Published in final edited form as:

Behav Med. 2019 ; 45(3): 240–248. doi:10.1080/08964289.2018.1514362.

Longitudinal Association of Sleep Problems and Distress Tolerance during Adolescence

Afton Kechter, M.S.¹, Adam M. Leventhal, Ph.D.¹

¹Department of Preventive Medicine, Keck School of Medicine, University of Southern California

Abstract

The mechanism by which sleep problems adversely impacts adolescent health is poorly understood. Distress tolerance—a multifactorial trait indicative of one’s ability to withstand negative emotions and persist toward long-term goals—is implicated in numerous emotional psychopathologies and an important target for research and practice. We hypothesized that the adverse psychobiological effects of sleep problems could disrupt the development of distress tolerance during adolescence. This longitudinal study examined whether sleep problems predicted changes in four facets of distress tolerance during adolescence: (1) absorption—feeling attention is captured by negative emotions, (2) appraisal—experiencing distress as unacceptable, (3) regulation—engaging in behaviors to terminate distress, and (4) tolerance—low perceived ability to tolerate distress. High school students (M baseline age=15.5 years, $N=2,309$, 56.1% female), completed self-report measures of sleep problems and distress tolerance at baseline and 1-year follow-up. In linear regression models adjusting for baseline distress tolerance, sleep problems predicted poorer distress tolerance at 1-year follow-up for each distress tolerance facet (β s=−.10 to −.24, p s .02). After additionally controlling for sociodemographics and emotional psychopathology, sleep problems were associated with poorer distress tolerance for absorption (β =−.13, p =.004) and appraisal (β =−.09, p =.049) facets, but not regulation or tolerance (p s .35) facets. Interventions targeting healthy sleep habits warrant consideration for improving adolescent development of certain facets of distress tolerance, and in turn various positive health outcomes improved by distress tolerance.

Keywords

Adolescence; sleep problems; distress tolerance; emotional psychopathology; longitudinal

INTRODUCTION

Sleep problems among high school adolescents are recognized as an international public health issue associated with numerous detrimental effects on mental health and healthy behaviors.^{1,2} According to the 2015 National Sleep Foundation’s updated recommendations,

Corresponding author: Adam Leventhal, Ph.D., Director, USC Health, Emotion, & Addiction Laboratory, Associate Professor of Preventive Medicine and Psychology, USC Norris Comprehensive Cancer Center, Keck School of Medicine, University of Southern California, 2250 Alcazar St., CSC 271, Los Angeles, CA 90033, Phone: 323-442-8222, adam.leventhal@usc.edu.

Conflict of Interest: The authors declare that they have no conflict of interest.

optimal sleep for adolescents (14-17 years old) is 8 to 10 hours per night.³ Yet, nearly 70% of U.S. adolescents reported getting less than 8 hours of sleep during an average school night on the 2013 Youth Risk Behavior Survey.⁴ With societal shifts toward electronic media use and multitasking,¹ these trends may only worsen. However, the mechanism by which sleep problems predict various health outcomes in youth is not well identified.

The prefrontal cortex, a brain region believed to underlie emotion regulation and behavioral inhibition, is sensitive to sleep loss both at chronic and acute levels. A chronic accumulation of insufficient sleep and variation in weekday versus weekend duration is linked to structural changes in the grey matter of the adolescent's prefrontal cortex.⁵ Additionally, a recent meta-analysis identified decreased activation in multiple regions of the brain including the prefrontal cortex following acute sleep deprivation.⁶ As such, it is not surprising that failure to obtain optimal quality and duration of sleep in adolescence is associated with numerous long-term detrimental effects on mental health and healthy behaviors,^{1,7,8} including poor dietary intake, physical inactivity, and substance use.^{7,9}

One potential explanation as to why sleep may have so many wide spanning adverse effects is because the neurodevelopmental prefrontal cortical alterations interferes with optimal development of core emotion regulation skills, which may give rise to numerous negative health outcomes. Distress tolerance is one core manifestation of emotion regulation skills or tendencies that has been associated with depression, anxiety, disordered eating, substance use, and other risky behaviors.¹⁰⁻¹³ Distress tolerance is conceptualized as one's ability to withstand negative emotions,¹⁴ which is theorized as a transdiagnostic risk marker underlying multiple psychological disorders and maladaptive or impulsive behaviors to alleviate distress.¹⁵ Given the multifaceted nature of distress tolerance, it is possible that different facets of distress tolerance may associate with health behaviors in a disparate manner.

While there are a number of operationalizations of the distress tolerance construct, which can be quantified by various behavioral and self-report measures, Simons and Gaher's (2005) four-dimensional model based on their self-report scale has been successfully applied in a number of previous studies among adults and adolescents and is robustly associated with poor health behavior and mental health outcomes.^{15,16} This model proposes a subjective manifestation of perceived distress tolerance, which involves four empirically- and conceptually-distinct components: (1) *absorption*, feeling much attention is absorbed by the negative emotion and how much it interferes with functioning, (2) *appraisal*, experiencing emotional distress as unacceptable, (3) *regulation*, engaging in behaviors to immediately terminates distress, and (4) *tolerance*, low perceived ability to tolerate affective distress.^{14,15} It is important for clinical and theoretical purposes to determine how health behaviors and risk factors increase vulnerability for developing certain facets of distress tolerance so as to understand how to best intervene on distress tolerance in a more targeted fashion. Emerging research shows different subscales have discordant patterns of associations with health outcomes. For example, there is some evidence suggesting that regulation is most associated with substance use¹⁴ and other research suggesting that absorption and appraisal are most associated with sleep problems.^{17,18}

Given the roles that distress tolerance has on emotion regulation, sleep on the prefrontal cortex region,¹⁹ and that this neural region is in a dynamic state of development during adolescence^{20,21}—it is plausible that sleep problems may interfere with the capacity to further develop and enact distress tolerance skills across adolescence. While the role of sleep problems in risk of emotional psychopathology is well documented,²² evidence on whether sleep problems are associated with subsequent disruption in distress tolerance is limited. To the best of our knowledge, the only research to date on the relation between sleep problems and facets of distress tolerance documents the cross-sectional association in two adult samples: veterans and homeless.^{17,18} Among the sample of veterans, Short et al. found after controlling for mood and anxiety disorders as well as substance use, sleep quality was significantly associated with lower distress tolerance for absorption and appraisal facets, but not with regulation or tolerance facets. Among the sample of homeless individuals, Reitzel et al. found absorption and appraisal facets significantly mediated the relation between unintentional waking and inadequate rest or sleep, respectively, with stress and mental/physical health. Nevertheless, several key gaps in the literature regarding distress tolerance, sleep problems, and adolescent health remain.

The first gap is that the temporal nature of the relation between sleep problems and distress tolerance remains unclear. For emotional psychopathology, sleep problems are bidirectional, with evidence that sleep problems predict risk of emotional disorders, and that sleep problems are a common consequence of emotional disorders.²² For distress tolerance, while there is a conceptual premise that poor sleep leads to lower distress tolerance, the reverse association is also possible. Hence, longitudinal research is needed to clarify whether sleep problems indeed predict distress tolerance. The second gap is that prior studies have not examined sleep problems predicting distress tolerance in the population of adolescents, which is a key omission in the literature due to the unacceptably high prevalence of sleep problems in this population.²³ Because adolescence is a unique time of biological and social development, it is unclear whether results from the prior cross-sectional studies on sleep problems and distress tolerance will generalize to the unique biopsychosocial context of adolescence. Furthermore, distress tolerance is likely to be particularly malleable during adolescence, because high school is a critical developmental time period when youth have new social and academic pressures that may influence distress tolerance and other emotion regulation skills.²⁴

Given the biological and psychosocial effects of sleep problems on adolescent emotional development,⁸ this longitudinal study tested the hypothesis that sleep problems at the outset of 10th grade would inversely be associated with distress tolerance at a 1-year follow-up. To this end, we applied the Simon and Gaher's four-factor model of distress tolerance to examine specific facets of distress tolerance. Based on prior cross-sectional studies on sleep problems and distress tolerance,^{17,18} we hypothesized sleep problems would be most robustly associated with the absorption and appraisal facets in the current study. We also examined whether the associations remained after controlling for sociodemographic and emotional psychopathology variables, which may confound the relation between sleep problems and facets of distress tolerance. Examining whether that association remains after controlling for emotional psychopathology is critical for inferring whether a unique etiological link may exist between sleep problems and distress tolerance, given that

psychopathology is closely tied to sleep problems and distress tolerance. This inference is critical to determining whether sleep problems should be a target of future research and intervention dedicated toward improving adolescent development of distress tolerance, and in turn, the multiple health outcomes impacted by distress tolerance.

METHODS

Participants and Procedures

Data were collected from high school students in a longitudinal survey-based study. Approximately 40 public high schools with diverse population demographic characteristics in a large metropolitan area were approached about participating and 10 accepted. To enroll, students were required to provide written or verbal assent and their parents were required to provide written or verbal consent. Assessment of distress tolerance occurred at fall 2014 during 10th grade (baseline for this paper) and fall 2015 during 11th grade (1-year follow-up for this paper). At both time points, paper-and-pencil surveys were administered onsite in students' classrooms. The author's university institutional review board approved the study.

Measures

Sleep Problems Questionnaire (SPQ)²⁵ is a four-item, self-report measure of the participant's past month of sleep, administered at baseline. Items are rated on a 0-5 scale in increments indicating the number of days they experienced sleep problems in the past month (0 = not at all, 1 = 1-3 days, 2 = 4-7 days, 3 = 8-14 days, 4 = 15-21 days, and 5 = 22-30 days), where a higher score indicates more sleep problems. Items include "Trouble falling asleep?"; "Wake up several times per night?"; "Have trouble staying asleep (including waking far too early)?"; and "Wake up after your usual amount of sleep feeling tired and worn out?" Previous research supports the use of SPQ in adolescent samples.²⁶ For clinical meaningfulness, participants have been classified as having sleep problems if they rated any of the four items as 15 or more days per month (responses 4 or 5).²⁷ We dichotomized SPQ responses in this study using the same cutoffs. Internal consistency was good across time-points in our sample ($\alpha = .87$ at baseline and $.85$ at follow-up).

Distress Tolerance Scale¹⁴ is a validated, 15-item self-report survey with 4 subscales: absorption (3-items), appraisal (6-items), regulation (3-items), and tolerance (3-items) that measures distress tolerance—one's ability to withstand negative psychological states. Items are rated on a 5-point Likert scale (1 = Strongly Agree to 5 = Strongly Disagree), where a higher composite score reflects a higher level of distress tolerance. The four subscale scores were calculated by taking the mean of the corresponding items. Example items include "When I feel distressed or upset, I cannot help but concentrate on how bad the distress actually feels" (absorption), "My feelings of distress or being upset are not acceptable" (appraisal), "I'll do anything to stop feeling distressed or upset" (regulation), and "There's nothing worse than feeling distressed or upset" (tolerance). Previous research indicates strong psychometric properties of the DTS among adolescent samples.²⁸ Internal consistency ranged from adequate to excellent across subscales and time-points (Absorption subscale $\alpha = .69$ at baseline and $.72$ at follow-up; Appraisal subscale $\alpha = .90$ at baseline

and .90 at follow-up; Regulation subscale $\alpha = .59$ at baseline and .59 at follow-up; Tolerance subscale $\alpha = .80$ at baseline and .82 at follow-up).

Covariates—Evidence suggests that both distress tolerance and sleep problems may differ by sociodemographic factors^{29,30} and therefore may confound associations tested here. We assessed and co-varied for age, gender, race/ethnicity, and highest parental education level, each measured using self-report responses to investigator-defined forced-choice items. Distress tolerance and sleep problems may also be manifestations of a generalized state of emotional distress. Thus, to parse out any predictive influence of sleep problems on distress tolerance, per se, rather than on a more global manifestation of distress, we assessed and adjusted for baseline Revised Child Anxiety and Depression Scale (RCADS).³¹ RCADS is a measure of DSM-IV anxiety and depression disorders and includes subscales for Major Depressive Disorder (MDD) with 10-items and Panic Disorder (PD) with 9-items. Items are rated on a 4-point Likert scale (0 = never, 1 = sometimes, 2 = often, and 3 = always) where a higher score indicates higher levels of anxiety and depressive symptoms. The subscale scores were calculated by taking the mean of the items. Example items include, “I feel sad or empty” (MDD scale) and “When I have a problem, I get a funny feeling in my stomach” (PD scale). We selected these two scales because collectively MDD and PD address the key symptomatic expressions of emotional psychopathology, which involves somatic symptoms associated with anxious arousal, general distress, and low positive/high negative affect of anhedonia.³² The RCADS has shown good psychometric properties in adolescent samples.^{33,34} Internal consistency was excellent in our sample (RCADS-MDD $\alpha = .94$ at baseline and RCADS-PD $\alpha = .93$ at baseline).

Statistical Analysis

Descriptive analyses of frequencies, means and SDs, as well as zero-order correlations were first tested. To examine the key relation of interest between sleep problems at baseline as a regressor and distress tolerance subscale scores at 1-year follow-up as the criterion variable, we ran three sequential multiple regression models for each of the four subscales. In the first model, we only controlled for the respective baseline DTS subscale score. In the second model, we adjusted for demographic covariates: age, gender, race/ethnicity, and parental education level. In the third model, we also adjusted for two RCADS subscales: MDD and PD. Although the data were nested by school, inter-class correlation estimates of follow-up DTS for school clustering were .01, suggesting minimal impact of clustering on standard error of estimates. Missing data across covariates were addressed utilizing multiple imputation strategies, in which five imputed datasets were generated and subject to the linear regression analysis, with a pooled estimate reported. Results are reported as standardized regression parameters β with 95% CI (confidence interval). To rule out the competing hypothesis that distress tolerance subscales predict sleep problems at 1-year follow-up, we ran 12 parallel models with each distress tolerance subscale at baseline as the regressor and reported the estimated odds of sleep problems 1-year later. All analyses were conducted in SAS 9.4 statistical software. Significance was set at 0.05.

RESULTS

Descriptive statistics and zero-order correlations

All 4,100 9th-graders were eligible, 3,874 students (94.5%) assented, and 3,396 parents (87.7%) consented. Data were collected from 3,383 (99.6%) at 9th grade, 3,277 (96.9%) at 10th grade (baseline for this paper), and 3,235 (98.7%) at 11th grade (1-year follow-up for this paper). The survey was two-part: core and supplemental. If students weren't on site or able to complete surveys within allotted time, only core surveys were followed up via phone and email. Since DTS was part of the supplemental surveys, which were strictly administered onsite; our analytic sample consists of 2,309 students (71.4%) who had complete data for all four DTS subscales and SPQ at baseline as well as 1-year follow-up. Comparisons between the 2,309 with complete data and the 926 participants with missing data showed those with complete data were more likely to be male than female (OR = 1.38; 95% CI= 1.15, 1.67), have parents who received more education (college versus high school OR = 1.47; 95% CI = 1.10, 1.96 and advanced degree versus college OR = 1.24; 95% CI = 0.90, 1.71), and be Asian versus Hispanic (OR = 1.98; 95% CI = 1.44, 2.73). The remaining sociodemographics did not differ significantly by completion status.

The analytic sample ($n = 2,309$) was 56.1% female with a mean age of 15.5 and ($n = 635$) 27.5% had sleep problems at baseline. Further detailed descriptive statistics for each covariate can be found in the "Overall Sample" column within Table 1. The $M(SD)$ of the DTS subscales at follow-up and $M(\%)$ of sleep problems by participant characteristics and covariates as well as the baseline associations are also provided in Table 1. Gender, race/ethnicity, and emotional psychopathology covariates were associated with DTS subscales at follow-up ($ps < .05$). Males reported higher distress tolerance on all four subscales and less sleep problems than females ($p < .0001$). Patterns suggest lower distress tolerance is associated with worse emotional psychopathology and more sleep problems. The correlations between all study variables, and respective Cronbach's alphas when applicable, are provided in Table 2. The largest DTS subscale correlation was between absorption and appraisal ($r = .74$), suggesting highly related constructs. While the other correlations were lower ($r = .27-.64$), suggesting moderately related constructs. Stability estimates for each DTS subscale ranged from .39 to .48, suggesting low stability across baseline and follow-up. That is, there was 77% to 85% between-person variance, suggesting adequate variability in changes over time for prediction modeling.

Association Between Sleep Problems and Distress Tolerance Subscales

As illustrated in Table 3, adjusting for baseline respective subscale only, the presence (versus absence) of sleep problems at baseline predicted lower distress tolerance at follow-up for all subscales ($ps < .05$). The magnitudes of these regression coefficients were non-equivalent across distress tolerance subscales: absorption ($\beta = -.24$), appraisal ($\beta = -.21$), regulation ($\beta = -.10$), and tolerance ($\beta = -.13$). After adjusting for sociodemographic covariates (age, gender, race/ethnicity, and parent education) the strength of the regression coefficient changed by only .01 standardized β units. After adding emotional psychopathology covariates (RCADS-MDD and RCADS-PD) into the model, the associations changed more substantially. Those with (versus without) sleep problems at baseline had significantly lower

DTS score for absorption (β [95% CI] = $-.13$ [$-.22, -.04$], $p = .004$) and appraisal (β [95% CI] = $-.09$ [$-.18, .00$], $p = .049$) at 1-year follow-up, suggesting that symptoms of depression and panic disorder did not entirely account for the associations of sleep problems with these facets of distress tolerance. However, in the fully adjusted model including symptoms of emotional psychopathology, the associations of sleep problems on DTS score for tolerance and regulation at follow-up were eliminated ($p = .35$). See Supplemental Table 1 for regression estimates of association for covariates, which show that major depression and panic disorder symptoms are associated with most distress tolerance outcomes in the full adjusted model and indicate moderate stability of distress tolerance over time.

The reverse path analysis showed that higher distress tolerance absorption and appraisal subscales (but not regulation and tolerance subscales) predicted reduced odds of sleep problems at 1-year follow-up in unadjusted models and models adjusted for sociodemographics (Supplemental Table 2). However, in the full model additionally adjusting for emotional psychopathology, all associations were non-significant ($ps > .05$).

DISCUSSION

To our knowledge this is the first study to test the prospective relation between sleep problems and facets of distress tolerance among adolescence. The results showed three main findings. First, sleep problems predicted worsening of all distress tolerance facets independent of demographic covariates. Second, after additionally adjusting for baseline emotional symptomatology the associations were markedly reduced for each facet of distress tolerance. Third, the magnitude of associations between sleep problems and worsening of distress tolerance were non-uniform across the different facets of distress tolerance—associations were most robust for absorption and appraisal versus regulation and tolerance. Overall, these findings suggest the development and perception of different facets of distress tolerance may have disparate linkages with (and potential consequences from) sleep problems.

To the best of our knowledge, this is the first longitudinal study to test the association between sleep problems and facets of distress tolerance, which advanced the cross-sectional evidence on this topic. The temporal direction of the association is important as the alternate direction of baseline distress tolerance facets did not predict greater sleep problems at follow-up in fully adjusted models. Hence, it is possible that this relation is unidirectional, which is concordant with the emerging conceptual premise that sleep problems disrupt psychosocial and biological pathways that promote the development of distress tolerance.^{17,18,35} The prospective evidence here is key toward advancing this theoretical model and indicating that clinical interventions addressing sleep may benefit distress tolerance, whereas those addressing distress tolerance (independent of emotional psychopathology) may not have a marked impact on sleep in adolescents.

The pattern of associations before and after adjusting for covariates yields insight into the reasons underlying the association between sleep problems and distress tolerance. First, adjusting for demographics had little impact, suggesting that despite the notion that distress tolerance may differ by gender or be impacted by cultural, or socioeconomic adversity³⁰

these factors did not explain the association. Second, there was a marked reduction in association of sleep problems with distress tolerance worsening for all facets before and after controlling for baseline emotional symptomatology. Therefore, given that sleep problems are common in many emotional disorders, including major depression and panic disorder,³⁶ the findings indicate one reason why sleep problems lead to lower distress tolerance is because sleep problems were a proxy for emotional symptomatology, which in and of itself may increase risk for exacerbation of distress tolerance.

Although associations of sleep problems with all facets of distress tolerance were reduced after controlling for emotional psychopathology, the association of the distress tolerance facets absorption and appraisal remained significant adjusting for emotional psychopathology. The reasons for the differential pattern of results across subcomponents of distress tolerance are not entirely clear. It is unlikely that the reason is due to measurement error across the subscales, which could modify the precision and statistical power to detect associations with one scale versus another. Inspection of internal consistency estimates for each scale did not suggest a pattern whereby absorption and appraisal were markedly higher than both regulation and tolerance (i.e., tolerance had an estimate in between absorption and appraisal, and regulation had the lowest). The current results align with findings from two cross-sectional studies that also found absorption and appraisal facets (versus regulation and tolerance facets) were most robustly associated with sleep problems and health problems in adult samples.^{17,18} Thus, it may be that sleep problems have differential associations (and perhaps causal influences) on different components of distress tolerance.

Other studies have also shown that dysregulation of psychological processes similar to those that are tapped by absorption and appraisal associate with maladaptive sleep and emotional outcomes. Absorption is defined as feeling much attention is absorbed by the negative emotion and how much it interferes with functioning; appraisal is defined as experiencing emotional distress as unacceptable.¹⁴ Danielsson et al. found catastrophic worry, such as rumination and fixation (which overlaps with absorption and appraisal), partially mediated the relation between sleep problems and greater depressive symptoms 1-year later.³⁷ In a cross-sectional study with healthy adults, Cox et al. found distress and impaired executive functioning partially mediated the relation between disturbed sleep and maladaptive thoughts, such as worry and rumination.³⁸ Altogether, it is likely that items measured by the DTS absorption subscale tap processes similar to rumination and items measured by DTS appraisal subscale tap processes similar to non-acceptance of distress.

Strengths of the current study include the use of a large, demographically diverse sample that included sizeable representation from more than six race/ethnic groups and socioeconomic strata represented by level of parental education. These permitted estimates of association with precision and potential generalizability to overall larger populations of adolescents, including sociodemographic minority groups that are not often included. Another strength is the prospective design and test of reverse pathways permitted inferences about the temporal and potentially causal nature of the association between sleep problems and facets of distress tolerance.

Limitations of the current study include the use of self-report questionnaires to measure constructs of sleep problems, distress tolerance, and emotional psychopathology. While the measures we used are common and comparable across studies, future studies should use multiple measures, ideally a mix of subjective and objective (i.e., perceived and behavioral distress tolerance; self-report and observed sleep), to avoid possible report bias. Furthermore, survey-based data does not allow us to infer causality due to its correlational nature. While we do have the power of longitudinal measures, which allowed for predictions, experimental studies are needed to examine why sleep problems may differentially impact changes in distress tolerance among adolescents.

Despite these limitations, there are a number of follow-up studies we suggest based on the current work. First, future research should continue to validate findings among similar and dissimilar samples. Second, given the relation between sleep problems and poor health outcomes, it is important to test these associations with various health behaviors. Lastly, future studies should examine trajectories across longer follow-up with three or more periods.

CONCLUSIONS

Sleep problems may mark youth at risk for failure to fully develop distress tolerance during mid-adolescence. Interventions targeting early development of healthy sleep habits are worth consideration for enhancing youth's ability to cultivate certain facets of distress tolerance. Pending replication of these findings, clinical interventions targeting ruminative responses and non-acceptance to distress, such as mindfulness-based cognitive therapy,³⁹ may help offset the adverse impact of sleep problems. Furthermore, given that both sleep and distress tolerance are connected to numerous long-term effects on health indicators, addressing sleep in the context of emotional disturbance is likely to be vital for advancing behavioral medicine research and practice.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Sample Descriptive Statistics of Study Covariates and Associations with Sleep Problems and Distress Tolerance ($N=2,309$)

Table 1.

Baseline study covariate	Overall Sample $N(\%)$ or $M(SD)$	Baseline sleep problems or follow-up distress tolerance subscale by study covariate status: Association (P-value or correlation coefficient) and ($M[SD]$ or $N[\%]$)				
		Absorption	Appraisal	Regulation	Tolerance	Sleep problems
Sleep problems		<.0001 ^a	<.0001 ^a	<.0001 ^a	<.0001 ^a	-
No	1674 (72.5%)	3.78 (1.18)	3.70 (0.80)	3.56 (1.18)	3.39 (1.23)	-
Yes	635 (27.5%)	3.12 (1.27)	3.34 (0.89)	3.32 (1.15)	3.04 (1.11)	-
Age	15.5 (0.41)	.34 ^{c, f}	.85 ^{c, f}	.21 ^{c, e}	.83 ^{c, e}	.09 ^{d, f}
Gender		<.0001 ^a	<.0001 ^a	<.0001 ^a	<.0001 ^a	<.001 ^b
Male	1013 (43.9%)	3.88 (1.16)	3.70 (0.81)	3.60 (1.19)	3.48 (1.16)	242 (23.9%)
Female	1296 (56.1%)	3.38 (1.25)	3.53 (0.86)	3.41 (1.16)	3.15 (1.08)	393 (30.3%)
Highest Parental Education Level		.80 ^a	.81 ^a	.58 ^a	.80 ^a	.14 ^b
<8th grade	80 (3.5%)	3.51 (1.30)	3.54 (0.86)	3.35 (1.16)	3.28 (1.17)	18 (22.5%)
Some high school	167 (7.2%)	3.59 (1.24)	3.59 (0.83)	3.49 (1.14)	3.36 (1.16)	36 (21.6%)
High school graduate	299 (13.0%)	3.66 (1.18)	3.61 (0.83)	3.47 (1.16)	3.29 (1.15)	87 (29.1%)
Some college	385 (16.7%)	3.54 (1.28)	3.57 (0.87)	3.46 (1.19)	3.23 (1.13)	110 (28.6%)
College graduate	662 (28.7%)	3.57 (1.27)	3.61 (0.86)	3.54 (1.18)	3.27 (1.13)	182 (27.5%)
Advanced degree	418 (18.1%)	3.63 (1.24)	3.65 (0.85)	3.55 (1.19)	3.35 (1.14)	131 (31.3%)
Didn't know	298 (12.9%)	3.65 (1.15)	3.57 (0.78)	3.42 (1.17)	3.29 (1.07)	71 (23.8%)
Race/Ethnicity		.02 ^a	.04 ^a	<.01 ^a	.01 ^a	.01 ^b
American Indian/Alaska Native	21 (0.9%)	3.73 (1.11)	3.72 (0.69)	3.89 (1.13)	3.52 (1.13)	4 (19.0%)
Asian	463 (20.4%)	3.49 (1.28)	3.54 (0.85)	3.39 (1.19)	3.20 (1.10)	126 (27.2%)
Black	91 (4.0%)	3.84 (1.22)	3.70 (0.88)	3.62 (1.21)	3.66 (1.07)	22 (24.2%)
Hispanic	1053 (46.5%)	3.64 (1.20)	3.61 (0.81)	3.51 (1.17)	3.32 (1.13)	259 (24.6%)
Native Hawaiian/Pacific Islander	101 (4.5%)	3.39 (1.21)	3.41 (0.83)	3.12 (1.26)	3.06 (1.08)	27 (26.7%)
White	374 (16.5%)	3.59 (1.27)	3.65 (0.86)	3.54 (1.15)	3.25 (1.17)	135 (36.1%)

Baseline study covariate	Overall Sample N(%) or M(SD)	Baseline sleep problems or follow-up distress tolerance subscale by study covariate status: Association (P-value or correlation coefficient) and (M[SD] or N[%])			
		Absorption	Appraisal	Regulation	Tolerance
Other	133 (5.9%)	3.53 (1.27)	3.63 (0.91)	3.64 (1.11)	3.32 (1.07)
Can't Choose	29 (1.3%)	4.08 (1.15)	3.93 (0.80)	3.62 (1.26)	3.33 (1.22)
Emotional Psychopathology					
RCADS-MDD	0.82 (0.72)	<.0001 <i>c, e</i>	<.0001 <i>c, e</i>	<.0001 <i>c, e</i>	<.0001 <i>c, e</i>
RCADS-PD	0.48 (0.61)	<.0001 <i>c, e</i>	<.0001 <i>c, e</i>	<.0001 <i>c, e</i>	<.0001 <i>c, e</i>

Note. RCADS-MDD = Revised Children's Anxiety and Depression Scale-Major Depressive Disorder; RCADS-PD = Revised Children's Anxiety and Depression Scale-Panic Disorder; Both RCADS scales range from 0-3.

^a P-value for ANOVA F test of group comparison of DTS by covariate status

^b P-value for Chi-square test of association of sleep problems by covariates status

^c P-value for pearsons r test of association of DTS and covariate level

^d P-value for point biserial r test of association of sleep problems by covariate level

^e Inverse association

^f Positive association

Table 2.

Correlation matrix with all study variables

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1. Absorption (T1)	(.69)	.74	.49	.62	.50	.43	.30	.37	-.27	-.16	.18	.02	.00	.05	-.48	-.55
2. Appraisal (T1)		(.90)	.57	.61	.44	.50	.33	.36	-.20	-.15	.10	.03	-.01	.06	-.47	-.49
3. Regulation (T1)			(.59)	.53	.27	.29	.40	.31	-.10	-.04	.09	-.04	-.06	.08	-.30	-.29
4. Tolerance (T1)				(.80)	.34	.33	.29	.44	-.18	-.09	.18	.02	.00	.02	-.30	-.31
5. Absorption (T2)					(.72)	.74	.54	.64	-.24	-.27	.20	.02	.03	-.01	-.36	-.40
6. Appraisal (T2)						(.90)	.58	.33	-.19	-.21	.10	.00	.01	.03	-.34	-.38
7. Regulation (T2)							(.59)	.56	-.09	-.12	.08	-.03	.02	.04	-.22	-.22
8. Tolerance (T2)								(.82)	-.14	-.15	.15	.00	.03	.00	-.23	-.23
9. SPQ (T1)									(.87)	.36	-.07	.04	-.06	.05	.29	.45
10. SPQ (T2)										(.85)	-.08	.00	-.06	.01	.21	.30
11. Gender											--	.10	-.07	-.01	-.17	-.20
12. Age												--	-.01	-.04	.00	.00
13. Ethnicity													--	-.33	.03	.04
14. Parental Education														--	-.04	-.07
15. RCADS-MDD															(.94)	.62
16. RCADS-PD																(.92)

Note. DTS = Distress Tolerance Scale. SPQ = Sleep Problems Questionnaire. Gender coded as 0=female, 1=male. Ethnicity coded as 0=non-Hispanic, 1=Hispanic. Parental education coded as continuous variable: 0=8th grade or less, 1=some high school, 2=high school graduate, 3=some college, 4=college graduate, 5=advanced degree. RCADS-PD = Revised Children's Anxiety and Depression Scale-Panic Disorder. RCADS-MDD = Revised Children's Anxiety and Depression Scale-Major Depressive Disorder. T1= Baseline. T2=Follow-Up.

$r > |.04|$ are significant at .05 level. Values on the diagonal represent Cronbach's alpha.

Table 3.

Baseline Sleep Problems Predicting Distress Tolerance by Subscales at 1-year Follow-Up ($N=2,309$)

	Estimate of Association of Sleep Problems with Respective Distress Tolerance Subscale							
	Absorption	P value	β (95% CI)	Appraisal	P value	Regulation	P value	Tolerance
Covariates included in model:								
Baseline DTS Subscale								
	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value
Demographic Covariates^a								
	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value
	-.24 (-.33, -.16)	<.0001	-.21 (-.28, -.13)	<.0001	-.10 (-.19, -.02)	.02	-.13 (-.22, -.05)	<.01
	-.24 (-.32, -.16)	<.0001	-.21 (-.29, -.13)	<.0001	-.09 (-.18, -.01)	.03	-.12 (-.21, -.04)	<.01
Emotional Psychopathology and Demographic Covariates^b								
	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value
	-.13 (-.22, -.04)	<.01	-.09 (-.18, .00)	.049	.01 (-.09, .10)	.91	-.05 (-.14, .05)	.35

Note. All estimates are standardized and derived from repeated linear regression models predicting distress tolerance subscale outcome at 1-year follow-up, controlling for respective baseline subscale. Sleep problems measured by the SPQ are represented as a binary variable (0=no sleep problems, reported score of 3 (8-14 days) or lower for all 4-items; 1=sleep problems, reported score of 4 (15-21 days) or higher for at least one of the 4 items).

^a Adjusted for respective baseline DTS subscale, gender, age, race/ethnicity, and parent education.

^b Adjusted for respective baseline DTS subscale, gender, age, race/ethnicity, parent education, RCADS-PD, Revised Children's Anxiety and Depression Scale-Panic Disorder, RCADS-MDD, Revised Children's Anxiety and Depression Scale-Major Depressive Disorder.

* See Supplemental Table 1 for covariate estimates.