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Daily Bidirectional Relationships Between Sleep and Mental Health Symptoms in Youth With Emotional and Behavioral Problems

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Abstract

Objective The present study examined the daily, bidirectional relationships between sleep and mental health symptoms in youth presenting to mental health treatment. Methods Youth aged 6 to 11 (36% female, 44% European American) presenting to outpatient behavioral health treatment (N = 25) were recruited to participate in the study. Children and parents completed daily questionnaires regarding the child's sleep, mood, and behavior for a 14-day period, while youth wore an actigraph watch to objectively measure sleep. Results Examining between- and within-person variance using multilevel models, results indicate that youth had poor sleep duration and quality and that sleep and mental health symptoms were highly related at the daily level. Between-person effects were found to be most important and significant bidirectional relationships exist. Conclusions Identifying and addressing sleep problems in the context of mental health treatment is important, as poor sleep is associated with increased symptomology and may contribute to worsened mental health.

Keywords: bidirectional; daily; mental health; pediatric; sleep

Sleep problems are highly prevalent in youth with behavioral and emotional problems, with research suggesting that poor sleep may be up to six times more common in youth clinical populations compared with community samples (Reigstad, Jorgensen, Sund, & Windstrom, 2010). Poor sleep is characteristic of many youth mental health problems, including anxiety, depression, attention-deficit hyperactivity disorder (ADHD), and conduct problems (Gregory & Sadeh, 2012). Inadequate sleep in these populations is concerning, considering the growing evidence that poor sleep can compromise mental and physical functioning (Beebe, 2011), creating the possibility of a "vicious cycle" in which sleep problems could exacerbate existing disruptions for at-risk youth with significant psychopathology. However, limited research has focused on how sleep and mental health symptoms interact in children with emotional and behavioral problems, and the few studies in this area have important limitations. Research aimed at better understanding this complex interplay is a critical need and has the potential to have a substantial impact on youth mental health services.

Research has consistently found that sleep is fundamental to nearly every aspect of optimal functioning in youth, including health, development, cognition, and behavior (Beebe, 2011; Byars, Yolton, Rausch, Lanphear, & Beebe, 2012; Owens, 2014). Considering the negative consequences of poor sleep, the high prevalence rates of sleep problems in children are alarming, with estimates for inadequate sleep and/ or sleep problems ranging from 10 to 40 percent in normally developing, nonclinical youth (Byars

et al., 2012; Owens & Mindell, 2011). Sleep problems are even more prevalent in youth with poor psychological functioning (Reigstad et al., 2010), and inadequate sleep may be particularly harmful for such at-risk youth.

Recent research suggests significant associations between sleep and mental health symptoms in nonclinical pediatric samples. For example, emotional, conduct, and hyperactivity symptoms have been found to be predictive of insufficient sleep in cross-sectional studies (Fosse, Pallesen, Hysing, & Morten Stormark, 2011) and reciprocally related in longitudinal studies of school-age youth (Kelly & El-Sheikh, 2013). Further, recent research suggests that there are complex and likely *dynamic, bidirectional* relationships between sleep and mental health in children (Alfano & Gamble, 2009; Gregory & Sadeh, 2012). Disruptions in sleep have been found to be commonly associated with psychological functioning as a precursor (Roberts, Roberts, & Duong, 2008) and consequence of clinical mental health symptoms (Dahl & Harvey, 2007). This literature hints at possible associations within clinical populations; however, studies with clinical samples are currently lacking and critically needed. Youth with clinical problems may be particularly vulnerable to the effects of sub-optimal sleep, as they may have poor baseline emotion regulation and coping skills, creating a deficit of resources to draw upon when faced with a stressor like sleep loss. Therefore, the associations between sleep and mental health symptoms found in nonclinical populations may be even stronger among children already showing disrupted emotional or behavioral functioning.

Although the field is beginning to explore these relationships, important questions remain about how sleep and mental health interact, and existing research suffers from significant limitations. First, the majority of research examining sleep and mental health has been conducted with adults, and the literature on pediatric sleep is much smaller (Gregory & Sadeh, 2012). Within the adult literature, research suggests that sleep variability is related to depressive symptoms, stress, ADHD, and psychopathology diagnosis (see Bei, Wiley, Trinder, & Manber, 2015 for a review), yet an examination of variability in sleep and mood in children is lacking. Second, even in the pediatric literature, studies have tended to focus more on healthy youth rather than those presenting for clinical issues. Third, existing pediatric research has rarely used objective measures, despite recognition that parent- and self-reports of sleep have poor validity, and the use of both objective and subjective measures is recommended (Dayyat, Spruy, Molfese, & Gozal, 2011). Fourth, most longitudinal studies of sleep and mental health have focused on *average* sleep and mental health symptoms over time in *unidirectional* analyses, missing the dynamic and bidirectional day-to-day interaction between the two constructs. These relationships are important because averaged data, particularly in regards to sleep, may be misleading due to the loss of variability in daily sleep (Bei et al., 2015). In other words, an individual's daily-level data contain more detailed, and potentially critical, information compared with averaged values alone (e.g., nightly sleep ranging from 7 to 13 hr but averaging 10 hr across days), and allow researchers to conduct a more finegrained analysis of dynamic relationships. Current research has yet to determine the relative influence of average (i.e., between-person) versus variable (i.e., within-person) relationships, which may have implications for determining the etiology of the sleep–mood connection and inform intervention strategies (Garrison, 2015). Relatedly, although it is known that youth with emotional and behavioral problems have poor sleep, there is a lack of understanding of how within-person variation impacts differential functioning. Overcoming these limitations to better explicate the relationships between sleep, mood, and behavior in youth with emotional and behavioral problems is critical to facilitate research and inform effective treatment strategies for children with clinical emotional and behavioral problems.

The primary goal of the present study is to better understand the associations between sleep and mental health symptoms in children with significant emotional and behavioral problems by examining the complex, bidirectional relationships between these constructs on a day-to-day basis with a sample of youth presenting for treatment. The central hypothesis is that there will be significant bidirectional relationships between sleep and mental health symptoms, such that poorer sleep exacerbates behavioral and emotional problems, and increased behavioral and emotional symptoms contribute to poorer sleep, creating a vicious cycle between worsening sleep and mental health symptoms. Our approach is consistent with the growing recognition that youth physical and mental health are not separate constructs, but rather interrelated aspects of overall health with bidirectional influences on each other (Nelson et al., 2013; Van Dyk et al., 2013). In addition to explicating these important and complex relationships, outcomes from this study have implications for targeting sleep problems within mental health treatment and will facilitate future research on sleep within clinical samples of youth.

Method

Participants

Participants included 25 children and their accompanying caregivers who were actively participating in group or individual outpatient behavioral health services. See Table I for clinical information at baseline and the daily level. To be eligible to participate, youth must have been between the

Table I. Descriptive Statistics for Baseline and Daily-Level Variables

Variable	*N (%)*	Mean	Median	*SD*	Minimum	Maximum
Baseline Variables						
Presenting concern[a]						
Anxiety/Stress	3 (12%)					
Defiance/Noncompliance	5 (20%)					
Emotional control	6 (24%)					
Social skills/problems	4 (16%)					
ADHD symptoms	8 (32%)					
Anger	3 (12%)					
Adjustment issues	1 (4%)					
Psychotropic medicationa						
Stimulant ADHD medication	10 (40%)					
Non-stimulant ADHD medication	1 (4%)					
CSHQ Total Sleep Disturbance Scale[a]		49.46	48.00	9.09	37.0	70.0
Pediatric Daytime Sleepiness Scale[b]		15.96	15.00	6.01	6.0	28.0
CBCL Internalizing Total Problems (T) [a]		58.96	61.00	9.28	41	75
CBCL Externalizing Total Problems (T) [a]		61.92	64.00	8.03	44	73
BASC Internalizing Problems Composite (T) [b]		53.89	49.00	11.90	39	86
BASC Inattention/Hyperactivity Composite (T) [b]		60.16	57.00	13.52	40	91
BASC Emotional Symptoms Composite (T) [b]		54.08	54.00	10.68	38	86
Daily-Level Variables						
Sleep efficiency (%)[c]		78.66	79.05	8.49	40.92	97.3
Total sleep time (min)[c]		456.96	459	67.48	112	604
Sleep quality[b]		3.81	4.00	1.33	1	5
BPM internalizing (T) [a]		53.51	50.00	5.70	50	73
BPM externalizing (T) [a]		55.39	51.00	7.19	50	74
Negative affect[b]		6.05	4.00	3.99	4	20

Some participants presented to treatment with more than one clinical concern and not all youth were prescribed psychotropic medication. CSHQ = Child Sleep Habits Questionnaire; CBCL = Child Behavior Checklist; BASC = Behavior Assessment System for Children; BPM = Brief Problems Monitor.
a. Parent-report.
b. Child-report.
c. Objective actigraphy.

ages of 6 and 11, accompanied by a parent/legal guardian, and the parent and child must have been able to speak and understand English. To ensure valid reporting of study variables and to avoid confounds related to adverse effects on sleep, exclusion criteria (based on parent report) included: (1) children diagnosed with clinical sleep problems; (2) children diagnosed with a cognitive/ developmental disability; (3) children with a pervasive developmental disorder; and (4) children not living with their parent/guardian.

Procedure

Participants were recruited between January 2014 and February 2015 from an outpatient, group behavioral parent training program for parents with children with emotional and behavioral difficulties or an outpatient behavioral health clinic that provides individual services to youth and families presenting with a wide range of emotional and behavioral concerns. Consistent with typical outpatient practice, youth presenting for services did not need to meet specific diagnostic criteria to receive services. Eligible families attended an initial baseline session and a debriefing session. At the initial session, after providing parental consent and child assent, the parent and child independently completed baseline measures of mental health and sleep behavior and the family was oriented to the daily portion of the study, including detailed instruction on how to wear the actigraph wristwatch and fill out daily measures. Youth were asked to wear an actigraph wristwatch all day and night for 14 consecutive days to measure sleep. During the 14-day period, the parent and child also completed brief online daily measures of child mental health symptoms and sleep. At the end of the 14-day period, parents and youth returned the actigraph wristwatch and, to facilitate recruitment and retention of participants, were compensated with cash (up to $160 based on adherence to study protocol). High rates of protocol adherence were obtained, with 94% adherence to the daily questionnaire and 96% adherence to the actigraph protocol. All procedures were approved by the University of Nebraska-Lincoln and Boys Town Institutional Review Boards.

Materials

Demographics
Parents reported on demographic (e.g., age, gender, ethnicity) and clinical information at baseline. Included in clinical information, parents reported any diagnosed mental health conditions, current psychotropic medications, and primary presenting concerns for their child (e.g., anger, anxiety, noncompliance).

Typical Youth Sleep
Initial baseline measures sampled information regarding the child's typical sleep quality and patterns. Children completed the Pediatric Daytime Sleepiness Scale (PDSS; Drake et al., 2003) and parents completed the Children's Sleep Habits Questionnaire (CSHQ; Owens, Spirito, & McGuinn, 2000). Further, parents reported on how much sleep their child typically obtained per day (including nighttime and daytime nap periods). The PDSS and CSHQ total scores were used in the present study and each demonstrated acceptable, $\alpha = .71$, and good, $\alpha = .82$, internal consistency in our sample, respectively.

Daily Youth Sleep Duration and Quality
Consistent with recent recommendations (Dayyat et al., 2011; Gregory & Sadeh, 2012), daily child sleep was measured using a combination of objective and subjective measures. Objective measurement of child sleep duration was measured using ActiGraphTM wristwatches, which were worn continuously for 14 days, and accompanying ActiSleep software (ActiGraph, 2015). The software converted raw data into a daily summary statistic for total sleep duration for nighttime sleep only. Our choice to examine sleep duration (as opposed to other sleep parameters such as wake after sleep onset) was based on validity research (Sadeh, 2011) and our ability to make comparisons with parental reports and national recommendations of sleep duration, so as to add to the clinical relevance and recommendations of findings. Subjective measurement of child sleep was obtained from daily child-report of sleep quality on a 5-point Likert-type scale item (e.g., How well did you sleep last night?) ranging from 1 (*did not sleep well*) to 5 (*slept very well*). In examining child report of sleep quality, we were aiming to evaluate the subjective feeling of not obtaining enough sleep, which may differ from objectively determined sleep amount (Gregory & Sadeh, 2012).

Baseline Youth Mental Health Symptoms
Baseline youth mental health functioning was assessed using child-report of the Behavior Assessment System for Children, Second Edition (BASC-2; Reynolds & Kamphaus, 2006), and parent-report of the full version of the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001).

Daily Youth Mental Health Symptoms
Child mental health symptoms were measured each day using a brief daily questionnaire from both the child and the participating parent. The child completed the shortened, 10-item Positive and Negative Affect Schedule for Children (PANAS-C; Ebesutani, Regan, Smith, Reise, Higa-McMillan, & Chorpita, 2012). The shortened PANAS-C asks youth to rate how much they felt different feelings and emotions (e.g., joyful, sad, afraid) for that day using a 5-point scale. The 10-item measure produces a negative affect scale that was used in the present study and demonstrated excellent internal consistency at the daily level in our sample, $a = .90$. In addition to online daily child-report of mood, parents completed the Brief Problems Monitor (BPM; Achenbach, McConaughy, Ivanova, & Rescorla, 2011). The BPM is a hardcopy, brief version of the CBCL that was designed to be administered over a period of days, weeks, or months (Achenbach et al., 2011), with validation completed on a weekly basis (Chorpita et al., 2010). Standardized scores for Internalizing and Externalizing Problems were used in the present study.

Analytic Rationale

Using data from the daily sleep and mental health measures described above, descriptive analyses were conducted. Associations between key sleep and mental health constructs were also examined at the daily level. To address the primary hypotheses regarding the daily relationships between sleep and mental health symptoms, individual fluctuation in sleep and emotional/ behavioral variables across 14 occasions was estimated with multilevel models using restricted maximum likelihood with SAS PROC MIXED. Because within-person fluctuation was of interest in these models, alternative covariance structures were examined to determine the best model fit. All predictors were mean-centered to enhance interpretability of conditional models. Outcomes were estimated in conditional models with between- and within-person components of predictors to examine how a singleunit change in one influences the other at the daily level (i.e., within-person variance) and on average (i.e., between-person variance). Effects were examined to determine the bidirectional relationships between sleep and mental health. Age and gender were also examined as predictors and moderators in each model. Only significant effects were retained, so that the most parsimonious models are presented.

Because the within-person variation in sleep and mental health symptoms across a 14-day period was of primary interest, an a priori power estimate was based on finding within-person effects and indicated that with 25 participants, across 14 days, there would be 80% power to detect medium-size effects ranging from .35 to .4.

Results

Descriptive Statistics

Youth had an average age of 8.72 (*SD* = 1.65); 9 (36%) were female; and 11 (44%) identified as European American, 6 (24%) as multiracial, 5 (20%) as African American, 2 (8%) as Hispanic, and 1 (4%) as American Indian. Descriptive statistics for baseline and daily-level sleep and emotional and behavioral symptoms are reported in Table I. When parents reported on baseline, stable sleep, they indicated that their child slept an average of 8.7 hr per night (*SD* = 1.51 hr), which is well below the 10 hr minimum of sleep recommended (National Heart, Lung, and Blood Institute, 2012). When reporting on baseline sleep problems, on average, most parents responded to items indicating that their child had sleep problems within the clinical range on the Total Sleep Disturbance scale of the Children's Sleep Habits Questionnaire (sample *M* = 49.46, clinical cutoff score = 41). When compared with objective, daily measures of sleep, parents overestimated reports of their child's typical sleep duration and sleep quality. Across all measurement days, children slept an average of 7.6 hr and had an average sleep efficiency of 78.66% (<85% clinical cutoff).

Preliminary Analyses

Daily outcome variables were first analyzed for differences in age and gender. Results indicate that at the daily level, younger participants tended to obtain more total sleep (as measured by actigraphy), $r(345) = -.30$, $p < .001$, and have fewer reported attention problems, $r(335) = .19$, $p < .001$. In regards to gender, females self-reported worse sleep quality ($M = 3.51$, $SD = 1.42$) than males ($M = 3.97$, $SD = 1.26$), $F(1, 305) = 8.4$, $p = .004$, but when objectively measured with actigraphy, received more sleep ($M = 480.98$, $SD = 66.14$) than males ($M = 444.14$, $SD = 64.77$), $F(1, 343) = 24.95$, $p < .001$. Males were also reported to have more externalizing problems ($M = 56.16$, $SD = 7.86$) than females ($M = 53.86$, $SD = 5.34$), $F(1, 333) = 7.82$, $p = .005$.

Before multilevel analyses were conducted to deconstruct between- and within-person effects, correlational analyses were run at the daily level to determine broadly (but not bidirectionally) how sleep, emotion, and behavior were related on a daily basis. Overall, sleep, emotion, and behavior were highly related at the daily level. Results indicate that objectively measured sleep duration at the daily level was significantly related to parent-reports of internalizing problems. Subjective child-report of sleep quality was also related to parent-report of internalizing and externalizing problems in addition to child-report of negative affect. See Table II for a correlation matrix of daily-level variables.

Multilevel models were then estimated to determine the daily-level effects of between- and within-person variance on the relationship between sleep and mental health symptoms in youth. Unconditional models were first examined. First, an empty means, random intercept model for each time-varying variable (to be examined as both outcomes and predictors to determine bidirectional relationships) was estimated to decompose and examine variance. Based on the intraclass correlation from each empty model, the following percentage of the total variance was accounted for by between-person differences for each daily-level variable: 74% for parent-report of internalizing symptoms, 70% for parent-report of externalizing symptoms, 63% for child-report of negative affect, 57% for child-report of sleep quality, and 23% for objective actual sleep time. Finally, to confirm the most appropriate model for each outcome, unconditional empty models, using alternative covariance structures due to the specific interest in within-person fluctuation, were estimated for each variable as an outcome.

Bidirectional Relationships Between Sleep and Mental Health Symptoms

To address the primary hypothesis, conditional models were estimated examining the effect of daily changes in emotion/behavior on sleep and vice versa. Measures of emotion and behavior were estimated in a series of models with objectively assessed sleep duration and then in a series of models examining subjectively measured daily sleep quality.

Objective Sleep Duration

The first set of conditional models examined the bidirectional relationships between objectively measured sleep duration and parent- and child-reports of emotional and behavioral symptoms. First, the betweenand within-person fixed effects of daily, *parent-report of externalizing problems* was estimated in a model predicting sleep duration to evaluate if daily fluctuation in externalizing mental health symptoms influences the following night's sleep. Consistent with hypotheses, in predicting sleep duration, there was a significant difference between youth as a function of average externalizing problems. For every 1 SD increase in person mean externalizing problems, mean sleep time decreased by 18.19 minutes ($p = .05$). Thus, the more externalizing problems a youth had on average, the less they tended to sleep. There were no within-person differences, which was contrary to hypotheses. These effects remained with a significant main effect of age added to the model. Younger youth tended to have more externalizing problems when all other variables in the model were held constant ($p = .004$); however, gender did not change the

Table II. Bivariate Correlations of Daily-Level Sleep and Mental Health Symptoms

Daily-Level Variable	1	2	3	4	5
1. Actigraph total time asleep (min)	1	.272**	–.146**	–.100	–.062
2. Child-report sleep quality	.272**	1	–.292**	–.140*	–.428**
3. Parent-report internalizing problems	–.146**	–.292**	1	.639**	.547**
4. Parent-report externalizing problems	–.100	–.140*	.639**	1	.492**
5. Child-report negative affect	–.062	–.428**	.547**	.492**	1

* $p < .05$; ** $p < .001$

association between sleep duration and externalizing problems. As hypothesized, results indicate that there were significant between-person bidirectional relationships. The inverse model predicting externalizing problems indicated that there were significant between-person differences between youth as a function of average total sleep. For every hour increase in person mean total sleep, mean externalizing problems *T* score decreased by 4.14 ($p = .047$). Again, there were no within-person differences and age and gender were not significant predictors.

Next, the bidirectional relationship between *parent- report of internalizing problems* and sleep duration was examined; however, contrary to hypotheses, there were no significant between- or within-person effects. Next, the bidirectional relationship between sleep duration and *child-report of negative affect* was examined. First, in a model predicting sleep duration, there was not a difference between youth as a function of average negative affect. However, there were within-person differences, but in the opposite direction than hypothesized. For every 1 SD increase in negative affect from a youth's average daily negative affect, there was a 13.77-minute increase in amount of sleep ($p = .04$). This effect remained when a significant main effect of age was added to the model. While younger youth had greater negative affect ($p = .005$), age did not change the association among affect and sleep. Examining the inverse model predicting negative affect, there was not a difference between youth as a function of average total sleep but there was a within-person effect in the opposite direction of the model predicting sleep duration. As hypothesized, for every hour increase in total sleep from a youth's average daily sleep, there was a .6 decrease in negative affect ($p < .001$). Neither age nor gender was a significant predictor.

Subjective Sleep Quality

The next set of conditional models examined bidirectional relationships with subjectively measured, child-report of sleep quality. Age and gender were also examined as main effects and moderators; however, they were not significant predictors as main effects, nor did they impact associations between sleep quality and mental health symptoms in any model ($p > .05$ for all). First, sleep quality was examined as an outcome in a model with between- and within-person fixed effects of daily *parent-report of internalizing problems*. As hypothesized, in a model with sleep quality as the outcome, there was a difference between youth as a function of average internalizing problems. For every 1 SD increase in person mean internalizing problems, mean sleep quality rating decreased by .57 ($p = .02$), so that the more internalizing problems a youth had on average, the worse sleep quality they tended to report. Contrary to expectations, there were no withinperson differences. In examining the inverse model, there was a bidirectional relationship, as hypothesized. There was a difference between youth as a function of average sleep quality. For every 1 SD increase in person mean sleep quality, mean internalizing problems *T* score decreased by 3.15 ($p = .04$). The better sleep quality a child reported, the fewer internalizing problems were reported by parents. Again, there were no within-person differences.

The bidirectional relationships between sleep quality and *parent-report of externalizing problems* were next examined. However, contrary to expectations, there were no significant between- or within-person effects when predicting sleep quality with externalizing problems or in the inverse model predicting externalizing problems with sleep quality.

Finally, a set of models examining the bidirectional relationships between sleep quality and *child-report of negative affect* were estimated. As hypothesized, in a model with sleep quality as the outcome, there was a difference between youth as a function of average negative affect. For every 1 SD increase in person mean negative affect, mean sleep quality rating decreased by .80 ($p = .002$). The more overall negative affect reported on average, the poorer quality of sleep reported. Contrary to expectations, there were no within-person differences. The inverse model with sleep quality predicting negative affect was next examined. There was a significant bidirectional betweenperson relationship, so that for every 1 SD increase in person mean sleep quality, mean negative affect decreased by 2.53 ($p = .001$). Thus, as expected, the better quality sleep a youth

reported on average, the less negative affect they tended to report. Again, there were no within-person differences.

Discussion

Overview of Findings

Overall, results suggest that sleep, mood, and behavior in youth with emotional and behavioral problems are related and that sleep is an important construct to consider when working with clinical populations. Findings provide an important, yet incremental, addition to our current knowledge. The present study is consistent with previous research on the relationship between sleep and mental health symptoms (Kelly & El-Sheikh, 2013) and extends the literature by providing an initial examination of these relationships *at the daily level* in a *clinical, treatment-seeking sample* and by evaluating the relative importance of *between- versus within-person differences* in sleep and mood. Findings indicate that youth presenting to mental health treatment receive an insufficient amount of sleep (averaging 7.6 hr compared with the 10 hr minimum recommended; NHLBI, 2012) and have poor sleep quality. Further, parents tend to overestimate both their child's sleep duration and quality. These findings are concerning in light of the remaining study results indicating that sleep and mental health symptoms are bidirectionally related when measured at the daily level, suggesting that youth with emotional and behavioral problems may be at increased risk for exacerbation of mental health symptoms due to poor sleep.

In examining the daily, bidirectional relationships between sleep and mental health symptoms, there was a particular interest in determining the differential impact of within-person fluctuation in symptoms compared with between-person effects. Overall, it was determined that between-person differences in sleep and mental health symptoms tended to matter more than daily fluctuations. In other words, although sleep and mental health symptoms were highly related at the daily level, between-person differences (i.e., having worse sleep or greater mental health symptomology on average across days than others) tended to matter more than if a child fluctuated from their typical presentation. This finding was contrary to our expectations but may not be surprising considering the characteristics of our sample. First, based on calculated ICCs, daily-level mental health symptoms (particularly those reported by parents) tended to have a proportionately larger amount of variance accounted for by between-person differences, making it potentially more difficult to find within-person differences. Second, participants had generally poor sleep, so even when sleep fluctuated, it tended to do so below a level that would be considered adequate. It is possible that variability in sleep matters more if there are nights when youth obtain sufficient sleep. Future studies should test these hypotheses by examining the impact of sleep variability in samples of youth with overall healthier sleep and by using experimental designs to introduce variability in sleep.

In regards to daily-level between-person differences, a variety of sleep (both objective and subjective) and mental health variables (both parent- and child-report) were significantly related. Also, many were bidirectionally related. Interestingly, mental health symptoms tended to be predictive of sleep at the daily level, regardless of measurement type. However, objective and subjective sleep were differentially predictive of types of mental health symptoms. More specifically, objectively measured sleep was more predictive of outward behaviors but not inwardly expressed mental health symptoms, whereas subjective sleep was more predictive of inwardly expressed, emotional symptoms. It could be that objective sleep loss has a measurable impact on neurobiological functioning (i.e., dysfunction within the prefrontal cortex) resulting in increased impulsivity and decreased inhibition (expressed as more externalizing symptoms; Kamphuis, Meerlo, Koolhass, & Lancel, 2012), whereas subjective sleep loss is more generally reflective of an overall low mood characterized by internal symptoms such as fatigue.

Implications

Results of the present study have important implications for practitioners and researchers. First, results suggest that youth with emotional and behavioral problems have very poor sleep. This in itself is alarming considering the multiple negative consequences associated with poor sleep (e.g., poor cognition, decreased motivation, worsened physical health; Beebe, 2011; Owens, 2014). Perhaps most important to this finding are subsequent results suggesting that receiving inadequate sleep may precipitate or exacerbate already existing emotional and behavioral problems. However, it appears that youth, already at a disadvantage in regards to their emotional and behavioral functioning, may be at increased risk for other serious detriments due to receiving insufficient and/or poor quality sleep. Beyond potentially exacerbating emotional and behavioral symptoms, it is unknown what the additive impact of worsened sleep and any associated negative consequences (e.g., poor physical health) may have on youth already experiencing difficulties related to emotion and/or behavior. It is possible that poor sleep contributes to increased complexity and decreased functioning in other domains, which may contribute to further difficulties for the child. Within the framework of a biopsychosocial model, future studies should attempt to more broadly evaluate the overall functioning of clinical samples of youth experiencing sleep problems with clinical samples obtaining healthy sleep.

Considering that these youth experience significant sleep deprivation and poor sleep quality, results also suggest that parents may not recognize this as a problem. One possible reason for this may be that the child's emotional and/or behavioral difficulties are a more salient issue for parents, thus problems with sleep either go unnoticed or are set aside. Another possible reason is that parents may not have an adequate understanding of age-appropriate and healthy sleep, particularly in regards to how much sleep is recommended. In either situation, parents of youth with emotional and behavioral difficulties would benefit from education regarding sleep recommendations for youth and the negative consequences of failing to consistently receive adequate sleep. More specifically for this population, psychoeducation regarding the association between sleep and emotional and behavioral functioning should be included.

It should also be noted that families within this sample were seeking some form of outpatient services related to their child's mental health and thus had contact with a care provider outside of the home. Therefore, it is recommended that providers serving youth and families presenting with emotional and behavioral difficulties be educated about healthy sleep and the relationships between sleep, mood, and behavior. Clinicians and primary care providers are uniquely suited to identify youth sleep problems and provide education and support to parents regarding this critical issue, particularly because of their access to this high-risk population.

Identification of sleep problems and of insufficient sleep is imperative in clinical practice so that appropriate services can be provided to families. Therefore, it is also recommended that providers systematically assess for sleep problems at intake into treatment. When possible, assessment should include the use of objective measures of sleep across days, as results from the present study suggest that sleep duration may not be accurately reported by parents. However, results also indicate that there is utility in subjective reports of sleep, as the subjective experience of feeling tired and/ or sleeping well were important predictors.

In addition to assessment and identification of sleep problems, it is recommended that sleep be addressed within the context of mental health treatment. The primary findings of the present study indicate that sleep, mood, and behavior are highly related in a bidirectional manner and that these relationships appear to impact youth at a daily level. More research is needed to determine if improvement in one domain positively impacts the other. For example, it is possible that intervening with sleep may improve functioning more broadly, including decreasing mental health symptoms. Research is just beginning to examine the impact of targeting sleep problems in clinical samples, with one clinic-based study demonstrating success in improving behavior when sleep is addressed early in treatment (Nelson, Van Dyk, McGinnis, Nguyen, & Long, 2016). However, the development and evaluation of a brief sleep intervention within the context of mental health treatment for youth is needed to fully appreciate the feasibility and impact of such treatments.

Intervening with sleep within the context of mental health treatment makes sense for multiple reasons. First, as already discussed, results suggest that sleep and psychopathology are closely intertwined. Second, clinicians are in a prime position to assess for sleep in these youth, as they have both access to the population and are often afforded more time with families to complete a thorough evaluation of functioning. Finally, mental health treatment providers are uniquely trained in behavioral principles that lend themselves to the implementation of behavioral sleep treatment. Research suggests that behavioral sleep treatments are an evidence-based, efficient, and effective way to address sleep problems in youth (Meltzer & Mindell, 2014). Despite evidence that sleep treatment could significantly improve emotional and behavioral outcomes, treatments for youth psychopathology do not tend to include a sleep component. However, it is recognized that existing pediatric sleep interventions may need to be modified to be successful in youth with above average emotional and behavioral problems. For example, more time may need to be spent on basic limit setting and differential attention when addressing bedtime problems (e.g., sleep timing, routines, bedtime resistance) and anxiety, fear, and mood may play a larger role in problems with sleep onset or frequent night awakenings. Thus, interventions should be modified to account for these unique influences and should be validated in clinical samples.

Limitations

Although the present study makes significant contributions to the literature in describing sleep and its relationship with emotional and behavioral functioning at the daily level in a clinical sample of youth, results should be considered preliminary, as several limitations exist. First, the relatively small sample size is a limitation preventing definitive conclusions from being made and cautioning against absolute generalizations. However, considering the clinical nature of our sample and the fact that there was adequate power to evaluate daily-level effects, the present sample size is sufficient as a first examination of sleep and mental health symptoms in this population. Future research with larger samples is needed to make more definitive conclusions regarding these relationships. Relatedly, although this sample is unique and interesting because they are treatment-seeking, it should be noted that

most reported clinical concerns and psychotropic medications were related to ADHD and thus broad generalizations to other diagnoses should be made with caution. Notably, research has established that youth with ADHD have significantly worse sleep quality and duration when both subjectively and objectively measured when compared with controls (Cortese, Faraone, Konofal, & Lecendreux, 2009). Next, measuring sleep and mental health symptoms across multiple days in a youth's natural environment is advantageous for making generalizations about typical functioning. However, within this design, it was impossible to control for all other possible confounds that could influence both sleep and emotional and behavioral functioning such as chaotic home environments or disruptions to regular routines (e.g., vacations, holidays, sleepovers). For example, it is reasonable to assume that the severity and pattern of mental health symptoms and sleep may differ during school breaks (e.g., summer vacation) and the inclusion of this information in the future would be important. Studies with more experimental control may have limitations to external validity but would help eliminate or account for some of these confounds. In relation to increased experimental control, future research should also aim to compare daily-level relationships between sleep and mental health symptoms in clinical versus nonclinical youth so that the unique effects of sleep and symptom variability for clinical youth can be determined. The lack of a comparison group in the present study is a relative limitation but highlights the emerging nature of this body of research and the need for further evaluation of intra-individual variability in youth. Next, the use of multi-method, multi-informant daily-level assessment is a significant strength and relatively novel aspect of the study. However, it should be noted that although the BPM was designed to be administered over a period of days, weeks, or months (Achenbach et al., 2011), the measure has only been validated on a weekly basis (Chorpita et al., 2010) and validation for daily assessment is still needed. The present study was also limited in its ability to adequately assess for mechanisms of the relationships between sleep and mental health. It would be useful to assess for possible mechanisms such as influences on executive functioning, emotion regulation, or changes in brain functioning. Finally, although significant and interesting, effects tended to be relatively small (e.g., a 4-point decrease in externalizing problems for every hour increase in sleep). However, although this is not a tremendous change, it may be clinically meaningful when considering the sample more broadly. For example, on average, youth in this sample slept around 7.5 hr, which is 2.5 hr below the recommended amount. Thus, if youth were to improve their sleep enough to meet standard recommendations, we may expect larger improvements in mental health symptoms. That said, statistical versus clinical meaningfulness should be considered when interpreting results, and future research should specifically aim to evaluate how clinical outcomes change when sleep is targeted in treatment.

Conclusions

The purpose of the present study was to examine the daily bidirectional relationships between sleep and mental health symptoms in a sample of youth with emotional and behavioral problems. Results add to the literature by describing the sleep of youth presenting to treatment and by supporting the hypothesis that sleep and mental health are closely and bidirectionally related. Further, findings support several important conclusions. First, youth with emotional and behavioral problems have very poor sleep. Second, poor sleep in this population may not be reported as a concern by parents and therefore may go unnoticed in primary care, school, and mental health settings unless specifically assessed. Third, identifying and addressing sleep problems is extremely important, as sleep is associated with worse emotional and behavioral functioning and may further exacerbate functioning or increase complexity of care. Finally, by treating sleep within the context of mental health treatment, results suggest that emotional and behavioral problems may be significantly improved.

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