Sleep and Mental Health: The Moderating Role of Perceived Adolescent-Parent Attachment

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Abstract

Objective: The present study investigated whether the effects of sleep duration and quality on adolescent adjustment were moderated by perceived attachment to mothers and fathers.

Design: The study utilized a cross-sectional design.

Setting: Participants were recruited from small town and semi-rural communities in Alabama.

Participants: Participants were 106 adolescents (*M* age = 13.61 years, *SD* = .73; 55% girls; 28% African American, 72% European American) and their parents.

Measurements: Sleep duration (minutes) and sleep quality (efficiency, number of long wake episodes) were derived using actigraphy, and subjective sleep/wake problems were derived with adolescent reports. Adolescents also reported on perceived attachment to mothers and fathers, internalizing symptoms, and self-esteem. Mothers and fathers reported on externalizing behaviors.

Results: Path model analyses indicated that perceived attachment to parents moderated relations between adolescents' sleep quality and their adjustment. For externalizing symptoms and self-esteem, adolescents at greatest risk for maladjustment were those who reported poor quality sleep (i.e., more sleep/wake problems, lower sleep efficiency) coupled with less secure attachment to parents. Conversely, adolescents who experienced better actigraphy-based sleep quality (i.e., higher sleep efficiency, fewer long wake episodes) in conjunction with more secure attachment to parents experienced the lowest levels of anxiety symptoms. Less secure attachment was associated with high levels of anxiety symptoms independent of sleep quality. Similar patterns of associations emerged for attachment to mothers and fathers.

Conclusions: Findings highlight the importance of examining the conjoint influence of sleep and adolescent-parent relationships towards explication of adolescent's mental health.

Keywords: sleep, actigraphy, attachment, adjustment, adolescence

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Among typically developing youth, insufficient and poor quality sleep are relatively common (1) and associated with a wide range of mental health problems (2, 3). However, not all youth with sleep problems experience mental health difficulties and explication of variables that can function to enhance vulnerability or protective factors in the link between sleep disturbances and adjustment are warranted. In addition to a growing body of work documenting relations between children's sleep and family functioning, an emerging literature suggests that family processes may function as moderators of risk and can alter the association between sleep problems and well-being in youth (4). Extending this literature, we examined adolescents' perceptions of attachment to parents as moderators of the association between sleep and mental health (also referred to as adjustment), including internalizing and externalizing symptoms as well as self-esteem. Attachment is defined as adolescents' *perceptions* of trust, open communication, and lack of alienation with mothers and fathers, and is thought to reflect security in these relationships. Several sleep parameters were derived: actigraphy-based sleep duration (minutes) and quality (efficiency, number of long wake episodes), and self-reported sleep/wake problems. In our study, sleep problems refer to shorter and poorer quality (lower efficiency, more frequent waking) sleep as derived from actigraphy, as well as subjective reports of more sleep/wake problems.

Sleep occurs in the context of the family, and associations between negative family interactions and poor sleep have been documented (for meta-analysis see Bartel, Gradisar, & Williamson (5). Because vigilance and sleep are incompatible, a safe and secure family environment facilitates sleep (6). Indeed, a secure attachment is associated with low levels of adjustment problems in youth (for meta-analyses see Fearon et al. (7) and Madigan et al. (8)), whereas an insecure attachment is linked with mental health problems (9). We propose that both sleep and attachment may interact and conjointly influence youths' mental health (10).

An emerging literature is beginning to identify conditions under which sleep and family

processes may interact to affect youth outcomes. In a study utilizing an earlier wave of data from the same data set as the current study, lower perceived attachment security to mothers coupled with short or less efficient sleep predicted poor academic achievement in children (11). In another study, maternal sensitivity, a correlate of attachment, during infancy was associated with lower adjustment problems in toddlerhood among children with longer but not shorter mother-reported sleep duration in infancy (12). Collectively, these findings support the proposition that sleep and parent-child relationships may interact to predict children's adaptation.

Although the aforementioned studies highlight the role of sleep in the contexts of attachment and maternal sensitivity among younger children, we are not aware of studies that have examined such associations among adolescents (13). Further, a majority of existing studies in the attachment literature focus primarily on mothers, with limited work on attachment to fathers (14). Yet, the inclusion of fathers is needed for a more comprehensive understanding of the link between parent-child relationships and youths' mental health (14). The few studies comparing relations between mother and father attachments or relationships and children's adjustment have yielded mixed findings, such that some have found similar patterns across mothers and fathers (15, 16), whereas others have found null effects or effects for only one parent (11). Our current assessments are likely to augment this literature.

The Present Study

We examined the moderating role of attachment to both mothers and fathers in the association between adolescent sleep and mental health. Consistent with dual-risk perspectives (17), in which an individual may have a vulnerability that increases risk or a protective factor that reduces risk, and insecure attachment may exacerbate the association between sleep problems and mental health difficulties and vice versa. It is also plausible that the benefits of a secure attachment would only be evident in the context of longer and/or better quality sleep. Such a pattern would reflect a protective-reactive moderating process, where a protective factor

(attachment) confers benefits in the context of low but not high risk (sleep problems, 18). These two patterns of moderation effects have emerged in the young literature examining sleep, family functioning, and development. Given the inconsistencies in this developing literature, we had no a priori hypothesis about the pattern of moderation effects.

Method

Participants

Data for the present study comes from Time 3 (T3; collected in 2009) of a larger study (for additional details see Kelly & El-Sheikh, 19). At the first wave (collected in 2004), participants were recruited from public elementary schools. Eligibility criteria included children who lived with both parents and had no diagnosis of a chronic illness, mental disability, attention deficit hyperactivity disorder (ADHD), or a diagnosed sleep disorder based on mothers' reports.

At T3, 113 youth participated. After the exclusion of youth without any data on primary study variables, and those who did not report on attachments to both parents, the final analytic sample included 106 adolescents ($M_{\text{age}} = 13.61$, $SD = .73$; 55% girls; 28% African Americans, 72% European Americans). At T3, 4% of participants were diagnosed with ADHD; 6-7% reported having asthma or allergies, respectively. Data were not collected on sleep disorders.

Procedures

The study was approved by the university's institutional review board. Sleep data were collected with actigraphs worn on adolescents' non-dominant wrists from bedtime to waking for seven consecutive nights (Sunday to Saturday) during the regular school year, excluding holidays. Parents kept a sleep diary with records of the adolescents' bedtimes and wake times to corroborate actigraphy data (20) and were called daily to obtain this information. Nights during which medication was used for illnesses (most commonly allergies, asthma) were excluded from analyses. Families visited the lab, on average, 0.72 days ($SD = 5.46$) following the final day of wearing the actigraph; a majority (77.3%) came the day following the last day of wearing the actigraph and one family came in 48 days later. In the lab, families completed

questionnaires and adolescents' weight (kg) and height (cm) were measured to compute body mass index (BMI).

Measures

Actigraphy-based sleep. Motionlogger Octagonal Basic actigraphs (Ambulatory Monitoring Inc., Ardsley, NY) were used to derive sleep parameters and data were scored using Sadeh's algorithm (21). Seven nights of valid actigraphy data were available for 55% of the sample; 23% had six nights, 9% had five nights, and 13% had four nights or fewer. Missing data were due to forgetting to wear the actigraph, use of medications and, less frequently, malfunctioning equipment. Only sleep data for individuals with ≥ 5 nights of valid actigraphy data (87%) were included in analyses (22). Several sleep variables were derived by averaging data across all available nights (21): sleep minutes (number of minutes scored as sleep between sleep onset and waking); sleep efficiency (percentage of epochs scored as sleep between sleep onset and offset); and long wake episodes (number of night wakings ≥ 5 minutes). Night-to-night stability was high for sleep minutes, sleep efficiency, and long wake episodes ($\alpha = .79 - .90$).

Subjective sleep quality. Adolescents completed the Sleep/Wake Problems scale of the School Sleep Habits Survey (23). Ten items measured how often youth had irregular sleep schedules, stayed up late at night, overslept in the morning, and had trouble going to sleep/staying asleep during the past two weeks. Items were rated on a 5-point scale (1 = *never* to 5 = *every day/night*; $\alpha = .70$).

Perceived attachment. Adolescents completed the Inventory of Parent and Peer Attachment (IPPA; 24) separately for mothers and fathers. The IPPA is a well-established measure that assesses the extent to which adolescents consider their parents to be sources of emotional security (24) and is comprised of three subscales: Trust (10 items; "My mother/father trusts my judgment"), Communication (nine items; "My mother/father helps me to talk about my difficulties"), and Alienation (six items, reverse-scored; "Talking over my problems with my

mother/father makes me feel ashamed or foolish”). Items were rated on a 5-point scale (1 = *almost never or never true* to 5 = *almost always or always true*). Consistent with prior literature (25), scores across the three scales were averaged to create a single score of perceived attachment. High internal consistency was found; α s = .91 and .88 for mothers and fathers, respectively.

Anxiety. Adolescents completed the well-established Revised Children’s Manifest Anxiety Scale (37 items; 26), which assesses whether participants felt anxious in various situations (0 = *no*, 1 = *yes*). Two items about sleep problems were removed (α = .82).

Depression. Adolescents reported on depressive symptoms using the Childhood Depression Inventory (26 items; 27). Each item included three possible responses (0 = *absence of symptom* to 2 = *presence of symptom*). One item regarding suicidal ideation was not included in the survey; two items about sleep problems were excluded (α = .81).

Externalizing symptoms. Mothers and fathers completed the 24-item Externalizing problems scale of the Personality Inventory for Children-2, which has demonstrated good psychometric properties (28). Mother (α = .93) and father (α = .91) scores were highly correlated (r = .85, p < .001) and averaged to create a single score for externalizing symptoms.

Self-esteem. Adolescents completed the 18-item Global Self-Worth Scale of the Self-Perception Profile for Children (29). Items contained two opposing statements (e.g. “Some kids are often unhappy with themselves BUT other kids are pretty pleased with themselves”). Youth made a choice between the two statements, rating the selected statement as “really true for me” or “sort of true for me”. Positively framed statements were scored higher (3 = *sort of true for me*, 4 = *really true of me*), whereas negatively framed statements were scored lower (1 = *really true of me*, 2 = *sort of true of me*). Higher scores reflect higher self-esteem; α = .81.

Covariates. We covaried child sex (0 = *girls*, 1 = *boys*), ethnicity (0 = *European American*, 1 = *African American*), family income (1 = < \$10,000 to 6 = > \$75,000), BMI, and puberty status (mother report on the Pubertal Development Scale; 1 = *prepubertal* to 5 =

postpubertal; 30).

Plan of Analysis

Study variables were checked for outliers and skew; skewness statistics were within the acceptable range (± 1.40). Path models were fitted in AMOS (31). Full information maximum likelihood (FIML) estimation was used to handle missing data (32), ranging from 12% to 25%. Separate models were fitted for each sleep and outcome variable. To model independent effects of each attachment relationship, perceived attachment to mothers and fathers were examined in the same models. In the models, covariates were entered first, followed by main effects of sleep, then main effects of attachments to mother and father, and lastly the interaction between sleep and attachment. To reduce multicollinearity, one interaction term was tested at a time (33). Exogenous variables were allowed to covary, as were the residuals of the endogenous variables, yielding a fully saturated model; thus, fit statistics are not provided. Tests of simple slopes were conducted for significant interactions (34). Plots illustrate the association between sleep and adolescent mental health at lower ($-1\ SD$) and higher ($+1\ SD$) levels of attachment.

Results

Descriptive statistics and correlations among primary study variables are presented in Table 1. Correlations among the covariates and main study variables are reported in Supplemental Table 1.

Sleep and Mental Health: Attachment as a Moderator of Relations

Results from path models are presented in Tables 2 (anxiety, depression) and 3 (externalizing, self-esteem) and plots of significant interactions are presented in Figures 1-5. Path model results for the associations between the covariates and adolescent mental health are reported in Supplemental Table 2. Main effects of sleep emerged such that across mother and father models, longer sleep duration and higher sleep efficiency predicted lower levels of anxiety and depression (Table 2) and higher levels of self-esteem (Table 3). Further, subjective

sleep/wake problems predicted higher levels of anxiety and depression symptoms as well as externalizing behaviors (Table 3). Main effects of long wake episodes did not emerge.

Additionally, consistent across the models, more secure attachment to mothers was associated with lower levels of anxiety and depression, and more secure attachment to fathers was associated with lower levels of depression and higher self-esteem.

Central to this investigation, attachment moderated the associations between some sleep parameters and mental health. Specifically, attachment to mothers and fathers moderated the associations linking both sleep efficiency and long wake episodes with anxiety (Table 2). Graphing the significant interactions revealed a similar pattern of effects for attachment to mothers and fathers for sleep efficiency (Figures 1a and 1b) and long wake episodes (Figures 2a and 2b). Specifically, the association between sleep efficiency and anxiety was evident at higher ($B = -.25$, $SE = .08$, $p < .01$; $B = -.26$, $SE = .08$, $p < .01$) but not lower ($B = -.02$, $SE = .08$, $p = .77$; $B = .01$, $SE = .08$, $p = .90$) levels of attachment to mothers and fathers, respectively. As shown in Figures 1a and 1b, anxiety symptoms were relatively high regardless of sleep at low levels of attachment. However, for adolescents with more secure attachment to parents, anxiety symptoms were high at low levels of sleep efficiency, but low at high levels of sleep efficiency. At high levels of sleep efficiency, adolescents with more but not less secure attachment to mothers and fathers had the lowest levels of anxiety symptoms, a difference of about 1.26 and .75 *SDs*, respectively.

A similar pattern of association emerged between long wake episodes and anxiety, such that a significant association was evident at higher ($B = .74$, $SE = .27$, $p < .01$; $B = .80$, $SE = .32$, $p < .05$) but not lower ($B = -.02$, $SE = .27$, $p = .94$; $B = -.10$, $SE = .15$, $p = .51$) levels of attachment to mothers and fathers, respectively. As shown in Figures 2a and 2b, anxiety was relatively high irrespective of sleep at low levels of attachment to parents. However, for adolescents with more secure attachment to parents, anxiety was higher among adolescents with more frequent wake episodes in comparison to their counterparts with fewer wake

episodes. In the context of fewer wake episodes, adolescents with less compared to more secure attachment to mothers and fathers reported more anxiety, a difference of about 1.17 and .79 *SDs*, respectively.

Additionally, attachment to mothers moderated the association linking subjective sleep/wake problems with externalizing symptoms, and the association linking sleep efficiency and self-esteem (Table 3). Further, attachment to mothers *and* fathers moderated the association between sleep/wake problems and self-esteem (Table 3). For externalizing symptoms, sleep/wake problems were associated with externalizing symptoms at lower ($B = .43$, $SE = .14$, $p < .01$) but not higher ($B = .02$, $SE = .18$, $p = .90$) levels of attachment to mothers. As shown in Figure 3, similar levels of relatively low externalizing symptoms were predicted at lower levels of sleep/wake problems regardless of attachment to mothers. However, at higher levels of sleep/wake problems, adolescents with a less secure attachment to mothers had higher levels of externalizing symptoms than their counterparts with a more secure attachment, a difference of about .53 *SD*.

Regarding the interaction between sleep efficiency and attachment to mothers, follow-up analyses revealed that the association between sleep efficiency and self-esteem was evident at low ($B = .13$, $SE = .06$, $p < .05$) but not high ($B = -.04$, $SE = .06$, $p = .55$) levels of attachment to mothers. As shown in Figure 4, the lowest levels of self-esteem were observed for youth with both low levels of sleep efficiency and low levels of attachment to mothers. The difference between higher and lower attachment to mothers was more evident in the context of low sleep efficiency, such that adolescents with low compared to high attachment reported the lowest levels of self-esteem, a difference of approximately .67 *SD*.

Similar to the pattern of findings with sleep efficiency, tests of simple slopes of the interactions between sleep/wake problems and attachments to both parents revealed that this sleep parameter was associated with lower levels of self-esteem at low ($B = -.16$, $SE = .04$, $p < .001$; $B = -.22$, $SE = .05$, $p < .001$) but not high ($B = .02$, $SE = .07$, $p = .80$; $B = .06$, $SE = .76$, $p =$

.45) levels of mother and father attachment, respectively. As shown in Figures 5a and 5b, the lowest levels of self-esteem were observed for youth with both high levels of sleep/wake problems and low levels of attachment to either mothers or fathers. Differences between adolescents with higher and lower attachment to parents tended to be somewhat more pronounced in the context of higher sleep problems, where adolescents with less compared to more secure attachment to mothers and fathers reported the lowest levels of self-esteem, a difference of about .44 and 1.40 *SDs*, respectively.

No interactions emerged between sleep minutes and attachment in the prediction of adolescent adjustment (Tables 2 and 3). Note that each model presented in Tables 2 and 3 was also fitted for mother and father attachment without controlling for the effects of the other. Results yielded very similar findings except that two interactions became non-significant.

Discussion

We examined adolescents' perceived attachment to parents as a moderator of the associations among several sleep parameters and mental health. Attachment to mothers and fathers moderated some of the associations among sleep quality (objective and subjective) and adolescents' adjustment. Given that adolescence is a period of heightened risk for internalizing and externalizing symptoms (35) as well as declines in self-esteem (36), findings suggest the importance of concurrent assessments of family and sleep variables towards a better understanding of adolescents' adaptation.

For anxiety, a similar pattern of associations emerged across attachment to mothers and fathers. Specifically, adolescents with less secure attachments to either parent tended to have higher levels of anxiety independent of their actigraphy-based sleep quality (efficiency, long wake episodes). However, more secure attachment did not buffer the effects of poor quality sleep. Rather, good quality sleep coupled with more secure attachment yielded the lowest levels of anxiety. This pattern of associations, in which the benefits of secure attachment are pronounced in the context of better quality sleep is consistent with a prior study in which

toddlers with the lowest levels of internalizing symptoms were those who experienced high maternal sensitivity accompanied by longer sleep duration in infancy (12). Further, both studies are consistent with the protective-reactive moderating model (18). Findings indicate that a more nuanced understanding of relations between sleep and mental health may be achieved when examined in the context of family processes.

Some moderation effects were also evident for adolescents' externalizing symptoms and self-esteem, but yielded a different pattern of moderation effects than the one observed for anxiety. Specifically, youth with the highest levels of externalizing problems and lowest levels of self-esteem were those with less secure attachment to parents along with higher levels of subjective and objective sleep problems. Furthermore, adolescents with lower levels of sleep problems tended to have lower levels of externalizing symptoms and higher levels of self-esteem regardless of their attachments. This pattern of associations is consistent with dual-risk perspectives (17) and findings from our prior study in which short sleep duration and poor sleep quality amplified the negative effects of attachment insecurity on children's achievement (11). Whereas similar patterns of associations for self-esteem were found for mothers and fathers, the one moderation effect for externalizing behaviors was only evident in relation to attachment to mothers.

Attachment did not moderate the association between sleep and depression. However, sleep minutes and sleep efficiency were associated directly with depression but not with anxiety, externalizing symptoms or self-esteem. Direct relations between depression and attachment to both parents were also found. It is not clear why differential effects were observed for the various mental health parameters and future assessments that attempt to explicate context of risk and vulnerability associated with sleep problems are warranted.

Although interaction effects are difficult to replicate, the two patterns of associations (i.e., dual-risk, protective-reactive) found across anxiety, externalizing symptoms, and self-esteem are consistent with others reported in this young literature examining interactions between sleep

and family functioning or parent-child relations as predictors of children's health and adaptation (11, 12, 37). Further, highlighting the importance of utilizing multiple methods for sleep assessments and several sleep parameters (38), subjective sleep problems in the context of family functioning have yielded protective-reactive patterns of moderation (12), whereas studies using actigraphy-based sleep parameters have found both dual-risk (11) and protective-reactive (37) patterns in the prediction of youth adjustment. Importantly, although the exact patterns of moderation have varied in this study and in the pertinent literature, the take home message is not very different. Basically, the worst adjustment outcomes are predicted for youth with poor sleep and either a familial risk factor (e.g., aggression) or a less secure attachment to parents, and the best outcomes are predicted for those with better sleep and a positive family context. Further, whereas attachment moderated the association linking subjective and objective sleep quality with adolescent adjustment, no moderation effects emerged for objective sleep duration. In the broader literature, findings regarding interactions between indices of sleep (duration vs. quality) and family functioning have been mixed, with some finding effects for both duration and quality (11), but others finding effects for one but not the other (39). It remains to be seen whether some sleep parameters are more robust than others in the literature.

Advancing the attachment literature, findings demonstrate that attachments to both parents moderated relations among sleep and both anxiety and self-esteem. Results are noteworthy because attachment to fathers was covaried when examining attachment to mothers and vice versa. In our prior study, we primarily found effects for mothers, which could be due to differences in participants' age or the outcomes of interest (11). Main effect findings linking attachment to both parents with depression are consistent with prior studies (15, 16). However, the differential effects for anxiety and self-esteem warrant additional research before conclusions can be drawn. Nonetheless, examining attachment to both mothers and fathers in this study, and controlling for one while assessing the effect of the other, advances the broader literature by identifying the unique contributions of attachment to each parent (14).

Results should be considered in light of several limitations. First, the cross-sectional design precludes conclusions about the direction of associations, and alternative models are possible (e.g., sleep as outcome; sleep effects on adolescent-parent attachment). Nevertheless, supportive of how the present study was conceptualized, there is evidence in the literature suggestive of sleep (2) and attachment (7, 8) predicting prospective adjustment in youth. Further, although there is some evidence of reciprocal relations between sleep and adjustment problems (internalizing, externalizing), a recent review suggests that sleep is a stronger predictor of mental health than the reverse (2). In addition, although sleep was conceptualized as the predictor and attachment as the moderator in our models, the significance of interaction effects between sleep and attachment still hold and would be the same if sleep was conceptualized as the moderator. Youth were from two-parent families, limiting generalizability to other family structures. Further, on average, youth reported relatively high levels of perceived attachment to their parents and low levels of adjustment problems, which limits generalization of findings to samples that may experience more negative parent-adolescent relationships and/or more mental health problems. Whereas this study and other independent studies from our lab have revealed that girls compared with boys have longer actigraphy-based sleep duration, other studies have found the reverse (40). This study utilized a multi-informant and multi-method design. However, it is possible that the common informant (i.e., adolescent) of perceived attachment, internalizing symptoms, and self-esteem influenced the findings across these two outcomes when sleep was examined subjectively. Although actigraphy has many advantages, it may underestimate sleep time and overestimate wake episodes after sleep onset in comparison to polysomnography (41).

Conclusions

Findings show that a combination of better quality sleep (actigraphy-based or subjective) and a more secure perceived attachment, or the presence of at least one of these factors in some circumstances, protected against anxiety, externalizing symptoms, and self-esteem

problems in adolescence. Further, even after accounting for shared variance between parents, similar interaction effects and patterns of associations emerged for mothers and fathers, suggesting that attachment to each parent uniquely predicted adolescent adjustment. Findings may encourage prevention or intervention efforts to take multiple approaches in the promotion of adolescent mental health via facilitating positive parent-adolescent relationships as well as providing education about healthy sleep habits to promote better sleep.

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Table 1.

Descriptive Statistics and Correlations among Sleep, Attachment, and Adolescent Mental Health.

	1	2	3	4	5	6	7	8	9	10
1. Sleep minutes	-									
2. Sleep efficiency	.68***	-								
3. Long wake episodes	-.43***	-.88***	-							
4. Sleep/wake problems	-.04	-.03	-.05	-						
5. Attachment to mothers	.06	.10	-.11	-.31**	-					
6. Attachment to fathers	.03	.04	-.07	-.31**	.62***	-				
7. Anxiety	-.17	-.21	.17	.50***	-.43***	-.39***	-			
8. Depression	-.24*	-.28*	.22	.39***	-.52***	-.51***	.62***	-		
9. Externalizing symptoms	.07	.02	-.09	.36**	-.31**	-.27*	.41***	.38***	-	
10. Self-esteem	.18	.12	-.02	-.36**	.38***	.53***	-.57***	-.63***	-.25*	-
Mean (SD)	430.95 (69.95)	87.22 (8.10)	3.77 (2.35)	19.98 (6.76)	4.26 (0.61)	4.06 (.68)	4.99 (4.37)	4.28 (3.79)	47.45 (7.86)	21.09 (3.27)
Range	231.67- 583.71	66.35- 99.20	.14- 9.86	7- 40	2.37- 5.00	2.01- 5.00	0- 17.00	0- 14.00	38- 73	11- 24

Note. Sleep minutes, sleep efficiency and long wake episodes were examined through actigraphy and sleep/wake problems were assessed with adolescent reports.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2.

Path Coefficients Linking Sleep and Attachment with Anxiety and Depressive Symptoms

	Anxiety				Depression			
	Attachment to mothers		Attachment to fathers		Attachment to mothers		Attachment to fathers	
	<i>B</i> (<i>SE</i>)	β	<i>B</i> (<i>SE</i>)	β	<i>B</i> (<i>SE</i>)	β	<i>B</i> (<i>SE</i>)	β
Sleep minutes	-.02 (.01)*	-.23*	-.02 (.01)*	-.25*	-.01 (.01)*	-.22*	-.01 (.01)*	-.24*
Attachment	-2.86 (.87)**	-.40**	-.64 (.77)	-.10	-2.33 (.71)***	-.37***	-1.37 (.62)*	-.25*
Sleep minutes x Attachment	-.01 (.01)	-.09	-.01 (.01)	-.07	-.004 (.01)	-.04	.01 (.01)	.11
R ²	31.3%		30.9%		39.4%		40.35	
Sleep efficiency	-.14 (.06)*	-.25*	-.13 (.06)*	-.23*	-.10 (.05)*	-.22*	-.10 (.05)*	-.22*
Attachment	-2.63 (.86)**	-.37**	-.81 (.75)	-.13	-2.18 (.71)**	-.35**	-1.44 (.62)*	-.26*
Sleep efficiency x Attachment	-.19 (.09)*	-.21*	-.20 (.08)**	-.26**	-.06 (.08)	-.07	-.004 (.06)	-.01
R ²	34.2%		36.4%		39.4%		39.0%	
Long wake episodes (LWE)	.36 (.20)	.20	.35 (.19)	.19	.21 (.16)	.13	.20 (.17)	.13
Attachment	-2.74 (.87)**	-.38**	-.98 (.76)	-.15	-2.28 (.71)**	-.36**	-1.56 (.64)*	-.28*
LWE x Attachment	.63 (.29)*	.22*	.66 (.24)**	.28**	.43 (.24)	.18	.24 (.20)	.12
R ²	32.4%		34.8%		39.2%		37.6%	
Sleep/wake problems (SWP)	.29 (.06)***	.45***	.30 (.06)***	.46***	.12 (.05)*	.21*	.13 (.05)*	.23*

Attachment	-2.27 (.81)**	-.32**	-.22 (.71)	-.03	-1.84 (.71)**	-.29**	-1.34 (.62)*	-.24*
SWP x Attachment	-.07 (.08)	-.08	-.06 (.10)	-.06	-.12 (.07)	-.16	-.15 (.08)	-.15
R ²	43.0%		42.8%		42.3%		42.1%	

Note. Models controlled for sex, ethnicity, income, BMI, and puberty. Models examining attachment to mothers controlled for attachment to fathers, and vice versa.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3.

Path Coefficients Linking Sleep and Attachment with Externalizing Symptoms and Self-esteem

	Externalizing				Self-esteem			
	Attachment to mothers		Attachment to fathers		Attachment to mothers		Attachment to fathers	
	<i>B</i> (<i>SE</i>)	β	<i>B</i> (<i>SE</i>)	β	<i>B</i> (<i>SE</i>)	β	<i>B</i> (<i>SE</i>)	β
Sleep minutes	.008 (.01)	.07	.01 (.01)	.10	.01(.01)*	.26*	.01 (.01)*	.24*
Attachment	-2.29 (1.76)	-.18	-1.65 (1.57)	-.14	.70 (.64)	.13	1.90 (.57)***	.40***
Sleep minutes x Attachment	.03 (.02)	.17	.02 (.02)	.10	-.02 (.01)	-.19	.01 (.01)	-.11
R ²	17.1%		15.6%		28.5%		36.3%	
Sleep efficiency	.06 (.11)	.07	.06 (.11)	.06	.05 (.04)	.12	.05 (.04)	.13
Attachment	-2.54 (1.78)	-.20	-1.53 (1.58)	-.13	.67 (.65)	.13	1.98 (.58)***	.41***
Sleep efficiency x Attachment	.12 (.19)	.07	.05 (.16)	.03	-.14 (.07)*	-.20*	-.02 (.06)	-.03
R ²	14.6%		14.2%		35.5%		31.8%	
Long wake episodes (LWE)	-.45 (.40)	-.14	-.46 (.40)	-.14	.04 (.15)	.03	.03 (.15)	.02
Attachment	-2.69 (1.78)	-.21	-1.74 (1.59)	-.15	.65 (.66)	.12	2.07 (.59)***	.43***
LWE x Attachment	.21 (.59)	.04	.08 (.50)	.02	.11 (.23)	.05	-.07 (.19)	-.04
R ²	15.5%		15.4%		30.8%		30.4%	
Sleep/wake problems (SWP)	.23 (.13)	.20	.29 (.13)*	.25*	-.07 (.05)	-.15	-.08 (.05)	-.17

Attachment	-1.12 (1.73)	-.09	-.98 (1.56)	-.09	.21 (.64)	.04	2.00 (.56)***	.42***
SWP x Attachment	-.34 (.16)*	-.22*	-.12 (.21)	-.06	.14 (.06)*	.23*	.20 (.07)**	.25**
R ²	23.0%		19.3%		38.3%		39.5%	

Note. Models controlled for sex, ethnicity, income, BMI, and puberty. Models examining attachment to mothers controlled for attachment to fathers, and vice versa.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 1a. Associations between actigraphy-derived sleep efficiency and anxiety symptoms at low (-1 SD) and high (+1 SD) levels of attachment to mothers.

Figure 1b. Associations between actigraphy-derived sleep efficiency and anxiety symptoms at low (-1 SD) and high (+1 SD) levels of attachment to fathers.

Figure 2a. Associations between actigraphy-derived long wake episodes and anxiety symptoms at low (-1 SD) and high (+1 SD) levels of attachment to mothers.

Figure 2b. Associations between actigraphy-derived long wake episodes and internalizing symptoms at low (-1 SD) and high (+1 SD) levels of attachment to fathers.

Figure 3. Associations between subjective sleep/wake problems and externalizing symptoms at low (-1 SD) and high (+1 SD) levels of attachment to mothers.

Figure 4. Associations between actigraphy-derived sleep efficiency and self-esteem at low (-1 SD) and high (+1 SD) levels of attachment to mothers.

Figure 5a. Associations between subjective sleep/wake problems and self-esteem at low (-1 SD) and high (+1 SD) levels of attachment to mothers.

Figure 5b. Associations between sleep/wake problems and self-esteem at low (-1 SD) and high (+1 SD) levels of attachment to fathers.