Predictors of Sleep-Problem Trajectories across Adolescence

By

Abigail E. Pine

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Approved:

Judy Garber, Ph.D.

Autumn Kujawa, Ph.D.

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CHAPTER I

Introduction

Youth sleep less as they age, such that only 25% of 12th graders report obtaining eight or more hours of sleep, in contrast to 84% of sixth graders (National Sleep Foundation, 2006; Owens et al., 2014). In addition to insufficient sleep, various types of sleep problems are common in youth and increase in parallel with pubertal development (Zhang et al., 2016). An estimated 7 to 36% of adolescents have difficulty falling asleep at night, and 20 to 40% of adolescents experience daytime sleepiness (e.g., falling asleep in school, too sleepy for activities; Gradisar et al., 2011). Insomnia disorder is prevalent among adolescents (de Zambotti et al., 2018), with 33.5% experiencing initial (difficulty falling asleep), 9.0% middle (difficulty staying asleep), and 6.5% terminal (early morning wakening) insomnia (Chung et al., 2011).

Insufficient sleep during adolescence may be related to shifts in circadian clocks that occur around puberty (Crowley et al., 2018), earlier school start times (Owens et al., 2014), and increasing academic demands (Owens & Weiss, 2017). Insufficient sleep is associated with an increased risk for depression and other psychopathology (Gregory & Sadeh, 2016; Lovato & Gradisar, 2014), obesity (Fatima et al., 2015; Shochat et al., 2014), and poor academic performance (Hysing et al., 2016). Insufficient sleep also has been found to be associated with increased risk for suicidal ideation (Baiden et al., 2020), as well as alcohol and substance use (Short & Weber, 2018).

Several factors have been linked to sleep disturbance in adolescents. One important correlate of youth sleep problems is stress (Bauducco et al., 2016; Brodar et al., 2020; Dahl & Lewin, 2002; Dewald et al., 2014; Doane & Thurston, 2014; Majeno et al., 2018; Maskevich et

al., 2020; Vidal Bustamante et al., 2020). For example, youth who report a more stressful day are more likely to sleep less that same night (Doane & Thurston, 2014). Stressful experiences have been connected to adolescent sleep problems both concurrently and prospectively in the first year of high school (Brodar et al., 2020). Additionally, greater than average stressful life events have been associated with greater variability in sleep duration during the current and following month (Vidal Bustamante et al., 2020). One important gap in this literature, however, is that existing longitudinal studies of the link between stress and sleep problems have been relatively short-term – one-year (Brodar et al., 2020; Vidal Bustamante et al., 2020), and all but one study (Vidal Bustamante et al., 2020) used questionnaires to measure stress. Longitudinal studies across multiple years using a life events interview will allow us to evaluate the durability of previously observed relations between stress and sleep problems, and thereby clarify the pattern of longer-term changes in both stress and sleep across adolescence.

A second important correlate of sleep problems in youth is a family history of psychopathology, particularly depression (Chen et al., 2012; Fatima et al., 2016; Hamilton et al., 2020; Taylor et al., 2016; Wescott et al., 2019). Offspring of depressed parents are at increased risk for many types of psychopathology and dysfunction as compared to children of nondepressed parents (Beardslee et al., 2011; Goodman, 2020), including sleep problems. For example, youth with a parental history of recurrent depression report worse sleep quality (Chen et al., 2012) and greater sleep disturbance (Hamilton et al., 2020) than offspring of mothers with no history of psychopathology. Further, postnatal maternal depression has been shown to predict sleep problems in offspring at ages 16 and 18 years (Taylor et al., 2016).

In addition to increased risk for sleep disturbances, offspring of depressed parents have heightened exposure to stress across development (Garber & Cole, 2010; Goodman, 2020;

Hammen et al., 2004). Prior research, however, has not examined the longitudinal relation between exposure to stress and sleep problems across adolescence in offspring of depressed parents. The aim of the current longitudinal study was to explore key correlates of sleep disturbance – stress and maternal depression – as possible prospective predictors of sleep problems during adolescence. We hypothesized that (a) greater levels of stressful life events would predict increases in sleep problems over time; (b) offspring of mothers with a history of depression (high-risk) would show an increasing trajectory of sleep problems as compared to children of nondepressed mothers (low-risk). Finally, we tested whether the relation between stress and sleep problems differed for offspring of depressed versus nondepressed mothers.

CHAPTER II

Method

Participants

Participants included 223 adolescents, assessed in grades 7 (*M* = 12.69 years, *SD* = 0.61; 54.7% female), 8, 9 and 11, and 223 mothers. The sample of youth was 82.5% Caucasian, 13.9% African American, 0.4% Hispanic, 0.4% Native American, and 2.7% reported "Other." Families were predominantly working (e.g., nurse's aide, sales clerk) to middle class (e.g., store manager, teacher) with a mean socioeconomic status (Hollingshead, 1975) of 42.30 (*SD* = 13.18).

Procedures

Parents of children from metropolitan public schools were invited to participate in a study about parents and children. A brief health history questionnaire and a letter describing the project were sent to over 3,500 families. The primary inclusion criteria were that the family had a mother with a history of a mood disorder. Of the 1,495 families interested in participating, the 587 mothers who had endorsed either a history of depression, use of antidepressants, or no history of psychopathology were interviewed further by telephone. Of these 587 screened, 349 mothers reported either a history of depression or no history of psychiatric problems. The remaining 238 families were excluded based on the following: the mothers did not indicate sufficient symptoms to meet criteria for a depressive disorder (38%), the mothers had other psychiatric disorders that did not also include a depressive disorder (19%), they were no longer

interested (21%), the mother or child had a serious medical condition (14%), or the family had moved away (2%).

Eligible mothers and adolescents provided written consent and assent, respectively. All study procedures were approved by the institutional review board. Research assistants collecting data about the child were unaware of the mother's psychiatric history. Data for the current analyses were obtained in grades 7, 8, 9, and 11; interview data were not collected in grade 10 due to a lapse in funding. Only those measures relevant to the current study are presented here.

Measures

Maternal History of Depression

The Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders diagnoses (SCID; Spitzer et al. 1990) was administered in person to the 349 mothers who indicated a history of either some depression or no psychiatric problems. Of the 349 mothers interviewed, 109 were excluded because the mother indicated a history of a psychiatric disorder that did not also include a mood disorder, or the mother or child had a serious medical condition. The final sample of 223 families consisted of 171 mothers with varying histories of a mood disorder (e.g., Major Depressive Disorder, Dysthymia) during the child's life, and 52 mothers who were lifetime free of psychopathology. Inter-rater reliability was calculated on a random subset of 25% of the SCID interviews. Agreement was at 94% ($k = .88$) for diagnoses of depressive disorders.

Sleep Problems in Adolescents

Sleep problems were assessed with an interview of mothers and adolescents about the adolescents' symptoms in the previous two weeks (Children's Depression Rating Scale-Revised

CDRS-R; Poznanski et al., 1985) at each of the four assessments. A sleep summary score was obtained based on mother and adolescent reports of insomnia and hypersomnia symptoms using a 1- to 7-point scale. The CDRS-R has good internal consistency, construct validity, inter-rater reliability, and is sensitive to changes in specific symptoms over time (Jain et al. 2007; Mayes et al. 2010). Cronbach's alpha of the CDRS-R summary scores in the current sample at each time point was ≥ 0.72.

Stressful Life Events

Stressful life events were assessed with the Life Events Interview for Adolescents (LEIA; Garber et al., 2002), based on the Life Events and Difficulties Schedule (Brown & Harris, 1978, 1989) and the Life Stress Interview (Hammen et al., 1987). Mothers and adolescents were interviewed separately about any events that had happened for the adolescent since the last assessment. They were asked to describe the event, when it occurred, and the objective impact of the event on the adolescent. Events reported by either the youth or the mother were included. If there were discrepancies, the interviewer sought additional information by asking each individual more questions for clarification (additional information about the LEIA is reported in Morris et al., 2010).

Interviewers presented data about adolescents' life events to a group of trained raters, unaware of information about mothers' and youths' psychopathology. The group rated the event based on the degree of objective threat for the adolescent, using a scale from 1 (*none*) to 7 (*severe*). Objective threat ratings for ongoing events reported for each week were summed to create a weekly stress rating score for all weeks since the last assessment. The current study examined stress exposure during the three months prior to each assessment of sleep problems. A three-month window was used here because several studies have shown that stressful events that

occur during the prior one to three months significantly correlate with the onset of depressive symptoms (Brown & Harris, 1978; Harkness & Monroe, 2016; Kendler et al., 1999).

Interrater reliability of the objective stress ratings was assessed by having interviewers present the information about each event simultaneously to two different groups who then individually rated each event. A total of 3,708 events were coded over the course of the study. Based on 202 events (5.4%), agreement among raters was at 89.6% (k = .79).

Data Analytic Plan

Demographic characteristics were compared between high- and low-risk youth using independent samples *t*-tests or chi-square analyses, where appropriate. Multi-group latent growth curve analysis was run using the lavaan package (Rosseel, 2012) in R (RStudio Team, 2020) to examine change in sleep problems across all four time points as a function of maternal depression history (i.e., risk). Factor loadings were fixed at 1 for the latent intercept and at 0, 1, 2, and 4 (corresponding to the study time points) for the latent slope. Maternal depression history presence or absence was included as the grouping variable. The sum of the stress ratings across the three months prior to each assessment was included as a time-varying predictor of sleep problems. We constrained the model in the following ways: (1) the relation is constant between stress rating at time *t* and *t*+1; (2) the relation is constant between sleep problems at time *t* and *t*+1; (3) the relation is constant between stress ratings at time *t* and sleep problems at *t*; (4) the relation is constant between sleep problems at time *t* and stress at *t*+1. Sleep problems at time *t* controlled for sleep problems at time *t*-1 and stress at time *t*. Similarly, stress at time *t* controlled for stress at time *t*-1 and sleep problems at time *t*. Figure 1 displays details of the model specification. Of variables included in the model, 11.7% of data were missing. Data were

missing under the assumption of missing completely at random [Little's MCAR test χ^2 (86) = 75.74, p = .78], and missing data were handled using full information maximum likelihood.

CHAPTER III

Results

Descriptive statistics for the sample are presented in Table 1. There were no differences between high- and low-risk youth in age ($p = .15$), sex ($p = .44$), or race distribution ($p = .14$). In each grade, youth with a maternal history of depression (i.e., high risk) had significantly more sleep problems ($p \leq .02$) and higher stress ratings ($p \leq .01$) than youth of mothers who were lifetime free of psychopathology (i.e., low risk). Correlations among all study variables are presented in Table 2.

Maternal Depression and Trajectory of Sleep Problems

Among youth of mothers with a history of depression, sleep problems significantly increased linearly from grades 7 to 11, b = 0.18, $p < .001$. No significant linear trajectory of sleep problems was found for youth of mothers who were lifetime free of psychopathology, b = 0.03, $p = .30$. See Figure 2 for the trajectories of sleep problems in these high- and low-risk youth.

Stability of Stressful Life Events and Sleep Problems over One Year

Sleep problems in one year did not significantly predict sleep problems a year later in grades 7, 8, and 9, for either the high-risk (b = -0.03, $p = 0.59$) or low risk youth (b = -0.02, $p = .75$). In contrast, for high-risk youth, stress ratings in one year significantly predicted stress ratings the following year in grades 7, 8, and 9 (b = 0.17, $p = .001$). Stress ratings in one year did not significantly predict stress rating one year later among low-risk youth (b = 0.07, $p = .26$).

Stressful Life Events and Sleep Problems

In high-risk youth, at each timepoint, ratings of stress occurring in the prior three months significantly predicted a greater level of sleep problems (b = 0.004, $p < .001$), whereas in low-risk youth, stress ratings during the prior three months did not significantly predict sleep problems at any time point (b = 0.001, $p = .25$). In addition, sleep problems predicted stress ratings a year later in 7th, 8th, and 9th grade for both high- (b = 13.12, $p < .001$) and low-risk (b = 5.07, $p = .001$) youth. Parameter estimates from the multi-group latent growth curve analyses are presented in Table 3, and the Full Model is presented in Figure 1.

CHAPTER IV

Discussion

Four main findings emerged from the current study. First, among offspring of depressed mothers (high-risk), sleep problems significantly increased from grade 7 through 11. Second, among high-risk youth, stress rating levels in one year significantly predicted stress rating levels in the following year. In contrast, for both high- and low-risk youth, sleep problems in one year did not significantly predict sleep problems a year later. Third, among high-risk youth, higher stress ratings during the prior three months significantly predicted greater levels of sleep problems at all four time points. Finally, for both high- and low-risk youth, a greater level of sleep problems predicted higher stress ratings a year later and this finding was consistent across all time points.

The current study highlights two important risk factors for sleep problems. Prior studies have found a connection between parental depression and adolescent sleep disturbance (Chen et al., 2012; Hamilton et al., 2020; Taylor et al., 2016; Wescott et al., 2019), but studies have not examined the relation between maternal depression and youth sleep problems at multiple time points across several years of adolescence. Parental depression has been linked to adolescents' sleep duration over a two-week period (Wescott et al., 2019), sleep disturbance but not duration over nine days (Hamilton et al., 2020), and poorer sleep quality over one week (Chen et al., 2012). Further, one longitudinal study found that postnatal maternal depression predicted sleep problems when offspring were 16- and 18-years-old (Taylor et al., 2016). The results from the current study are consistent with these past findings and extend them by showing a consistent

and significant association between maternal depression and increases in sleep problems across multiple time points during adolescence.

Findings also go beyond the extant literature on the link between stress and disrupted sleep in adolescents, which has been based on cross-sectional (Bauducco et al., 2016) or short-term longitudinal designs (Dewald et al., 2014; Doane & Thurston, 2014; Majeno et al., 2018; Maskevich et al., 2020). One-year prospective studies of adolescents showed that changes in stressful life events were associated with variability in sleep duration a year later (Vidal Bustamante et al., 2020), and the stress of starting high school predicted increases in symptoms of insomnia (Brodar et al., 2020). The current four-year longitudinal study demonstrates a link between stress and sleep problems in adolescents for a longer period of time than was followed in these other two studies. Our findings point to the durability of the relation between stress and sleep in high-risk youth during a developmental time period characterized by significant changes (Crowley et al., 2018).

Notably, the current study found that stress significantly predicted sleep problems in the high- but not the low-risk youth. High-risk youth had significantly higher levels of both stress and sleep problems as compared to low-risk youth in the current sample. Therefore, the lack of a significant association in the low-risk sample might have been due, in part, to a restriction of range on the measures of stress and sleep, as evidenced by the smaller standard deviations in the low-risk sample. Further studies are needed to determine whether the link between stress and sleep disturbance found here among offspring of depressed mothers also would be observed in individuals with a larger range and more elevated levels of stress and sleep problems, regardless of risk status.

Current results also highlight the possibility that the relation between stress and sleep may be bidirectional in adolescents. That is, we found that higher stress ratings in the prior three months significantly predicted greater sleep problems in the high-risk youth, and more sleep problems at one point in time predicted higher stress ratings one year later in both high- and low-risk youth. Results of prior studies examining the direction of this relation have been mixed (e.g., Doane & Thurston, 2014; Fuligni & Hardway, 2006; Kortesoja et al., 2020; Ten Brink et al., 2020). For example, Doane and Thurston (2014) showed that sleep disturbance and duration on one night was connected to greater reports of stress the next day, whereas by contrast, Fuligni and Hardway (2006) reported that sleep duration on one night did not relate to stress on the following day.

Perhaps the relation between sleep and subsequent stress is mediated by the effects of disturbed sleep on adolescent coping behaviors. Specifically, poor sleep has been linked to ineffective coping strategies (Matthews et al., 2016), excessive repetitive negative thinking (Brodar et al., 2020), greater rumination (Wang & Yip, 2020), and decreased coping self-efficacy (Ten Brink et al., 2020). Thus, youth with more sleep problems may fail to utilize effective coping and emotion regulation strategies (Baum et al., 2014), which in turn, might increase subsequent stress.

Strengths, Limitations, and Future Directions

Strengths of the current study include the four-year longitudinal study design, the use of a comprehensive interview to assess stressful life events, and interview-based measures of mothers' and adolescents' symptoms of psychopathology. In particular, the life events interview allows for an objective measure of stressful life events and their consequences for the teen. Thus,

the stress ratings were unlikely due to reporter bias given that the ratings of stress were based upon the reports of both mothers and teens and scored by independent raters.

Limitations of the current study also should be noted and provide directions for future research. First, sleep problems were assessed as part of a clinical interview but not through a comprehensive, lab-based sleep evaluation. Moreover, the information obtained from the interview did not allow us to examine the different types of sleep disturbances separately (e.g., initial, middle, or terminal insomnia; hypersomnia). Future studies should include more specific measures of sleep problems as well as an objective measure of sleep, such as actigraphy or polysomnography. Given the notable discrepancies between self-report and actigraphy (Guedes et al., 2016) or polysomnography (Combs et al., 2019) measures of sleep problems in adolescents, the current findings should be explored further using multiple indicators of sleep disturbance.

Second, it is possible that the one-year time lag between assessments missed important information between evaluations. A significant association was found between sleep and subsequent stress levels a year later, but we do not know if the strength of that association might have been even stronger had the assessments occurred more frequently. Similarly, the selection of a three-month interval between the measure of stress and subsequent sleep problems was based on previous literature (Brown & Harris, 1978; Harkness & Monroe, 2016; Kendler et al., 1999), but perhaps other time frames would yield a different degree of association between them. Determining the "best" time interval between the experience of stress and the onset of sleep problems has important implications for determining the optimal time to intervene to prevent such problems after exposure to stress. Last, given the small sample of low-risk youth, it is

possible that some of the relations observed in the high-risk sample also might have been evident in low-risk youth had the sample contained more participants.

Finally, prior research has shown a significant association between parental and offspring sleep problems (Brand et al., 2009; Kalak et al., 2012; Meltzer & Mindell, 2007; Meltzer & Montgomery-Downs, 2011; Rönnlund et al., 2016; Urfer-Maurer et al., 2017). Studies have found a connection between parents' reports of their own sleep problems and objective measures of young children's sleep using EEG (Urfer-Maurer et al., 2017), as well as connections between parents' and adolescents' objective measures of sleep (Kalak et al., 2012). Other studies, however, have found that parental sleep problems were related to subjective, but not objective, youth sleep measured by actigraphy (Rönnlund et al., 2016; Urfer-Maurer et al., 2017). As such, parents with their own sleep difficulties might show some bias in reporting about their child's sleep patterns (Gartstein et al., 2009; Gobin et al., 2015). Future work should examine the extent and nature of the relation between maternal and youth sleep problems.

In conclusion, maternal depression history and stress exposure predicted higher levels of sleep problems in each of four years of adolescence. Given that insufficient sleep predicts deleterious outcomes for youth such as increased risk for psychopathology, alcohol and substance use (Short & Weber, 2018), and academic problems (Owens & Weiss, 2017), programs that target the prevention or reduction of sleep disturbances in high-risk adolescents exposed to stress should be a focus of future intervention efforts.

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Table 1. Descriptive Statistics

	Whole Sample N = 223	Offspring of Depressed Mothers N = 171	Offspring of Nondepressed Mothers N = 52	*p*
	M ± SD	M ± SD	M ± SD	
Age at Time 1	12.69 ± 0.61	12.72 ± 0.62	12.58 ± 0.54	.15
Sex				.44
Female	54.7%	56.1%	50.0%	
Male	45.3%	43.9%	50.0%	
Race				.14
Caucasian	82.5%	84.8%	75.0%	
African American	13.9%	12.9%	17.3%	
Hispanic	0.4%	0.6%	0.0%	
Native American	0.4%	0.0%	1.9%	
Other	2.7%	1.8%	5.8%	
	M ± SD	M ± SD	M ± SD	
Time 1 Sleep Problems	1.52 ± 0.89	1.60 ± 0.95	1.26 ± 0.60	.02*
Time 1 Stress[a]	48.97 ± 60.31	57.81 ± 62.62	20.10 ± 40.74	<.001*
Time 2 Sleep Problems	1.54 ± 0.80	1.61 ± 0.85	1.30 ± 0.58	.02*
Time 2 Stress[a]	27.38 ± 33.95	34.36 ± 35.92	6.59 ± 13.10	<.001*
Time 3 Sleep Problems	1.63 ± 0.91	1.76 ± 0.97	1.22 ± 0.47	<.001*
Time 3 Stress[a]	30.46 ± 43.13	36.94 ± 46.47	10.73 ± 21.15	<.001*
Time 4 Sleep Problems	1.98 ± 1.28	2.17 ± 1.38	1.39 ± 0.61	<.001*
Time 4 Stress[a]	25.98 ± 40.88	30.56 ± 44.70	12.62 ± 22.29	.01*

[a]Stress level in the prior three months
p-value represents group comparison; M = mean; SD = standard deviation
*p <.05.

Table 2. Correlations among Study Variables

	Age at T1	**Sex**	**Mat Dep**	**T1 Stress**	**T2 Stress**	**T3 Stress**	**T4 Stress**	**T1 Sleep**	**T2 Sleep**	**T3 Sleep**	**T4 Sleep**
Age at Time 1	--										
Sex	.12	--									
Maternal Depression	.10	-.05	--								
T1 Stress levels	-.02	.07	.27**	--							
T2 Stress levels	-.05	-.11	.36**	.29**	--						
T3 Stress levels	.05	.01	.26**	.10	.24**	--					
T4 Stress levels	.08	-.14	.19*	.09	.09	.30**	--				
T1 Sleep Problems	.07	-.06	.16*	.21**	.13	.09	.16*	--			
T2 Sleep Problems	.16*	-.03	.17*	.16*	.30**	.13	.15	.39**	--		
T3 Sleep Problems	.08	-.04	.26**	.03	.26**	.28**	.33**	.22**	.24**	--	
T4 Sleep Problems	.19*	-.10	.27**	.08	.20**	.14	.32**	.26**	.32**	.31**	--

Note: T1 = Time 1; T2 = Time 2; *p <.05; **p <.01

Table 3. Parameter Estimates from Multigroup Latent Growth Curve Analyses

	Unstandardized Estimates	*SE*	*z*	*p*
High-Risk Youth				
Intercept	1.34	0.08	16.67	<.001
Slope	0.18	0.04	4.86	<.001
Stress at time *t* → Stress at time *t+1*	0.17	0.05	3.19	.001
Sleep at time *t* → Sleep at time *t+1*	-0.03	0.06	-0.53	.59
Stress at time *t* → Sleep at time *t*	0.004	0.001	3.82	<.001
Sleep at time *t* → Stress at time *t*+1	13.12	1.62	8.11	<.001
Low-Risk Youth				
Intercept	1.23	0.09	13.73	<.001
Slope	0.03	0.03	1.04	.30
Stress at time *t* → Stress at time *t+1*	0.07	0.06	1.14	.26
Sleep at time *t* → Sleep at time *t+1*	-0.02	0.06	-0.33	.75
Stress at time *t* → Sleep at time *t*	0.001	0.001	1.15	.25
Sleep at time *t* → Stress at time *t*+1	5.07	1.51	3.36	.001

Figure 1. Model Specifications

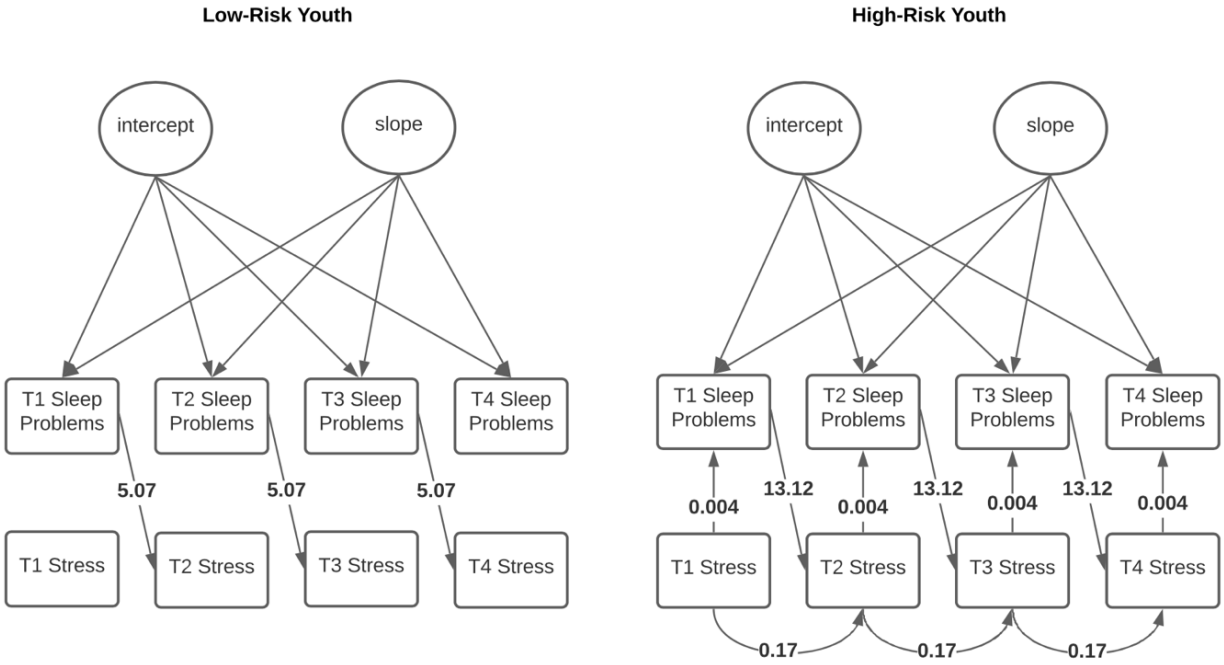

Figure 2. Sleep Problem Trajectories