

Adolescent Sleep Quality Mediates Family Chaos and Adolescent Mental Health: A Daily Diary-Based Study

Jack S. Peltz
Daemen College

Ronald D. Rogge
University of Rochester

Thomas G. O'Connor
University of Rochester Medical Center

The aim of the current study was to examine adolescents' sleep duration and quality as potential mediators of the association between chaotic and disorganized family environments and adolescent anxiety and depressive symptoms. A total of 193 adolescent (ages 14–17; $M_{\text{age}} = 15.7$ years old, $SD = .94$; 54.4% female; 71% White) and parent dyads completed baseline, online surveys, and adolescents also completed online 7-day, twice-daily sleep diaries. Parents ($M_{\text{age}} = 47.6$ years old, $SD = 5.4$; 80% female) reported on levels of family chaos, socioeconomic status (SES), and school start times, whereas adolescents completed daily reports of their sleep duration and quality (morning diary) and their anxiety and depressive symptoms (evening diary). At the within-person level, daily fluctuations in both sleep duration and quality were significantly linked to corresponding daily fluctuations in anxiety and depressive symptoms. At the between-person level, adjusting for parenting quality; adolescents' age, gender, daytime napping, school start time; and the family's SES, we found that adolescent sleep quality mediated the association between family chaos and disorganization and symptoms of anxiety and depression. The current study illuminates the potential influence that family chaos and disorganization play in adolescents' sleep and mental health symptomatology and underscores the need to assess the family context to support better adolescent health and well-being.

Keywords: adolescence, sleep, family, mental health

Adolescent mental health and well-being are put at risk because of their insufficient and poor-quality sleep (Alfano, Zakem, Costa, Taylor, & Weems, 2009; Dahl & Lewin, 2002; Gregory & Sadeh, 2016; National Sleep Foundation, 2006; Short, Gradsar, Lack, & Wright, 2013). Extensive research documents the role that sleep problems play in adolescent academic, behavioral, and psychosocial functioning (Fallone, Owens, & Deane, 2002; Owens, 2014; Peltz, Rogge, Connolly, & O'Connor, 2017; Shochat, Cohen-Zion, & Tzischinsky, 2014; Smaldone, Honig, & Byrne, 2007), including clinical outcomes such as suicide (Fitzgerald, Messias, & Buysse, 2011; Gangwisch et al., 2010). These findings are especially concerning given the epidemic levels of insufficient and poor quality sleep experienced by most adolescents (Gregory &

Sadeh, 2016; National Sleep Foundation, 2006; Owens, 2014; Short et al., 2013) and underscore the need for research to identify potential sources of adolescent sleep disturbances. One promising area of adolescent sleep research that has emerged focuses on the family environment (El-Sheikh & Kelly, 2017). In the current study, we capitalize on the analytic power of collecting repeated measures to test the novel hypothesis that family disorganization and chaos predict day-to-day adolescent sleep problems and partly explain the association between disorganized and chaotic family environments and adolescent affective symptoms.

Building on the strong body of research linking adolescent sleep and mental health (Gregory & Sadeh, 2016; Meltzer, 2017), the first aim of the current study was to extend these findings by examining the association between a leading indicator of family disorganization and chaos with multiple indicators of adolescent sleep. Family systems theory suggests that because of the interdependent nature of the family system, disorder or instability within the system is predicted to reverberate throughout the system and impact its component parts (Minuchin, 1985). In this light, several studies suggest that there may be components of the family environment associated with adolescent sleep quality (Billows et al., 2009; Dahl & El-Sheikh, 2007; Gregory, Caspi, Moffitt, & Poulton, 2006), but there remain questions about the dimensions of family functioning and the types and nature of the effect on sleep. For instance, Billows and colleagues (2009) demonstrated that family disorganization and chaos were associated with adolescent

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Jack S. Peltz, Department of Psychological Sciences, Daemen College; Ronald D. Rogge, Department of Clinical and Social Psychology, University of Rochester; Thomas G. O'Connor, Department of Psychiatry, University of Rochester Medical Center.

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Correspondence concerning this article should be addressed to Jack S. Peltz, Department of Psychological Sciences, Daemen College, 4380 Main Street, Amherst, NY 14226. E-mail: jpeltz@daemen.edu

sleep-related problems via their sleep hygiene practices. Accordingly, the current study sought to test a mediational model by examining the level of family disorganization as an influence on adolescents' daily reports of their sleep, which, in turn, might impact their levels of anxiety and depressive symptoms over the course of the day.

Evolutionary, clinical, and developmental studies and theory suggests that a stable and safe family environment is an essential ingredient to good sleep (Dahl, 1996, 2002). It is in this family context that individuals typically derive a sense of safety and become free of the vigilance maintained in daily life to protect oneself from external threats (Worthman & Melby, 2002). Evidence suggests that positive family environments that support better sleep tend to involve order or routines (Billows et al., 2009), the establishment of parent-set bedtimes (Adam, Snell, & Pendry, 2007; Bartel, Gradisar, & Williamson, 2015), positive parental involvement (Cousins, Bootzin, Stevens, Ruiz, & Haynes, 2007; Tynjälä, Kannas, Levälähti, & Välimaa, 1999), and the absence of family conflict (Gregory et al., 2006). One limitation of many of these studies is that associations between the family environment and adolescent sleep were largely based on single reporter information and single occasions of measurement (e.g., Adam et al., 2007; Billows et al., 2009). Multirespondent and longitudinal associations are infrequent, but Gregory and colleagues (2006) were able to demonstrate this association longitudinally. Specifically, they showed that higher levels of family conflict, defined as expressed anger and aggression between family members, experienced by children between the ages of 9 and 15, predicted insomnia at age 18. The authors, however, acknowledge that their measure of the family environment (i.e., the Moos Family Environment Scale; Moos & Moos, 1986) did not clearly differentiate between family conflict and family environments marked by higher levels of disorganization and chaos. Building on this work and the work of others (e.g., El-Sheikh & Kelly, 2017), the current study sought to specifically examine chaotic and disorganized family environments, as opposed to family conflict, as their higher levels of disorder and commotion portray a more normative depiction of family environments with adolescent-age children, but still have been shown to be associated with children's sleep problems (Billows et al., 2009).

The second, more novel aim of the study was to test the hypothesis that family influences on adolescents' disrupted sleep may account for variation in their affective symptoms. There is substantial evidence showing a correspondence between adolescents' insufficient and problematic sleep and their mental health problems (for a review, see Gregory & Sadeh, 2012; Owens, 2014; Richardson, 2007; Shochat et al., 2014), and research suggests that these links are most likely bidirectional (Kahn, Sheppes, & Sadeh, 2013). In this light, Kahn and colleagues (2013) have suggested that emotional or cognitive stressors, such as prebedtime arguments, might influence physiological responses, such as increased cortisol secretion, which has been shown to predict both sleep disturbance and mental health problems. Furthermore, research suggests that sleep-deprived individuals have demonstrated both decreased prefrontal cortex functioning and increased amygdala activation in response to negative stimuli, which, in turn, has been shown to disrupt emotional regulation, a key correlate of depression (Yoo, Gujar, Hu, Jolesz, & Walker, 2007). Although research examining the influence of depression on sleep disturbance has

been largely correlational, Schmidt and Van der Linden (2009) reported that emotions (e.g., regret and guilt) associated with depression, which are experienced presleep, predicted insomnia severity. Despite the bidirectional nature of the associations between adolescent sleep and mental health, precipitating events, such as parent-child prebedtime arguments, have the potential to set in motion a negative cascade. While the aim of the current study was to elucidate the role that family level processes might play in influencing adolescent mental health through sleep, we must acknowledge that further research is needed to clarify the mechanisms linking sleep and adolescent mental health symptoms.

It is important to note, however, that both sleep quality and duration may be independently associated with adolescents' mental health (Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010). Despite the wealth of evidence in this literature, there remains a paucity of longitudinal studies documenting the link between adolescent sleep and their mental health outcomes (Shochat et al., 2014; for exceptions, see Johnson, Roth, & Breslau, 2006; Roberts & Duong, 2013). Shorter-term studies (e.g., in contrast to 6-, 12-, or 24-month intervals between assessments) are particularly absent, despite the power that more intensive, closely spaced assessment intervals may provide for drawing causal connections (Collins & Graham, 2002). That is, the relatively infrequent temporal spacing of assessments might not map onto the timeframes in which family environment or sleep disturbances may be associated with affective symptoms.

Consistent with this hypothesis is the observation that the impact of insufficient or disturbed sleep is also experienced more immediately (i.e., the following day; Talbot, McGlinchey, Kaplan, Dahl, & Harvey, 2010). Accordingly, the current study sought to assess sleep across the 7 days of an adolescent's school week with a sleep diary. Not only do sleep diaries, with a minimum of 5 weekday nights, provide the gold standard for reliably assessing subjective sleep behaviors (Short, Arora, Gradisar, Taheri, & Carskadon, 2017), but the current study's inclusion of both morning (to measure sleep-related constructs) and evening (to measure mood-related constructs) diary entries builds upon this area of research by minimizing inflated correlations associated with once-a-day assessments; modeling the direction of influence between sleep and mental well-being; and modeling the within-person variation of adolescents' sleep quality and duration. As a result, our results are better able to adjust for individual variation in sleep need as evidenced by the wide range of optimal sleep suggested for adolescents (i.e., 8–10 h per night; National Sleep Foundation, 2006).

As depicted in our conceptual model (see Figure 1), we hypothesized a negative association between family disorder and chaos and adolescent sleep duration and quality. Furthermore, capitalizing on 7-day diary data, we hypothesized a negative association between adolescents' sleep duration and quality (based on morning reports of their sleep the previous night) and levels of anxiety and depressive symptoms (based on evening reports of their mood during the day). Finally, we hypothesized that adolescent sleep duration and quality will serve as mediators of the indirect effect between the family environment and adolescent mental health outcomes.

The family environment, however, is only one of many potential contextual influences on adolescent sleep and symptoms. In fact, family chaos or disorder might be considered a more distal aspect

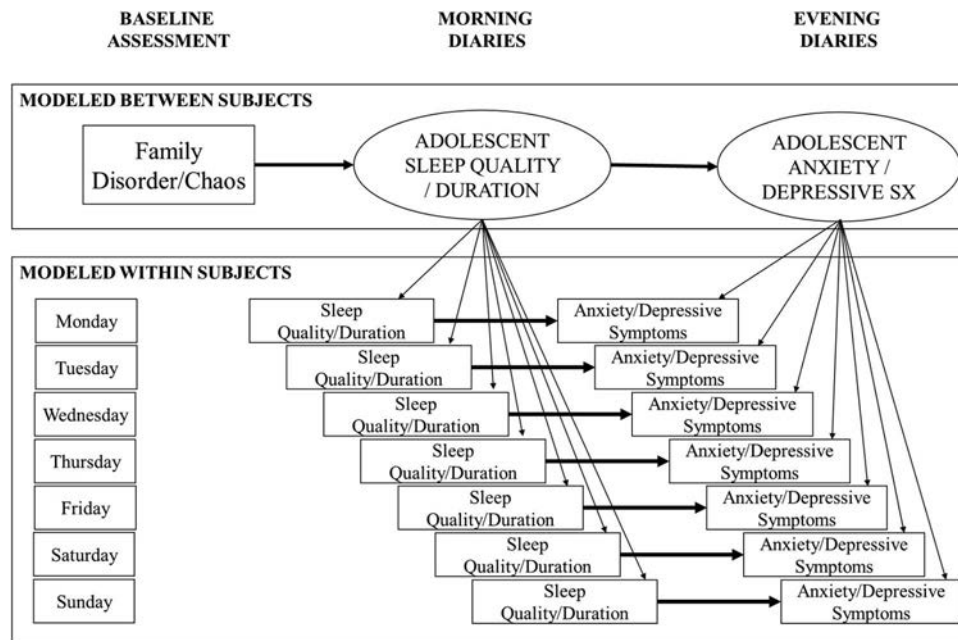


Figure 1. Conceptual model.

within the family environment when compared with more proximal influences of adolescent behavior, such as parenting. In this light, to illuminate the role of the larger family environment (i.e., more distal) as a unique predictor of adolescent sleep and functioning, we included parents' use of inconsistent discipline, a key ingredient of parenting quality, as a control. Not only has parents' use of inconsistent discipline been linked to sleep quality (Brand, Hatzinger, Beck, & Holsboer-Trachsler, 2009), but it is also associated with children's psychological adjustment (Parent, McKee, & Forehand, 2016). Another salient factor that has emerged as a strong predictor of both of these constructs is school start time (Bowers & Moyer, 2017; Wahlstrom, Berger, & Widome, 2017). Research suggests that schools with later starting times afford adolescents longer sleep durations, which is associated with better academic, behavioral, and psychological outcomes (Boergers, Gable, & Owens, 2014; Shochat et al., 2014). Furthermore, individual sleep-related factors, such as daytime napping, have also been linked with both adolescent sleep and mental health outcomes (Gau et al., 2007; Loessl, Valerius, Kopasz, Hornyak, Riemann, & Voderholzer, 2008). Finally, adolescents' age, gender, and family socioeconomic status (SES) have demonstrated consistent associations with their sleep and mental health functioning (El-Sheikh, Kelly, Buckhalt, & Benjamin Hinnant, 2010; Fredriksen, Rhodes, Reddy, & Way, 2004). Accordingly, we also consider these potential confounds in our analyses.

Method

Participants and Recruitment

Participants were adolescent-parent dyads ($N = 193$), who were recruited through direct solicitation (e.g., receiving a study brochure after a brief presentation at school), emails to distribution

lists (e.g., parenting groups), and through ResearchMatch, a national health volunteer registry that was created by several academic institutions and supported by the U.S. National Institutes of Health as part of the Clinical Translational Science Award program. ResearchMatch has a large population of volunteers who have consented to be contacted by researchers about health studies for which they may be eligible. To participate, adolescents had to be in 9–11th grades in either a public or private day school within the United States, between the ages of 14 and 17, living 7 days/week in the participating family's household, and both parent and child had to agree to participate.

A total of 193 adolescents ($M_{\text{age}} = 15.7$ years old, $SD = .94$; 54.4% female) completed the baseline and 7-day sleep diary surveys, and their parents ($M_{\text{age}} = 47.6$ years old, $SD = 5.4$; 80% female) provided data from the baseline survey on levels of family chaos, family SES, and school start times. The adolescents reported being in 9th (37%), 10th (32%), or 11th (31%) grade. The majority of adolescents and parents identified as White (71 and 79%, respectively), with another 14 and 14% (respectively) identifying as Black or African American, 8 and 2% (respectively) identifying as multiracial, 3 and 2% (respectively) identifying as Latino/a, 2 and 2% (respectively) identifying as Asian American, and 2 and 1% (respectively) identifying as "other." Parents had relatively high levels of education, with approximately 42% reporting a graduate degree, 35% with a BA/BS, 19% with some college or an associate degree, and 4% with a high school diploma or GED or less. Mean income was \$81,600 ($SD = \$27,800$); 17.6% of families reporting incomes equal to or less than \$45,000.

Procedure

The study was approved by the University of Rochester's Research Subjects Review Board (RSRB00055929; Project R.E.S.T. –

Research and Evaluation of Sleep in Teenagers) and informed consent from parents and assent from adolescents was obtained before participation. The baseline survey took roughly 20–25 min to complete; respondents were compensated \$10 each as an incentive. During the baseline survey, parents and adolescents provided their own e-mail addresses (to obtain a dyadic sample), and parents set a start date for their child to complete the 7-day sleep diary. After completing the baseline survey, adolescents were invited to complete a 7-day daily sleep diary. To optimize the temporal spacing of sleep and daily mood reports, the sleep diary consisted of both a morning and an evening portion. Using an online survey platform that time-stamped every entry, we asked that the morning diary survey (e.g., sleep-related measures) be completed within an hour of waking up, and the evening diary survey (e.g., mood-related measures) be completed within an hour of going to sleep. Although rare, surveys that were not received within this approximate timeframe were considered as missing and removed from the dataset (see below for percentages of missing data). Adolescent respondents received \$15 for completing a minimum of 4 morning and evening diary entries, an entry to win a lottery prize (an iPad mini) for every diary entry completed, and brief feedback on their sleep (e.g., average bed/wake times based on the diary data they provided) after the conclusion of the data collection.

Longitudinal Follow-Up Assessments

On average, the parents and adolescents completed their baseline surveys 8.4 days ($SD = 5.7$) before the adolescent began the sleep diary. A total of 186 adolescents (96.4%) completed at least 2 days of the daily diaries and 178 adolescents (92.2%) completed at least 4 days of the daily diaries. Analysis of variance (ANOVA) and χ^2 analyses suggested that the respondents participating in the daily diaries did not differ from participants who only completed the baseline survey across all primary variables and demographic covariates. In addition, only two families (1.0%) were missing the parent report of family chaos from the baseline survey. Thus, using current best practice guidelines (Schlomer, Bauman, & Card, 2010), we used FIML estimation within Mplus to handle that missing data, thereby retaining the full sample in our analyses.

Measures

Family environment. To assess the level of disorganization and chaos in the family environment, parents completed the seven-item Confusion, Hubbub, and Order Scale (CHAOS; Matheny, Wachs, Ludwig, & Phillips, 1995) during the baseline assessment. These items assessed the level of “environmental confusion” (Matheny et al., 1995, p. 430) in the household (e.g., “There is very little commotion in our home”—reverse-scored; “You can’t hear yourself think in our home”; “Our home is a good place to relax”—reverse-scored), were rated on 5-point scales (*definitely untrue* to *definitely true*), and were averaged so that higher scores indicated higher levels of chaos in the family environment ($\alpha = .71$).

Daily sleep quality. Sleep quality was self-reported by the adolescent with a four-item measure in the morning for each of the seven consecutive days on the daily diary. Adapted from the recommendations of Ohayon and colleagues (2017), the measure included overall sleep quality (“Indicate how you slept.”) that was

rated on a 5-point response scale (1 = *very restless* to 5 = *very sound*), sleep latency (approximate number of minutes before falling asleep—reverse-scored), the level of restedness (“Indicate how rested you felt upon awakening.”) that was rated on a 5-point response scale (1 = *exhausted* to 5 = *very refreshed*), and the number of wake-after-sleep episodes (reverse-scored). Scores were standardized and summed with higher scores indicating better sleep quality ($\alpha = .63$).

Daily sleep duration. Sleep duration was assessed in the morning diaries and was calculated for each of the seven consecutive days on the daily diary by taking the differences between the time the child reported going to sleep and waking up the next morning.

Daily psychological functioning. To assess adolescents’ psychological functioning, respondents self-reported on their anxiety (two items) and depressive (two items) symptoms in an adapted version of the Patient Health Questionnaire-4 (Löwe et al., 2010) in the evening portion of their diary. Although the anxiety portion of the PHQ-4 has demonstrated slightly higher sensitivity/specificity than the depressive symptoms portion (Kroenke, Spitzer, Williams, & Löwe, 2009), the depressive symptoms portion has demonstrated strong reliability and validity in adolescent samples (Richardson, Rockhill, et al., 2010), with high levels of sensitivity/specificity (i.e., greater than 74%) for detecting youth meeting *Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition (DSM-IV)* criteria for major depression (Richardson, McCauley, et al., 2010). Respondents reported how much they had been bothered by the following symptoms since waking up that morning: “feeling nervous, anxious or on edge,” “not being able to stop or control worrying,” “little interest or pleasure in doing things,” and “feeling down, depressed, or hopeless.” The items were rated on 4-point response scales (*not at all* to *nearly all day*) and were summed so that higher scores indicated higher levels of anxiety and depressive symptoms ($\alpha = .83$).

Covariates. Five covariates, assessed in the baseline survey, were included in the model: parents’ use of inconsistent discipline, child age and gender, adolescent-reported daily daytime naps (in minutes), school start time, and family SES. Parents’ use of inconsistent discipline was assessed with the six-item inconsistent discipline subscale of the Alabama Parenting Questionnaire (Shelton, Frick, & Wootton, 1996). The items (e.g., “You threaten to punish your child and then do not actually punish him/her”; “Your child is not punished when he/she has done something wrong”), were rated on 5-point scales (*never* to *always*), and higher scores indicated higher levels of inconsistent discipline ($\alpha = .76$). Parents provided the start time for their child’s school in the baseline survey in addition to the family’s SES, the composite of the standardized forms of the respondent’s educational attainment (“Less than high school” to “Advanced degree”) and approximate family income.

Results

Preliminary Analyses

Descriptive statistics for the sample and intercorrelations among the key variables are presented in Table 1. Parents reported a mean score of 7.8 ($SD = 4.4$) on the family disorder/chaos scale, with approximately 16% reporting scores 1 SD above the mean and approximately 19% reporting scores 1 SD below the mean. Re-

Table 1
Psychometrics and Bivariate Correlations Between Study Variables

Variables	Range	M	SD	Bivariate correlations								
				1	2	3	4	5	6	7	8	9
1. CHAOS (parent-reported)	0–22	7.8	4.4	—								
2. Anxiety/depression symptoms	0–10.2	1.3	1.7	.06	—							
3. Sleep quality	–2.0–1.6	.0	.7	–.19	–.37	—						
4. Sleep duration	4.6–11.5	8.2	1.0	–.06	–.01	.07	—					
5. Parents' use of inconsistent discipline	0–18	6.3	3.6	.37	.10	–.03	.01	—				
6. Child's age	14.1–17.9	15.7	.9	–.10	.05	–.09	–.27	–.01	—			
7. Child's gender (male = 0, female = 1)	54.4% female			–.03	.24	–.10	.07	–.08	.01	—		
8. Child's daytime napping (minutes)	0–154.3	10.9	19.8	.02	–.01	.04	–.13	.08	.14	.06	—	
9. School start time	6:55–9:30 a.m.	7:55	29.3 min	.08	.14	.05	.16	.12	–.06	–.03	–.09	—
10. Family SES	–3.4–1.2	.1	1.0	–.04	–.16	.01	–.17	–.12	–.07	–.04	–.04	–.12

Note. CHAOS = Confusion, Hubbub, and Order Scale; SES = socioeconomic status. To facilitate interpretation, this table presents unstandardized means and SDs for the study variables, with the exception of Family SES (as this variable was created by averaging standardized reports of parent education and family income). All diary-reported data have been averaged across all waves of follow-up. All bolded correlations are significant at the $p < .05$ level.

garding the four indicators of sleep quality, adolescents reported an average rating of 3.99 ($SD = 1.1$) for sleep quality on a 5-point scale; an average of 22.20 min ($SD = 26.1$) of sleep latency; an average of 0.62 ($SD = 1.0$) episodes of wake-after-sleep-onset; and an average rating of 3.13 ($SD = 1.2$) for restedness on a 5-point scale. Parent-reported family disorder was positively associated with parents' use of inconsistent discipline. Adolescent sleep quality was negatively associated with both family chaos and adolescent self-reported anxiety and depressive symptoms, and adolescent sleep duration was negatively associated with the adolescent's age and family SES and positively associated with school start times. In addition, girls reported higher levels of anxiety and depressive symptoms, and adolescents from families with higher SES reported lower levels of anxiety and depressive symptoms, and earlier school start times.

Primary Analyses

The repeated observations from the daily diaries represented multiple assessments nested within adolescents. To appropriately model the nested nature of the data, multilevel SEM models (Mplus, Version 7; Muthén & Muthén, 2012), using a mediational framework (Preacher, Zyphur, & Zhang, 2010), were used. As depicted in our conceptual model (see Figure 1), repeated assessments within individual adolescents across time (i.e., 7-day daily diary data) were modeled at Level 1 and nested within families at Level 2. Based on the best practices articulated by Preacher and colleagues (2010), we used a 2–1–1 mediational model for the separate analyses that either included adolescent sleep quality or sleep duration as mediators. Because many commonly used multilevel modeling approaches are at high risk of conflating the between- and within-level components of mediational effects, the multilevel SEM approach distinguishes the variation associated both between-person (at Level 2) and within-person (i.e., the repeated assessments at Level 1) by creating latent variables based on the Level 1 predictors that can be used to test mediation with the Level 2 predictor (Preacher et al., 2010). Specifically, the indirect effect is based on the product of (a) the path linking the baseline Level-2 predictor (i.e., family disorder) to the latent variable representing morning diary reports of sleep duration or

quality and (b) the path linking the latent sleep quality/duration variable to the latent variable representing evening diary reports of mental health (i.e., anxiety and depressive symptoms). More important, this model tests the proposed mediation across families (at Level 2) while controlling for how these same processes are linked (i.e., covary) on a day to day basis (at Level 1), thereby providing a more conservative test of that mediation (see Preacher et al., 2010). In addition to our key baseline predictor of parent-reported family chaos, both mediation models included the adolescents' age, gender, school start time, and the family's SES as between-family controls, and daytime napping (minute) as a within-family control. Although multilevel models are unable to provide standardized path coefficients, all variables (predictors, controls, and outcomes) were standardized (i.e., z-scored) before entering them into the analysis, thereby yielding rough approximations of standardized path coefficients within this multilevel, multivariate context. Overall model fit was assessed with the comparative fit index (CFI; Bentler, 1990; values above .90 indicating good fit), the root-mean-square error of approximation (RMSEA; Kline, 2011; values below .08 indicating good fit) and the standardized root-mean-square residual (SRMR; Hu & Bentler, 1999; values below .10 indicating good fit). For both the model with sleep duration as a mediator ($\chi^2(39) = 114.86$, $p < .001$; RMSEA = .02; CFI = .93; SRMR_{between} = .06) and the model with sleep quality as a mediator ($\chi^2(39) = 143.92$, $p < .001$; RMSEA = .01; CFI = .96; SRMR_{between} = .05), model fit was acceptable. Results from both models are presented separately below.

Results With Controls

A number of significant effects emerged linking the controls to sleep quality and duration and anxiety and depressive symptoms. These effects were included in the models testing our main hypotheses to ensure that any mediation emerging could not be better accounted for by one of these possible third-variable constructs. *Model Including Sleep Duration as a Mediator.* As seen in Table 2, later school start times ($B = .09$, $SE = .04$) were associated with longer sleep durations, and the child's age ($B = -.15$, $SE = .04$) and the family's SES level ($B = -.09$, $SE = .04$) were negatively associated with adolescent sleep duration. Thus, a family having

Table 2
Coefficients for Mediation Models at the Between-Family Level

Model 1: Sleep duration as mediator				
Predictors	B	SE	95% CI	
			LL	UL
Predicting sleep duration				
Family CHAOS	−.04	.04	−.12	.04
Parents' use of inconsistent discipline	−.02	.04	−.10	.07
Child's age	−.15	.04	−.23	−.07
Child's gender (male = 0, female = 1)	.01	.04	−.07	.09
Family SES	−.09	.04	−.16	−.02
Child's school start time	.09	.04	.02	.16
Predicting anxiety/depressive symptoms				
Sleep duration	−.27	.23	−.72	.18
Family CHAOS	.00	.06	−.11	.12
Parents' use of inconsistent discipline	.05	.06	−.08	.17
Child's age	.01	.08	−.14	.17
Child's gender (male = 0, female = 1)	.20	.06	.09	.31
Family SES	−.10	.08	−.25	.06
Child's school start time	.10	.06	−.03	.22
Model 2: Sleep quality as mediator				
Predicting sleep quality				
Family CHAOS	−.11	.05	−.21	−.01
Parents' use of inconsistent discipline	.02	.05	−.08	.12
Child's age	−.09	.05	−.18	.01
Child's gender (male = 0, female = 1)	−.11	.05	−.20	−.02
Family SES	−.01	.04	−.10	.08
Child's school start time	.08	.05	−.02	.17
Predicting anxiety/depressive symptoms				
Sleep quality	−.73	.14	−1.01	−.45
Family CHAOS	−.07	.06	−.18	.04
Parents' use of inconsistent discipline	.07	.07	−.06	.20
Child's age	−.01	.06	−.13	.11
Child's gender (male = 0, female = 1)	.12	.05	.02	.22
Family SES	−.08	.06	−.21	.04
Child's school start time	.13	.06	.00	.25

Note. CHAOS = Confusion, Hubbub, and Order Scale (Matheny, Wachs, Ludwig, & Phillips, 1995); LL = lower level; UL = upper level. The predictors and outcome variables were standardized in their final levels of the data before running the multilevel models. Thus, the regression coefficients serve as rough approximations of standardized regression coefficients. All bolded results are significant at the $p < .05$ level.

an SES 1 SD higher than average (e.g., a primary caregiver with about 2.4 more years of education and roughly \$28,000 higher income than average) predicted adolescents reporting 0.1 SDs shorter sleep durations (i.e., about 6 min less sleep per night). In addition, adolescent female respondents reported higher levels of anxiety and depressive symptoms ($B = .20$, $SE = .06$). *Model Including Sleep Quality as a Mediator.* In this model (see Table 2), adolescent female respondents reported lower levels of sleep quality ($B = -.11$, $SE = .05$) and higher levels of anxiety and depressive symptoms ($B = .12$, $SE = .05$). As a within-family control, more daytime napping by adolescents was associated with lower levels of anxiety and depressive symptoms across the week ($B = -.11$, $SE = .02$).

Sleep Duration (Figure 2A)

Hypothesis 1: Family Chaos Predicting Sleep. Family chaos did not predict adolescents' sleep duration ($B = -.04$, $SE = .04$, ns).

Hypothesis 2: Sleep Predicting Anxiety and Depressive Symptoms. Based on the within-person data from the 7-day daily diary, sleep duration significantly predicted adolescents' anxiety and depressive symptoms ($B = -.08$, $SE = .02$, $p < .01$) such that longer sleep durations the previous night (reported in the morning) were associated with fewer anxiety and depressive symptoms reported that evening. This association emerged after controlling for average levels of sleep duration (modeled as a latent variable at Level 2) and average levels of anxiety and depressive symptoms (also modeled at Level 2). Thus, this association represents links between daily fluctuations in sleep duration (above and below one's own typical levels) and corresponding fluctuations in anxiety and depressive symptoms (above and below one's own typical levels). After controlling for these daily links between sleep duration and anxiety and depressive symptoms in addition to the controls in the model (child's age and gender, daytime napping, school start time, and family SES), this association was not significant at the

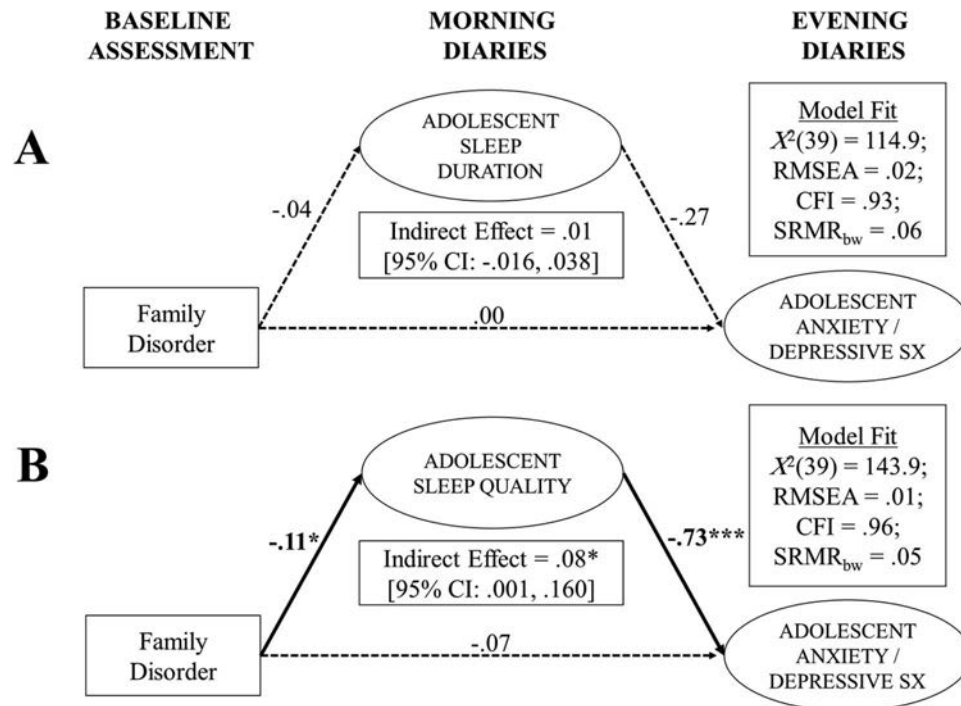


Figure 2. Mediation results based on multilevel structural equation modeling. * $p < .05$. *** $p < .001$.

between-person level, at which mediation was ultimately tested ($B = -.27$, $SE = .23$, ns). **Hypothesis 3: Mediation.** The indirect effect of family disorder on adolescents' anxiety and depressive symptoms was not significant (Indirect effect = .01, $SE = .01$, ns ; 95% confidence interval, CI [-.02, .04]), suggesting that adolescents' sleep durations do not mediate the influence of the family environment on their anxiety and depressive symptoms. Based on the estimated residual variances, this model accounted for roughly 5% of the variance in adolescents' anxiety and depressive symptoms. This is consistent with the markedly small effect size of this indirect effect (.01) suggesting that sleep duration is not a particularly robust mechanism linking family chaos to adolescent mental health functioning.

Sleep Quality (Figure 2B)

Hypothesis 1: Family Chaos Predicting Sleep. Family chaos significantly predicted adolescents' sleep quality such that more chaotic and disorganized family environments were associated with lower levels of sleep quality ($B = -.11$, $SE = .05$, $p < .05$). **Hypothesis 2: Sleep Predicting Anxiety and Depressive Symptoms.** Based on the within-person data from the 7-day daily diary and consistent with our hypothesis, better sleep quality significantly and negatively predicted adolescents' anxiety and depressive symptoms ($B = -.11$, $SE = .03$, $p < .01$) such that better quality sleep the previous night (reported in the morning) was associated with fewer anxiety and depressive symptoms reported that evening. This association was also significant at the between-person level ($B = -.73$, $SE = .14$, $p < .001$), suggesting that at the between-family level, higher typical levels of sleep quality for an adolescent (across the morning diaries) predicted lower typical

levels of anxiety and depressive symptoms for that adolescent across the evening diaries. **Hypothesis 3: Mediation.** Consistent with our hypothesis, the indirect effect of family chaos on adolescent anxiety and depressive symptoms was significant: more chaotic and disorganized family environments predicted lower levels of sleep quality, which, in turn, predicted higher levels of adolescents' anxiety and depressive symptoms (Indirect effect = .08, $SE = .04$, $p < .05$; 95% CI [.001, .16]). This result suggests that family environments marked by higher levels of disorder or chaos predict poorer quality sleep in adolescents and that this poorer quality sleep ultimately predicts higher levels of anxiety and depressive symptoms. Based on the estimated residual variances, this model accounted for roughly 56% of the variance in adolescents' anxiety and depressive symptoms. Thus, although the effect size of the indirect effect is fairly small in magnitude (.08), the results suggest that it represents one of the mechanisms by which family chaos might influence adolescent mental health functioning.

Daily diary reports of depressive and anxiety symptoms were aggregated in the main analyses to focus on the broader construct of internalizing symptoms. This was supported by a fairly high correlation across the days of the diaries ($r = .64$). To ensure that this analytic strategy did not inadvertently obscure meaningful differences between those two outcomes, we ran secondary analyses testing depressive and anxious symptoms as separate outcomes in separate models. The results of these two sets of analyses were virtually identical to one another and to the main results presented above, suggesting that it is likely the shared variance between depressive and anxiety symptoms driving the results obtained.

Discussion

Incorporating data from a 7-day daily diary, we found that family disorganization and chaos were associated with adolescents' poorer sleep quality, which was associated with their increased affective symptoms. Building on previous research linking the family environment to adolescent sleep quality (Billows et al., 2009) and duration (Gregory et al., 2006), this study extends that work by highlighting a short-term longitudinal model that incorporates parent-reports of family disorder and twice-daily adolescent-reports of their sleep (morning diary) and mental health functioning (evening diary). Furthermore, the results emerged despite adjusting for environmental constructs that might be considered more directly influential on adolescents' behavior, such as parents' use of inconsistent discipline. In an attempt to better understand the recent increase in adolescent mental health concerns and their documented connection to sleep (Fitzgerald et al., 2011; Gangwisch et al., 2010; Shochat et al., 2014), the current results suggest that, above and beyond aspects of parenting quality, disorganized and chaotic family environments potentially influence adolescents' quality of sleep, which negatively impacts their mental well-being.

Consistent with Billows and colleagues (2009), who also used the CHAOS measure (Matheny et al., 1995), disorganized family environments are believed to prevent those living in the home from capitalizing on the sense of safety that the home typically provides and that is essential for effective sleep-related behaviors and ultimately good sleep (Dahl, 1996, 2002; Worthman & Melby, 2002). Although the current study did not examine the mechanisms through which a disorganized or chaotic family environment might impact an adolescent's sleep quality, Billows and colleagues (2009) suggested that such environments negatively impacted adolescents' sleep hygiene practices, which, in turn, appeared to disturb adolescents' sleep. Although Billows and colleagues' (2009) study was cross-sectional and could not differentiate the direction of effects in their model, our results support their conclusions that adolescents in homes characterized by family disorder and chaos might be limited in their ability to engage in effective sleep hygiene habits. For example, habits central to sleep hygiene such as sleeping in quiet spaces, engaging in consistent routines around bedtime, and adhering to consistent bed and wake times (LeBourgeois, Giannotti, Cortesi, Wolfson, & Harsh, 2005) would likely be impeded for adolescents living in disruptive, noisy homes marked by high levels of commotion and few routines. Accordingly, high levels of family disorganization could effectively rob adolescents of what little control they might have had over their own sleep hygiene, thereby disrupting the quality of their sleep. Alternatively, chaotic family environments might also increase adolescents' levels of stress; thus, leading to increased production of cortisol, a known predictor of insomnia (Richardson, 2007). Future work should, therefore, seek to clarify how sleep hygiene and hormonal dysregulation might act as potential mechanisms in this process. It is important to note, however, that the association between adolescent sleep and mental health is likely bidirectional, although stronger evidence appears to support sleep problems predicting later anxiety and depressive symptoms and not the converse (Alvaro, Roberts, & Harris, 2013).

It is important to note, however, that our between-family findings demonstrating a link between family chaos and adolescents' sleep emerged only for the quality of adolescents' sleep and not for

sleep duration. Adolescent sleep duration is probably the most frequently examined construct in the adolescent sleep literature (Shochat et al., 2014), and its correlates are well established (Astill, Van der Heijden, Van IJzendoorn, & Van Someren, 2012). Although we hypothesized that family disorder would impact adolescents' sleep duration, our results did not support this expected finding. One possible reason for this null finding is that disorganized and chaotic family environments only appear to affect adolescents' ability to get to sleep and to enjoy refreshing and restorative sleep (i.e., slow wave sleep). However, once an adolescent is asleep, it is possible that they can engage in sleep for a sufficient duration regardless of the environment around them. It is also possible that the sleep behaviors and sleep patterns established in chaotic and disorganized family environments take more time to impact adolescents' sleep durations. As suggested by Gregory and colleagues (2006) who found that family conflict experienced by children at ages 9–15 predicted their insomnia at age 18, family disorder may disrupt sleep hygiene and quality in the short-term and these maladaptive processes may ultimately lead to insomnia, a disorder characterized by both disturbed and insufficient sleep.

Consistent with our hypotheses, at a within-person level (Level 1 of our models) adolescents' morning reports of both sleep quality and duration from the previous night significantly predicted their anxiety and depressive symptoms later that evening across the 7 days of the daily diary assessments. Thus, daily fluctuations either above or below an adolescent's average levels in sleep quality or duration are significantly linked with corresponding fluctuations in the adolescent's anxiety and depressive symptoms emerging later those same days. Similar results have been found for adolescents' intraindividual sleep/wake patterns (Becker, Sidel, Van Dyk, Epstein, & Beebe, 2017), and they suggest that within-person shifts in adolescents' sleep play an important role in not only adolescent mental health, but also physical and cognitive functioning as well. These links have been demonstrated in short-term diary-based studies that are consistent with our findings (Fuligni, Tsai, Krull, & Gonzales, 2015; Peltz, Rogge, Pugach, & Strang, 2017), and they have also been evidenced by multiwave studies with much longer intervals between assessments (see Shochat et al., 2014 for examples). Taken together, these findings highlight the importance of sleep routines that involve consistent bed and wake times for adolescents. Avoiding this variability is challenging for many adolescents because they tend to oversleep on weekends to catch up on sleep missed during the week (Carskadon, 2011). Given our current results, it appears that securing a good night's sleep on a regular basis can be even more challenging for adolescents in chaotic and disorganized families.

We must acknowledge several of the current study's limitations. First, all measures of adolescent sleep and mental health symptoms were self-reported, and so may be confounded by response-biases. Although we tried to limit such response-bias by using separate assessments for sleep and anxiety and depressive symptoms, future studies would benefit from augmenting self-report surveys with additional methods (e.g., actigraphy) or reports from other observers (i.e., parents). Likewise, only one parent reported on the level of disorder in their household, which provides only a limited portrayal of the family environment. Future studies might benefit from assessing multiple reporters or including more objective observational methods to assess the nature of the family environ-

ment. Second, although comparable with other samples recruited primarily via the Internet (Peltz et al., 2017), the sample was predominately White, well-educated, and economically advantaged, and findings may only generalize to a similar population. Accordingly, future studies should seek to examine these questions in more nationally representative samples to ensure a broad generalizability of the findings. Third, our mediational model supports a direction of effects from family chaos to adolescent sleep to adolescent mental health symptoms. Although our longitudinal design supports the directionality of our findings, it is entirely possible that the opposite direction of influence could also emerge. In secondary analyses, we ran separate models with the previous evening's mental health reports predicting that night's sleep quality or duration, thereby testing the opposite direction of temporal causality. Although this was not a true examination of bidirectionality—as both directions of influence were not estimated simultaneously in the same model—evening depressive symptoms failed to predict the following morning's reports of adolescent sleep duration or quality. Thus, the current results favor the direction of causality hypothesized in our mediation model. Support does exist for the bidirectional links between adolescent sleep and mental health functioning (e.g., Roberts & Duong, 2013; van Zundert, van Roekel, Engels, & Scholte, 2015), and future studies will ideally include models that can simultaneously test reciprocal associations between these constructs to clarify this issue. Finally, although the current results provide a solid starting point for understanding the correlates of adolescent sleep quality, the effect size of the indirect effect was fairly small, suggesting that there are likely additional mechanisms linking family chaos to adolescents' mental health that could be explored in future studies. We also did not control for adolescents' substance use (e.g., alcohol, medications, and caffeine), which may have influenced their sleep quality. Future research could further elucidate the mechanisms linking family chaos to adolescent's poor sleep quality and adolescent's poor sleep quality to depressive and anxious symptoms. Accordingly, future research could examine factors such as family conflict, ambient environmental noise, and sleep hygiene across the family as constructs explaining how family chaos might disrupt an adolescent's sleep quality. Similarly, future research could examine how factors such as irritable mood, ineffective coping strategies, and negative social interactions during the day might link poor sleep quality to greater negative emotions experienced during the day.

Despite these limitations, the current study illuminates the potential role that larger family disorganization and chaos play in adolescents' mental health symptomatology. Given the rise in adolescents' hospitalizations for both suicidal ideation and attempts over the past decade (Plemmons et al., 2018), finding key predictors of adolescents' mental well-being has grown in importance. Sleep is not only a fundamental human need, but also its link to adolescent mental health remains crucial to consider as clinicians and other service providers assess the needs of teenagers. By expanding our understanding of the predictors of adolescent sleep to the family environment, we hope that assessments of adolescent functioning will consistently include this broader contextual factor because of its impact on adolescent's sleep and ultimately their psychosocial functioning.

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