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Concurrent Associations among Sleep Problems, Indicators of Inadequate Sleep, Psychopathology, and Shared Risk Factors in a Population-based Sample of Healthy Ontario Children

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Objectives Examine the contribution of sleep problems and indicators of inadequate sleep to psychopathology among children after accounting for shared risk and comorbid psychopathology. **Methods** Secondary analyses of cross-sectional data on 4- to 11-year-old ($N = 1,550$) children without chronic illness or developmental delay or disability. Parents provided information about sleep problems, indicators of inadequate sleep, symptoms of psychopathology, and risk factors for psychopathology. Teachers provided information about indicators of inadequate sleep and symptoms of psychopathology. **Results** Adjusting for risk factors and comorbid psychopathology, sleeping more than other children was related to parent-rated aggression. Nightmares and trouble sleeping were related to parent-rated anxious/depressed mood. Sleep problems were not related to attention problems. Being overtired was related to parent- and teacher-rated psychopathology. **Conclusions** Relations among sleep problems, indicators of inadequate sleep, and psychopathology are complex; accounting for potential confounding variables and considering sleep variables separately may clarify these relations.

Key words children; mental health; risk; sleep.

Adequate sleep is increasingly recognized as a pillar of physical and mental health (Dahl, 1996; Taylor, Lichstein, & Durrence, 2003). Indicators of inadequate sleep (e.g., being overtired, sleepiness, and fatigue) and sleep problems in children (e.g., trouble sleeping and snoring) are related to higher rates of concurrent (Stein, Obermeyer, Amromin, & Benca, 2001) and future (Gregory & O'Connor, 2002) psychopathology. However, large-scale, population-based studies that adequately address possible confounding variables (e.g., shared risk factors for both sleep and psychopathology, comorbid psychopathology) in the observed relations among sleep problems, indicators of inadequate sleep, and symptoms of psychopathology are lacking. Failure to account for confounding variables may result in spurious findings that can have significant research and clinical implications

(e.g., by misdirecting intervention efforts). In the following sections, we describe two of these potential confounds.

Shared Risk Factors for Sleep Problems, Inadequate Sleep, and Psychopathology

Many factors associated with children's psychopathology (e.g., low income, stressful life events, maternal depression, and marital distress; Sameroff, 2000) also affect children's sleep (El-Sheikh, Buckhalt, Mize, & Acebo, 2006). Thus, children's sleep and symptoms of psychopathology may be related only because they are both outcomes of another variable. For example, it may be that poor family functioning (e.g., family conflict, marital distress), a known risk factor for psychopathology, contributes to increased physiological arousal in children, thereby interfering with their ability to settle to sleep (El-Sheik et al., 2006). If family

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functioning is not controlled for, a spurious finding that children's sleep and psychopathology are directly related to one another may result.

Few studies have controlled for shared risk factors, beyond child sex, ethnicity, and socioeconomic status. Those that have, rarely examined more than one additional risk factor or have examined the relation of sleep to psychopathology in special or at-risk populations (Bates, Viken, Alexander, Beyers, & Stockton, 2002; Johnson, Chilcoat, & Breslau, 2000). Recently, Reid, Hong, and Wade (2009), in a sample representative of healthy Canadian 2- to 3-year-olds, controlled for multiple risk factors for psychopathology (i.e., child temperament, parenting, parental depression, family functioning); child sleep problems accounted for a small, but significant, proportion of the variance in internalizing and externalizing symptoms. Similar investigations in a population-based sample of healthy older children are required.

Symptoms of Comorbid Psychopathology

A second potential confound in the relation between sleep problems and symptoms of psychopathology is comorbid psychopathology. Substantial comorbidity exists among emotional and behavioral disorders and attention-deficit/hyperactivity in children (Wilens, Beiderman, Brown, Tanguay, Monuteaux, Blake et al., 2002); it may be that the relation between children's sleep and psychopathology can be accounted for by the influence of sleep problems associated with comorbid psychopathology (for discussion, see Ivaneko & Johnson, 2008). For example, children may have both anxiety and attention problems along with trouble sleeping. If the trouble sleeping is actually related to anxiety (e.g., fear of being away from parents), but anxiety is not statistically accounted for, it may appear that a relation between attention problems and having trouble sleeping exists. Comorbid oppositional behavior and anxiety disorders have been identified as significant confounds in relationships between sleep problems and attention-deficit/hyperactivity disorder (ADHD; Corkum, Moldofsky, Hogg-Johnson, Humphries, & Tannock, 1999; Mick, Biederman, Jetton, & Faraone, 2000). Corkum et al. (1999) have broadly called for the control of comorbidity by using techniques such as the inclusion of clinical comparison groups in investigations of the relationship between sleep and ADHD. In the present study, we control for both a range of shared risk factors and for comorbid symptoms of psychopathology.

Purpose and Hypothesis

The purpose of the present study was to better understand observed relationships among sleep problems, indicators

of inadequate sleep, and concurrent symptoms of psychopathology in a representative community sample of healthy children aged 4–11 years. It was predicted that sleep problems and indicators of inadequate sleep (overtired, sleeping in class) would be significantly associated with symptoms of psychopathology (aggression, attention problems, anxious/depressed mood) after accounting for shared risk factors and comorbid symptoms of psychopathology. As results of studies using parent-rated and teacher-rated outcomes have been inconsistent (cf., Bates et al., 2002; Johnson et al., 2000; Paavonen, Almqvist, Tamminen, Moilanen, Piha, Rasanen, et al., 2002), this hypothesis was explored separately for both parent-rated and teacher-rated symptoms of psychopathology.

Method

Secondary data analyses of the Ontario Child Health Study (OCHS; Boyle, Offord, Hofmann, Catlin, Byles, Cadman, et al., 1987) were conducted. The primary purpose of the OCHS was to estimate the prevalence of emotional and behavioral disorders among Ontario children aged 4–16 years; it has made substantial contributions to the risk and child psychopathology literature (Offord, Boyle, & Racine, 1989; Rae-Grant, Thomas, Offord, & Boyle, 1989). Methodology for the OCHS is described elsewhere (Boyle et al., 1987). Briefly, data collected through a home interview with the female head of the house included demographic information and child physical health, parent-rated questionnaires for risk factors (e.g., family functioning), and parent-rated psychopathology checklists. Data were obtained for 1,992 children aged 4–11 years.¹ For participating and consenting families, teachers were asked to complete teacher-rated checklists of psychopathology. Parent nonresponse (missing checklists and questionnaires) was low (<1.5%); teacher nonresponse was more substantial (16.1% for 4- to 11-year-olds). Analyses of sample loss by the OCHS investigators revealed no statistically significant differences between 4- and 11-year-olds with and without teacher forms on sociodemographic variables and on estimates of parent-rated psychopathology (Boyle et al., 1987). The sample was representative of Ontario households with children aged 4–16 years at the time of the 1981 census (Boyle et al., 1987).

¹Data for adolescents (aged 12–16 years) are to be reported in a separate article (Coulombe, Reid, Boyle, & Racine, 2009); relations among sleep, sleepiness, and psychopathology may be qualitatively different for adolescents compared to children (Crowley, Acebo, & Carskadon, 2007).

Study-specific Methodology

The current study was approved by the Research Ethics Board at McMaster University.

Participants

Data for healthy children aged 4–11 years were analyzed; parents have reasonable knowledge of their children's sleep at these ages (Owens, Spirito, & McGuinn, 2000). Children with chronic medical conditions, significant physical limitations, mental retardation, developmental delay, and for whom this information was missing ($n = 442$) were excluded from analyses because sleep problems and physical health problems tend to co-exist (Mindell & Owens, 2003) and because the sleep problems of these children likely differ from healthy children (Stores, 1999). The final sample size for this study was 1,550 children (50% male; age $M = 7.7$ years, $SD = 2.3$) from 1,107 households.

Measures and Key Variables

Shared risk factors

The pediatric sleep (El-Sheik et al., 2006) and developmental psychopathology literature (Mash & Dozois, 2003) were examined to identify risk factors with consistent and robust associations with child psychopathology and that may also affect children's sleep (e.g., single parent status, maternal depression or negative affect, poverty, poor family functioning). Published analyses of the OCHS were then examined in order to better understand how these risk factors performed in relation to one another and within our sample. For example, in previous analyses of the OCHS, family functioning and low family income (poverty) attenuated the relationship between single parent status and child psychopathology (Munroe Blum, Boyle, & Offord, 1988). Thus, family functioning and family income were selected as predictors in the current analyses, while single parent status was not. The following variables were included: child sex, child age, family income (in \$5,000 intervals), maternal education (years of education), maternal negative affect (measured using the Bradburn Affective Balance Scale; 5 items, $\alpha = .64$ in current sample; for description see Bradburn, 1969), stressful life events (count of the number stressful events that the family experienced in the previous year; Boyle et al., 1987), marital disharmony (4 items measuring overall relationship and frequency of enjoyable activities, expressive caring, and quarrelling; see Byles, Byrne, Boyle, & Offord, 1988), and family functioning (assessed by the General Functioning Scale of the McMaster Family Assessment Device; $\alpha = .86$, previously reported in a sub-sample of

the OCHS, see Byles et al., 1988). Continuous scores were used for all variables other than child sex. Higher scores indicate: increasing age, higher family income, more maternal education, greater maternal negative affect, more stressful life events, greater marital disharmony, and poorer family functioning.

Sleep Problems, Indicators of Inadequate Sleep, and Symptoms of Psychopathology

Sleep problems, indicators of inadequate sleep, and symptoms of psychopathology (aggression, attention problems, and anxious/depressed mood) scores were derived from Child Behavior Checklist (CBCL; Achenbach, 1991a) and associated Teacher's Report Form (TRF; Achenbach, 1991b) items (see Boyle et al., 1987). Respondents rated how each item described the target child "now or within the past 6 months" using a 3-point scale (0 = "never or not true", 1 = "sometimes or somewhat true", 2 = "often or very true").²

Symptoms of Psychopathology. Parent-rated and a teacher-rated aggression, attention problems, and anxious/depressed mood scores were calculated for each child using CBCL/TRF items. Prior to imputing missing data, internal consistencies for the parent-rated scales in our sample were: aggression ($\alpha = .82$; 20 items), attention problems ($\alpha = .76$; 11 items), and anxious/depressed mood ($\alpha = .87$; 14 items). Internal consistencies for the teacher-rated scales in our sample were: aggression ($\alpha = .94$; 25 items), attention problems ($\alpha = .94$; 20 items), and anxious/depressed mood ($\alpha = .88$; 18 items). No sleep problem or indicator of inadequate sleep item was included in any of the symptoms of psychopathology scales.

Sleep Problems and Indicators of Inadequate Sleep. As different types of sleep problems may have unique relations with symptoms of psychopathology (e.g., aggression, attention problems, anxious/depressed mood; see Stein et al., 2001), we chose to consider individual sleep problems and indicators of inadequate sleep as separate predictors of symptoms of psychopathology, rather than using a single sleep problem score (see Gregory & O'Connor, 2002).

Five sleep problem items were rated by parents: "trouble sleeping," "sleeps less than other children" ("sleeps less"), "nightmares," "talks or walks in sleep," and "sleeps more than other children during the day and/or night" ("sleeps more"). One indicator of inadequate

²This varied slightly from standard CBCL/TRF response options, where: 0 = "not true," 1 = "somewhat or sometimes true," and 2 = "very true or often true."

sleep was rated by parents: “overtired.” Two indicators of inadequate sleep were rated by teachers: “overtired” and “sleeps in class”. All sleep scores ranged from 0 to 2.

Data Analyses

Analyses were conducted using Statistical Package for the Social Sciences (SPSS) version 16.0 and, for the regressions, STATA (Statistics/Data Analysis, 2006) version 10.1.

Missing Data

Less than 10% of the values were missing for any parent-rated variables (i.e., risk factors, parent-rated sleep variables, parent-rated symptoms of psychopathology). Few differences among data imputation methods have been found when <10% of data is missing, either randomly or systematically (Roth, 1994); data imputation specific to each type of parent-rated variable in the present study is described below. Up to 26% of the values were missing for teacher-rated variables. When children were missing teacher-rated variables (i.e., teacher-rated indicators of inadequate sleep, teacher-rated psychopathology) two sets of analyses were run: (a) analyses excluding these children (list-wise), and (b) analyses including these children with scores imputed as described below. Patterns of results were compared; as no significant differences in patterns were noted, analyses using imputed teacher-rated data are reported.

Risk Factors for Psychopathology

Missing values for all continuous risk factor variables, with the exception of marital disharmony (described next), were substituted with the sample mean for that variable (George & Mallery, 2002).

Single parents were missing marital disharmony scores ($n = 146$). Two sets of analyses were conducted: (a) with single parents excluded from analyses and (b) with single parents provided a score indicative of “no marital disharmony.” As the pattern of results did not differ when these analyses were compared, single parents were retained in analyses and given scores indicative of “no marital disharmony.”

Symptoms of Psychopathology

Two data imputation methods were used for psychopathology scales, depending on how many items were missing per scale. For children missing <33% of items on a given scale, missing items were replaced with the value of the most highly correlated item on that scale (Boyle et al., 1987). For example, children missing a score on the parent-rated item “argues a lot” would be given their score on the parent-rated item “disobedient at home”

the item on the aggression scale with which “argues a lot” is most highly correlated ($r = .42$). Parent-rated items were used to impute items on parent-rated scales; teacher-rated items were used to impute items on teacher-rated scales. This imputation method was identified as providing the “best combination of accuracy and economy” (p. 830) over four other methods (e.g., replacing missing values with 0) examined during the original analyses of the OCHS (Boyle et al., 1987).

For children missing >33% of items on a given psychopathology scale (i.e., aggression, anxious/depressed mood, attention problems), missing data were replaced with the sample mean for that scale.

Sleep Problems and Indicators of Inadequate Sleep

For children missing a sleep problem item or indicator of inadequate sleep, the sample mean for that item was used.

Data Transformation

All continuous predictor variables were nonnormally distributed; as the distribution of predictor variables has little impact on the regression model, no transformations were applied (Babyek, 2004). Symptoms of psychopathology scale scores were nonnormally distributed; as the distribution of outcome variables may impact the regression model (Babyek, 2004), transformations were applied following imputation of missing data. Square root transformations produced skewness and kurtosis values closest to 0 (Tabachnik & Fidell, 2007). When symptoms of psychopathology acted as predictors, the transformed variable was used to maintain consistency.

Multivariate Analyses

Linear regressions examined the contribution of risk factors, comorbid symptoms of psychopathology, sleep problems (trouble sleeping, sleeps less, nightmares, talks or walks in sleep, sleeps more), and indicators of inadequate sleep (overtired, sleeps in class) to the prediction of symptoms of parent-rated and teacher-rated aggression, attention problems, and anxious/depressed mood. All regressions were run in STATA (Statistics/Data Analysis, 2006) and controlled for the clustering of siblings within households. Specifically, the standard errors are adjusted to account for the fact that data from siblings within the same household are not independent. All variables were standardized prior to entry, allowing the regression coefficients to be interpreted as beta weights (Bring, 1994).

Predictors were entered in two blocks. Shared risk factors and symptoms of comorbid psychopathology were entered into the first block (Model 1). As the prediction of

psychopathology from risk factors alone was not a focus of the study, these regressions are not presented. Sleep problems and symptoms of inadequate sleep were entered into the second block (Model 2), testing the hypothesis that sleep problems and symptoms of inadequate sleep would be significantly associated with symptoms of psychopathology after accounting for shared risk factors and comorbid psychopathology. Regressions were completed separately for parent-rated and teacher-rated symptoms of psychopathology. As described in the results, two sets of regressions were conducted for teacher-rated psychopathology to aid in comparing results between the parent- and teacher-rated outcomes.

Results

Correlations among sleep problems and indicators of inadequate sleep and among parent- and teacher-rated symptoms of psychopathology are available online (Supplementary Tables S1 and S2).

Parent-rated Psychopathology

Table I presents the results of regressions examining the contribution of sleep problems and indicators of inadequate sleep to parent-rated symptoms of psychopathology. In all regressions, the risk factors and comorbid symptoms of psychopathology entered in the first block (Model 1, data not shown) accounted for 44–52% of the variance in parent-rated psychopathology. Parent-rated sleep problems and parent- and teacher-rated indicators of inadequate sleep (Model 2) accounted for an additional 1–3% of the variance in parent-rated psychopathology. Examination of the regression coefficients in Model 2 indicates that parent-rated overtired was a significant correlate of all three types of psychopathology, and teacher-rated overtired was a significant correlate of attention problems. Sleeping more than other children was uniquely associated with aggression, while trouble sleeping and nightmares were uniquely associated with anxious/depressed mood. None of the five sleep problem variables were significantly related to attention problems.

Teacher-rated Psychopathology

To aid comparisons with regression when parent-rated psychopathology was the outcome, two sets of regressions were conducted for teacher-rated psychopathology. In Model 2, parent-rated sleep problems and indicators of inadequate sleep were entered after controlling for risk factors and parent-rated symptoms of comorbid psychopathology. In Model 3, parent-rated sleep problems and

Table I. Hierarchical Regressions Examining the Contribution of Sleep Problems and Indicators of Inadequate Sleep to Parent-rated Psychopathology after Accounting for Shared Risk and Comorbid Psychopathology

	Aggression Model 2 B	Attention problems Model 2 B	Anxious/ depressed Model 2 B
Shared risk			
Child age	−0.089***	0.055**	0.129***
Child sex ^a	−0.100**	−0.190***	0.186***
Maternal education	0.041	−0.024	0.036
Maternal negative affect	0.040	0.039	0.104***
Marital disharmony	0.003	0.009	−0.004
Stressful life events	0.015	0.014	0.055**
Family income	−0.023	−0.007	0.010
Family functioning	0.027	0.026	−0.005
Comorbid psychopathology			
Parent-rated attention problems	0.416***	—	0.248***
Parent-rated anxious/ depressed mood	0.278***	0.229***	—
Parent-rated aggression	—	0.441***	0.320***
Sleep problems			
Trouble sleeping	−0.011	0.020	0.086***
Sleeps less	0.046	−0.005	0.033
Sleeps more	0.052**	0.029	0.005
Nightmares	0.033	0.011	0.062**
Talks and walks in sleep	0.020	0.010	0.016
Indicators of inadequate sleep			
Parent-rated overtired	0.106***	0.102***	0.098***
Teacher-rated overtired	0.028	0.054**	−0.048
Teacher-rated sleeps in class	0.001	0.003	0.008
R ² change ^b	0.018	0.014	0.032
R ² model	0.540	0.512	0.471

Model 1 included only the shared risk and comorbid psychopathology variables; results are not reported. All models control for clustering of siblings. —, variable not entered in regression.

^aChild sex: 1, female and 2, male.

^bR² change, from last step in the model when the sleep variables were added.

Predictor significant at $p < .01$; *predictor significant at $p < .001$.

both parent-rated and teacher-rated indicators of inadequate sleep were entered after controlling for risk factors and teacher-rated symptoms of comorbid psychopathology; similar to regressions with parents these analyses have both the outcome and comorbid psychopathology obtained from the same rater (in these regressions, teachers).

The risk factors and comorbid symptoms of parent-rated psychopathology entered in the first block (Model 1, data not shown) accounted for 9% of the variance in teacher-rated aggression and attention problems, and 2% of the variance in symptoms of anxiety/depressed mood. Parent-rated sleep variables (sleep problems, parent-rated

Table II. Hierarchical Regressions Examining the Contribution of Sleep Problems and Indicators of Inadequate Sleep to Teacher-rated Psychopathology after Accounting for Shared Risk and Comorbid Psychopathology

Predictors	Aggression		Attention problems		Anxious/depressed	
	Model 2 B	Model 3 B	Model 2 B	Model 3 B	Model 2 B	Model 3 B
Shared risk						
Child age	-0.014	-0.047**	0.063**	0.039	0.060	0.055
Child sex ^a	-0.301***	-0.135**	-0.371***	-0.205***	0.018	0.204***
Maternal education	0.010	0.018	-0.030	-0.026	0.031	0.046
Maternal negative affect	-0.036	-0.007	-0.041	-0.012	-0.002	0.028
Marital disharmony	-0.044	0.005	-0.064	-0.016	-0.074	-0.038
Stressful life events	0.019	0.013	0.016	0.011	-0.011	-0.014
Family income	-0.073**	-0.018	-0.083**	-0.031	-0.064	-0.019
Family functioning	0.033	-0.016	0.083**	0.047	0.041	0.000
Comorbid Psychopathology						
Parent-rated attention problems	0.239***	—	—	—	0.079	—
Parent-rated anxious/depressed mood	-0.136***	—	-0.098**	—	—	—
Parent-rated aggression	—	—	0.184***	—	-0.010	—
Teacher-rated attention problems	—	0.555***	—	—	—	0.302***
Teacher-rated anxious/depressed mood	—	0.113***	—	0.199***	—	—
Teacher-rated aggression	—	—	—	0.488***	—	0.151***
Sleep Problems						
Trouble sleeping	-0.052	-0.036	-0.027	-0.005	0.003	0.024
Sleeps less	-0.003	-0.007	-0.002	0.002	0.004	0.001
Sleeps more	-0.010	-0.008	-0.003	-0.004	0.045	0.047
Nightmares	0.048	0.028	0.023	-0.011	0.052	0.037
Talks and walks in sleep	-0.032	-0.022	0.001	0.036	-0.068	-0.059
Indicators of inadequate sleep						
Parent-rated overtired	0.033	0.030	0.039	0.036	-0.019	-0.028
Teacher-rated overtired	—	0.066	—	0.160***	—	0.161***
Teacher-rated sleeps in class	—	-0.003	—	0.036	—	-0.006
R ² change ^b	0.005	0.006	0.002	0.026	0.006	0.028
R ² model	0.091	0.443	0.094	0.510	0.0230	0.255

Model 1 included only the shared risk and comorbid psychopathology variables; results are not reported, variable not entered in regression.

^aChild sex: 1, female and 2, male.

^bR² change, from last step in the model when the sleep problems and indicators of inadequate sleep variables were added.

Predictor significant at $p < .01$; *predictor significant at $p < .001$.

overtired scores; Model 2, Table II) accounted for <1% of the additional variance in teacher-rated psychopathology.

The risk factors and comorbid symptoms of teacher-rated psychopathology entered in the first block (Model 1, data not shown) accounted for 44% of the variance in teacher-rated aggression, 48% in attention problems, and 23% in symptoms of anxiety/depression. After controlling for the risk factors and teacher-rated comorbid psychopathology, only teacher-rated overtired was significantly related to teacher-rated symptoms of attention and symptoms anxiety/depression (Model 3, Table II). Parent-rated sleep problems were not significantly related to any of the three teacher-rated psychopathology variables and neither parent- nor teacher-rated indicators of inadequate sleep were related to teacher-rated aggression.

Discussion

Previous studies have shown that disturbed sleep and psychopathology co-vary in school-aged children (Paavonen et al., 2002); however, potential confounds that may underlie the relation between sleep and psychopathology have not been adequately addressed. To our knowledge, this is the first study among children of this age controlling for both: (a) a number of established “shared” risk factors for sleep problems and psychopathology and (b) symptoms of comorbid psychopathology in a large population-based community sample. We predicted that sleep problems and indicators of inadequate sleep would be significantly associated with symptoms of psychopathology in a population-based sample of healthy

children aged 4–11 years, after controlling for two potential confounds- shared risk factors for psychopathology and symptoms of comorbid psychopathology. This hypothesis was only partially supported.

First, although some sleep variables (sleep problems, indicators of inadequate sleep) were significantly associated with some symptoms of psychopathology, after accounting for shared risk factors for psychopathology and symptoms of comorbid psychopathology, the variance accounted for by sleep variables was small (0–3%). Using CBCL sleep items, with a different method of scoring (total problem score) and without considering a range of shared risk factors and comorbid psychopathology, other investigators (Gregory & O'Connor, 2002) have suggested that sleep problems may identify children at greater risk of developing psychopathology; our results highlight the importance of considering alternate explanations. Further, the interpretation of the magnitude of the associations between sleep variables and symptoms of psychopathology reported in previous studies may need to be tempered by the methodological and statistical limitations of not controlling for other sources of variance. The clinical significance of the magnitudes of associations observed in our study is unclear.

Second, our hypothesis was only partially supported because not all sleep variables were significantly associated with all types of psychopathology. Gregory and O'Connor (2002) using a total CBCL sleep problem score ($\alpha = .50$ to $.59$), found robust “nonspecific” (p. 969) associations between sleep problems and psychopathology. In contrast, other authors have used more specific sleep problem scores (e.g., parasomnias, tiredness, insomnia; see Stein et al., 2001) and have found associations between specific sleep problems and symptoms of psychopathology. The results of our study are more consistent with those of Stein et al. (2001) and again highlight the need for increasing precision in our methodological and analytic approaches as we seek to improve our understanding of how sleep and psychopathology may be related. These investigations, in turn, may have significant clinical implications (e.g., identifying mechanisms of potential intervention for both sleep problems and psychopathology). The identification of specific associations between sleep problems and psychopathology was likely also assisted by controlling for comorbid psychopathology in our analyses.

That said, it should be noted that while associations between sleep problems (e.g., nightmares) and symptoms of psychopathology (e.g., anxious/depressed mood) tended to be specific, a more general association between being seen as overtired and symptoms of psychopathology

emerged. Parent-rated overtired predicted all types of parent-rated psychopathology examined; teacher-rated overtired predicted all types of teacher-rated psychopathology examined and parent-rated attention problems. Although the direction of the associations between being overtired and symptoms of psychopathology cannot be determined in our study, our findings may support Dahl's (1996) thesis that inadequate sleep contributes to psychopathology via cognitive and affective dysregulation. Alternately, the association of overtired to symptoms of psychopathology may due to raters including symptoms of psychopathology (e.g., being moody, irritable) in their definitions of being overtired. This may help to explain why sleeping in class (a relatively clear marker of sleepiness or inadequate sleep) was not associated with psychopathology, while being overtired was. Further investigation, with improved measurement and clarification of the construct of being seen as “overtired” (e.g., fatigue, sleepiness), is required.

Limitations

A small number of studies have examined the relation between parent-rated sleep problems and teacher-rated psychopathology, with inconsistent results. Johnson et al. (2000) found that parent-rated sleep problems were associated with parent, but not teacher-rated, anxious/depressed mood, while Paavonen et al. (2002) found that parent-rated sleep problems were associated with teacher-rated internalizing and externalizing problems, but not teacher-rated hyperactivity. Neither actigraphy (Aronen, Paavonen, Fjallberg, Soininen, & Torronen, 2000) nor experimental manipulation (Fallone, Seifer, Acebo, & Caraskadon, 2000) have shed light on these inconsistencies. Our study was similarly unable to draw any firm conclusions in this regard. Although teacher-rated overtiredness was associated with parent-rated attention problems, no parent-rated sleep variable was associated with any teacher-rated psychopathology. We are unable to determine the extent to which common rater effects may explain our findings. This requires further attention in future investigations.

The present cross-sectional correlational study could not determine if sleep problems and symptoms of inadequate sleep were causally related to children's psychopathology; however, the scope, size, and nature of the OCHS permitted analyses that could respond to two significant limitations in the existing literature: (a) lack of control for shared risk, and (b) lack of control for symptoms of comorbid psychopathology. In doing so, we believe that we have highlighted areas in which significant caution should be applied (i.e., in suggesting direct or

causal relations between sleep problems and symptoms of psychopathology; for discussion see Chervin, Dillon, Archbold, & Ruzicka, 2003; Paavonen et al., 2002). Longitudinal analyses testing the contribution of sleep problems, indicators of inadequate sleep, and risk factors to the development of psychopathology are required. Again, however, care should be taken in interpreting any longitudinal results when comorbid symptoms of psychopathology and sleep problems are not accounted for both at baseline and at the time in which outcomes are assessed.

Our analyses of sleep problems and indicators of inadequate sleep as separate scores enhanced our understanding of relations among sleep variables and symptoms of psychopathology. However, each sleep variable was measured by only one item; better measurement of these constructs is needed for future work. Measures of other potentially important sleep problems (e.g., snoring, periodic limb movement), sleep duration or variability were not available. Validated measures of sleep problems and inadequate sleep (e.g., Owens et al., 2000) exist and could be used in future research. Observational measures of child behavior may also assist in teasing apart the influence of common rater effects. Further, it should be noted that not all potential confounds could be accounted for in this study (e.g., parenting), nor were all common symptoms of psychopathology considered (e.g., withdrawal, social problems). The inclusion of additional potential confounds might have further reduced the magnitude of the association among sleep and psychopathology variables. Alternately, improved measurement of sleep variables (e.g., the use of validated scales, objective measures) may have increased the magnitude of the associations observed.

A significant portion of teacher-rated data was missing. However, analyses of sample loss by the original OCHS investigators revealed no statistically significant differences between 4- and 11-year-olds with and without teacher forms on sociodemographic variables and on estimates of parent-rated psychopathology. Further, our results were similar when children missing teacher-rated data were excluded and when they were included in analyses using mean substitution.

We chose to restrict our sample to children without chronic medical conditions, functional limitations, and developmental delays or disabilities. Additional research is required to examine if similar patterns of results may be found in these populations. Our use of pre-existing composite variables in the original dataset to exclude children with medical conditions and functional limitations may have resulted in less specificity in our exclusionary criteria than would be optimal; children whose medical conditions or functional limitations might not interfere

with sleep may have been excluded. Further, medications which may alter with sleep were not controlled for.

Finally, although we have attempted to apply theory and concepts from both the pediatric sleep and psychopathology literatures, concurrent and longitudinal investigations will continue to be hampered until discrete and testable models of how sleep, sleep problems, indicators of inadequate sleep, and psychopathology may be related are proposed and shared.

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Supplementary material

Supplementary data can be found at: <http://www.jpepsy.oxfordjournals.org/>

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