four of these measures were labeled as “multidimensional,” suggesting that they assess a broad range of sleep problems. The Brief Infant Sleep Questionnaire (Sadeh, 2004) focuses on sleep duration, location, and night wakings among infants; whereas, the Children’s Sleep Habits Questionnaire (Owens et al., 2000; Goodlin-Jones et al., 2008), the Pediatric Sleep Questionnaire (Chervin et al., 1997, 2000), and the Sleep Disturbance Scale for Children (Bruni et al., 1996) place more emphasis on various sleep disturbances, including snoring, breathing problems, hyperhydrosis, as well as sleep anxiety and resistance. Despite their comprehensive nature, each measure assesses different sleep domains with some overlap between measures.

Table 1

Pediatric sleep measures determined to be well-established by Lewandowski et al., 2007

Measure	Ages	Subscales	Reporter
Infant Sleep Questionnaire (Morrell, 1999)	12-18 months	Sleep habits, Parent's view of sleeping difficulties	Parent
Pediatric Daytime Sleepiness Scale (Drake et al., 2003)	11-15 years; Additional 5-13 years validation sample	Sleepiness	Child & Adolescent
Brief Infant Sleep Questionnaire (Sadeh, 2004)	0-29 months	Nocturnal sleep duration, Daytime sleep duration, Number of night wakings, Duration of wakefulness during the night hours, Nocturnal sleep-onset time, Settling time, Method of falling asleep, Location of sleep, Preferred body position	Parent
Children's Sleep Habits Questionnaire (Owens et al., 2000; Goodlin-Jones et al., 2008)	4-10 years; Additional 2.5-5 years validation sample	Bedtime Resistance, Sleep Onset Delay, Sleep Duration, Sleep Anxiety, Night Wakings, Parasomnias, Sleep Disordered Breathing, Daytime Sleepiness	Parent
Pediatric Sleep Questionnaire (Chervin et al., 1997; Chervin et al., 2000)	2-18 years	Snoring, Breathing problems, Mouth breathing, Daytime sleepiness, Inattention/hyperactivity, Other symptoms	Parent
Sleep Disturbance Scale for Children (Bruni et al., 1996)	5-15 years	Disorder of initiating and maintaining sleep, Sleep breathing disorder, Disorders of arousal/nightmares, Sleep wake transition disorders, Disorders of excessive somnolence, Sleep hyperhydrosis	Parent

A later qualitative review of 57 sleep assessment tools (Spruyt & Gozal, 2011) found a number of methodological weaknesses in the sleep assessment literature. For example, Spruyt and Gozal (2011) commented that the process of measure development tends to lack standardized methodological steps for validation and evaluation. At times, investigatory teams miss crucial steps in the measure development process. Spruyt and Gozal's 2011 review also reported concerns regarding the lack of evidence of validity and overreliance on reliability, as well as minimal use of factor analytic techniques. Of the 57 identified sleep assessments, only two provided a comprehensive report of psychometric criteria, signifying the methodological weaknesses of the field. These weaknesses limit the conclusions that can be drawn from the data and lead to ambiguity in the constructs of interest.

Although there was relatively little overlap in the measures reviewed by Lewandowski et al. (2007) and Spruyt and Gozal (2011), the two investigatory teams reached some similar conclusions and common themes emerged. For instance, Lewandowski and colleagues (2007) found that sleep measures assessing multiple dimensions were the most widely used; yet, according to Spruyt and Gozal (2011), the majority of existing assessment tools singularly focus on sleep-wake patterns and sleep problems, although several tools include sleepiness and sleep disturbance scales (e.g., sleep-disordered breathing, insomnia). This suggests that multidimensional measures are more widely used, but singularly focused measures are more numerous in the field. Additionally, both reviews agreed that past research has generally focused on parent-report measures with few self-report measures, primarily for children age 11 and older. Finally, Lewandowski et al. (2007) reported the need for more factor analytic techniques to better understand the constructs being assessed, especially the use of objective sleep assessment tools in the validation process. Spruyt and Gozal (2011) further highlighted this concern by commenting on the lack of confirmatory factor analyses, and by extension, the demonstration of construct validity.

Based on these observations, both reviews put forth recommendations to strengthen existing sleep measures and aid in the development of future assessments. First, Lewandowski et al. (2007) and Spruyt and Gozal (2011) noted the need for more self-report measures. Lewandowski et al. (2007) called for more reliable and valid child- and youth-report measures, especially for youth of different ages. Spruyt and Gozal (2011) also reported that additional child-report measures are still needed, as their estimates indicate that the majority of existing measures are parent report. Children's report of their own sleep behavior becomes increasingly important with age. When relying solely on parent report, estimates suggest that one-third of sleep problems, including body pains and waking up during the night, go undetected (Amschler & McKenzie, 2005; Owens, Spirito, McGuinn, & Nobile, 2000). Research has shown that children are able to provide reliable and valid information regarding their health when given developmentally-sensitive questionnaires (Riley, 2004). Further, children may be able to provide insight into and information about their sleep behaviors of which their parents may be unaware.

Within child-report measures, specific assessments of sleep hygiene and insomnia are still needed (Lewandowski, Toliver-Sokol, & Palermo, 2007). Of note, a measure of sleep hygiene is missing from all four "well-established" multidimensional measures. Yet, commonly, sleep problems in childhood are related to poor sleep hygiene, including caffeine intake, activities before bed, and sleep location (e.g., Hayes, Parker, Sallinen, & Davare, 2001). Future measures should also allow for differential reports of weeknight and weekend sleep behavior, as children's "typical" nighttime sleep patterns often differ during the week (e.g., Spruyt, Molfese, & Gozal, 2011). Inquiring about independent weeknight and weekend sleep behavior will provide more descriptive data, which can be used to evaluate patterns that emerge based on the time of the week. Spruyt and Gozal (2011) recommended a self-report option when inquiring about sleep onset latency, bedtime and wake time, and sleep duration, rather than relying on categorical data to examine this information.

In an attempt to address the lack of child-report measures with the added capability of capturing insomnia and sleep hygiene, Meltzer and colleagues (2013) developed the Children's Report of Sleep Patterns (CRSP), a multidimensional self-report measure for children ages 8-12. Building on the sleep measures available in the literature, some items for the CRSP were drawn from existing measures (e.g., Pediatric Daytime Sleepiness Scale [Drake et al., 2003], Epworth Sleepiness Scale [Melendres, Lutz, Rubin, & Marcus, 2004], Children's Sleep Habits Questionnaire [Owens et al., 2000]), while other items were generated by the authors based on their clinical experience. After the questions were formulated, a multidisciplinary team of 15 sleep experts categorized each item into one of the three modules (Sleep Patterns, Sleep Hygiene Index, and Sleep Disturbance), and then classified them into the specific indices/scales.

The CRSP consists of four Sleep Hygiene indices (Caffeine Index, Activities Hour Before Bed Index, Sleep Location Index, and Electronics Use at Sleep Onset Index), four Sleep Disturbances Scales (Bedtime Fears/Worries Scale, Restless Legs Scale, Parasomnias Scale, and Insomnia Scale), three Indicator Items, and a Sleepiness Scale. Each Sleep Disturbance Scale serves as a latent construct and is made up of two to six items. Each question is expected to independently load onto its predetermined construct. The Sleepiness Scale serves as a single construct consisting of five items.

A preliminary validation study of the five-item Sleepiness Scale in children ages 8-12 yielded promising findings in support of the scale (Meltzer et al., 2012). The Sleepiness Scale demonstrated adequate internal consistency ($\alpha = .77$). Additionally, sleepiness was relatively stable over time (test-retest reliability = .82) and construct validity for the scale was supported through actigraphy and child-report measures of sleep disruptions, sleep quantity, and frequency of naps. Interestingly, the correlations between sleepiness and parent-reported sleep disturbances and sleep hygiene were weak, signifying that sleepiness is a subjective experience that is not adequately captured by an outside reporter. Overall, these findings suggest that a child's perspective of their own sleepiness is highly relevant and beneficial. Furthermore, preliminary evidence is provided for the independent utility of the Sleepiness Scale, although it remains unknown how the Sleepiness Scale functions as part of the CRSP.

In 2013, the initial validation study of the complete CRSP displayed several strengths. Construct validity was supported when the Sleep Disturbances Scales and the Sleep Hygiene Indices were positively associated with the total Sleep Disturbance score of the Children's Sleep Habits Questionnaire (Owens et al., 2000) and the Children's Sleep Hygiene Scale (LeBourgeois, Giannotti, Cortesi, Wolfson, & Harsh, 2004), respectively. The CRSP was also able to differentiate between children presenting to a sleep clinic, sleep laboratory, and pediatric oncology hospital (Meltzer et al., 2013). As was expected, children in the clinical sample reported more sleep disturbances and, consistent with previous research (National Sleep Foundation, 2004, 2006), older children reported poorer sleep hygiene. Children who reported poorer sleep quality experienced more sleep disturbances and had poorer sleep hygiene. Test-retest reliability was > .80 for indices/scales with the exception of the Restless Legs Scale. Intraclass correlations between parent- and child-report ranged from .42-.71, suggesting that both reporters are able to uniquely contribute information about children's sleep behavior.

The development of the CRSP addressed many of the recommendations put forth by Lewandowski et al. (2007) and Spruyt and Gozal (2011). First, support was provided for the self-report nature of the measure. A significant number of children reported poor sleep quality, night wakings, and difficulties falling asleep, which went unreported by their parents. Results from the CRSP validation study demonstrated that children were able to contribute unique information about their sleep patterns independent of what their parents were observing. The response format of the CRSP encouraged a differentiation between school and weekend nights. Second, the inclusion of the descriptive section on sleep patterns allowed for a differentiation between what is considered a "typical" night's sleep on both weekdays and weekends, addressing the need for distinction as identified by Lewandowski and colleagues (2007). Furthermore, Meltzer and colleagues (2013) responded to the call to validate the CRSP with other sleep assessment tools by including actigraphy and polysomnography as part of the initial validation study. Third, the CRSP was responsive to recommendations by Spruyt and Gozal (2011) regarding the need for noncategorical descriptors of sleep patterns (e.g., bedtime, wake time, sleep duration): The CRSP allows children to self-report bed- and wake times, as well as provides categorical response options in which answers are presented in 30-minute increments.

While the CRSP provides a first step in examining child self-report of sleep hygiene in relation to a multitude of other sleep problems that a child may experience, it is not without its own limitations. Despite a preliminary publication of the five-item Sleepiness Scale which yielded good model fit (e.g., root mean square error of approximation [RMSEA] = .09, standardized mean square residual [SMSR] = .04, and comparative fit index [CFI] = .95) and adequate internal consistency (α = .77; Meltzer et al., 2012), the initial validation of the complete CRSP in children ages 8-12 reported a number of scales and indices that were not empirically evaluated and only Cronbach alphas were reported. Relying solely on internal consistency is an unsound practice, as it says nothing about what construct is being assessed (Spruyt & Gozal, 2011). Further, the alphas reported (.64-.76) were generally below the acceptable threshold for clinical (.90) and research (.80) use (Carmines & Zeller, 1979; Streiner, 2003; Nunnally, 1967). The lack of exploratory and confirmatory factor analyses suggests that refinement of the measure may be necessary to improve its representation of the constructs of interest.

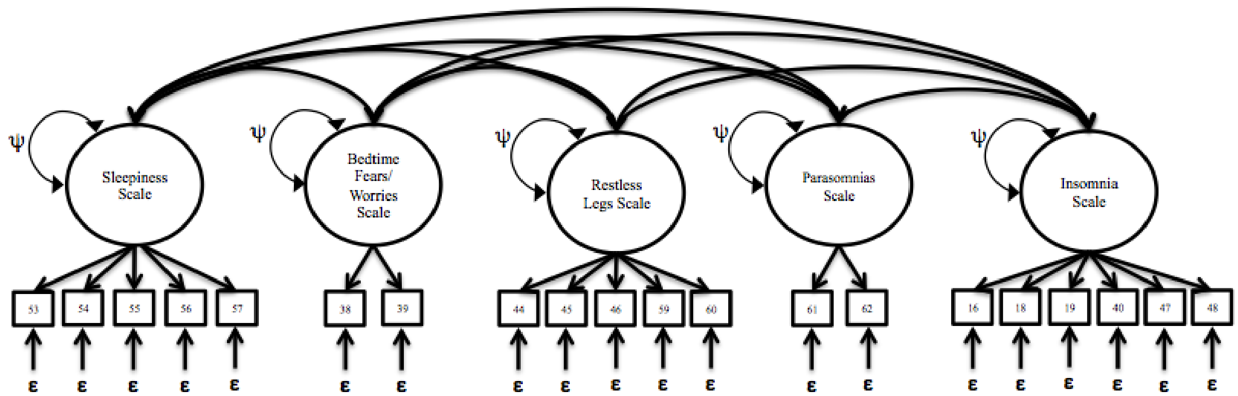
Following publication of the initial CRSP validation study with children ages 8-12, Meltzer et al. (2014) published a second validation study in adolescents (ages 13-18). Based on findings from Meltzer et al. (2013), the Restless Legs Symptoms Scale was divided into two categories to reflect symptoms experienced by the adolescent (Restless Legs Symptoms) and those observed by others (Restless Legs Report). An item capturing difficulty falling asleep because of worries about the day was moved from the Insomnia Scale to the Bedtime Fears/Worries Scale as the item was believed to more accurately reflect anxiety-related cognitive distortions experienced in adolescence. The factor structure of the Sleep Disturbances Scales was evaluated using confirmatory factor analysis (CFA). All items loaded significantly onto the expected factors and moderate to good fit (e.g., RMSEA = .08, SMSR = .06, and CFI = .91) was demonstrated by fit indices. All scales were significantly associated with self-reported sleep quality in the expected direction, which suggests that a higher order construct may be beneficial to more succinctly describe an adolescent's sleep disturbance behavior. Generally, estimates of internal consistency among the scales were similar (.61-.76) to the original (2013) sample. The Bedtime Fears/Worries Scale demonstrated the lowest internal consistency of the Sleep Disturbances Scales (α = .61); however, among children in the Meltzer et al. (2013) publication, this scale yielded an internal consistency score more consistent with the other scales (α = .70). This perhaps suggests a developmental differential response pattern or item interpretation between children and adolescents.

As suggested by Holmbeck and Devine (2009), a standardized process of measure evaluation lends support to an instrument's evidence base. A major component of the process involves measure refinement, an iterative process that requires validation through numerous studies across multiple samples. To further explore the psychometric properties of the CRSP in school-aged children, factor analysis is necessary to understand the latent structure, as well as the relationships among the constructs. The refinement process encourages close examination of each item. Scrutinizing each item individually aids in the determination of its content and performance, which may lead to more parsimonious models with greater interpretability (Brown, 2006). Furthermore, without further investigation of the measure, poor discriminant validity between factors may go undetected (Brown, 2006).

The primary aim of the proposed study is to validate the CRSP in a community sample of 3^{rd}–5^{th} grade children. Structural equation modeling (SEM) was used to conduct a CFA of the originally proposed model (Meltzer et al., 2012, 2013; see Figure 1) of the CRSP. As noted previously, in the initial validation study consisting of children ages 8-12, the factor structure of the Sleep Disturbance Scales were not examined, and in the 2014 study, the sample consisted of children ages 13-18. The present study tests the factor structure of the Sleepiness Scale and the Sleep Disturbances Scales of the CRSP in a sample of preadolescent children. Specifying the factor structure of these scales provides a test of the appropriateness of the measure for use in community samples. It is hypothesized that the factor structure of the Sleepiness Scale and the Sleep Disturbances Scales reported by Meltzer et al. (2012, 2014; see Figure 1) will hold in this population. Latent constructs are hypothesized to positively correlate with one another.

Figure 1

Single-step CFA model examining the correlations of latent constructs and their association with objective sleep data

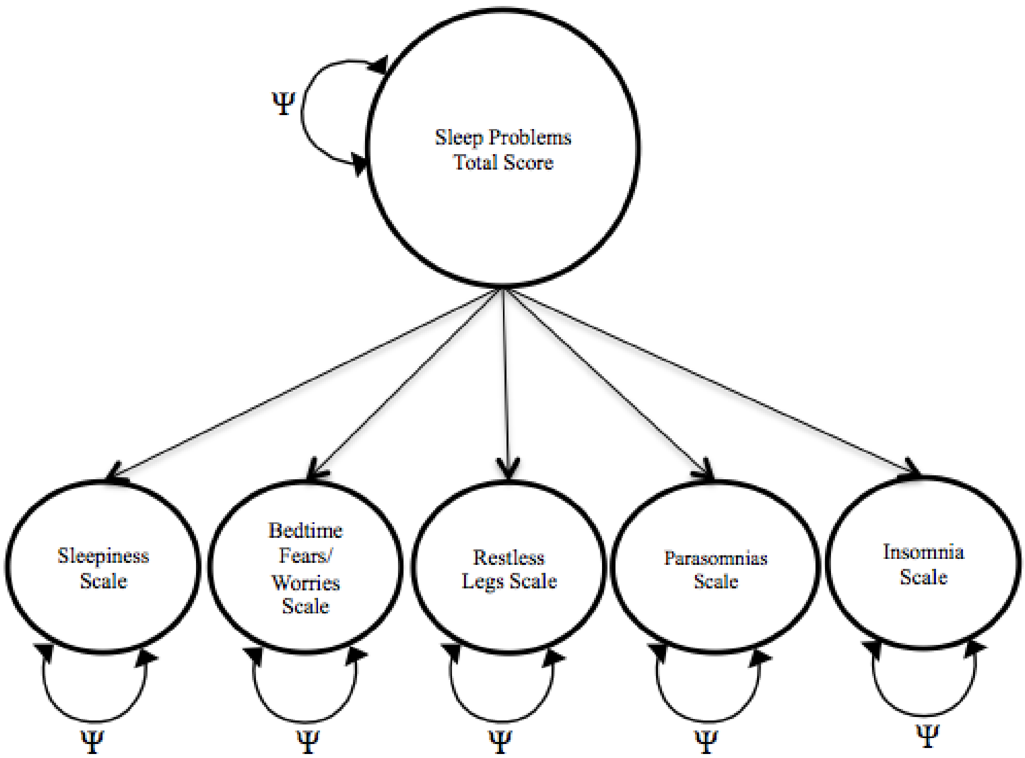


Building on the proposed model in Aim 1, an exploratory aim will examine the degree to which the five scales contribute to a higher-order latent construct (Figure 2). Respecification of the initial CFA model may improve parsimony and account for covariation among latent constructs. If the initial model fits the data well, it is hypothesized that a higher-order CFA will yield a Sleep Problems Total Score. Successful respecification of the initial model would provide support for a more global sleep problems dimension consistent with existing measures in which a total score is calculated (Owens, Maxim, Nobile, McGuinn, & Msall, 2000; Owens et al., 2000).

Although previous publications of the CRSP have examined individual Sleep Disturbances Scales, evaluation of sleep disturbances as a global dimension is important for several reasons. Establishing a higher order composite of these scores may indicate the extent of sleep problems. Elevated levels across domains may have treatment implications based on the severity of the problems. Other similar measures such as the Children's Sleep Habits Questionnaire (Owens et al., 2000), and the Children's Sleep Hygiene Scale (LeBourgeois et al., 2004) provide a total score. Owens, Spirito, and McGuinn (2000) have demonstrated that a total score is a viable option for differentiating between community samples and children presenting to sleep clinics. A Sleep Problems Total Score from the CRSP would allow for efficient assessment of overall sleep problems, after which contributors to the total problems score could be examined.

Figure 2

Second-order factor structure evaluating the Sleep Problems Total Score



Overall, the proposed study seeks to provide additional support for the CRSP in a sample of children ages 8-12. The use of CFA will determine the factor structure in this population and the appropriateness of a higher-order Sleep Problems Total Score. Confirmation of the factor structure would make the CRSP the only "multidimensional" self-report sleep measure that captures insomnia and sleep hygiene in one assessment.

Methods

Procedures

Two elementary schools in Lawrence, Kansas were targeted for inclusion in the study based on the variability in demographic characteristics and socioeconomic status. After receiving approval from the Institutional Review Board of the University of Kansas (Office of Research) , Unified School District 497, and respective building principals, 3rd, 4th, and 5th grade students were recruited from the two elementary schools. All eligible students were given an information sheet and consent form that was completed by the child's parents before the child could participate in the proposed study. In addition, children provided assent prior to data collection and were given the opportunity to withdraw from the study.

Questionnaire packets were sent home with participating children and were completed and returned five days later. Questionnaire packets included measures about physical activity, eating attitudes, health-related quality of life, and affect as part of a larger three-year longitudinal study. Research assistants returned to the schools to collect the questionnaire packets. Students who returned their packets were mailed a $5 gift card as an incentive for packet completion.

Questionnaire packets were distributed to 133 children. A total of 109 packets (82%) were returned to the schools. The final sample consisted of 109 participants and was comprised of 52 females (47.7%). Mean age of participants was 9.55 year (SD = 1.01 years). Participants were predominantly Caucasian (67%). Other races/ethnicities were represented as follows: 3.7% of participants identified as Hispanic, 2.8% identified as American Indian, 8.3% identified as Black (non-Hispanic), 3.7% identified as Asian, and additional 14.7% identified as belonging to some "other" ethnic/racial group. Due to the variability in sample characteristics between schools, the demographic information is presented separately in Table 2.

Table 2

Demographic Characteristics

Demographics	**Quail Run Elementary (*n* = 71)**	**New York Elementary (*n* = 38)**
Age (years)	9.54 (*SD* = 1.01)	9.23 (*SD* = .87)
Gender		
Male	41 (57.8%)	16 (42.1%)
Female	30 (42.2%)	22 (57.9%)
Race/Ethnicity		
White (non-Hispanic)	54 (76.1%)	19 (50.0%)
Black (non-Hispanic)	5 (7.0%)	4 (10.5%)
Hispanic	1 (1.4%)	3 (7.9%)
Asian	4 (5.6%)	0 (0.0%)
American Indian	1 (1.4%)	2 (5.3%)
Other	6 (8.5%)	10 (26.3%)

Measures

Self-Report of Sleep Patterns and Behaviors. The Children's Report of Sleep Patterns (CRSP; Meltzer et al., 2013) is a 62-item self-report multidimensional measure of sleep that has been shown to differentiate between children presenting to a sleep laboratory, sleep clinic, and pediatric oncology clinic. Questions included in the Sleep Patterns section provide descriptive information about typical bedtime and wake times during weekdays and weekends. The measure consists of four Sleep Hygiene indices (Caffeine Index, Activities Hour Before Bed Index, Sleep Location Index, and Electronics Use at Sleep Onset Index), four Sleep Disturbances Scales (Bedtime Fears/Worries Scale, Restless Legs Scale, Parasomnias Scale, and Insomnia Scale), three Indicator Items, and a Sleepiness Scale. The CRSP has been validated in children ages 8-12, demonstrating questionable reliability (α = .64-.76; George & Mallery, 2003). Test-retest reliability was > .80 for indices/scales with the exception of the Restless Legs Scale. Metlzer et al. (2013) reported that internal consistency statistics for the four Sleep Hygiene indices were not calculated as multiple indicators for indices may be indicative of frequency (e.g., caffeine). Intraclass correlations between parent- and child-report ranged from .42-.71, suggesting that children are able to uniquely contribute information that parent reports may not be capturing. As described in Meltzer et al. (2014), composite scores for the domains of interest were calculated and used for analyses.

Data Analysis

Confirmatory factor analyses (CFAs) with covariates (i.e., multiple indicator, multiple cause; MIMIC models) were conducted to examine the factor structure of the CRSP in the current sample. Hypothesized MIMIC models were performed using SEM in Mplus 7 (Muthén & Muthén, 1998-2011). Grade and school were entered as covariates to explore the measurement equivalence of the CRSP between schools and across grades. Testing the invariance of a measure is necessary to ensure that differences in mean levels between groups are due to meaningful and true differences, and not because of unintended differences in measurement (Brown, 2006).

First-Order Factor Structure. First, a single-step model using SEM was performed on the entire sample in an attempt to establish the factor structure (Figure 1). Specifically, a five-factor measurement model was specified corresponding to the Sleepiness Scale, Bedtime Fears/Worries, Restless Legs, Parasomnias, and Insomnia scales. The latent factors were allowed to correlate freely.

Second-Order Factor Structure. To determine the utility of a Sleep Problems Total Score, a second-order measurement model was specified (Figure 2). The Sleep Problems Total Score was made up of the five latent constructs derived from the Sleep Disturbances Scales and Sleepiness Scale.

Model Fit Indices

Several model fit indices were used to examine the fit of the two hypothesized models. A chi-square statistic was used to indicate the overall fit of the models. Nonsignificance of the chi-square statistic suggests that the model fits the data. Due to the sensitivity of chi-square to sample size, other fit indices were evaluated. To examine the magnitude of fit between the sample and model covariance matrices, Bentler's comparative fit index (CFI) and the Tucker-Lewis index (TLI) were included. The root mean square error of approximation (RMSEA) was included as it assesses how the model fits the population. Fit indices were evaluated using guidelines put forth by Little (2013). Good model fit for CFI and TLI was set at .95, while values between .90-.95 represent an acceptable fit, .85-.90 represent a mediocre fit, and <.85 represent a poor fit. The RMSEA was considered a poor fit if the value was >.10, a mediocre fit if the value ranged from .10-.08, an acceptable fit if it fell between .08-.05, a good fit if between .05-.02, and a great fit if the value was <.01.

Power Analysis

A Monte Carlo simulation study was used to calculate a power analysis. Marker variable methodology was used to fix the first indicator of each construct to 1.0. The other parameters were freely estimated. School and grade served as covariates. The model was identified so that each variable loaded on only one factor. The data were generated so that the factors correlated at .50 in the population. Results of the power analysis for the measurement model examining correlations between the Sleep Disturbances Scales and the Sleepiness Scale (*df* = 135) indicated that 110 participants would be required to achieve a close fit to the data if a close fit is achievable. To evaluate the exploratory aim, the simulation study indicated that 110 participants (*df* = 144) would again be necessary to achieve a close fit to the data if a close fit is possible.

Missing Data

Missing data analysis was performed to determine the amount and pattern of missing data among the returned packets. Results suggested that the data were missing completely at random, indicating that there was no relationship between the missing and observed values. The missing data were likely the result of participant oversight. Due to the marginal amount of missing data in the first model (1.39%), the expectation maximization (EM) algorithm in Statistical Package for the Social Sciences version 22 (SPSS) was used to generate a complete dataset. In the EM algorithm, regression analyses are used to impute missing variables and the complete data set is then modeled using maximum likelihood (Kline, 2011).

Data Screening

Prior to performing analyses, the distribution of the data was screened for normality. The majority of CRSP items were significantly positively skewed (i.e., <1.0; see Table 3). Based on these findings, data were modeled using Robust Maximum Likelihood (MLM) using the Satorra-Bentler X^2 (X_{SB}^2) scaled test of model fit. The X_{SB}^2 is a corrected model test statistic, in which a scaling correction is applied to the model X^2 when the data are non-normal (Brown, 2006). When using the X_{SB}^2, a scaled difference in chi-square test should be used to evaluate differences in model fit (Brown, 2006).

Results

Descriptive Statistics. To test the relationship between school and grade level, a Pearson's Chi-Square Test of Independence was performed. There was not a statistically significant relationship between the variables, $X^2(2) = 1.41$, $p > .05$, suggesting that grade level was unrelated to school.

Table 3

Descriptive Statistics for the Children's Report of Sleep Patterns

CRSP Item	M (SD)	α
Bedtime Fears/Worries		.72
38	1.63 (.77)	
39	1.58 (.73)	
Restless Legs Symptoms		.80
44	1.61 (.89)	
45	1.55 (86)	
46	2.02 (1.22)	
Restless Legs Report		.64
59	1.62 (.61)	
60	1.83 (.68)	
Parasomnias		.32
61	1.42 (.51)	
62	1.20 (.43)	
Insomnia		.80
16	1.91 (.78)	
18	1.62 (.79)	
19	1.97 (1.11)	
40*	1.88 (.94)	
47	1.98 (.91)	
48	2.02 (.92)	
Sleepiness		.87
53	1.27 (69)	
54	1.29 (.70)	
55	1.61 (.96)	
56	1.23 (.52)	
57	1.68 (.96)	
Sleep Problems Total Score		.81

Note. *Item deleted from all analyses.

Aim 1. Aim 1 of the current study was to establish the factor structure of the CRSP in a community sample of 3rd, 4th, and 5th grade children. Specifically, a five-factor MIMIC model of the Sleepiness Scale and the Sleep Disturbances Scales was specified based on the factor structure proposed by Meltzer et al. (2012, 2013). Grade and school served as covariates to assess measurement invariance and heterogeneity. In the null model, the error terms of the 20 items were freely estimated and factor loadings were fixed to 0. The baseline model yielded a poor fit to the data, X_{SB}^2 (230, *N* = 109) = 1014.52, *p* < .001, CFI = 0.00, TLI = 0.00 RMSEA = 1.8. The alternative model was compared to this model and model respecification was based on change in fit statistics relative to the null model.

Alternative Model. The five-factor hypothesized MIMIC model (see Figure 1) was specified using MLM to account for non-normality of the data. Grade and school were included as covariates and latent constructs were allowed to correlate freely (see Figure 4). Compared to the baseline model, fit significantly improved as evidenced by the Satorra-Bentler scaled test of model fit, ΔX_{SB}^2 (38, *N* = 109) = 580.79, *p* < .001. However, fit statistics continued to demonstrate a poor fit to the data, X_{SB}^2 (192, *N* = 109) = 345.64, *p* < .001, CFI = .80, TLI = .77, RMSEA = .09. All factor loadings were significant, but three items loaded below .4 (*"You kick your legs when you are sleeping;" "You move a lot in your sleep;" "Are you thinking about that day or the next day which makes it hard to fall asleep?"*), suggesting that they explain less than 16% of the variance of the latent factor.

Based on the low factor loadings referenced above, and recommendations by Meltzer et al. (2014), item numbers 59 (*"You kick your legs when you are sleeping."*) and 60 (*"You move a lot in your sleep."*) on the Restless Leg Scale were loaded onto a new factor, the Restless Leg Report Scale (see Figure 3). Additionally, item number 40 on the Insomnia Scale (*"Are you thinking about that day or the next day which makes it hard to fall asleep?"*) was moved to the Bedtime Fears/Worries Scale. Respecification of the model revealed an improvement in model fit, ΔX_{SB}^2 (45, *N* = 109) = 631.75, *p* < .001. The resulting fit indices were in the poor to acceptable range, X_{SB}^2 (185, *N* = 109) = 296.26, *p* < .001, CFI = .86, TLI = .82, RMSEA = .07.

A final revised model was tested in which item number 40 (*"Are you thinking about that day or the next day which makes it hard to fall asleep?"*) was removed. Fit significantly improved, ΔX_{SB}^2 (64, N = 109) = 723.66, p < .001, and fit statistics demonstrated a mediocre to acceptable fit, X_{SB}^2 (166, N = 109) = 243.92, p < .001, CFI = .89, TLI = .86, RMSEA = .07.

As previously stated, grade and school were entered in the model as covariates to account for potential noninvariance. The regression paths from grade to Bedtime Fears/Worries (Υ = -.39), Restless Legs Symptoms (Υ = -.25) and Sleepiness (Υ = .20) were significant. The regression paths from school to Restless Legs (Υ = .22) and Sleepiness (Υ = .32) were also significant. The nonsignificant regression paths were retained as pruning them may affect the solution in small sample sizes (Kline, 2011).

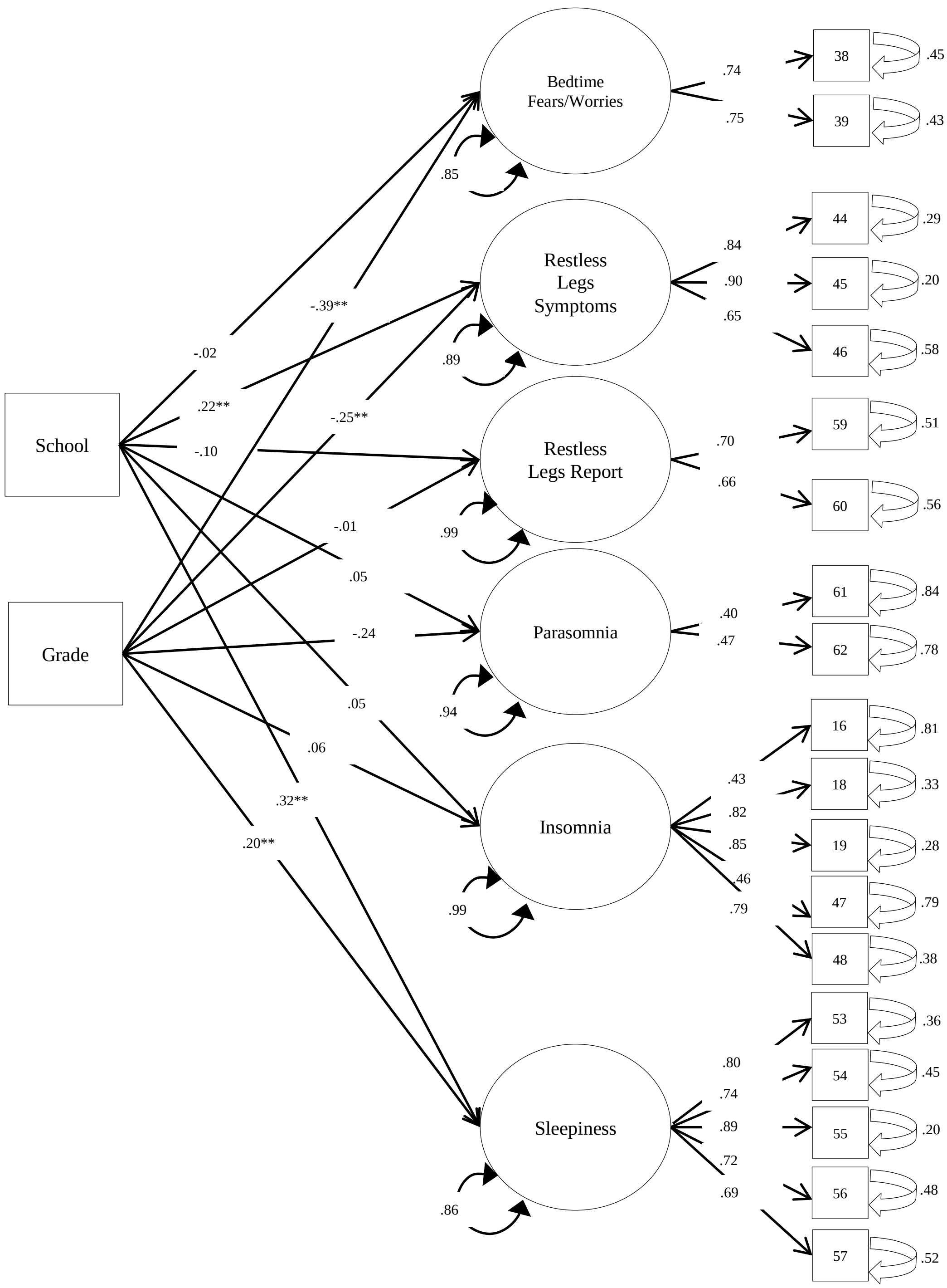
Table 4

Estimated and Standardized Factor Loadings, Residuals, and R^2 Values for Each CRSP Indicator

Indicator	Standardized Loading (SE)	Theta	R^2
Bedtime Fears/Worries			
38	.74 (.05)	.45	.55
39	.75 (.06)	.43	.57
Restless Legs Symptoms			
44	.84 (.06)	.29	.71
45	.90 (.04)	.20	.80
46	.65 (.07)	.58	.42
Restless Legs Report			
59	.70 (.05)	.51	.49
60	.66 (.05)	.56	.44
Parasomnias			
61	.40 (.09)	.84	.16
62	.47 (.10)	.78	.22
Insomnia			
16	.43 (.10)	.81	.19
18	.82 (.04)	.33	.67
19	.85 (.04)	.28	.72
47	.46 (.09)	.79	.22
48	.79 (.04)	.38	.62
Sleepiness			
53	.80 (.06)	.36	.65
54	.74 (.06)	.45	.55
55	.89 (.03)	.20	.80
56	.72 (.07)	.48	.52
57	.69 (.06)	.52	.48

Figure 3

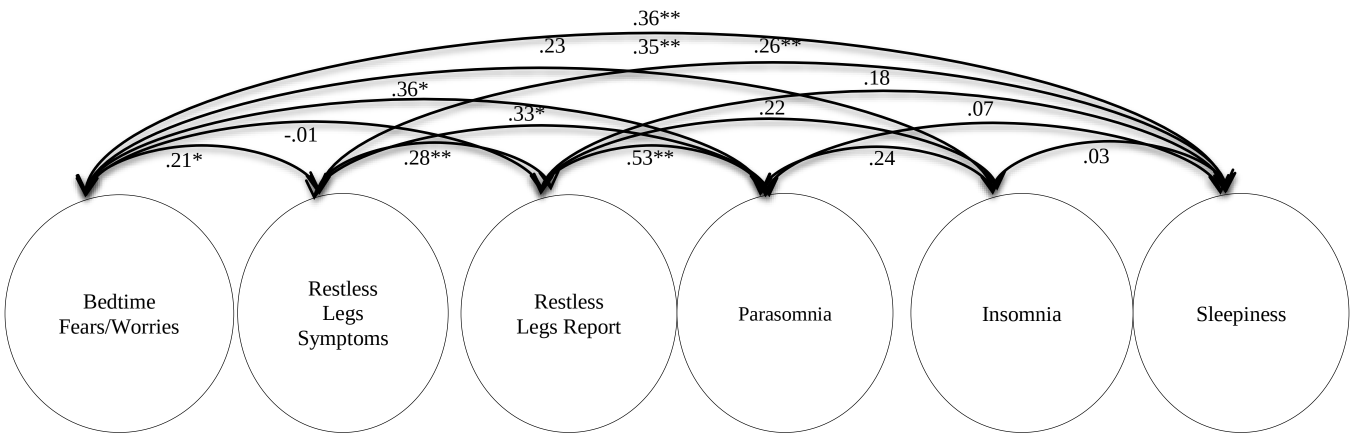
Aim 1 Revised Alternative Model



Note. Due to the small sample size, nonsignificant relationships among covariates and latent factors were not pruned as they may alter the solution (Kline, 2011); * $p \leq .05$, ** $p \leq .01$

Figure 4

Latent Correlations of the Aim 1 Revised Alternative Model



Note. * $p \leq .05$, ** $p \leq .01$

Aim 2. To test the degree to which the six scales contribute to a Sleep Problems Total Score (Figure 5), a higher-order latent construct was specified. The Sleep Problems Total Score was made up of the six latent constructs (Bedtime Fears/Worries, Restless Legs Symptoms, Restless Legs Report, Parasomnias, Insomnia, and Sleepiness) derived from the alternative model in Aim 1. All factor loadings were significant (Table 5) and the higher-order model demonstrated a mediocre to acceptable fit to the data, X_{SB}^2 (175, N = 109) = 258.69, p < .001, CFI = .88, TLI = .86, RMSEA = .07.

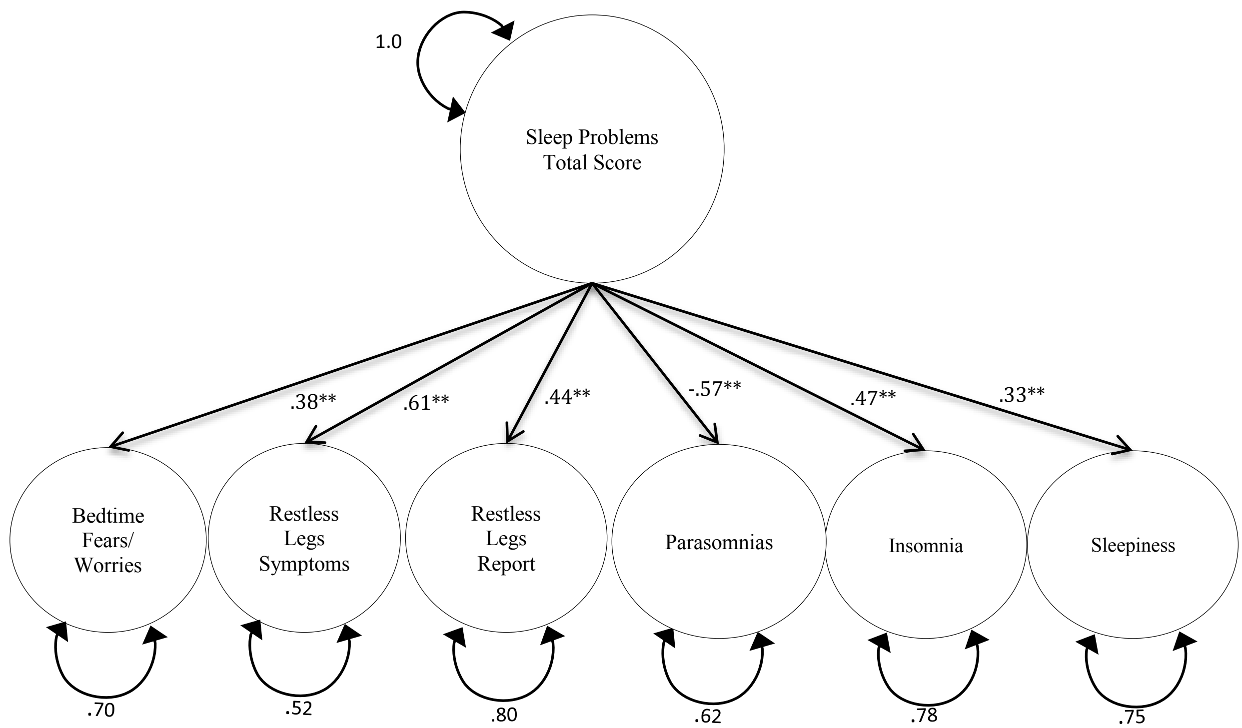
Table 5

Estimated and Standardized Factor Loadings, Residuals, and R^2 Values for the CRSP subscales on the Sleep Problems Total Score

Indicator	Standardized Loading (SE)	Theta	R^2
Bedtime Fears/Worries	.38 (.14)	.70	.30
Restless Legs Symptoms	.61 (.12)	.52	.48
Restless Legs Report	.44 (.12)	.80	.20
Parasomnias	.57 (.21)	.62	.38
Insomnia	.47 (.13)	.78	.22
Sleepiness	.33 (.13)	.75	.25

Figure 5

Aim 2 Higher Order Factor Structure



Note. * $p \leq .05$, ** $p \leq .01$

Reliability. Cronbach's α was used to estimate the internal consistency of the Sleep Disturbances and Sleepiness Scales. For the present sample, internal reliability coefficients ranged from .32 to .87 (Table 3). The poor internal consistency of the Parasomnias Scale may be the result of only having two items. However, it should be noted that the internal consistencies are significantly lower than previous findings (Meltzer et al., 2013; Meltzer et al., 2014).

Discussion

The current study aimed to evaluate the factor structure of the Children's Report of Sleep Patterns in a community sample of 3^{rd}-5^{th} grade children. For continued development and validation, a factor analysis was necessary to understand the latent structure of the instrument, as well as the relationships among the hypothesized constructs. As suggested by Holmbeck and

Divine (2009), factor analysis, as part of a standardized process of measure development, lends support to an instrument's evidence base. Not unlike other widely used measures (e.g., Children's Depression Inventory; Kovacs, 1985, 1992), the CRSP was theoretically developed, utilized, and only subsequently factor analyzed in an adolescent population. A standardization sample of elementary-age children is lacking and this is the first known attempt to factor analyze the CRSP in a sample of children in which it was originally intended to be used. Consequently, the model fit indices from this study were interpreted as compared to a null model because model fit in a similarly aged sample is unavailable.

The findings from the present study do not support the hypothesized factor structure of the CRSP in a community sample of elementary-age children. The original subscales represent a structure proposed by Meltzer et al. (2013) with poor fit to the data and weak factor loadings. Based on modifications and recommendations made by Meltzer et al. (2014) in an adolescent sample, an alternative factor structure was tested using these data. Although the previous publication of the revised CRSP in adolescents yielded moderate to good fit indices (Meltzer et al., 2014), the model fit in this younger sample was significantly worse.

A major component of the iterative process of measure development involves measure refinement (Holmbeck & Divine, 2009). Although the hypothesized factor structure does not hold as expected, findings from the present study suggest that model fit may be improved by several modifications. First, in line with modifications made by Meltzer et al. (2014), it is recommended that the Restless Legs Scale be divided into two subscales, Restless Legs Symptoms and Restless Legs Report. The construction of two independent scales improves model fit and results in stronger factor loadings for the items on each subscale. Meltzer et al. (2014) postulated that this change might reflect the subjective experience of restless legs symptoms versus symptoms reported to the child by another person or caregiver. Furthermore, the creation of two scales is consistent with other measures of restless legs symptoms in which both parent- and self-report information is solicited (Pediatric Restless Legs Syndrome Severity Scale; Arbuckle et al., 2010), signaling that the detection of different aspects of restless legs symptoms varies based on the reporter.

As a second modification to the CRSP, results from this study suggest that item 40 (*"Are you thinking about that day or the next day which makes it hard to fall asleep?"*) be removed. Meltzer et al. (2014) moved the item to the Bedtime Fears/Worries subscale speculating that it better captures cognitive distortions related to anxiety rather than the experience of insomnia. However, in this sample, three models were tested: 1) the proposed factor structure in which item 40 loads onto the Insomnia subscale, 2) a respecified model in which item 40 was moved to the Bedtime Fears/Worries subscale and, 3) a final model in which the item was removed from the model entirely. Fit indices of the final model (i.e., with item 40 removed) suggested a significantly better fit to the data. The significant improvement in model fit after removal of the item may be attributed to previous attempts to constrain the item to one factor, even though results suggest it loads adequately on two. Consequently, improvement in model fit was observed after the item was removed. It is conceivable that model fit would improve if the item were allowed to load onto multiple factors. Nevertheless, this theory was not tested because recommendations within the CFA literature suggest that modifications should be restricted to those justified on the basis of prior theory (Brown, 2006; Silvia & MacCallum, 1988). The proposed modifications ultimately resulted in a model with mediocre to acceptable fit indices.

Despite acceptable model fit, three of the subscales (Bedtime Fears/Worries, Restless Legs Report, and Parasomnias) yielded coefficient alpha scores below the acceptable threshold for research use (Carmines & Zeller, 1979; Streiner, 2003; Nunnally, 1967). However, when applying a more liberal cut-off value (i.e., $<.70$; Nunnally, 1978), the Bedtime Fears/Worries subscale falls into the acceptable range. The low internal consistencies of the Restless Legs Report and Parasomnias subscales should be interpreted with caution, as these two scales are limited to two items each. Because the loadings of the indicators on their respective latent factors are significant, the low internal consistencies are not necessarily problematic; instead, it may suggest that the items are uniquely contributing information and are capturing different components of the construct (Ackerman, Donnellan, & Robins, 2012).

The relatively high internal consistency ($\alpha = .81$) of the Sleep Problems Total Score, as well as the significant factor loadings, suggest that a global dimension of sleep problems may be a viable option for researchers and clinicians when differentiating between community samples and children presenting to sleep clinics. The added dimension of the Sleep Problems Total Score suggests that the CRSP is on par with other existing sleep measures in which a total score can be calculated (Children's Sleep Habits Questionnaire [Owens, Spirito, & McGuinn, 2000], Children's Sleep Hygiene Scale [LeBourgeois et al., 2004]). Additionally, it provides a global rating of the extent and severity of sleep problems. The Sleep Problems Total Score allows for an efficient screening of sleep problems, which could then be followed by a more in-depth evaluation of elevated subscales.

Results from the MIMIC models suggest noninvariance across grade and school for several of the subscales. First, the regression paths from school to the Restless Legs Symptoms and Sleepiness latent constructs were significant, indicating that sleep characteristics of the participants vary by school. This may be the result of numerous factors, including socioeconomic status, which has previously been implicated as a predictor of sleep duration and sleep difficulties (El-Sheikh, Kelly, Buckhalt, & Hinnant, 2010; Knutson & Lauderdale, 2009; Marco, Wolfson, Sparling, & Azuaje, 2012). These findings may also be attributed to the differences in ethnic diversity between the two schools, as prior research has demonstrated racial and ethnic differences in general sleep problems (El-Sheikh et al., 2010).

Second, the regression paths from grade to Sleepiness, Restless Legs Symptoms, and Bedtime Fears/Worries were also significant. Meltzer et al. (2013) reported that age was significantly and inversely related to only one of the Sleep Disturbances Scales (Parasomnias). However, the current findings suggest that older children also experience *fewer* Bedtime Fears/Worries and Restless Legs Symptoms. Conversely, Sleepiness seemingly increases with age, consistent with previous research in which an increasing linear trend of daytime sleepiness has been observed as children age (Fallone et al., 2002; Meltzer & Mindell, 2006; Urschitz et al., 2013). Understanding changes in daytime sleepiness as children age is increasingly important as it negatively impacts functional domains, including behavior, mood, and performance (Fallone et al., 2002).

The CRSP was developed to address the limitations of existing sleep measures, but it does not perform as expected. Thus, in order to align with its stated aims, more work is needed. Specifically, further exploration of the factor structure is warranted. Going forward, an exploratory factor analysis (EFA) may be necessary to understand the stability of the constructs. Although viewed as a data-driven approach, an EFA is a plausible next step, as two factor analyses have yielded different factor structures. EFAs have been useful in the development of other measures by establishing the stability of certain constructs, and indicating the weaknesses of others, especially in the presence of heterogeneity (e.g., Children’s Depression Inventory; Steele et al., 2006). Additionally, an EFA may help explain why item 40 has the ability to load on two constructs and help determine the best fit for the item.

It is also conceivable that differences in factor structure may be attributed to heterogeneity across populations. Meltzer et al. (2014) sought to explore the factor structure in a sample of predominantly treatment-seeking adolescent youth. The present study differed from the 2014 study in two key aspects, such that the participants were younger (8-12 years old) and targeted for inclusion based upon their non-treatment seeking status. These changes reflect an age by community sample interaction, and therefore, it is unknown how performance of the factor structure changed as a result of these two modifications in the sample characteristics. Consequently, formal invariance testing is needed to examine potential noninvariance and assess across-group equivalence.

The division of the Restless Legs scale into two independent factors suggests that the subjective experience of restless legs is a distinct experience from the symptoms a child reports to a caregiver. Understanding which of these two scales more accurately predicts a child's disrupted sleep behavior may have significant implications for treatment and whether the two subscales give rise to different patterns of disrupted sleep behavior. Although children and adolescents are able to contribute unique information that their parents are not reporting with respect to their sleep behavior (Amschler & McKenzie, 2005; Meltzer et al., 2013; Owens et al., 2000), knowing whether restless legs symptoms are better captured by subjective experience versus a caregiver's report of what the child is describing is important information for determining if the independent constructs are predictive of specific sleep disruptions. Empirically identifying the noninvariance of the constructs benefits clinical practice by guiding clinicians on what symptoms to assess, how to assess those symptoms, and whom to ask for relevant information.

Unexpectedly, the Sleepiness Scale was unrelated to several latent constructs to which it is theoretically related. Present findings indicated that the Sleepiness Scale was not associated with the Insomnia, Parasomnia, and Restless Legs Report Scales, contrasting previous research suggesting that there is a direct relationship between sleepiness and parent-reported sleep disturbances (e.g., Calhoun et al., 2011; Li et al., 2014). The current lack of a relationship between these constructs may be due, in part, to the small sample size. Therefore, future validation studies of the CRSP should examine the relationships between these scales and seek to determine if an association exists. If null findings persist, further exploration of these CRSP scales may be warranted to assess convergent validity.

In light of the contributions of this study, several limitations should be noted. First, actigraphy data was unavailable for the sample. Although children have been shown to be adequate reporters of their sleep patterns (Meltzer & Westin, 2011; Meltzer et al., 2013; Riley, 2004), an objective measure of sleep duration and efficiency would have allowed for further validation of the CRSP. Additionally, 24 packets were not returned to the school and subsequently those data were missing from the analyses. Despite being statistically powered to find significant effects, these children without CRSP data may have had different sleep disturbances that impacted outcomes. With respect to the power analysis, correlations among the latent factors were set at .50 in the population. However, results from the present study suggest significantly weaker associations among the factors. Therefore, greater power may have been needed to allow for firmer conclusions to be made about the present findings. Furthermore, the small sample size precluded formal invariance testing of the factor structure, factor loadings, and factor variances-covariances between schools. However, the use a MIMIC model allowed for the detection of measurement noninvariance across schools and grades and provides support for future research to determine how these covariates differentially impact item response. Finally, due to the design of data collection, it is possible that someone other than the child (e.g., parent) could have completed the measure. The methodology employed was similar to techniques used in a number of other research studies, including those in which measure validation was the primary aim (e.g., Cella et al., 2010; Meltzer et al., 2014).

In conclusion, because several modifications to the factor structure of the CRSP are needed to achieve mediocre to acceptable model fit, further scale development and continued validation of the psychometric properties is necessary. Consistent with previous literature and theoretical bases (Children's Sleep Habits Questionnaire [Owens, Spirito, & McGuinn, 2000], Children's Sleep Hygiene Scale [LeBourgeois et al., 2004]), and although the originally proposed factor structure does not hold in this sample, the Sleep Problems Total Score appears to be internally consistent with the ability to assess a more global sleep construct. Therefore, it is recommended that the Sleep Problems Total Score be calculated and used in conjunction with other scales obtained from the CRSP. Despite promising findings, researchers interested in using the CRSP should continue to assess its validity by exploring the relationship between the measure and objective measures of sleep patterns and behavior.

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