

Childhood Bedtime Problems Predict Adolescent Internalizing Symptoms Through Emotional Reactivity

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Abstract

Objective Sleep problems are frequent in children and robustly predict internalizing symptoms in adolescence and adulthood. Longitudinal investigations have nonetheless used broad measures of childhood sleep problems, precluding understanding of the specific sleep problems that presage affective disturbances. Similarly, prospective examinations of mechanistic variables linking early sleep with subsequent internalizing symptoms are lacking. **Method** Childhood bedtime and nighttime waking problems were examined as independent predictors of adolescent internalizing symptoms within a community sample from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development ($N = 1,089$). The mediational role of emotional reactivity in late childhood also was examined. **Results** Bedtime but not nighttime waking problems significantly predicted adolescent internalizing problems. This relationship was partially explained by child emotional reactivity. **Conclusions** Some childhood sleep problems may more reliably predict later internalizing symptoms than others. Temperamentally based emotional reactivity may potentiate affective risk associated with childhood sleep difficulties.

Key words: bedtime problems; emotional reactivity; internalizing; sleep; youth.

Accumulated evidence shows sleep problems occurring in childhood to robustly predict emotional problems, particularly anxiety and depression, later in life (Gregory et al., 2005; Gregory, Eley, O'Connor, & Plomin, 2004; Gregory & O'Connor, 2002; Ong, Wickramaratne, Tang, & Weissman, 2006). These connections extend well into the adolescent and adult years. In children 4–19 years of age who were followed longitudinally for 14 years, early sleep problems robustly predicted later depression and anxiety (Gregory, Van der Ende, Willis, & Verhulst, 2008). Another investigation found 46% of children with persistent sleep problems between the ages of 5 and 9 years had an anxiety disorder by age 21 (compared with 33% of children without persistent sleep problems; Gregory et al., 2005). Moreover, severe sleep problems at age 5 have been shown to significantly

elevate risk for depression almost 30 years later, at age 34 (Greene, Gregory, Fone, & White, 2014). These longitudinal relationships highlight the presence of a specific pathway between sleep behaviors at or around the time of school entry and the development of affective disturbances.

One noteworthy limitation within this body of research relates to the divergent ways “sleep problems” are commonly measured and defined. In some studies, a singular sleep item (e.g., Does your child have sleep difficulties?) has been used to assess the presence of childhood sleep problems (Greene et al., 2014). Other studies have used a composite measure of sleep-related items from broader measures of child behavior, most commonly the Child Behavior Checklist (CBCL; Achenbach, Howell, Quay, & Conners, 1991; Gregory & O'Connor, 2002). Sleep-related items

included on the CBCL assess a limited range of both broad and specific types of nighttime behaviors and phenomena including “trouble sleeping,” “sleeping more/less than other kids,” “nightmares,” and being “overtired.” However, other common types of sleep-related problems observed in children, such as bedtime fears and nighttime awakenings, are not assessed. Still, other studies have examined the predictive value of one or several sleep problems such as sleepiness (Ong et al., 2006), inconsistency of bed/wake times (Ong et al., 2006), and/or nighttime wakings (Gregory et al., 2004). Such measurement differences are in part reflective of the inherent challenges in defining problematic sleep in children, given the consistent changes in sleep need and behaviors that distinguish early development (Dahl, 1996; Glaze, Rosen, & Owens, 2002). Still, measurement inconsistency precludes identification of precise targets for early prevention/intervention that might serve to alter the long-term trajectories of at-risk children. For example, even though child behavior problems that occur at or just before bedtime are typically lumped together with problematic awakening from an actual sleep state, divergent behavioral strategies may be used to reduce these problems. The current study therefore assessed the presence of problematic child behaviors that occur at or around bedtime as compared with during the night (i.e., awakenings from sleep) as independent predictors of adolescent internalizing symptoms.

Beyond questions related to the predictive utility of discrete types of sleep problems, precise mechanisms underlying sleep-internalizing relationships across development remain surprisingly unexplored. Experimental research in adults provides evidence that inadequate sleep may increase risk for affective disturbances via alterations in emotional reactivity (Dinges et al., 1997; Franzen, Buysse, Dahl, Thompson, & Siegle, 2009; Kahn-Greene, Killgore, Kamimori, Balkin, & Killgore, 2007; Sagaspe et al., 2006) and limited but emerging findings in youth are suggestive of similar relationships. For example, experimental sleep restriction produces decreased positive affect (Talbot, McGlinchey, Kaplan, Dahl, & Harvey, 2010), elevated emotional intensity, and decrements in emotion regulation skill among adolescents (Baum et al., 2014; Leotta, Carskadon, Acebo, Seifer, & Quinn, 1997). Although sleep deprivation studies are useful for understanding the acute effects of sleep on emotional outcomes, one night of sleep deprivation does not lead to permanent changes in emotional processing. Surprisingly few studies have examined the longer-term impact of children’s bedtime/nighttime behaviors on emotional outcomes. As the effects of disrupted sleep may be even greater in youth, for whom key brain regions are still developing (Casey, Giedd, & Thomas, 2000), altered patterns of emotional reactivity may

provide a direct conduit from sleep problems to affective problems.

Increased emotional reactivity (defined as a coordinated set of responses to an emotional trigger involving experiential, behavioral, and physiological systems; Gross, 2015) is not only a core feature of most psychiatric conditions but a potent risk factor for internalizing problems (Joormann, Talbot, & Gotlib, 2007; Suveg & Zeman, 2004). Children with internalizing disorders report and demonstrate increased levels of emotional intensity and have fewer emotion regulation strategies than do healthy children (Suveg & Zeman, 2004). Likewise, healthy adolescents with increased emotional lability and less effective emotion regulation skills experience increased depressive symptoms (Silk, Steinberg, & Morris, 2003).

Regulatory skills develop gradually with age and experience, with the most significant changes occurring in early childhood (Calkins & Hill, 2007). Adolescence, and the onset of puberty more specifically, also coincides with improvements in affect modulation and the ability to discriminate among emotional cues relative to childhood (Yurgelun-Todd, 2007): skills shaped in part by advances in executive functioning and emotional processing via ongoing maturation of the prefrontal cortex, the amygdala, and connective pathways linking these areas (Casey et al., 2000; Gee et al., 2013; Schumann et al., 2004). These skills promote adaptive responses across different social and emotional situations (Salovey, Mayer, Caruso, & Yoo, 2009) and become increasingly critical as peer relationships expand and sensitivity to social evaluation heightens (Brown, 2004; Furman, 2002; O’Brien & Bierman, 1988; Steinberg & Morris, 2001). In light of these stage-specific demands and challenges, the current study was interested in the mechanistic role of emotional reactivity both in general and in late childhood (i.e., the pre-adolescent years) specifically in explaining linkages between childhood sleep and adolescent internalizing symptoms.

Current Study

Using data from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD), the current study had two primary objectives. First, we examined bedtime problems (e.g., problems getting into bed, problems falling asleep) and nighttime waking problems (e.g., awakening more than once during the night, awakened by a frightening dream) in middle childhood (i.e., during 3rd grade) as independent predictors of adolescent (i.e., at age 15) internalizing symptoms. In the

absence of previous studies examining the predictive value of *specific* types of childhood sleep problems, we expected both types of sleep-related problems to serve as significant predictors of adolescent internalizing symptoms. Second, the role of emotional reactivity was examined as a putative mediator of these relationships. In light of the salient emotional changes that coincide with the onset of adolescence, we were specifically interested in levels of emotional reactivity during the pre-adolescent years (i.e., age 11–12) and therefore included childhood levels of emotional reactivity in our analyses. We hypothesized increased levels of emotional reactivity in preadolescence would partially explain relationships between specific sleep problems in 3rd grade and internalizing problems at age 15.

Method

Sample

Children ($N = 1,364$) and their families enrolled in the NICHD SECCYD were examined. The original pool of participants was selected in accordance with a continuously random sampling plan. Data were collected on facets of child social, emotional, intellectual development, language development, behavioral problems, adjustment problems, and physical health. See [NICHD Early Child Care Research Network \(2005\)](#) for more detailed information about the sample and the sampling plan. Participants were assessed annually (demarcated by academic grade) from birth to age 15, but only data collected at birth, in *middle childhood* (i.e., during 3rd grade), *late childhood* (i.e., during 5th grade), and *adolescence* (i.e., at age 15) were used in the current study. Of the original sample, 48.3% were female and 80.4% identified the child participant as White. In middle childhood, the majority (58.8%) of children had parents who were married and living together. Mean household income in middle childhood was \$77,000 ($SD = \$68,273$). See [Table I](#) for a detailed breakdown of demographic information.

Previous studies assessing sleep using the SECCYD data set have examined infant sleep and attachment ([McNamara, Belsky, & Fearon, 2003](#)), the impact of adolescent sleep disruption on social relationships ([Maume, 2013](#)), longitudinal associations between sleep and cognitive and language outcomes ([Dearing, McCartney, Marshall, & Warner, 2001](#)), the impact of sleep problems on adolescent risk taking ([Thomas, Monahan, Lukowski, & Cauffman, 2015](#)), and the relation between sleep, self-control, and delinquency ([Meldrum, Barnes, & Hay, 2015](#)). However, no study has examined the longitudinal relation between childhood sleep problems and adolescent internalizing symptoms or examined possible explanatory mechanisms of this link using the SECCYD data set.

Table I. Demographics

Demographic variable	% (n)
Female	48.3 (659)
Marital status	
Married, living together	58.8 (802)
Partnered, living together	4.1 (56)
Separated/divorced	9.9 (135)
Other	4.4 (60)
Missing	22.8 (311)
Race	
American Indian, Eskimo, Aleutian	0.4 (5)
Asian or Pacific Islander	1.6 (22)
Black	12.9 (176)
White	80.4 (1,097)
Ethnicity	
Hispanic	6.1 (83)
Mother's education	
Less than high school diploma	10.2 (139)
High school graduate or GED	21 (287)
Some college or AA degree	33.4 (455)
Bachelor's degree	20.8 (284)
Some graduate work/master's degree	11.8 (161)
Law degree	11.8 (161)
More than masters/MD/PhD	1.7 (23)
Father/partner's education	
Less than high school diploma	8.4 (105)
High school graduate or GED	20.8 (284)
Some college or AA degree	27.2 (340)
Bachelor's degree	19.9 (271)
Some graduate work/master's degree	10.9 (149)
Law degree	1.4 (19)
More than masters/MD/PhD	3.7 (51)
	M (SD)
Total family income	\$77,008.04 (\$68,272.663)

Measures

My Child's Sleep Habits

Collected in middle childhood, this set of questions was derived from the original Children's Sleep Habits Questionnaire (CSHQ; [Owens, Spirito, & McGuinn, 2000](#)), a parent-report measure of child sleep behaviors, habits, and difficulties with sleep. The original CSHQ ([Owens et al., 2000](#)) is a well-validated and highly used measure that assesses a range of child sleep problems using a 3-point scale for each item (3 = *usually*, 2 = *sometimes*, 1 = *rarely*, and *don't know*). Based on the CSHQ, the modified questionnaire used in the current study used a reversed coding scale (1 = *usually*, 2 = *sometimes*, 3 = *rarely*, and *don't know*) relative to the original coding. Several items from the modified scales were reverse coded (i.e., three items from the bedtime problems scale and four items from the nighttime waking problems scale; see [Table II](#)). One question requesting an impairment rating regarding nighttime wakings (i.e., "How much of a problem are sleep wakings for you?") was scored on a similar 3-point scale (3 = *A big problem*, 2 = *A bit of a problem*, 1 = *Not a problem*). Parents were provided with guidelines for each rating category (i.e., usually = if something occurs five or more times in a

Table II. Sleep Questionnaire Items by Problem Type and Response Rates

Sleep problems	Usually = 1 % (N)	Sometimes = 2 % (N)	Rarely = 3 % (N)	Don't know/no response % (n)
Bedtime problems				
My child goes to bed at the same time every night	72.3 (784)	18.2 (198)	4 (43)	5.6 (60)
Child falls asleep within 20 minutes of bedtime	67.7 (735)	18.9 (205)	7.6 (82)	5.9 (63)
My child falls asleep in own bed	79.1 (858)	8.9 (97)	6.5 (70)	5.5 (60)
Child needs me/parent in room to fall asleep ^a	6.1 (66)	9.3 (101)	78.6 (853)	6 (65)
My child is afraid of sleeping alone ^a	5.9 (64)	13.1 (142)	74.3 (806)	6.7 (73)
Getting my child to bed at night is a problem ^a	4.1 (44)	24.3 (264)	65.9 (715)	5.7 (62)
Nighttime waking problems				
Child awakens at night screaming/sweating/inconsolable ^a	0.4 (4)	1.4 (15)	91.7 (955)	6.5 (71)
My child awakens alarmed by a frightening dream ^a	0.5 (5)	10 (108)	82.7 (897)	6.9 (75)
My child awakes once during the night ^a	4 (43)	17.6 (191)	769.3 (752)	9.1 (99)
My child awakes more than once during the night ^a	0.8 (9)	3.1 (34)	86.4 (937)	9.7 (105)
How much of a problem are sleep wakings for you ^b	87.6 (950)	5.4 (59)	1.5 (16)	5.5 (60)

Note. Prevalence rates are presented based on the 1,085 participants who completed the bedtime problems and nighttime waking problems scales.

^aReverse-coded items.

^bItem scored on altered scale: 1 = *Not a problem*, 2 = *A bit of a problem*, 3 = *A big problem*.

week; sometimes = if it occurs two to four times in a week; rarely = if something occurs never or one time during a week). Only items from the modified bedtime problems and nighttime waking problems subscales (see Table II) were used in the current study, although parents completed a total of 27 items across the bedtime problems, nighttime waking problems, sleep problems, morning waking problems, and daytime sleepiness problems subscales. Item scores were averaged for both the bedtime problems and nighttime waking problems scales. Although there was no parasomnia scale on this questionnaire, it should be noted that two parasomnias were assessed in our nighttime waking problems scale (i.e., nightmares and night terrors). Internal reliability for the bedtime problems scale (six items) was $\alpha = .67$, and $\alpha = .81$ for the nighttime waking problem scale (five items). These estimates are consistent with previous child sleep research and are somewhat expected, as Cronbach alpha values are relatively sensitive to the number of items used (e.g., <10 items; DeVellis, 2003).

Parent Report of Children's Reactions

Mother report of child emotional reactivity was collected via a 10-item questionnaire administered both in middle childhood and in late childhood. This measure was developed for the SECCYD based on items adapted from Larsen and Diener's (1987) Affective Intensity Scale (El-Sheikh & Buckhalt, 2005) to assess maternal perceptions of child emotional expression in response to events. The original Affective Intensity Scale is a reliable and valid measure of emotional reactivity (Larsen & Diener, 1987). Example items from the adapted scale used in the current study include "my

child responds very emotionally to stories, movies, and events," and "when my child feels an emotion, either positive or negative, my child feels it strongly." Mothers rated the general frequency (no time frame was specified) of different observed emotional responses in their children using a 5-point scale for each item (1 = *never*, 2 = *occasionally*, 3 = *about half the time*, 4 = *usually*, 5 = *always*). Items from this scale were summed to produce the total Emotional Reactivity score in middle childhood and in late childhood. The summed total from late childhood was used in all mediation analyses and the summed total from middle childhood was used as a covariate in the final mediation model. Reliability of the scale was acceptable for both middle childhood ($\alpha = .76$) and late childhood ($\alpha = .77$).

Youth Self-Report

Collected in adolescence, the Youth Self-Report (YSR) is a widely used self-reported measure of social competence and problem behavior for youth between 11 and 18 years of age (Achenbach, 1991b). Each child rated every behavior on a 3-point scale. Broad-band scales of internalizing and externalizing problems, and narrow band scales of social problems, aggression, attention problems, and depression (among others) were derived from a computerized scoring program. The YSR is highly reliable and internally consistent (Achenbach, 1991b). Raw scores from the broad-band internalizing problems scale were used in regression analyses in the current study. Broad-band internalizing problems t-scores were used for calculating prevalence estimates of clinically significant internalizing problems.

Child Behavior Checklist

Collected in middle childhood, the CBCL is a widely used measure of social competence and problem behavior in children between 4 and 18 years of age (Achenbach, 1991a). Each mother rated approximately 100 different behaviors on a 3-point scale. The CBCL is a highly reliable and internally consistent measure (Achenbach, 1991a). In the current study, broad-band internalizing raw scores were used to control for baseline levels of internalizing problems. Broad-band internalizing t-scores were used to calculate prevalence estimates of clinically significant internalizing symptoms in middle childhood.

Analytic Plan

Linearity for all variables was found to be acceptable based on results of scatter plots and bivariate correlations. Multicollinearity diagnostics were acceptable. Data were significantly non-normally distributed; however, transformations were not completed as normality is regarded as the least essential of assumptions required for linear regression and research has demonstrated that severe normality violations only impact statistical inferences in small samples (Hayes, 1996, 2013).

Missing Data

Completely Missing/Dropout. Although retention was good throughout the project, of the original sample ($N = 1,364$), 275 (20.16%) participants had missing data across sleep, emotional reactivity, and internalizing measures or had dropped out of the study before middle childhood. These participants did not differ on sex, race, or parental marital status from participants who remained in the study ($N = 1,089$).

Missing Individual Measures. Of the remaining 1,089 participants, 4 (0.4%) were missing parent report of bedtime problems, 4 (0.4%) were missing parent report of nighttime waking problems, 67 (6.2%) were missing mother report of emotional reactivity, and 67 (6.2%) were missing mother report of internalizing problems in 3rd grade. In late childhood (5th grade), 68 (6.2%) participants were missing mother report of emotional reactivity. At age 15, a total of 174 (16%) participants were missing self-report of internalizing symptoms. Little's Missing Completely at Random test rejected the hypothesis of completely at random missing data ($\chi^2_{(126)} = 349.874, p < .001$); meaning there was a statistical relation between missing and observed variables. We then assessed whether data were missing at random (MAR; i.e., missingness was conditional on another variable) by comparing participants with and without missing data. Significantly more White than minority children were missing emotional reactivity in middle childhood ($\chi^2 = 4.374, p = .036$) and mother-reported internalizing problems in middle childhood ($\chi^2 = 4.374,$

$p = .036$). Also, significantly more males than females were missing parent report of internalizing problems in middle childhood ($\chi^2 = 5.826, p = .016$) and parent report of emotional reactivity in middle childhood ($\chi^2 = 4.640, p = .031$). No meaningful trends in missing data were found, and data were therefore assumed to be MAR and Expectation Maximization imputation was completed (Peugh & Enders, 2004). This form of data imputation involves an expectation step, in which missing values are imputed using a regression imputation, and a maximization step in which the covariance matrix and mean vector are estimated. This process continues iteratively until the differences between covariance matrices from the ongoing maximization steps differ by only a trivial amount.

Planned Analyses

All analyses were conducted using SPSS version 23. Before imputation, the prevalence of bedtime problems and nighttime waking problems was examined for participants with complete data on these scales. Prevalence rates for both bedtime and nighttime waking problems scales were calculated by first dummy coding all items marked "sometimes" and "always" (i.e., score of 2 or 3) as a *sleep problem* and all items marked as "rarely" (i.e., score of 1) as *no sleep problem*. Dummy coded items for each participant were then summed to calculate the total number of bedtime problems and nighttime waking problems, respectively.

Demographic variables were dummy coded for all correlation, regression, and mediation analyses (i.e., White vs. all other racial statuses, married and living together vs. all other groups at birth, and females vs. males). Aim 1 was examined using a hierarchical linear regression framework. Two separate hierarchical linear regression models were examined for bedtime problems and nighttime waking problems in middle childhood. Covariates (total family income, marital status, sex, and internalizing problems in middle childhood) were entered into Step 1 in both models. Bedtime problems was entered into Step 2 in the first model, and nighttime waking problems was entered into Step 2 in the second model. Adolescent internalizing problems was entered as the dependent variable across both models.

Aim 2 was analyzed using the PROCESS Macro in SPSS. PROCESS is a conditional process modeling program developed by Preacher and Hayes that uses an ordinary least squares-based path analytical framework to test for both direct and indirect effects (Hayes, 2013). This procedure was used to examine each regression pathway in mediation models and to test the indirect effect of the predictor on the criterion variable through the mediator. Emotional reactivity in late childhood was examined as a mediator of the link

Table III. Bivariate Correlations

Variables	1	2	3	4	5	6	7	8	9	10
1. Sex (female)	1									
2. Race (White)	-.004	1								
3. Marital status	-.021	.308**	1							
4. Income	.003	.168**	.304**	1						
5. Bedtime problems (X ₁)	-.038	-.118**	-.176**	-.094**	1					
6. Nighttime waking problem (X ₂)	-.047	-.087**	-.127**	-.005	.508**	1				
7. Emotional reactivity in LC (M)	.056	.015	-.008	-.084**	.108**	.078**	1			
8. Emotional reactivity in MC	.006	.032	-.008	-.079*	.094**	.050	.674**	1		
9. Internalizing in MC	.039	-.015	-.099**	-.128**	.168**	.101**	.221**	.257**	1	
10. Internalizing in Adol (Y)	.182**	-.015	-.087**	-.100**	.097**	.043	.112**	.216**	.198**	1

Note. Sex—dummy coded, female; Marital status—dummy coded, married, and living together; Race—dummy coded, White vs. all else. MC = middle childhood; LC = late childhood; Adol = adolescence.

* $p < .05$; ** $p < .01$.

between middle childhood sleep problems and adolescent internalizing problems using four mediation models. Two models were planned with specific sleep problems entered as the predictor in either model. In both models, internalizing problems in adolescence was entered as the criterion variable, identified covariates (i.e., total family income, marital status, sex, and internalizing problems in middle childhood) were accounted for, and emotional reactivity in late childhood was entered as the mediator. Two additional mediation models were also planned, with emotional reactivity in middle childhood entered as an additional covariate to account for any changes in emotional reactivity across development. All relative indirect effects were subjected to follow-up bootstrap analyses with 10,000 samples and a 95-percentile confidence interval estimate (as recommended by Hayes & Matthes, 2009; Preacher & Hayes, 2008). Across all models, covariates were entered for the mediator and outcome variables.

Results

Prevalence of Sleep Problems

Of participants with complete bedtime problems data ($N = 1,085$), 57.6% ($n = 625$) experienced one or more bedtime problems and 35% ($n = 382$) experienced two or more bedtime problems at least two to four nights per week (i.e., “sometimes”). Specifically, 22.2% ($n = 241$) of parents reported their child does not go to bed at the same time each night, 26.5% ($n = 287$) of parents reported their child does not fall asleep within 20 min of going to bed, 15.4% ($n = 167$) of parents reported their child does not fall asleep in his/her own bed, 15.4% ($n = 167$) of parents reported their child needs a parent in the room to fall asleep, 19% ($n = 206$) of parents reported their child is afraid of sleeping alone, and 28.4% ($n = 308$) of parents reported that getting their child to bed at night is a problem.

Of individuals with complete nighttime waking problems data ($N = 1,085$), 27% ($n = 296$) had one or

more nighttime waking problems and 9% ($n = 98$) experienced two or more nighttime waking problems at least two to four nights per week (i.e., “sometimes”). Specifically, 1.8% ($n = 19$) of parents reported that their child awakens with night terrors, 10.4% ($n = 113$) of parents reported that their child experiences nightmares, 21.6% ($n = 234$) of parents reported their child awakens once during the night, 4% ($n = 43$) of parents reported their child wakes up more than once a night, and 6.9% ($n = 75$) of parents reported that nighttime waking problems in their child is a problem for them. A detailed breakdown of individual sleep item prevalence ratings is presented in Table II.

Prevalence of Internalizing Problems and Emotional Reactivity

Before imputation the prevalence of internalizing problems on the CBCL and YSR were examined in middle childhood and in adolescence, respectively. Of the participants ($N = 1,022$) with complete CBCL scores, 3.1% ($n = 31$) of mothers reported a t-score of ≥ 69 on the internalizing problems scale, indicating clinically significant internalizing symptoms. Additionally, 6.8% ($n = 68$) of mothers reported t-scores in the borderline range. Of the adolescents with complete YSR data ($N = 915$) at age 15 years, 2.5% ($n = 23$) of youth reported a t-score of ≥ 69 on the internalizing problems scale, indicating clinically significant internalizing symptoms. Additionally, 4.7% ($n = 42$) of youth reported t-scores in the borderline range. Emotional reactivity scores (summed total score ranging from 10 to 50) were relatively similar across middle ($M = 33.91$, $SD = 5.59$) and late childhood ($M = 33.50$, $SD = 5.66$).

Bivariate Correlations

Bivariate Pearson correlation coefficients (presented in Table III) using the final imputed sample ($N = 1,089$) were examined and identified total family income,

Table IV. Hierarchical Linear Regressions of Bedtime Problems and Nighttime Waking Problems on Adolescent Internalizing Problems

Model—independent variable	Step	Variable	R ² change	F change	p	β	p
Bedtime problems	1	Covariates	.077	22.579	<.001**		
		Sex (female)				.183	<.001**
		Income				-.056	.071
		Married				-.025	.413
		Internalizing in MC				.168	<.001**
	2	Bedtime problems	.005	5.389	.020*	.070	.020*
Nighttime waking problems	1	Covariates	.077	22.579	<.001**		
		Sex (female)				.183	<.001**
		Income				-.058	.060
		Married				-.031	.311
		Internalizing in MC				.175	<.001**
	2	Nighttime waking problems	.001	1.557	.212	.037	.212

Note. β corresponds to standardized β in a model with all variables included. MC = middle childhood.

marital status, and sex as covariates to be included in all remaining regression and mediation analyses.

Regression Analyses

Overall hierarchical linear regression models examining both bedtime and nighttime waking problems were significant (bedtime problems: $_{adj}R^2 = .078$, $df = 5$, $1,079$, $F = 19.215$, $p < .001$, $N = 1,089$; nighttime waking problems: $_{adj}R^2 = .074$, $df = 5$, $1,079$, $F = 18.389$, $p < .001$, $N = 1,089$). However, only the inclusion of bedtime problems increased model significance ($F_{change} = 4.458$, $p = .035$). Thus, the planned mediation models using nighttime waking problems as a predictor were not conducted. Parameter estimates (see Table IV) revealed that bedtime problems was a significant predictor of internalizing problems in adolescence ($t = 2.111$, $p = .035$), as was being female ($t = 6.085$, $p < .001$), total family income ($t = -2.007$, $p = .045$), and internalizing problems in middle childhood ($t = 5.665$, $p < .001$).

Mediation Analyses

When examining emotional reactivity in late childhood (5th grade) as a putative mediator of the link between middle childhood bedtime problems and adolescent internalizing problems (see Figure 1), the total direct mediation model was significant ($_{adj}R^2 = .078$, $df = 5$, $1,079$, $F = 19.215$, $p < .001$, $N = 1,089$; path c), as was the full model with emotional reactivity included as a mediator ($R^2 = .086$, $df = 6$, $1,078$, $F = 16.858$, $N = 1,089$, $p < .0001$). The direct effect (c' path) of bedtime problems on internalizing problems in adolescence after accounting for covariates (i.e., total family income, marital status, and sex, and internalizing problems in middle childhood) and 5th grade emotional reactivity remained significant per Maximum Likelihood (ML)

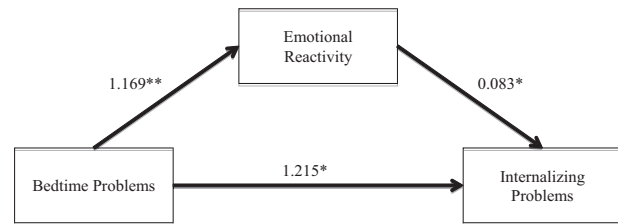


Figure 1. Mediation model of the significant indirect effect of bedtime problems on internalizing problems through emotional reactivity. Test of the indirect effect: $b = .097$, $SE = 0.063$, Confidence Interval (lower) = 0.010, Confidence Interval (upper) = 0.265*; ** $p < .01$; * $p < .05$.

confidence intervals (CI), $t = 2.147$, $p = .03$, 95% CI (0.105, 2.326). There was also a significant indirect effect of bedtime problems on internalizing problems through emotional reactivity, demonstrated by the bootstrapped 95% CI of the indirect effect, $b = 0.096$, $SE = 0.063$, 95% CI (0.010, 0.265). See Table V.

In the second mediation model, which included emotional reactivity in middle childhood (3rd grade) as an additional covariate, the total direct model was significant ($_{adj}R^2 = .078$, $df = 5$, $1,079$, $F = 19.215$, $p < .001$, $N = 1,089$; path c), as was the full model with emotional reactivity in late childhood included as a mediator ($R^2 = .085$, $df = 6$, $1,078$, $F = 16.7160$, $p < .0001$, $N = 1,089$). The direct effect (c' path) of bedtime problems on internalizing problems in adolescence after accounting for covariates and emotional reactivity in late childhood remained significant per ML confidence intervals, $t = 2.3247$, $p = .0203$, 95% CI (0.203, 2.395). However, there was no significant indirect effect of bedtime problems on internalizing problems through emotional reactivity, per the bootstrapped 95% CI of the indirect effect, $b = 0.0539$, $SE = 0.0466$, 95% CI (-0.027, 0.1951). See Table VI.

Table V. Meditation Model Results

Simple mediation	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>	CI (lower)	CI (Upper)
Bedtime problems →ER (a)	1.169	0.453	2.579	.010**	0.280	2.059
ER→ YSR (b)	0.083	0.0379	2.178	.030*	0.008	0.148
Bedtime problems →YSR (c)	1.312	0.565	2.321	.020*	0.203	2.420
Bedtime problems →YSR (c')	1.215	0.566	2.148	.032*	0.105	2.326
X ₁ →M→Y (a1*b1)	0.097	0.063			0.010	0.265*

Note. ER = emotional reactivity in late childhood [mediator], YSR = internalizing in adolescence.

Covariates included total family income, marital status, sex, and internalizing problems in middle childhood.

p* < 0.05; *p* < 0.01.

Table VI. Meditation Model Results With Emotional Reactivity in Middle Childhood as a Covariate

Simple mediation	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>	CI (lower)	CI (Upper)
Bedtime problems →ER (a)	0.596	0.3343	1.784	.075	-0.060	1.253
ER→ YSR (b)	0.090	0.0508	1.780	.075	-0.009	0.190
Bedtime Problems →YSR (c)	1.312	0.565	2.321	.020*	0.203	2.420
Bedtime Problems →YSR (c')	1.299	0.5588	2.325	.0203*	0.203	2.395
X ₁ →M→Y (a1 × b1)	0.054	0.047			-0.003	0.195

Note. ER = emotional reactivity in late childhood [mediator], YSR = internalizing in adolescence.

Covariates included total family income, marital status, sex, internalizing problems in middle childhood, and emotional reactivity in middle childhood.

**p* < 0.05.

Discussion

Recognition that sleep problems in childhood independently and reliably predict anxiety and depression later in life calls for research aimed at explicating these robust relationships. With this goal in mind, the current study sought to address some critical gaps in the research literature. First, rather than using a broad-based measure of childhood sleep problems, we examined difficulties occurring at or around bedtime and awakenings during the actual sleep period as separate predictors of later internalizing symptoms. Just over 57% of youth in middle childhood (i.e., 8–9 years of age) experienced at least one bedtime problem, while 27% experienced at least one nighttime waking problem (i.e., occurring at least two to four times per week). Overall, our findings are consistent with rates of sleep problems reported in community-based studies of school-aged children (Kahn et al., 1989; Mindell, 1993; Sadeh, Raviv, & Gruber, 2000).

Analyses showed bedtime problems but not nighttime waking problems in 3rd grade to significantly predict internalizing problems in adolescence. This result must be considered within the developmental period sleep problems were assessed. Specifically, our measure of bedtime problems examined a range of child behaviors occurring at or around lights out that typify behavioral insomnia in school-aged children, such as bedtime resistance or refusal. Younger children may be more likely to awaken during the night and seek parental comfort—problems that typically resolve with age. By comparison, problems with sleep

initiation may persist over time and strengthen a developmental shift toward an evening circadian preference in adolescence (Jenni, Achermann, & Carskadon, 2005), in turn increasing internalizing risk (Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002; Selvi et al., 2010). As such, the current set of results may not generalize to younger children.

It is also possible that some bedtime problems serve to forecast later internalizing issues more than others. As an example, bedtime/nighttime fears serve as a specific marker for later anxiety (Kushnir, Gothelf, & Sadeh, 2014), and approximately 20% of children with nighttime fears suffer from anxiety disorders (Muris, Merckelbach, Mayer, & Prins, 2000). Although commonly described by parents as “sleep problems,” the extent to which nighttime fears correspond with actual sleep alterations is not known. Persistently elevated levels of arousal at bedtime, poor child coping strategies, parental sleep loss, and/or responses to children’s fearful nighttime behavior may equally serve to elevate affective risk. Still, the finding that 3rd grade bedtime problems rather than nighttime waking problems predict later internalizing symptoms has potentially meaningful implications for early intervention efforts. With additional research clarifying the specific types of sleep problems that elevate risk, development of more targeted interventions may be possible.

In comparison with bedtime problems, the relatively low frequency of nighttime waking problems reported by parents was somewhat surprising. A lower

base rate together with nonsignificant prediction of adolescent internalizing problems may be explained by the specific items that comprised this scale. For example, parasomnias such as night terrors are normative in young children and diminish with age (*DSM-5*, 2013). Moreover, parental awareness of night awakenings may only occur when they are frequent and/or severe enough to require parental involvement (i.e., child calls for or seeks out the parent on awakening from sleep). Thus, in addition to incorporating child reports, research exploring relationships between more specific types of nighttime awakenings and subsequent internalizing symptoms in youth is needed.

We chose to examine emotional reactivity at/around the age of 11 years based on developmental research suggesting the onset of puberty to mark a key developmental window for understanding the emergence of internalizing symptoms (Dahl, 2004; Spear, 2000; Steinberg et al., 2006). Analyses showed emotional reactivity in late childhood to partially mediate (i.e., explain) the relationship between middle childhood bedtime problems and internalizing problems at age 15. This finding is consistent with a body of experimental research showing inadequate sleep to produce heightened levels of emotional arousal (Cousins et al., 2011; Franzen et al., 2009) as well as cross-sectional studies finding increased levels of emotional reactivity among youth with internalizing problems and disorders (Suveg & Zeman, 2004; Weems, Zakem, Costa, Cannon, & Watts, 2005). However, this mediational effect was not observed after including levels of emotional reactivity in middle childhood in the model. This result likely reflects the fact that individual differences in emotional reactivity are observable aspects of temperament that emerge during infancy and remain relatively stable across development (Fox, 1989; Gunnar, Porter, Wolf, Rigatuso, & Larson, 1995). Studies comparing emotional reactivity to emotion regulation skills in youth also find consistent levels of reactivity, whereas regulatory skills continue to develop with age (McRae et al., 2012; Silvers et al., 2012). Although our reactivity measure was comprised not just of items reflecting negative emotions but of reactivity/arousal in general (e.g., “When happy, my child is contented and calm rather than exhilarated and excited”), we did not specifically assess dimensions of temperament in the current study. Ostensibly, difficulty settling down for sleep, problems falling asleep, and intense emotional displays during the day represent behaviors occurring along a broader dimension of emotional arousal.

Limitations

Several limitations need to be considered. Although bedtime and nighttime waking problems scales were

derived from a validated sleep measure (Owens et al., 2000), the reliability of this alternative version of the original CSHQ has not been established. Additionally, the persistence of bedtime and nighttime waking problems was not assessed in the current study, and previous research has highlighted the chronicity of sleep problems to be particularly important in predicting later internalizing symptoms (Gregory et al., 2005). Although evidence for a bidirectional relationship exists between sleep and internalizing problems (Cousins et al., 2011; Fuligni & Hardway, 2006), inconsistent measurement of sleep across time points (i.e., adolescents reported on their morningness/eveningness preferences at age 15 rather than sleep behaviors) prevented meaningful examination of bidirectional effects. Still, internalizing symptoms in middle childhood may contribute to the maintenance of specific sleep problems across development.

We examined emotional reactivity in the current study but note this is only one aspect of Gross's five-part process model of emotional generation (Gross, 1998) and other related and salient processes (e.g., emotion regulation) were not assessed. We also relied on parent report of emotional reactivity rather than self-reports or objective measures. Physiologic measures would ultimately provide stronger evidence for the role of emotional reactivity; although self- and parent-reported measures of emotion correlate with objective measures (El-Sheikh & Buckhalt, 2005; Vasilev, Crowell, Beauchaine, Mead, & Gatzke-Kopp, 2009). Further, we focused on internalizing symptoms in adolescence, but sleep problems have been shown to forecast externalizing problems as well (Gregory et al., 2008). Lastly, as both sleep and emotional reactivity measures were collected via maternal report, shared-source variance may have impacted our results.

Implications and Conclusions

Results from the current study make several important contributions to our understanding of childhood sleep problems and their relation to later psychological problems. Although a majority of studies reveal sleep problems, broadly, to predict later internalizing problems (Gregory et al., 2004, 2005; Gregory & O'Connor, 2002; Ong et al., 2006), our results suggest this relationship may be more specific to problematic behaviors occurring at or around bedtime. If replicated, this finding could hold important implications for childhood assessment approaches and prevention/early intervention strategies. For example, brief interventions that target the sleep onset period specifically may produce more efficient and robust reduction of internalizing risk. Particularly as the U.S. healthcare system becomes more integrated, such interventions hold potential for wider

dissemination and, ultimately, reducing the societal costs of psychological care.

Our results also suggest that levels of emotional reactivity partially explicate longitudinal links between sleep and internalizing symptom domains. Incorporation of objective measures of reactivity and assessment of other aspects of the emotion generation process (e.g., emotion regulation) is necessary nonetheless for clarifying mechanistic relationships and advancing understanding. Finally, the ways in which early sleep patterns and simultaneous changes in emotion-based skills intersect to heighten affective vulnerability during the post-pubertal years is an area of increasing attention but as of yet has limited understanding. Longitudinal, multi-method designs are best suited to addressing these developmental questions.

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