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Nightmares and Self-Injury Among High-Risk Adolescents: Examining the Role of Emotion Regulation

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NIGHTMARES AND SELF-INJURY AMONG HIGH-RISK ADOLESCENTS:

EXAMINING THE ROLE OF EMOTION REGULATION

by

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ABSTRACT

NIGHTMARES AND SELF-INJURY AMONG HIGH-RISK ADOLESCENTS: EXAMINING THE ROLE OF EMOTION REGULATION

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Self-injurious thoughts and behaviors (SITBs) are a public health concern among youth. SITB rates rise drastically during adolescence -- a critical and sensitive developmental period characterized by dramatic changes in biological and social systems. Prior research has identified distal risk factors which tell us *who* is at risk for SITBs. Emerging research suggests proximal risk factors may be useful to identify *when* an individual may be at risk for SITBs. One promising proximal risk factor for SITBs is sleep problems. Although the relation between sleep problems and SITBs has been widely documented, little is known about the short-term, proximal links between nightmares, a specific sleep problem, and SITBs. Furthermore, our knowledge about the mechanisms through which nightmares increase risk for SITBs is limited, particularly in youth. The current study examined the emotion regulation mechanisms linking nightmares and SITBs in two clinically high-risk samples of youth by conducting secondary data analyses using data from two real-time monitoring studies. Results of this study provide more fine-grained evidence supporting the link between sleep problems and SITBs among high-risk youth. Further, this study found initial evidence supporting emotion regulation as a potential mechanism linking nightmares and SITBs, although results were mixed. Ultimately, findings from this research utilizing a real-time monitoring approach could inform proximal, modifiable targets for intervention to reduce SITB risk in youth.

This thesis is dedicated to my family.

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CHAPTER I

INTRODUCTION

Self-injurious thoughts and behaviors (SITBs) refer to a wide range of thoughts and actions that are related to intentional and self-directed harm to one's own body (Nock, 2009, 2010). Within this larger class of SITBs, distinctions are often made between: (1) suicidal self-injury: self-harming thoughts (suicide ideation) and behaviors (suicidal behavior) with at least some intent to die, and (2) nonsuicidal self-injury (NSSI): self-harming thoughts and behaviors without intent to die (Nock, 2009, 2010). Converging research suggests a complex relation between nonsuicidal and suicidal self-injury (Glenn et al., 2017; Hamza et al., 2012; Joiner et al., 2012). Although these two categories represent distinct forms of SITBs (e.g., based on the intention to die, method used, frequency, and lethality, Muehlenkamp & Gutierrez, 2004, 2007), growing research indicates that NSSI is a robust predictor of future suicidal behavior (Riberio et al., 2016).

SITBs are a major public health concern among youth. Prevalence rates from a 2021 nationwide survey indicate that, in the past year, 22% of youth seriously considered suicide and 10% of youth made a suicide attempt (Centers for Disease Control and Prevention [CDC], 2021b). Furthermore, prevalence rates of NSSI peak during adolescence, with high rates in both community (e.g., 18%; Muehlenkamp et al., 2012) and clinical samples (e.g., 50%; Asarnow et al., 2011; Nock, 2010). Moreover, emerging research indicates co-occurrence of SITBs (e.g., suicidal ideation emerging before, or at the same time as, NSSI, Glenn et al., 2017) and escalation of SITBs (e.g., transitions from thinking about suicide to planning or attempting suicide, Nock et al., 2013) during adolescence. These high rates are alarming as SITBs during adolescence are associated with significant interpersonal and health impairment, both concurrently (Glenn & Klonsky, 2013) and over the long term into adulthood (Copeland et al., 2017). Taken together, adolescence represents a critical window of opportunity for early detection, intervention, and prevention of SITBs (King et al., 2018; Whitlock et al., 2014; Wyman, 2014).

Overview of SITB risk factors in youth

Current knowledge of SITB risk factors can be categorized into distal (long-term) risk factors and proximal (short-term) risk factors. Examples of robust distal risk factors include demographic characteristics (e.g., sex, age, race/ethnicity), psychiatric history (e.g., major depressive disorder, conduct disorder, attention-deficit hyperactivity disorder), past SITB history, family history of SITBs, and childhood maltreatment (Cha et al., 2018; Franklin et al., 2017; Nock et al., 2013; O'Connor & Nock, 2014; Ribeiro et al., 2016). Most studies to date have focused on identifying these distal risk factors, which are important for distinguishing *who* may be at risk for experiencing SITBs. However, findings from recent meta-analyses indicate that distal risk factors are unable to distinguish *when* individuals may be at greatest risk for SITBs and may be limited in predicting future SITB outcomes (Franklin et al., 2017; Ribeiro et al., 2016). Furthermore, most risk factor research has followed individuals over longer time periods (e.g., months, years), which is helpful for predicting low base rate behaviors, such as suicide attempts or deaths, but tells us far less about risk over the short-term (e.g., hours, days). Moreover, many distal risk factors are time-invariant and immutable (e.g., demographics, family history) and therefore cannot point to malleable targets for intervention. Emerging research suggests that identifying proximal, time-varying, and modifiable risk factors may yield key information about *when* individuals may be at greatest risk for SITBs and how we can intervene to reduce risk (Kleiman et al., 2019).

To identify risk factors for SITBs, we need techniques that allow for intensive longitudinal measurement over shorter time intervals. Real-time monitoring techniques, such as daily diary designs or ecological momentary assessments (EMA), may be helpful to employ since these methodologies allow for the examination of within-person day-to-day fluctuations among constructs of interest. Daily diary designs assess experiences of interest over the day at one fixed time point on each day whereas EMA designs collect data at momentary levels, or multiple times each day (Shiffman et al., 2008). Both study designs involve short data collection intervals that provide the opportunity to assess current or recent thoughts, feelings, and the ability to examine dynamic fluctuations in thoughts, feelings, and behaviors. Real-time monitoring may be particularly useful to identify time-varying risk factors for SITBs in addition to examination of day-to-day and within-day fluctuations of SITBs (Kleiman et al., 2017). In fact, there has been a recent surge in the suicide and self-injury research field to examine the dynamic presence of SITBs and associated proximal risk factors using these methodologies (for reviews/commentaries see: Gee et al., 2020; Hepp et al., 2020; Kleiman et al., 2019; Kleiman & Nock, 2018; Rabasco & Sheehan, 2021; Sedano-Capdevila et al., 2021). One promising proximal risk factor for SITBs that is of increasing interest is sleep problems.

The association between sleep problems and SITBs

Sleep problems include a broad range of difficulties associated with the onset and maintenance of sleep, and growing research indicates a robust association between sleep problems and SITBs (Kearns et al., 2020; McCall & Black, 2013; Pigeon et al., 2012; Pigeon et al., 2016). Notably, sleep problems may be promising as proximal, time-varying, and modifiable risk factors for SITBs. Given that sleep problems are amenable to treatment (Blake et al., 2017;

Blake et al., 2018; Taylor & Pruiksma, 2014), sleep interventions offer promise in reducing SITB risk.

Sleep problems that are frequently examined include insomnia, hypersomnia, and nightmares. Insomnia, a common sleep problem among adolescents and adults, refers to frequent difficulties falling asleep or staying asleep, and often results in insufficient sleep duration (American Psychiatric Association, 2013). Recent meta-analyses indicate insomnia is consistently linked with SITB risk (Harris et al., 2020; Liu et al., 2020). In addition, hypersomnia, or extended sleep time (>9 or 10 hours), also is associated with greater SITB risk (for review see Chiu et al., 2018). Finally, nightmares are vivid, dysphoric dreams that result in awakening during sleep (Levin & Nielsen, 2009), and are shown to be a robust, independent predictor of SITB risk across multiple studies (Harris et al., 2020; Liu et al., 2020). However, nightmares are understudied relative to other sleep risk factors for SITBs, and this represents a significant gap given the robust emerging evidence highlighting the link between nightmares and SITBs (Harris et al., 2020; Liu et al., 2020).

In the following sections, we will provide an overview of the existing literature on the relation between nightmares and SITBs. Although there are notable strengths of the existing literature, there are four major limitations that guide this master's thesis research. First, most research has focused on sleep problems more broadly and their association to SITBs, with far fewer studies examining the link between *nightmares* and SITBs specifically. Second, most of this research was conducted in adult samples, and far less is known about the nightmare-SITB link in youth. Third, most existing studies are limited by their retrospective study design and temporally insensitive methodology, restricting our understanding of the short-term relation between nightmares and SITBs. Fourth, little is known about potential mechanisms linking nightmares and SITBs in youth, which is particularly critical for developing effective interventions to reduce SITBs.

Adult populations

Even though many empirical studies in adult samples have demonstrated a link between sleep problems and SITBs (Pigeon et al., 2012; Pigeon et al., 2016; Russell et al., 2019), relatively few have specifically examined the role of nightmares. In three different cross-sectional studies with large samples (*ns* = 280-583) of non-clinical undergraduate students, nightmares were significantly associated with suicide ideation (Lee & Suh, 2016; Nadorff et al., 2011; Suh et al., 2016). These associations remained significant even after adjusting for symptoms of depression, anxiety, post-traumatic stress disorder (Nadorff et al., 2011), and suicide theory-specific correlates (e.g., feelings of belonging) of SITBs (Suh et al., 2016). Furthermore, cross-sectional associations between nightmares and suicide ideation were present in clinical outpatient samples (Bernert et al., 2005; Krakow et al., 2011) and a sample of older adults (Golding et al., 2015). Far less research has focused on the nightmare-suicide ideation association longitudinally. In the only prospective longitudinal study to date, Bernert et al. (2017) found nightmares predicted change in suicide ideation from baseline to a seven-day follow-up in a sample of college students with prior SITB history.

In addition to suicide ideation, the link between nightmares and suicidal behavior has been demonstrated cross-sectionally in both clinical (Agargun et al., 2007; Littlewood et al., 2016; Sjostrom et al., 2007) and non-clinical (Speed et al., 2018) samples. Moreover, nightmares prospectively predicted suicidal behavior after adjusting for key psychiatric correlates (e.g., anxiety, depression) in a longitudinal study with a two-month follow-up period (Sjostrom et al., 2009). Similar findings of nightmares predicting future suicidal behavior emerged in a non-clinical population level study with an average 14-year follow-up period (Tanskanen et al., 2001).

Lastly, there is some evidence to suggest a relation between nightmares and NSSI in adults; however, the literature in this area remains sparse. Ennis et al. (2017) found that nightmares were associated with NSSI cross-sectionally in both clinical and non-clinical samples, even when controlling for depressive symptoms. Hochard et al. (2015) examined this association via daily diary in a sample of university students and found that nightmares significantly increased the risk of experiencing post-sleep SITBs (i.e., self-harming or suicidal thoughts within 1 hour of waking up; this study did not distinguish between nonsuicidal and suicidal self-injury). Taken together, nightmares are significantly associated with SITBs, and emerging research suggests nightmares and SITBs may be linked longitudinally (Harris et al., 2020; Liu et al., 2020).

Notably, meta-analytic research on this longitudinal relation indicates that the follow-up time period in longitudinal studies was significantly associated with SITB outcomes (Harris et al., 2020; Liu et al., 2020). Specifically, Harris et al. (2020) found evidence to suggest that effects were strongest when the study follow-up time period was 6 months or less for all SITB outcomes. Interestingly, Liu et al. (2020) noted a similar finding such that studies with a follow-up period of less than one year yielded significantly larger effects than did those with follow-ups of one year or more, specifically for suicide ideation. This would suggest future research should examine how sleep problems, and specifically nightmares, confer risk for SITBs over shorter time periods.

Adolescent populations

Compared to adults, far less research has examined sleep problems as they relate to SITBs among youth. Although sleep problems broadly have been found to be cross-sectional correlates and, in some studies, longitudinal predictors of SITBs in youth (Asarnow et al., 2020; Goldstein et al., 2008; Kearns et al., 2020; Koyawala et al., 2015), considerably less research has focused on the nightmare-SITB relation during adolescence specifically.

Initial research indicates a promising link between nightmares and SITBs among adolescents. For example, cross-sectional studies have demonstrated a significant association between nightmares and suicide ideation in both clinical (Kaplan et al., 2014) and non-clinical adolescent samples (Russell et al., 2018). Additionally, the link between nightmares and suicidal behavior has been demonstrated longitudinally (1-year follow-up) in a large sample of non-clinical school-aged youth (Liu et al., 2019). Furthermore, in the same sample of non-clinical school-aged youth noted above, nightmares and NSSI were linked in both a cross-sectional study (Liu et al., 2017) and longitudinal studies (1-year follow-up; Liu et al., 2019 and 3-year follow-up; Liu et al., 2021). It is important to note that only one study to date has examined the nightmare-suicide ideation link prospectively in youth using an EMA methodology (Glenn et al., 2021). Glenn et al. (2021) found that nightmares significantly predicted next-day suicide ideation after controlling for baseline depression and daily-level sadness in a high-risk clinical sample of youth.

Despite preliminary evidence supporting the nightmare-SITB relation, there are some notable gaps that represent critical areas for future research. First, prospective longitudinal studies are needed for temporal precedence to establish nightmares as a risk factor for SITBs (Kraemer et al., 1997). Second, research specifically focused on identifying the mechanisms through which nightmares may confer short-term risk for SITBs is warranted to elucidate processes that may contribute to risk (Fernandes et al., 2021; Goldstein & Franzen, 2020). Lastly, our knowledge of the nightmare-SITB link in *youth* is limited, which is critical since sleep problems may be particularly pernicious for this population – a critical issue discussed next.

Developmental changes in sleep during adolescence

Adolescence represents a critical and sensitive developmental period characterized by widespread changes in biological and social systems (Cha et al., 2018; Miller & Prinstein, 2019), resulting in substantial shifts in sleep patterns and circadian rhythms (Harvey et al., 2018; McGlinchey & Harvey, 2015). Changes in sleep patterns during adolescence can be attributed to shifts in the circadian rhythm preference from "morningness" to "eveningness" (Carskadon et al., 2004; Harvey et al., 2018) with approximately 40% of adolescents preferring a delayed sleep-wake schedule with later bedtimes and wake times (Harvey et al., 2018). Additionally, shifts in the circadian rhythm can be influenced by increased use of late-night electronics. Not only does this behavior prolong the onset of sleep (Bartel et al., 2015), but also light emitted from electronic devices suppresses melatonin production further interfering with sleep preparation (Wahl et al., 2019). Adolescents' preference for a delayed sleep-wake schedule conflicts directly with early school start times, and often results in adolescents experiencing insufficient sleep duration or sleep deprivation. Most adolescents do not get the recommended 8-10 hours of sleep per night (Hirshkowitz et al., 2015).

Furthermore, existing research suggests that adolescents undergo changes in sleep architecture and sleep depth, or changes in the amount of time spent in each sleep stage (Carskadon et al., 2004; Crowley et al., 2018; Jenni et al., 2005). Each sleep stage serves a specific function, and converging research indicates that adolescents spend less time in deep sleep stage (Colrain & Baker, 2011; Jenni & Carskadon, 2004) resulting in less restorative sleep. Adolescents continue to spend time in the rapid eye movement (REM) sleep stage where nightmares are most often experienced. Although findings are mixed, there is evidence (in adult samples) to suggest that individuals who experience nightmares spend more time in the REM stage of sleep (Germain & Nielsen, 2003; Simor et al., 2012). Furthermore, REM stage abnormalities such as increased REM sleep duration has been found in both adult and adolescent samples with a history of depression (Palagini et al., 2013; Urrila et al., 2015). Taken together, it may be that sleep depth and architecture alterations in the REM sleep stage (where nightmares most often occur), may be associated with insufficient sleep and nighttime awakenings among adolescents.

Prevalence of nightmares peaks during childhood (ages 6-10) and decreases in adolescence (Ophoff et al., 2018; Peterman et al., 2015). Although nightmares are less common during adolescence, nightmare presence may contribute to nighttime awakenings, reduce total sleep time, and result in insufficient or less restorative sleep (Krakow et al., 1995; Krakow, 2006). Given that adolescence is already characterized by changes in circadian rhythms, alterations in sleep architecture, and external demands that contribute to poor sleep, experiencing nightmares during adolescence may cause further sleep disruptions. Adolescents who experience nightmares may be particularly at risk for increases in mental health symptoms including SITBs.

A critical gap in the existing literature is understanding *how* nightmares may confer risk for SITBs in youth. No research to date has empirically examined this link. Emerging research indicates emotion regulation may be a potential mechanism linking nightmares and SITBs in adults (Andrews & Hanna, 2020), however, this relation has not previously been tested among adolescents. Next, we provide an overview of the associations between sleep problems and emotion regulation difficulties, and emotion regulation difficulties and SITBs which, taken together, provide compelling evidence for the role of emotion regulation as a mechanism in the nightmare-SITB link.

Emotion regulation

Emotion regulation can be broadly defined as changes in emotion intensity and emotion duration when emotions are activated (Cole et al., 2004; Thompson, 1994). Emotion regulation is an adaptive process that is critical for mitigating the adverse effects of stressors (Compas et al., 2017). In contrast, difficulties with emotion regulation have been implicated in many clinical diagnoses and are considered a transdiagnostic risk factor for many forms of psychopathology (Gross & Jazaeiri, 2014; Kring, 2010). Adolescence represents an ideal period to examine emotion regulation, a crucial skill associated with psychosocial adjustment and psychopathology specifically during this time frame (McLaughlin et al., 2011). This developmental period is associated with biological and psychosocial changes that may impact emotion regulation ability (Casey et al., 2008; Dahl, 2004; Spear, 2000) and examining emotion regulation may provide insight into individual differences in mental health during adolescence.

In this thesis we examine four components of emotion regulation (emotion reactivity/intensity, expressive suppression, emotional awareness, and negative urgency) that are most consistently associated with psychopathology. Emotion reactivity (or affective reactivity, affect intensity) refers to the intensity, duration, and persistence of emotions that an individual experiences; often, emotion reactivity precedes difficulties with adaptive emotion regulation (Cole et al., 1994; Eisenberg et al., 1995). Expressive suppression is the deliberate inhibition of emotion expression after the emotional response has been generated (Gross & Levenson, 1993), and is considered an ineffective form of emotion regulation (Aldao et al., 2010). Emotional awareness, or awareness of one's negative emotional state is a necessary and critical component preceding adaptive emotion regulation (Barrett et al., 2001; Kalokerinos et al., 2019). In order to modulate adaptive emotion regulation strategies, one must be able to identify or be aware of their emotional state to change their thoughts about the situation. Lastly, negative urgency refers to an individual's tendency to act impulsively when faced with negative affect and has been widely used as a measure of emotion dysregulation (Cyders & Smith, 2007). These emotion regulation facets were chosen given their links with psychopathology in youth. Increased symptoms of anxiety, depression, and psychopathology are linked with higher emotion reactivity (Pine et al., 2001; Shapero et al., 2016; Silk et al., 2003), greater expressive suppression (Schafer et al., 2017), lower emotional awareness (Kranzler et al., 2016; Nook et al., 2021; Weissman et al., 2020), and greater negative urgency (Smith et al., 2013).

Sleep problems and emotion regulation difficulties

Prior theoretical and empirical evidence indicates that sleep and emotion regulation are inextricably intertwined. On a neurobiological level, the brain structures that regulate emotional responses and behavior also govern sleep (Palmer & Alfano, 2017; van der Helm & Walker, 2009), suggesting a strong relation between these two domains. Furthermore, multiple studies in both adults and adolescents have demonstrated a strong link between insufficient sleep and poorer emotion regulation (e.g., difficulty with cognitive reappraisal, greater expressive suppression, rumination, avoidance; Baum et al., 2014; Mauss et al., 2013; Palmer et al., 2018). In adolescents, insufficient sleep induced via an experimental sleep restriction procedure worsened negative mood (McMakin et al., 2016), as well as increased irritability (Baum et al., 2014) and anxiety (Talbot et al., 2010). Additionally, there are associations between insufficient sleep and heightened affective reactivity to negative stimuli (McMakin et al., 2016; Reddy et al., 2017). Taken together, sleep plays a critical role in various components of emotion regulation, and it is evident that sleep problems negatively impact emotion regulation ability.

Little research has specifically explored the relation between nightmares and emotion regulation which represents a critical gap in understanding how nightmares may confer risk for SITBs. Levin and Nielsen (2009) proposed a neurocognitive model to elucidate the relation between nightmares and emotion regulation. The neurocognitive model suggests that normal sleep processes involve down-regulation of negative emotional arousal and extinction of fear memories (Levin & Nielsen, 2009). Nightmares can occur when there is a disruption in the normal affective processes during sleep, and emotional content is not appropriately down-regulated, suggesting that nightmares inhibit the emotion regulation function of dreams (Levin & Nielsen, 2009). Further, nightmares can additionally disrupt sleep resulting in increased propensity to experience negative affect during the day. In sum, nightmares may contribute to difficulties with emotion regulation through multiple pathways, which could in-turn increase risk for SITBs.

Emotion regulation difficulties and SITBs

Extant research provides compelling evidence to support an association between emotion regulation and SITBs. In fact, there is widespread recognition that emotion regulation difficulties may increase risk for engagement in NSSI (Fox et al., 2015; Wolff et al., 2019). Several theoretical models of NSSI describe this behavior as a maladaptive response to strong negative emotions (Hooley & Franklin, 2018; Klonsky, 2007; Nock & Prinstein, 2004), and empirical research suggests that affect regulation is the leading function of NSSI (Bentley et al., 2014; Nock, 2009; Nock & Mendes, 2008; Nock & Prinstein, 2004). Furthermore, recent daily diary and EMA studies have explored negative affective states immediately preceding thoughts of

NSSI and/or engagement in NSSI. Results from multiple studies suggest that higher negative affect intensity (ex: sadness, fear, shame) predicted later thoughts of NSSI and NSSI engagement (Dillon et al., 2021; Kuehn et al., 2022; Victor & Klonsky, 2014; Victor et al., 2019). Altogether, this evidence suggests that negative affect intensity and NSSI are strongly linked, and that NSSI may serve as a regulatory function and aid in reduction of negative affect.

Furthermore, there is converging evidence to indicate that emotion regulation may play a role in suicidal thoughts and behaviors. Central to many of the existing theories of suicide is intense emotional or psychological pain, which individuals may be unable to effectively regulate, and thereby increasing likelihood of experiencing suicidal thoughts or engaging in suicidal behaviors. For instance, Shneidman's psychological theory of suicide suggests that suicide results when individuals' psychache, extreme mental or emotional pain, becomes unbearable (Shneidman, 1993). In addition, the escape theory (Baumeister, 1990) describes a process in which negative affect arises as a result of self-perceptions that the individual has failed to meet standards, and suicide is seen as a way to escape from or alleviate current psychological suffering. A more recent theory of suicide, the three-step theory (3ST; Klonsky & May, 2015) similarly identifies pain (strong negative affect) as a driving force contributing to suicidal desire. The 3ST posits that when an individual experiences an event that is miserable, painful, or aversive, and is hopeless about their situation improving, suicidal desire increases.

Prior studies have demonstrated a link between emotion regulation and suicidal thoughts and behaviors. Empirical research in adolescents indicates that higher emotion reactivity, lower emotional awareness, and restriction of emotion expression are associated with increased likelihood of experiencing suicide ideation (Brausch & Woods, 2019; Viana et al., 2019) or suicidal behavior (Dour et al., 2011; Jacobson et al., 2011). A systematic review found a positive association between emotion dysregulation and suicidal thoughts and behaviors in adults; however, the predictive relation between these variables did not hold after controlling for demographic (e.g., age, gender) and psychiatric (e.g., post-traumatic stress disorder, bipolar disorder, depressive symptoms) variables (Turton et al., 2021). Findings from a within-person, case-crossover design study in adults (comparing the day before a suicide attempt to the day the suicide attempt occurred) indicate that negative affective states increase in the hours immediately preceding suicide attempts (Bagge et al., 2017). Altogether, there is preliminary evidence to suggest further examination of the role of emotion regulation difficulties and negative affect intensity in suicide ideation and behavior.

Evidence for emotion regulation as the mechanism linking nightmares and SITBs

To date, there have been three studies (all conducted in adult samples) examining emotion regulation as the mechanism linking nightmares and SITBs. Two studies used a cross-sectional study design (Ennis et al., 2018; Ward-Ciesielski et al., 2018), and one study used a daily diary design (Hochard et al., 2015).

Cross-sectional findings from Ennis et al. (2018) determined that the relation between nightmares and NSSI was atemporally mediated by emotion dysregulation in a non-clinical sample of undergraduate students. Due to the cross-sectional nature of their study, they conducted an alternative mediation analysis to demonstrate the unidirectional relation between nightmares and NSSI via emotion dysregulation. The alternative mediation model, which included emotion dysregulation as the predictor and NSSI as the mediator, was not significant. Although this study provides substantive evidence for the relation between nightmares and NSSI, it is limited by the study design which precludes inferences that can be made about causality and temporality of the variables of interest.

Results from Ward-Ciesielski et al. (2018) demonstrated that emotion regulation deficits (assessed via borderline personality disorder symptoms) atemporally mediated the relation between nightmares and suicide risk in a large online sample (n = 972) of non-clinical adults. Additionally, they examined the moderating role of emotion regulation (assessed via a self-regulatory capability scale) on the mediation relationship and found that downregulation of negative emotions significantly moderated the mediated relationship. This suggests that nightmares may lead to deficits with emotion regulation (assessed via borderline personality disorder symptoms; mediator) which increases suicide risk, and this relation is further exacerbated by inability to effectively downregulate emotions (assessed via a self-regulatory capability scale; moderator). Limitations of this previous study include lack of generalizability and inability to infer directionality due to the cross-sectional study design.

Lastly, Hochard et al. (2015) conducted a five-day daily diary study to elucidate the link between nightmares, negative affect, and post-sleep SITBs in a sample (n = 72) of university students. Results demonstrated a unidirectional predictive relation between nightmares and post-sleep SITBs (i.e., self-harming or suicidal thoughts within 1 hour of waking up). In addition to this direct effect, negative affect intensity was found to partially mediate the relation between nightmares and post-sleep SITBs, providing empirical evidence for the impact nightmares may have on negative affect intensity, and in-turn on risk for SITBs. However, limitations of this prior study include restriction of post-sleep SITB endorsements to within one hour of waking, pen and paper methodology for the daily diaries which cannot confirm that the diary was completed at the required time, and utilization of data from the same daily assessments for mediation analyses (negative affect ratings and SITB endorsements were collected concurrently).

Altogether, findings from this study provide preliminary support for emotion regulation as a mechanism linking nightmares and SITBs.

Gaps linking nightmares as a proximal risk factor to adolescent SITBs

The existing literature provides preliminary evidence linking nightmares and SITBs; however, there are four critical gaps that should be noted. First, most research has focused on sleep problems more broadly and their association to SITBs, with far fewer studies examining the link between *nightmares* and SITBs specifically. Second, most existing research related to nightmares and SITBs was conducted in adult samples, and far less is known about the nightmare-SITB link in youth. This is particularly critical, given the ongoing changes with sleep and emotion regulation during adolescence which may further increase vulnerability to risk factors for SITBs.

Third, there is a paucity of research that has examined the short-term links between nightmares and SITBs. Most existing studies are limited by their retrospective study design and temporally insensitive methodology restricting our understanding of the short-term relation between nightmares and SITBs. Given the fluctuating nature of both SITBs and nightmares, shorter time intervals for measurement may yield more reliable results regarding the nature of this relationship which would further our knowledge of when SITB risk is greatest. Much of the existing research in this area is cross-sectional or conducted over extended periods of time (months, to years) limiting our ability to understand short-term predictors of SITBs. Newer study designs (real-time monitoring) and advanced statistical methods may allow for a more fine-grained approach to uncover the nightmare-SITB link. Moreover, prior studies in youth may have been limited in their ability to statistically detect SITBs, since SITBs are infrequent and considered low-base rate events. Focusing research on high-risk populations during high-risk time frames, such as periods of time when adolescents were hospitalized or in the period following discharge from acute psychiatric care (Chung et al., 2017), can increase power or ability to detect significant effects.

Lastly, although existing research has linked nightmares and SITBs (Ennis et al., 2017; Glenn et al., 2021; Hochard et al., 2015; Russell et al., 2018; Sjostrom et al., 2009), little is known about the mechanisms underlying this relation. This is a crucial area for future research because identification of risk mechanisms can inform targets for intervention and prevention of SITBs. One potential mechanism linking nightmares and SITBs is emotion regulation, which has garnered the strongest empirical support in adult populations (for review see Andrews & Hanna, 2020). However, only one study in adults has investigated emotion regulation as a mechanism linking nightmares and SITBs longitudinally (Hochard et al., 2015). Moreover, this mechanism has not been tested previously among adolescents.

The present study

To address these gaps in the literature, we aimed to elucidate the emotion regulation mechanisms linking nightmares and SITBs in high-risk youth. We conducted secondary data analysis in two clinically high-risk samples of youth, utilizing data from two real-time monitoring studies. Sample 1 consists of adolescents hospitalized for suicide or self-injury risk who completed a daily diary study while on an inpatient psychiatric unit. Sample 2 consists of adolescents who completed an EMA study for 28-days post-discharge from acute psychiatric care for suicide risk. Taken together, these complementary study samples will allow us to capitalize on a range of SITBs and provide novel insights into the proximal mechanisms linking nightmare and SITBs in high-risk youth during high-risk periods.

Although the primary sleep problem of interest in the present study is presence of nightmares, we conducted additional secondary analyses with a continuous measure of a sleep problem in the form of sleep quality. Sleep quality generally refers to ratings of one's satisfaction of the sleep experience, and incorporates aspects of sleep time, sleep onset, awakenings during sleep, and feelings of rest upon awakening (Kline et al., 2013; Krystal & Edinger, 2008). Not only is poorer sleep quality associated with chronic insomnia (Edinger et al., 2004), but also, individuals who experience nightmares report poorer sleep quality (Paul et al., 2005), indicating that sleep quality may represent a transdiagnostic measure of sleep problems.

Nightmares and sleep quality will collectively be referred to as "sleep problems" for the remainder of this thesis.

Sample 1

Aim 1. We will examine between-person associations between sleep problems (poorer sleep quality, nightmare presence) and likelihood of NSSI behavior during the daily diary study period.

Hypothesis 1a. Poorer sleep quality will increase likelihood of NSSI behavior during the daily diary study period.

Hypothesis 1b. Presence of nightmares will increase likelihood of NSSI behavior during the daily diary study period.

Aim 2. We will examine between-person associations between trait-level emotion regulation constructs (assessed at baseline) and sleep problems during the daily diary study period.

Hypothesis 2a. Higher trait-level negative urgency, higher trait-level emotion reactivity, higher trait-level expressive suppression, and lower trait-level emotional awareness will predict poorer sleep quality during the daily diary study period.

Hypothesis 2b. Higher trait-level negative urgency, higher trait-level emotion reactivity, higher trait-level expressive suppression, and lower trait-level emotional awareness will increase likelihood of nightmare presence during the daily diary study period.

Aim 3. We will examine between-person associations between trait-level emotion regulation constructs (assessed at baseline) and NSSI behavior during the daily diary study period.

Hypothesis 3. Higher trait-level negative urgency, higher trait-level emotion reactivity, higher trait-level expressive suppression, and lower trait-level emotional awareness will increase likelihood of NSSI behavior during the daily diary study period.

Aim 4. We will examine within-person associations between sleep problems and NSSI behavior during the daily diary phase.

Hypothesis 4a. During the daily diary study, poorer sleep quality will predict increased likelihood of next-day NSSI behavior.

Hypothesis 4b. During the daily diary study, poorer sleep quality will predict increased frequency of next-day NSSI behavior.

Hypothesis 4c. During the daily diary study, nightmare presence will predict increased likelihood of next-day NSSI behavior.

Hypothesis 4d. During the daily diary study, nightmare presence will predict increased frequency of next-day NSSI behavior.

Aim 5. We will conduct exploratory within-person analyses to examine trait-level emotion regulation constructs as moderators of the relationship between sleep problems (poorer sleep quality, nightmares) and likelihood of NSSI behavior during the daily diary phase. The person-level moderator (emotion regulation) will moderate the observation-level associations (sleep problems predicting likelihood of NSSI behavior). We hypothesize that poorer emotion regulation abilities will increase the strength of the sleep problem-NSSI behavior association.

Sample 2

Aim 1. We will examine between-person associations between sleep problems (insomnia symptom severity [past two weeks], lifetime history of nightmares) and SITBs, assessed at baseline.

Hypothesis 1a. Greater insomnia symptom severity will be associated with increased likelihood and severity of recent suicide ideation.

Hypothesis 1b. Greater frequency and distress associated with experiencing nightmares will be associated with increased likelihood and severity of recent suicide ideation.

Hypothesis 1c. Greater insomnia symptom severity will be associated with increased likelihood of past month NSSI behavior.

Hypothesis 1d. Greater frequency and distress associated with experiencing nightmares will be associated with increased likelihood of past month NSSI behavior.

Aim 2. We will examine within-person associations between sleep problems and next-day SITB outcomes.

Hypothesis 2a. Poorer sleep quality will predict higher next-day NSSI thought intensity.

Hypothesis 2b. Poorer sleep quality will predict greater next-day suicidal thought intensity.

Hypothesis 2c. Nightmare presence will predict higher next-day NSSI thought intensity.

Hypothesis 2d. Nightmare presence will predict greater next-day suicidal thought intensity.

Aim 3. We will examine within-person associations between sleep problems and next-day negative affect intensity and variability.

Hypothesis 3a. Poorer sleep quality will predict higher next-day negative affect intensity.

Hypothesis 3b. Poorer sleep quality will predict greater next-day negative affect variability.

Hypothesis 3c. Nightmare presence will predict higher next-day negative affect intensity.

Hypothesis 3d. Nightmare presence will predict greater next-day negative affect variability.

Aim 4. We will examine within-person (observation-level) associations between negative affect intensity and SITB outcomes.

Hypothesis 4a. Higher negative affect intensity will predict higher NSSI thought intensity contemporaneously (same EMA survey).

Hypothesis 4b. Higher negative affect intensity will predict greater suicidal thought intensity contemporaneously (same EMA survey).

Hypothesis 4c. Higher negative affect intensity will predict higher next-point NSSI thought intensity.

Hypothesis 4d. Higher negative affect intensity will predict greater next-point suicidal thought intensity.

Aim 5. We will examine daily sleep problems as a day-level moderator of the within-person contemporaneous relationship between negative affect intensity and SITB outcomes (i.e., predictor and outcome from the same EMA survey).

Hypothesis 5a. We hypothesize that the relation between negative affect intensity and NSSI thought intensity will be stronger on days with poorer prior-night sleep quality.

Hypothesis 5b. We hypothesize that the relation between negative affect intensity and suicidal thought intensity will be stronger on days with poorer prior-night sleep quality.

Hypothesis 5c. We hypothesize that the relation between negative affect intensity and NSSI thought intensity will be stronger on days with prior-night presence of nightmares.

Hypothesis 5d. We hypothesize that the relation between negative affect intensity and suicidal thought intensity will be stronger on days with prior-night presence of nightmares.

Aim 6. We will conduct exploratory analyses to examine sleep problems as a moderator of the within-person lagged effect relationship between negative affect intensity and SITB outcomes (predictor assessed at time T, outcome assessed at time T+1).

Hypothesis 6a. We hypothesize that the relation between negative affect intensity and next-point NSSI thought intensity will be stronger on days with poorer prior-night sleep quality.

Hypothesis 6b. We hypothesize that the relation between negative affect intensity and next-point suicidal thought intensity will be stronger on days with poorer prior-night sleep quality.

Hypothesis 6c. We hypothesize that the relation between negative affect intensity and next-point NSSI thought intensity will be stronger on days with prior-night presence of nightmares.

Hypothesis 6d. We hypothesize that the relation between negative affect intensity and next-point suicidal thought intensity will be stronger on days with prior-night presence of nightmares.

CHAPTER II

STUDY 1 METHOD

Participants

Participants included 118 inpatient adolescents (ages 12-19, $M = 15.72$, $SD = 1.77$) enrolled in a study investigating risk factors for self-injury. Participants self-identified as 80.5% White, non-Hispanic, 4% Asian, 4% African American, 4% Hispanic, and the remainder endorsed more than one race, and 79.8% of the participants were assigned female at birth. Adolescents who were admitted to an inpatient psychiatric unit for serious self-injury risk (e.g., nonsuicidal self-injury, suicidal thoughts and behaviors) were eligible to participate. Participants were excluded if they were unable to provide informed assent/consent (e.g., extreme cognitive impairment, current mania or psychosis, non-English speaking).

Procedure

All study procedures were approved by the Franciscan Children's Hospital and affiliated university (Harvard University) institutional review boards. The study was conducted during participants' stay on the inpatient unit; participants were recruited and enrolled as close as possible to their hospital admission date. Prior to study participation, informed assent (12-17 yo) or consent (18-19 yo) was obtained from participants. For participants younger than 18-years-old, parents/guardians were approached first to get their written permission before obtaining written assent from the adolescent minor. Potential participants 18-years-old or older were approached directly for written consent. Study participation consisted of one baseline assessment (which took approximately 45 minutes to complete) and a daily diary phase ($M = 6.11$ days of data per participant, $SD = 6.06$, Range = 1 – 37). At the baseline assessment, participants completed a variety of self-report measures on a study iPad (see Measures). Following a baseline assessment, participants met with a study staff member at approximately the same time each weekday for the duration of their inpatient stay (*M* = 11.04 days, *SD* = 11.6, Median = 7, Range = 1 – 77) to answer a series of self-report questions (see Measures). Specifically, participants were asked to report about experiences, emotions, and events since the prior check-in (approximately 24 hours prior during weekdays and 1-2 days prior if the Monday after a weekend). The specific instructions were: “The following questions are asking about the time between now and the last time you answered these questions. The last time you answered these questions may have been more than a day ago, and if that’s the case, please think about the entire time between now and the last time you answered these questions.” When participants endorsed a specific experience (e.g., on the items described below), they were asked when the event occurred (“today”, “yesterday”, “two days ago”). This allowed the research team to identify when an event occurred if more than 24 hours had passed since the last check-in (e.g., over the weekend or a holiday). Participants were not compensated, in accordance with hospital policy. Additionally, there was no formal debrief process at the end of study participation since the aims of the study were transparent and communicated to participants during the consent process.

Baseline Measures

Emotion regulation was measured at baseline from the adolescent using several self-report measures. Each of these measures provides information about various aspects of trait-level (person-level) emotion regulation difficulties (see Table 1 for descriptive statistics).

Negative urgency

The UPPS-P short-form (Cyders et al., 2014) is a 20-item self-report measure of five dimensions of impulsivity: negative urgency, positive urgency, (lack of) perseverance, (lack of) premeditation, and sensation seeking. For this thesis, we used the four-item negative urgency subscale (see Appendix A) which has been widely used as a form of emotion dysregulation. Items are scored on a 1 (*agree strongly*) to 4 (*disagree strongly*) Likert scale, reverse coded if indicated, and summed such that higher scores reflect greater levels of negative urgency. The UPPS-P short-form has demonstrated good internal consistency in young adult samples (α's ranged from .74 - .88 across subscales; Cyders et al., 2014) and samples of international youth (Donati et al., 2021; Wang et al., 2020). In the current study sample, the UPPS-P negative urgency subscale demonstrated low reliability (α = .67).

Emotion reactivity

The Emotion Reactivity Scale (ERS; Nock et al., 2008) is a 21-item self-report measure of emotion reactivity (see Appendix B). The ERS includes items that measure the sensitivity, arousal/intensity, and duration of emotions. Items are scored on a 0 (*not at all like me*) to 4 (*completely like me*) Likert scale and summed to create an overall emotion reactivity score. Higher scores reflect greater levels of emotion reactivity. The ERS has demonstrated strong internal consistency (α = .94) and convergent validity with a measure of behavioral inhibition in adolescents (r = .37; Nock et al., 2008). In the current study sample, the ERS demonstrated strong reliability (α = .93).

Expressive suppression

The Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA; Gullone & Taffe, 2012) is a 10-item self-report measure of two emotion regulation strategies: cognitive reappraisal and expressive suppression. For this thesis, we used the four-item expressive suppression subscale (see Appendix C) which indicates inefficient emotion regulation. Items are scored on a 1 (*strongly disagree*) to 7 (*strongly agree*) Likert scale and summed such that higher scores reflect greater tendency to use expressive suppression as an emotion regulation strategy.

The ERQ-CA suppression subscale has demonstrated sound internal consistency (α = .75) and convergent validity with a child depression measure among children and adolescents (r = .37; Gullone & Taffe, 2012). In the current study sample, the ERQ-CA suppression subscale demonstrated acceptable reliability (α = .75).

Emotion awareness

The Comprehensive Inventory of Mindfulness Experiences–Adolescents (CHIME-A; Johnson et al., 2017) is a 25-item self-report measure of mindfulness and emotional awareness. We used a three-item awareness of internal experiences subscale (see Appendix D) in which items are scored on a 1 (*never true*) to 5 (*always true*) Likert scale and summed such that higher scores reflect greater tendency to experience internal emotional awareness. For this study, the subscale was reverse coded, such that higher scores indicate lower tendency to experience internal emotional awareness. The CHIME-A has demonstrated adequate internal consistency (α = .80) in adolescents and has been shown to be a strong, consistent predictor of positive and negative psychological states (Johnson et al., 2017). In the current study sample, the CHIME-A awareness of internal experiences subscale demonstrated acceptable reliability (α = .70).

Table 1

Emotion regulation descriptive statistics (Sample 1)

Emotion regulation variable	***M***	***SD***	***Range***
Negative urgency	12.61	2.28	5 – 16
Emotion reactivity	49.25	16.93	2 – 82
Expressive suppression	16.28	5.52	4 – 28
Internal emotional awareness	7.69	2.63	3 – 14

Daily diary measures

Poor sleep quality

Sleep quality was assessed by asking "How well did you sleep last night?" using a Likert scale from 1 (*very poorly*) to 10 (*very well*). Relevant to study aims 1, 2, 4, and 5, initial descriptive statistics indicate an average (grand mean) sleep quality of 6.90 (*SD* = 1.62, Range = 2 – 10) across participants in the sample.

Nightmare presence

Nightmare presence was assessed by asking "Did you have any nightmares since the last check-in?" with a yes/no response. Relevant to study aims 1, 2, 4, and 5, initial descriptive statistics suggest that 51 participants (43.2%) reported experiencing nightmares while on the inpatient unit, with a total of 136 instances of nightmares reported.

NSSI behavior presence

NSSI behavior was assessed by asking participants whether they had hurt themselves on purpose since the last check-in ("since the last check-in" was changed to "since yesterday" when speaking to a patient for the first time) with a yes/no response. Relevant to study aims 1, 3, 4, and 5, initial descriptive statistics indicate that 41 participants (34.75%) reported engaging in NSSI at least once while on the inpatient unit. Across those 41 participants, there were 162 days of engaging in NSSI since the last check-in.

It is important to note that questions assessing NSSI behavior were created in collaboration with the inpatient unit director to ensure that questions were phrased in a manner consistent with language used on the inpatient unit by unit staff. In addition, reports of NSSI behavior were made anonymously through the study iPad and were not reported to inpatient unit staff. As part of inpatient unit protocols, patients were checked on every 5 minutes by inpatient unit staff to monitor safety. Due to these protocols and to ensure participant confidentiality, data were not reviewed in real-time and research study staff were not required to retroactively report instances of NSSI behavior to inpatient staff. Study participants were made aware of reporting procedures and that no identifying information would be linked to their responses (see Kellerman et al., 2022 for greater detail regarding study procedures).

NSSI behavior frequency (Outcome)

NSSI behavior frequency was assessed by asking "How many times did you hurt yourself on purpose since the last check-in?". Relevant to study aims 4 and 5, across 162 days of NSSI engagement, participants reported a total of 388 individual instances of NSSI during the daily diary study period. NSSI behavior frequency was used as a proxy for NSSI behavior severity.

Data preparation

Missing data for variables assessed at baseline (CHIME-A, ERQ-CA, ERS, and UPPS-P) involved a completely missing survey rather than missing items from an otherwise complete survey. This type of missingness cannot be imputed and therefore pair-wise deletion was used when indicated (see Results section below).

For the within-person analyses, data were required to be available on consecutive days (day 1 predicting day 2) given the study aim. Therefore, if either the predictor variable (previous night's nightmare presence or sleep quality) or the outcome variable (next-day NSSI) was missing, that day's data were not included in the model.

Statistical assumptions for cross-sectional linear and logistic regression analyses were checked (Shatz, 2023) using the "check_model" function from the *performance* package in R (Ludecke et al., 2021). The following parameters were assessed using the "check_model" function: homogeneity of variance, linearity, influential observations, collinearity, normality of residuals, independence of observations, and binned residuals (for models with binomial distribution).

In addition, statistical assumptions for multilevel linear and logistic regression analyses were checked using the "check_model" function from the *performance* package in R (Ludecke et al., 2021). The following parameters were assessed using the "check_model" function: homogeneity of variance, linearity, influential observations, collinearity, normality of residuals, normality of random effects, and binned residuals (for models with binomial distribution). Multilevel modeling was used to address violations of the independence of observation assumption of traditional linear regression. Independence of person-level units was assumed based on ensuring participants were not repeated/duplicated during recruitment. Data were randomly sampled at the observation-level and person-level.

Given the extensive number of models run to test hypotheses for Sample 1, specific results on all statistical assumptions are not provided for brevity. Assumptions outlined above were deemed acceptable.

Additionally, outliers in the between-person variables were assessed for each variable using boxplots and were removed via pair-wise deletion (see Results section below). Lastly, between-person continuous variables (emotion regulation variables, age) were grand mean centered to prevent multicollinearity and improve interpretation of effects.

Covariates

Due to the wide age range of participants during this adolescent developmental period (12-19 yo), we explored if covarying for age in statistical models was warranted. Prior research indicates that emotion regulation varies as a function of age (Cole et al., 2004; Tottenham et al., 2011). Furthermore, NSSI (Swannell et al., 2014) and sleep problems (Ophoff et al., 2018) may also be age dependent. We empirically determined if covarying for age was indicated based on the relation between age and emotion regulation, NSSI, and sleep problems. Bivariate between-person correlations were conducted (see Table 4 for all results). Age was significantly correlated with the primary SITB outcome of interest, NSSI behavior, and therefore age was included as a covariate in all models.

Analytic strategy

In this section, we present each analytic strategy (organized by aim), followed by a description of the power analysis for each analysis. First, we present aims and power analyses for between-persons (cross-sectional) logistic and linear regression models. Next, we present aims and power analyses for multilevel models.

We first conducted power analyses for between-persons (cross-sectional) logistic regression models; due to the differing nature of predictors and outcomes in each of the proposed analyses, we conducted a power analysis for each proposed analysis to adequately characterize the odds ratio of the predictor, event ratio probability of the outcome, power, and required sample size. All analyses were conducted in R (R Core Team, 2022) with the *pwr2ppl* package (Aberson, 2022). The "LRcont" function was used to compute power for logistic regression with continuous predictors. We also conducted power analyses for between-persons (cross-sectional) linear regression models using the *pwr* package in R (Champely et al., 2020).

Prior to conducting statistical analyses, we computed descriptive statistics for major study variables that were used in analyses and bivariate correlations between our between-person variables.

Aim 1a

We conducted between-person (cross-sectional) logistic regression analyses to examine whether poorer sleep quality was associated with presence of NSSI behavior. For this analysis, we capitalized on the multiple data points of sleep quality that were assessed during the daily diary phase of the study. We computed average sleep quality (mean sleep quality) for each participant in addition to the average variability in sleep quality (standard deviation of sleep quality) for each participant (Bei et al., 2016). Since this is a between-person analysis, any participant report of NSSI behavior during the daily diary phase of the study was considered as presence of NSSI behavior (yes/no). Average sleep quality and average variability in sleep quality were examined separately in relation to NSSI behavior. These logistic regression models were analyzed using the "glm" function from the *stats* package in R (R Core Team, 2022) and a binomial distribution was specified. Average sleep quality and average variability in sleep quality were grand-mean centered using the "center" function from the *misty* package in R (Yanagida, 2023).

Based on findings from a study examining sleep quality as a predictor of NSSI behavior presence in a sample of non-clinical adolescents (Liu et al., 2017), 2.17 was used for the odds ratio of the predictor. The event ratio probability of the outcome (NSSI behavior presence) was determined to be .42 based on prior research investigating the frequency of these behaviors occurring in high-risk clinical samples (Czyz et al., 2021). Power was set to .80 and alpha level was set to .05. The resulting sample size calculation is 54, which suggests we have adequate power to conduct this analysis in the current sample ($N = 118$).

Aim 1b

In a separate logistic regression model, we examined whether nightmare presence was associated with presence of NSSI behavior. Since this is a between-person (cross-sectional) analysis, any participant report of nightmares during the daily diary phase of the study was considered as presence of nightmares (yes/no). Any participant report of NSSI behavior during the daily diary phase of the study was considered as presence of NSSI behavior (yes/no). This logistic regression model was analyzed using the "glm" function from the *stats* package in R (R Core Team, 2022) and a binomial distribution was specified.

Most studies investigating the link between nightmares and NSSI have opted to use continuous predictors such as nightmare frequency or severity. In this study, participants were only asked to provide a yes/no response to experiencing nightmares. This would suggest our power analysis should incorporate the probability of NSSI behavior occurring when nightmares are present in addition to the probability of NSSI behavior occurring when nightmares are absent (as is suggested with a categorical predictor). However, these probabilities are extremely difficult to calculate from most published research (i.e., not enough information is provided to calculate these probabilities). We instead opted to use an odds ratio (4.17) from a daily diary study that is the only published study using both a dichotomous predictor (nightmares, yes/no) and outcome (NSSI behavior, yes/no; Hochard et al., 2015). The event ratio probability of the outcome (NSSI behavior presence) was determined to be .42 based on prior research investigating the frequency of these behaviors occurring in high-risk clinical samples (Czyz et al., 2021). Power was set to .80 and alpha level was set to .05. The resulting sample size calculation is 16, which suggests we have adequate power to conduct this analysis ($N = 118$).

Given that the prior power analysis yielded a very high effect size, we conducted a second power analysis with a more conservative odds ratio of 2, using the same event ratio probability of the outcome, power, and alpha levels as above. The resulting sample size calculation is 68, which suggests we have sufficient power to conduct this analysis ($N = 118$).

Aim 2a

We explored how various trait-level emotion regulation constructs (assessed at baseline) predicted poorer sleep quality (during the daily diary phase of the study) using cross-sectional linear regression models. We first examined each trait-level emotion regulation construct (separately) as a predictor of average sleep quality. Then, we examined each trait-level emotion regulation construct (separately) as a predictor of average variability in sleep quality. These linear regression models were analyzed using the "lm" function from the *stats* package in R (R Core Team, 2022). Trait-level emotion regulation constructs were grand-mean centered using the "center" function from the *misty* package in R (Yanagida, 2023).

To date, very few studies have examined affect/emotion regulation as a predictor of sleep, with mixed results due to varying temporal information between predictors and outcomes (ten Brink et al., 2022). This remains a significant gap in the field. As a result, we conservatively estimated a small effect size for this analysis. Post-hoc power analyses suggest that with one predictor (emotion regulation), 118 participants, a small effect size ($f^2 = .02$), and a critical alpha of $p < .05$ would yield insufficient power ($1 - \beta = .33$). This would suggest we are underpowered to detect this effect.

Aim 2b

We examined each trait-level emotion regulation construct (separately) as a predictor of nightmare presence using logistic regression models. Since this is a between-person (cross-sectional) analysis, any participant report of nightmares during the daily diary phase of the study was considered as presence of nightmares (yes/no). These logistic regression models were analyzed using the "glm" function from the *stats* package in R (R Core Team, 2022) and a binomial distribution was specified. Trait-level emotion regulation constructs will be grand-mean centered using the "center" function from the *misty* package in R (Yanagida, 2023).

Based on findings from a daily diary study examining negative affect intensity (emotion regulation) as a predictor of SITBs, 1.2 was used as the odds ratio of the predictor (Hochard et al., 2015). The event ratio probability of the outcome (nightmare presence) was determined to be .46 based on prior research investigating the frequency of nightmares occurring in high-risk clinical samples (Kaplan et al., 2014). The resulting sample size calculation is 951, suggesting we are not adequately powered to conduct this analysis. However, it is important to note that, although there is strong theoretical evidence to support this relation (Levin & Nielsen, 2009), very few studies have empirically examined emotion regulation as a predictor of nightmares specifically. Given the strong conceptual rationale for this analysis, we conducted this exploratory analysis in the current study.

Aim 3

We examined trait-level emotion regulation constructs (separately) as a predictor of NSSI behavior using cross-sectional logistic regression models. Any participant report of NSSI behavior during the daily diary phase of the study was considered as presence of NSSI behavior (yes/no). These models were analyzed using the *stats* package in R (R Core Team, 2022). These logistic regression models were analyzed using the “glm” function from the *stats* package in R (R Core Team, 2022) and a binomial distribution was specified. Trait-level emotion regulation constructs were grand-mean centered using the “center” function from the *misty* package in R (Yanagida, 2023).

Based on findings from a recent meta-analysis examining emotion dysregulation as a risk factor for NSSI behavior (Wolff et al., 2018), 2.4 was used for the odds ratio of the predictor. The event ratio probability of the outcome (NSSI behavior presence) was determined to be .42 based on prior research investigating the frequency of these behaviors occurring in high-risk clinical samples (Czyz et al., 2021). Power was set to .80 and alpha level was set to .05. The resulting sample size calculation is 43, which suggests we have adequate power to conduct this analysis in the current sample ($N = 118$).

Multilevel descriptives

Since the data collected for this study were multilevel, we also used multilevel modeling to examine whether sleep problems (poorer sleep quality and nightmare presence) predicted NSSI behavior (presence and frequency) during the daily diary phase of the study. Multilevel modeling was most appropriate because of the nested nature of the data (daily observations nested within people). Multilevel modeling allowed for examination of within-person (level 1; observation-level) and between-person (level 2; person-level) effects. To examine within-person fluctuations in sleep quality, nightmares, and NSSI behavior, we calculated intraclass correlations (ICC) using the "ICCest" function from the *ICC* package (Wolak, 2022) in R. Specifically, ICCs indicated the proportion of variance attributable to within-person and between-person differences in sleep quality, nightmares, and NSSI behavior presence. Higher ICC scores indicate greater between-person variance and lower within-person (i.e., observation-to-observation) variance. ICCs were also used to assess reliability of metrics collected from the daily diary portion of the study (Calamia, 2019). Furthermore, the root mean square of successive differences (RMSSD) was calculated using the "rmssd" function from the *psych* package (Revelle, 2017). RMSSD values indicate the average variability in sleep quality and NSSI behavior frequency over the course of the daily diary study (von Neumann et al., 1941). Larger RMSSD values indicate more variability from one time point to the next. Lastly, we computed repeated measure correlations using the "rmcorr" function from the *rmcorr* package (Bakdash & Marusich, 2017) in R to examine the within-person associations for repeated measures across participants.

Multilevel model specifications

A series of a priori decisions were made regarding model specifications for multilevel analyses. We attempted to analyze all multilevel models with random intercepts and random slopes. However, there were two instances in which we decided not to use random slope models. First, if model convergence was an issue, we opted to use fixed slope models instead. Second, random slopes may not substantially improve model fit or affect interpretation of models. We tested and compared the model fit of random slope versus fixed slope models using a confusion matrix via the "confusionMatrix" function from the *caret* package (Kuhn, 2008) for multilevel logistic regression models and likelihood ratio testing via the "ranova" function from the *lmerTest* package in R (Kuznetsova et al., 2017) for multilevel linear regression models. If model fit was not substantially improved with inclusion of random slopes, a simplified fixed slope model was used. Lastly, we computed statistical significance of random effects components for multilevel linear regression models by creating 95% confidence intervals for each of these estimates using the "confint" function from the *stats* package in R (R Core Team, 2022). Statistical significance for random effects components from multilevel logistic regression models were tested using the "model_parameters" function from the *parameters* package in R (Ludecke et al., 2020). These model specifications are relevant to study aims 4 and 5 that are described below.

Aim 4a

We examined poorer sleep quality as a predictor of NSSI behavior presence using a multilevel logistic regression model. This model included two levels where daily diary responses (observation-level) were nested within people (person-level), NSSI behavior presence was specified as the outcome variable, and this model used random intercepts and random slopes. This model was analyzed using the *lme4* (Bates et al., 2015) and *EMAtools* (Kleiman, 2017) packages in R. The "glmer" function from the *lme4* package was used to conduct a multilevel logistic regression model and a binomial distribution with logit link was be specified. Poorer sleep quality (continuous predictor) was person-mean centered using the "pcenter" function from the *EMAtools* package to facilitate interpretation of within-person effects.

Power analyses for multilevel logistic regression models were conducted. Given that not much documentation exists for how to conduct these analyses, we conducted a power analysis using a combination of West et al.'s (2011) equation and the "LRcont" function from the *pwr2ppl* package. A power analysis for the multilevel logistic regression model examining poorer sleep quality as a predictor of NSSI behavior presence was conducted. First, we calculated N-effective from West et al.'s (2011) equation to take into account the expected amount of clustering in the data due to the multilevel design (ICC). N-effective represents the total number of "independent" observations needed to power this analysis. After accounting for the multilevel nature of the data, the N-effective is equal to 96. Findings from a power analysis conducted above (between-persons sleep quality predicting NSSI behavior presence, using the "LRcont" function) suggest that a sample size of 54, or 54 independent observations, are needed for adequate power ($1 - \beta = .80$), which suggests that this current multilevel model is sufficiently powered.

Aim 4b

We examined poorer sleep quality as a predictor of NSSI behavior frequency using a multilevel linear regression model. This model included two levels where daily diary responses (observation-level) were nested within people (person-level), NSSI behavior frequency was specified as the outcome variable, and this model used random intercepts and random slopes. This model was analyzed using the *lme4* (Bates et al., 2015) and *EMAtools* (Kleiman, 2017) packages in R. This multilevel linear regression model was analyzed using the restricted maximum likelihood estimator in *lme4*, which is recommended to reduce biased random effects estimates. Poorer sleep quality (continuous predictor) was person-mean centered using the "pcenter" function from the *EMAtools* package to facilitate interpretation of within-person effects.

To determine if the multilevel linear regression model examining poor sleep quality as a predictor of NSSI behavior frequency was adequately powered, we used the "smpsize_lmm" function from the *sjstats* R package (Ludecke, 2021). The "smpsize_lmm" function is based on a power calculation for standard single-level designs but has been adjusted to accommodate multilevel (two-level) designs with continuous outcome variables. The “smpsize_lmm” function requires a specified effect size, power threshold, alpha level, number of participants (person-level units), number of observations per participant (observation-level units), and the expected intraclass correlation (ICC). Consistent with prior meta-analyses examining the longitudinal association between overall sleep problems and SITBs, an effect size of .5 was used (Liu et al., 2020). Power was set to .80, alpha level was set to .05, expected ICC was set to .5, the number of observations per participant was set to 3, and the number of participants (with a minimum of 3 pairs of consecutive days of observations) was set to 48. Results indicate 255 observations are needed to achieve sufficient power. Final analyses included between 276 – 291 observations depending on the model tested, indicating we were sufficiently powered for analyses.

Aim 4c

We examined nightmare presence as a predictor of NSSI behavior presence using a multilevel logistic regression model. This model included two levels where daily diary responses (observation-level) were nested within people (person-level), NSSI behavior presence was specified as the outcome variable, and this model used random intercepts and random slopes. This model was analyzed using the *lme4* (Bates et al., 2015) and *EMAtools* (Kleiman, 2017) packages in R. The “glmer” function from the *lme4* package was used to conduct a multilevel logistic regression model and a binomial distribution with logit link was specified. A power analysis for the multilevel logistic regression model examining nightmare presence as a predictor of NSSI behavior presence was conducted. The estimate for N-effective is 100. Findings from a power analysis conducted above (between-persons nightmare presence predicting NSSI behavior presence, using the “LRcont” function with a conservative odds ratio of 2 suggest that a sample size of 68, or 68 independent observations, are needed for adequate power ($1 - \beta = .80$), which suggests that this current multilevel model is sufficiently powered.

Aim 4d

We examined nightmare presence as a predictor of NSSI behavior frequency using a multilevel linear regression model. This model included two levels where daily diary responses (observation-level) were nested within people (person-level), NSSI behavior frequency was specified as the outcome variable, and this model used random intercepts and random slopes. This model was analyzed using the *lme4* (Bates et al., 2015) and *EMAtools* (Kleiman, 2017) packages in R. This multilevel linear regression model was analyzed using the restricted maximum likelihood estimator in *lme4*, which is recommended to reduce biased random effects estimates.

To determine if the multilevel linear regression model examining nightmare presence as a predictor of NSSI behavior frequency was adequately powered, we used the "smpsize_lmm" function from the *sjstats* R package (Ludecke, 2021). The "smpsize_lmm" function requires a specified effect size, power threshold, alpha level, number of participants (person-level units), number of observations per participant (observation-level units), and the expected intraclass correlation (ICC). Consistent with prior meta-analyses examining the longitudinal association between nightmares and SITBs, an effect size of .5 was used (Liu et al., 2020). Power was set to .80, alpha level was set to .05, expected ICC was set to .5, the number of observations per participant was set to 3, and the number of participants (with a minimum of 3 consecutive days of observations) was set to 48. Power analysis results indicate 255 observations are needed to achieve sufficient power. Final analyses included between 276 – 291 observations depending on the model tested, indicating we were sufficiently powered for analyses.

Aim 5

We conducted exploratory analyses examining trait-level emotion regulation constructs as moderators of the relationship between nightmare presence and NSSI behavior presence. Since these analyses were exploratory, a power analysis was not conducted. We conducted four multilevel logistic regression models, with shared predictor and outcome variables, but different emotion regulation moderators for each model. All models included two levels where daily diary responses (observation-level) were nested within people (person-level), NSSI (yes/no) was specified as the outcome variable, and models used random intercepts and random slopes. Emotion regulation constructs were assessed at the person-level, so we used cross-level interactions between nightmares and emotion regulation to examine whether each emotion regulation construct moderates the relation between nightmare presence and NSSI behavior presence. Since we conducted cross-level interactions, we included random slopes for the lowest level data (daily diary observations). This approach is consistent with recommendations in the field to reduce heteroscedasticity in observation level measures across people when conducting cross-level interactions (Heisig & Schaffer, 2019). This model was analyzed using the *lme4* (Bates et al., 2015) and *EMAtools* (Kleiman, 2017) packages in R. The "glmer" function from the *lme4* package was used to conduct a multilevel logistic regression model and a binomial distribution with logit link was specified. For models examining poorer sleep quality (continuous predictor), this variable was person-mean centered using the "pcenter" function from the *EMAtools* package to facilitate interpretation of within-person effects. Person-level emotion regulation constructs were grand-mean centered using the "gcenter" function from the *EMAtools* package.

CHAPTER III

STUDY 2 METHOD

This study was part of a larger project examining short-term risk factors for suicidal thoughts and behavior in adolescents during the high-risk period following discharge from acute psychiatric care. The method for this project has been described in detail in a prior paper (Glenn et al., 2022). A brief overview of methods related to the current study are summarized below.

Participants

The study sample consists of 48 adolescents (ages 12-18, $M = 14.96$, $SD = 1.60$), who were eligible for the study if they had recently received acute psychiatric care (i.e., psychiatric emergency department, inpatient unit, or partial hospitalization) for suicide risk (i.e., suicide ideation with intent and/or plan, suicide attempt) and were being discharged to outpatient care. Participants self-identified their race and ethnicity as follows: Black or African American ($n = 4$, 8.3%), White ($n = 37$, 77.1%), Hispanic/Latinx ($n = 6$, 12.5%), and mixed race ($n = 6$, 12.5%). Participants self-identified their gender identity as follows: cisgender female ($n = 34$, 64.6%), cisgender male ($n = 9$, 16.7%), and nonbinary or gender diverse ($n = 10$, 18.8%). Youth were not eligible to participate if they were unable to provide informed consent for themselves (e.g., due to extreme cognitive impairment, current mania or psychosis), unwilling to complete the study procedures (i.e., unwilling to wear wrist actigraphy device or complete smartphone-based EMA surveys), or a safety concern (i.e., imminent risk for suicide or other-directed violence). Of note, adolescents without a smartphone were loaned an Android (Tracfone) with a pre-paid data plan.

Procedure

Adolescents were enrolled in the study within two weeks of discharge from acute psychiatric care. Prior to study participation, informed consent was obtained from the adolescent (assent if 12-17-year-olds, consent if 18-years-old) and one parent or legal guardian (parental permission or consent). All study procedures were approved by the University of Rochester's Institutional Review Board (RSRB00066408).

Study participation consisted of a baseline assessment, a 28-day EMA phase, and a final phone assessment at the end of the EMA phase. The baseline assessment included interviews and questionnaires to assess background sociodemographic and diagnostic information, in addition to prevalence of SITBs over the adolescents' lifetime, past year, and past month. Following the baseline assessment, adolescents completed 28 consecutive days of EMA. Several types of EMA surveys from the larger project are relevant for the current study.

ICAM: Interval-contingent surveys were completed at a fixed time each morning (ICAM) within 2 hours of waking up. Adolescents answered questions about sleep quality and the presence of nightmares or distressing dreams the prior night (see Measures section). The median ICAM completion time was 1 min 36 s (*SD* = 4 min 2 s).

SC: Signal-contingent (SC), or random, surveys were completed multiple, 3–6, times each day. After receiving the survey prompt, adolescents were given 30 minutes to complete each survey. The window to complete surveys was based on each adolescent's availability, which provided more time on some days than others (leading to a range of 3–6 available surveys). Adolescents were not prompted to complete surveys during weekday school hours. Although several SC prompts were offered each day, adolescents were only required to complete three SC surveys daily. During the EMA period, participants completed an average of 62.36 SC surveys (*SD* = 31.03, Range = 6-116). Of note, because the number of SC prompts differed across adolescents based on their enrollment time in the study and each adolescent's daily availability, survey completion is reported as raw numbers instead of percentages. The median completion time for these surveys was 3 minutes 25 seconds. In these surveys, adolescents responded to prompts about their current negative affect, suicidal thoughts, and thoughts of engaging in NSSI (see Measures section).

Baseline Measures

Lifetime history of nightmares

The Disturbing Dreams and Nightmares Severity Index (DDNSI; Krakow et al., 2002) is a five-item self-report measure (see Appendix E) used to assess the frequency of nightmares and distress associated with experiencing nightmares. This measure was scored in accordance with parameters outlined in Krakow et al., 2002 such that higher scores indicate greater frequency and distress associated with experiencing nightmares. The DDNSI has demonstrated acceptable reliability in the current sample (α = .78; Glenn et al., 2022), and has been previously used to assess nightmares in youth (Bernert et al., 2017; Russell et al., 2018). Relevant to study aim 1, the average DDNSI total score in the sample is 10.35 (*SD* = 9.04, Range 0 – 27; Glenn et al., 2021).

Current insomnia symptom severity

The Insomnia Severity Index (ISI; Bastien et al., 2001) is a seven-item self-report measure (see Appendix F) used to assess current daytime and nighttime impairment associated with insomnia. Items are scored on a 0 to 4 Likert scale and summed to create an overall insomnia severity. Higher scores reflect poorer sleep quality and greater symptom severity associated with insomnia. The ISI has demonstrated acceptable reliability in the current sample (α = .77; Glenn et al., 2022), and has been previously used to assess insomnia in adolescents (Conroy et al., 2019; Palermo et al., 2017). Relevant to study aim 1, the average ISI total score in the sample is 13.72 (*SD* = 5.22, Range 2 – 22; Glenn et al., 2021).

Recent suicide ideation

Severity and presence of past month suicide ideation was assessed using the Columbia-Suicide Severity Rating Scale (C-SSRS; Posner et al., 2011), a semi-structured interview validated in adolescents (Brent et al., 2009; Gipson et al., 2015). Relevant to study aim 1, 44 participants (91.7%) reported past-month SI (Glenn et al., 2021).

A post-hoc decision was made to additionally include the Beck Scale for Suicide Ideation (SSI; Beck et al., 1988) which assesses severity of past-week suicide ideation and plans. This measure was included to better align measurement time frames with other baseline measures. The SSI has demonstrated acceptable reliability in prior adolescent samples ($\alpha = .95$; Holi et al., 2005). Relevant to study aim 1, the average SSI score in the sample is 8.98 ($SD = 8.03$, Range 0 – 27).

Past month NSSI behavior

Presence of past month NSSI behavior was assessed using the supplemental form associated with the Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007), which has been previously used in adolescents (Barrocas et al., 2012; van Alphen et al., 2017). Relevant to study aim 1, 28 participants (58.3%) reported past-month NSSI behavior (Glenn et al., 2021).

EMA Measures

Nightmare presence

Each morning (ICAM survey), nightmare presence was assessed by asking “Did you have any nightmares or distressing dreams last night?” with a yes/no response, from the DDNSI (Krakow et al., 2002). Relevant to study aims 2, 3, 5, and 6, initial descriptive statistics suggest that 32 participants (66.6%) reported experiencing nightmares during the EMA study period, with a total of 151 instances of nightmares reported.

Poor sleep quality

Each morning (ICAM survey), sleep quality was assessed by asking "How would you rate the quality of your sleep last night?" on a 5-point Likert scale (where 1 = Very poor, 2 = Poor, 3 = Fair, 4 = Good, 5 = Very good), from the consensus sleep diary (Carney et al., 2012). Relevant to study aims 2, 3, 5, and 6, initial descriptive statistics indicate an average (grand mean) sleep quality of 3.14 (*SD* = .63) across participants in the sample.

Negative affect intensity

Negative affect was assessed multiple times each day in the SC surveys using affect ratings adapted from the Positive and Negative Affect Schedule (PANAS) short form (Mackinnon et al., 1999) and the previous EMA study by Nock et al. (2009). The negative emotions assessed were angry, sad, agitated, guilty, and nervous on a 5-point Likert scale (where 0 = Very slightly/not at all, 1 = A little, 2 = Moderately, 3 = Quite a bit, 4 = Extremely), consistent with prior work (Kleiman et al., 2017). Depending on the model (see analytic strategy section below), negative affect may be assessed as highest-point negative affect intensity, within-day variability (standard deviation) of negative affect, or average (mean) negative affect intensity, all within-person (Bentley et al., 2021; Silk et al., 2003). Relevant to study aims 3, 4, 5, and 6, initial descriptive statistics of negative affect intensity states are presented below in Table 2.

Table 2

Negative affect descriptive statistics (Sample 2)

Negative affect variable	***M***	***SD***
Angry	.59	.49
Nervous	.98	.88
Sad	1.20	.86
Agitated	1.07	.82
Guilty	.78	.92

Suicidal thought intensity

Suicidal thoughts were assessed at multiple time points during the day via the SC surveys (see Appendix G). Participants responded to two items adapted from prior EMA studies (Kleiman et al., 2017; Nock et al., 2009), that assessed current (at that moment) suicide desire (a measure of active ideation) and suicide intent on a Likert scale from 0 (absent) to 5 (extremely strong). Higher scores indicate greater suicidal thought intensity. We created a composite variable consisting of these two items. This variable was computed as aggregated suicidal thoughts at the day-level and at the observation level depending on the model (see analytic strategy section below). Relevant to study aims 2, 4, 5, and 6, initial descriptive statistics of suicidal thoughts variables are presented below in Table 3 (Glenn et al., 2022).

Table 3

Suicidal thoughts descriptive statistics (Sample 2)

Suicidal thoughts variable	***M***	***SD***
Suicide desire (Active suicide ideation)	.65	1.03
Suicide intent (Suicide intent)	.27	.62

NSSI thought intensity

NSSI thoughts were assessed at multiple time points during the day via the SC surveys by asking participants "Are you right now (or were you recently) thinking about hurting yourself (but not to die)?" with a yes/no response (Kleiman et al., 2017; Nock et al., 2009). If participants responded "yes" to the NSSI thought presence question, they were asked to rate the intensity of NSSI thoughts on a scale from 0 (not at all intense) to 4 (extremely intense). For this thesis, we will compute a recoded scale for the NSSI thought intensity variable (where 0 = absence of NSSI thoughts, 1 = present but not at all intense, 2 = a little intense, 3 = moderately intense, 4 = very intense, 5 = extremely intense; Magnus & Chen, 2022), to match how suicidal thoughts were measured. Descriptive statistics suggest that 35 participants (72.9%) reported experiencing NSSI thoughts at least once during the EMA study period, and across those 35 participants, there were 157 instances of experiencing NSSI thoughts. Relevant to study aims 2, 4, 5, and 6, initial descriptive statistics indicate an average (grand mean) NSSI thought intensity of .27 (*SD* = .41) across participants in the sample.

Data preparation

Missing data at baseline are minimal, since study procedures prioritized data collection of measures related to sleep problems and self-injurious thoughts and behaviors (which are the focus of this proposed study). The nature of missing data involved a completely missing survey (either DDNSI or ISI) rather than missing items from an otherwise complete survey. This type of missingness cannot be imputed and therefore pair-wise deletion was used when indicated (see Results section below).

For EMA, data are missing at the survey level (i.e., a survey was not completed) rather than at the item level (i.e., all items were completed in a single survey). If an ICAM survey (i.e., sleep diary) is missing, that day's data were not included in the model (because the predictor is missing for that day), which is relevant to aims 2, 3, 5, and 6. If a SC survey is missing (i.e., negative affect, suicidal thoughts, NSSI thought intensity), other SC surveys from that day were included in the model (for aims 2, 3, and 4). For study aim 5, if all SCs are missing for that day (following an ICAM), or (for study aim 6) all but one (since we will be using two consecutive SCs for full temporal mediation), that day's data were not included in the model. The configuration of our missing data involved a completely missing survey rather than a missing item from an otherwise complete survey. This type of missingness is expected in multilevel modeling (effectively only leading to unevenly spaced data) and is not something that can be imputed.

Statistical assumptions for cross-sectional linear and logistic regression analyses were checked using the "check_model" function from the *performance* package in R (Ludecke et al., 2021). The following parameters were assessed using the "check_model" function: homogeneity of variance, linearity, influential observations, collinearity, normality of residuals, independence of observations, and binned residuals (for models with binomial distribution).

In addition, statistical assumptions for multilevel linear and logistic regression analyses were checked using the "check_model" function from the *performance* package in R (Ludecke et al., 2021). The following parameters were assessed using the "check_model" function: homogeneity of variance, linearity, influential observations, collinearity, normality of residuals, normality of random effects, and binned residuals (for models with binomial distribution). Multilevel modeling is used to address violations of the independence of observation assumption of traditional linear regression. Independence of person-level units was assumed based on ensuring participants were not repeated/duplicated during recruitment. Data were randomly sampled at the observation-level and person-level.

Given the extensive number of models run to test hypotheses for Sample 2, specific results on all statistical assumptions are not provided for brevity. Assumptions outlined above were deemed acceptable.

Additionally, outliers in the between-person variables were assessed for each variable using boxplots and were removed via pair-wise deletion (see Results section below). Lastly, between-person continuous variables (age) were grand-mean centered to prevent multicollinearity and improve interpretation of effects.

Covariates

As previously stated in the covariates section for Study 1, sleep problems, and SITBs may vary as a function of age. We empirically determined if covarying for age was indicated based on the relation between age, sleep problems, and SITBs. Bivariate between-person correlations were conducted (see Table 12 for all results). Age was significantly correlated with a primary SITB outcome of interest, NSSI behavior, and therefore age (grand-mean centered) was included as a covariate in all models.

Analytic strategy

In this section, we present each analytic strategy (organized by aim), followed by a description of the power analysis for each analysis. First, we present aims and power analyses for between-persons (cross-sectional) regression models. Next, we present aims and power analyses for multilevel models.

We first conducted power analyses for between-persons (cross-sectional) logistic regression models; due to the differing nature of predictors and outcomes in each of the proposed analyses, we conducted a power analysis for each proposed analysis to adequately characterize the odds ratio of the predictor, event ratio probability of the outcome, power, and resulting sample size. The "LRcont" function from the *pwr2ppl* package (Aberson, 2022) was used to compute power for logistic regression with continuous predictors. We also conducted power analyses for between-persons (cross-sectional) linear regression models using the *pwr* package in R (Champely et al., 2020).

Prior to conducting statistical analyses, we computed descriptive statistics of baseline variables and computed bivariate between-person correlations.

Aim 1a & 1b

We conducted between-person (cross-sectional) regression analyses to examine how lifetime history of nightmares (assessed at baseline) and insomnia symptom severity (assessed at baseline) are separately associated with likelihood of presence of past month suicide ideation and past month suicide ideation (SI) severity. The logistic regression models predicting presence of past-month suicide ideation were analyzed using the "glm" function from the *stats* package in R (R Core Team, 2022) and a binomial distribution was specified. The linear regression models predicting past month suicide ideation severity were analyzed using the "lm" function from the *stats* package in R (R Core Team, 2022). Lifetime history of nightmares and insomnia symptom severity were grand-mean centered using the "center" function from the *misty* package in R (Yanagida, 2023).

Based on findings from a study examining nightmares as a predictor of SI presence in a sample of non-clinical adolescents (Russell et al., 2018), 3.38 was used for the odds ratio of the predictor for the power analysis. The event ratio probability of the outcome (SI presence) was determined to be .82 based on prior research investigating the frequency of this occurrence in high-risk clinical samples (Czyz et al., 2021). Power was set to .80 and alpha level was set to .05. The resulting sample size calculation is 36, which suggests we have adequate power to conduct this analysis (N = 48).

Based on findings from a study examining insomnia as a predictor of SI presence in a sample of non-clinical adolescents (Russell et al., 2018), 3.19 was used for the odds ratio of the predictor for the power analysis. The event ratio probability of the outcome (SI presence) was determined to be .82 based on prior research investigating the frequency of this occurrence in high-risk clinical samples (Czyz et al., 2021). Power was set to .80 and alpha level was set to .05. The resulting sample size calculation is 40, which suggests we have adequate power to conduct this analysis (N = 48).

We conducted another power analysis for linear regression models since we additionally examined sleep problems predicting SI severity (continuous) assessed at baseline. Post-hoc power analyses suggest that with one predictor (history of nightmares or insomnia symptom severity), 48 participants, a medium effect size ($f^2 = .15$), and a critical alpha of $p < .05$ would yield insufficient power ($1 - \beta = .74$). These results would suggest we are slightly underpowered to detect this effect.

Aim 1c & 1d

We conducted between-person logistic regression analyses to examine whether lifetime history of nightmares (assessed at baseline) and insomnia symptom severity (assessed at baseline) are separately associated with likelihood of presence of past month NSSI behavior. The logistic regression models predicting presence of past month NSSI behavior were analyzed using the "glm" function from the *stats* package in R (R Core Team, 2022) and a binomial distribution was specified. Lifetime history of nightmares and insomnia symptom severity were grand-mean centered using the "center" function from the *misty* package in R (Yanagida, 2023).

Based on findings from a study examining nightmares as a predictor of NSSI behavior in a sample of non-clinical adolescents (Liu et al., 2019), 2.96 was used for the odds ratio of the predictor. The event ratio probability of the outcome (NSSI behavior) was determined to be .42 based on prior research investigating the frequency of this behavior in high-risk clinical samples (Czyz et al., 2021). Power was set to .80 and alpha level was set to .05. The resulting sample size calculation is 28, which suggests we have adequate power to conduct this analysis ($N = 48$).

Based on findings from a study examining insomnia as a predictor of self-harm in a sample of non-clinical adolescents (Hysing et al., 2015), 1.87 was used for the odds ratio of the predictor. The event ratio probability of the outcome (NSSI behavior) was determined to be .42 based on prior research investigating the frequency of this behavior in high-risk clinical samples (Czyz et al., 2021). Power was set to .80 and alpha level was set to .05. The resulting sample size calculation is 87, which suggests we are under-powered to conduct this analysis ($N = 48$). It is important to note, insomnia has not been found to significantly predict NSSI behavior across many studies (Ennis et al., 2018; Liu et al., 2017, 2019), as reflected by the low odds ratio. Furthermore, prior studies included non-clinical samples and the present study includes a high-risk clinical sample enriched for these variables increasing our ability to detect these low-base rate events.

Multilevel modeling descriptives

Since the data collected for this study are multilevel, we also used multilevel modeling to examine associations between variables during the EMA phase of the study. Multilevel modeling was most appropriate because of the nested nature of the data. Multilevel modeling allowed for examination of within-person and between-person effects.

To examine the fluctuations in negative affect intensity, NSSI thought intensity, suicidal thoughts, sleep quality, and nightmare presence, we calculated intraclass correlations (ICC) using the "ICCest" function from the *ICC* package (Wolak, 2022) in R. Specifically, ICCs indicated the proportion of variance attributable to within-person and between-person differences. Higher ICC scores indicate greater between-person variance and lower within-person (i.e., observation-to-observation) variance. ICCs were also used to assess reliability of metrics collected from the EMA portion of the study (Calamia, 2019). Furthermore, the root mean square of successive differences (RMSSD) was calculated using the "rmssd" function from the *psych* package (Revelle, 2017). RMSSD values indicate the average variability in negative affect intensity, NSSI thought intensity, suicidal thoughts, sleep quality, and nightmare presence over time (von Neumann et al., 1941). Larger RMSSD values indicate more variability from one time point to the next. Lastly, we computed repeated measure correlations using the "rmcorr" function from the *rmcorr* package (Bakdash & Marusich, 2017) in R to examine the within-person associations for repeated measures across participants.

Power analysis for multilevel data

A power analysis for multilevel data was conducted using the “smpsize_lmm” function from the *sjstats* R package (Ludecke, 2021). The “smpsize_lmm” function is based on a power calculation for standard single-level designs but has been adjusted to accommodate multilevel (two-level) designs with continuous outcomes. The “smpsize_lmm” function requires a specified effect size, power threshold, alpha level, number of participants (person-level units), number of observations per participant (observation-level), and the expected intraclass correlation (ICC). Consistent with prior meta-analyses examining the longitudinal association between sleep problems and SITBs, and prior real-time monitoring studies examining the link between negative affect and SITBs, an effect size of .5 was used (Liu et al., 2020; Victor & Klonsky, 2014). Power was set to .80, alpha level was set to .05, the number of participants in Sample 2 is 48, and the number of observations per participant was set to 28. The ICC value of 0.46 was used based on expected variability from prior research (Glenn et al., 2022). Results indicate 1711 observations are needed to achieve sufficient power, specifically for day-level analytic models. Final analyses included between 634 – 738 observations for day-level analyses, and 1776 – 2735 observations for observation-level analyses, depending on the model tested. We recognize that while the proposed multilevel analyses are preliminary and some analyses may be underpowered, they are worthwhile for investigation given the lack of research examining short-term predictors of SITBs among high-risk youth.

Multilevel model specifications

To analyze EMA data, we used multilevel modeling which is the most appropriate given the nested data structure. A series of a priori decisions were made regarding model specifications for multilevel analyses. We attempted to analyze all multilevel models with random intercepts and random slopes. However, there were two instances in which we decided not to use random slope models. First, if model convergence was an issue, we opted to use fixed slope models instead. Second, random slopes may not substantially improve model fit or affect interpretation of models. We tested and compared the model fit of random slope versus fixed slope models using likelihood ratio testing via the "ranova" function from the *lmerTest* package in R (Kuznetsova et al., 2017) for multilevel linear regression models. If model fit was not substantially improved with inclusion of random slopes, a simplified fixed slope model was used. Lastly, we computed statistical significance of random effects components by creating 95% confidence intervals for each of these estimates using the "confint" function from the *stats* package in R (R Core Team, 2022). These model specifications are relevant to study aims 2, 3, 4, 5, and 6 that are described below.

Aim 2

This multilevel model consisted of two levels: day-level nested within-person. We examined sleep problems (poorer sleep quality and nightmare presence) as a predictor of SITB outcomes (worst-point NSSI thought intensity and worst-point suicide ideation [SI]). All predictors and outcomes will be examined in separate models. The predictors (poorer sleep quality and nightmare presence) are day-level variables and the SITB outcomes (worst-point NSSI thought intensity and worst-point SI) will be aggregated at the day-level. Models used random intercepts and random slopes. This model was analyzed using the *lme4* (Bates et al., 2015) and *EMAtools* (Kleiman, 2017) packages in R. This multilevel linear regression model was analyzed using the restricted maximum likelihood estimator in *lme4*, which is recommended to reduce biased random effects estimates. Poorer sleep quality (continuous predictor) was person-mean centered using the "pcenter" function from the *EMAtools* package to facilitate interpretation of within-person effects.

Aim 3

This multilevel model consisted of two levels: day-level nested within-person. We examined sleep problems (poorer sleep quality and nightmare presence) as a predictor of highest-point negative affect intensity and variability in negative affect. All predictors and outcomes were examined in separate models. The predictors (poorer sleep quality and nightmare presence) are day-level variables, and the outcomes (highest-point negative affect intensity and negative affect variability) are aggregated at the day-level. Models used random intercepts and random slopes. This model was analyzed using the *lme4* (Bates et al., 2015) and *EMAtools* (Kleiman, 2017) packages in R. This multilevel linear regression model was analyzed using the restricted maximum likelihood estimator in *lme4*, which is recommended to reduce biased random effects estimates. Poorer sleep quality (continuous predictor) was person-mean centered using the "pcenter" function from the *EMAtools* package to facilitate interpretation of within-person effects.

Aim 4

This multilevel model consisted of two levels: observation-level nested within-person. There is a "day-level", but this level was ignored due to the complexity of the model structure, in addition to our lesser interest in day-level differences across participants. We examined observation-level mean negative affect intensity as a predictor of SITB outcomes (observation-level NSSI thought intensity and SI). All predictors and outcomes were examined in separate models. The predictor (mean negative affect intensity) is an observation-level variable, and the outcomes (NSSI thought intensity and SI) are observation-level variables. We conducted both contemporaneous (mean negative affect intensity and SITB outcome from same EMA survey) and lagged effect analyses (mean negative affect intensity predicting next-point SITB outcomes) for this aim. Models used random intercepts and random slopes. This model was analyzed using the *lme4* (Bates et al., 2015) and *EMAtools* (Kleiman, 2017) packages in R. This multilevel linear regression model was analyzed using the restricted maximum likelihood estimator in *lme4*, which is recommended to reduce biased random effects estimates. Negative affect intensity (continuous predictor) was person-mean centered using the "pcenter" function from the *EMAtools* package to facilitate interpretation of within-person effects.

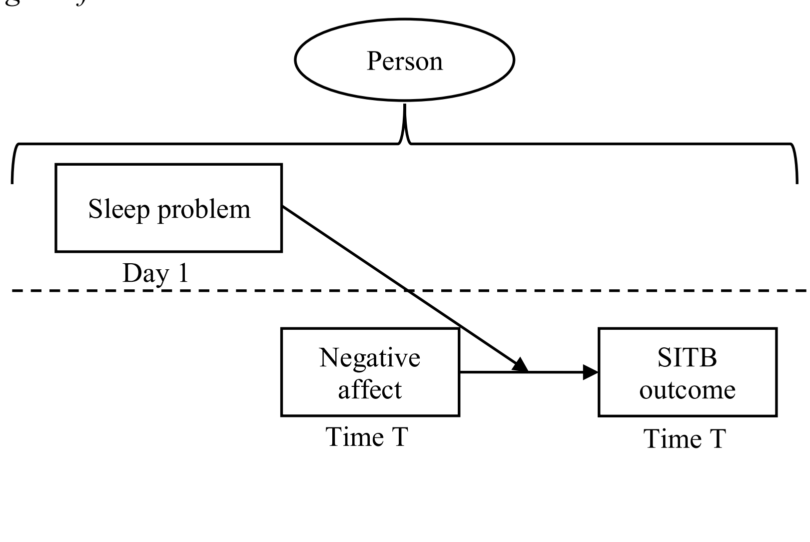
Aim 5 & 6

To test Aim 5 and Aim 6, we had to contend with complexity in data structure (observation-level, within-day, within-person) and the risk of reducing statistical power to conduct advanced analytic approaches (e.g., multilevel mediation).

Ultimately, we chose to conduct three-level multilevel moderation analyses. Specifically, we treated our predictor, sleep problems (poorer sleep quality and nightmares), as a day-level moderator of the observation-level relationship between negative affect intensity and SITB outcomes (NSSI thought intensity and SI), all nested within-person (see Figure 1). Sleep problems were assessed at the day-level, so we used cross-level interactions between negative affect intensity and sleep problems to examine whether presence of nightmares or poorer sleep quality moderated the relation between negative affect intensity and SITB outcomes. All predictors and outcomes were examined in separate models. Models used random intercepts, and since we are conducting cross-level interactions, we included random slopes for the lowest level data (observation-level data). This approach is consistent with recommendations in the field to reduce heteroscedasticity in observation level measures across people when conducting cross-level interactions (Heisig & Schaffer, 2019). By using the multilevel moderation approach, we capitalized on the numerous observation-level data points. Although this analytic strategy treats sleep problems as a moderator rather than a focal predictor, it is important to note that sleep problems were temporally assessed prior to negative affect intensity and SITBs. To test aim 5, negative affect intensity and SITB outcomes were contemporaneous (same EMA survey), and to test aim 6, negative affect intensity predicted next-point SITB outcomes (lagged effects). These models were analyzed using the *lme4* (Bates et al., 2015) and *EMAtools* (Kleiman, 2017) packages in R, and the restricted maximum likelihood estimator in *lme4* was used, which is recommended to reduce biased random effects estimates. Negative affect intensity (continuous predictor) and poorer sleep quality (continuous moderator) were person-mean centered using the "pcenter" function from the *EMAtools* package to facilitate interpretation of within-person effects.

Figure 1

Multilevel model diagram for Aims 5 and 6



CHAPTER IV

STUDY 1 RESULTS

Data reduction for between-person models

For between-person models (aims 1-3), pair-wise deletion was used to maximize available data and limit biases to parameter estimates, and it was assumed data were missing completely at random. Regarding emotion regulation variables, out of 118 participants who completed the study, ten participants were missing CHIME-A data, four participants were missing UPPS data, two participants were missing ERQ data, and four participants were missing ERS data. Regarding sleep variables, two participants were missing average sleep quality data and 21 participants were missing average sleep variability data. Regarding age, six participants did not have age data and therefore were excluded from regression analyses which included age as a covariate in all models. The data were checked for outliers prior to analyses using the "boxplot.stats" function from the *grDevices* package (R Core Team, 2022) in R which identifies any observations that are more than 1.5 times the interquartile range below the first quartile, or more than 1.5 times the interquartile range above the third quartile as outliers. Across all measures, five outliers were identified and removed via pair-wise deletion.

Correlations and between-person descriptives

Between-person descriptives and correlations between main study variables are included in Table 4.

Table 4

Bivariate (between-person) correlations and descriptives of main study variables (Sample 1)

	1. Nightmares+ (Yes/No)	2. Average sleep quality	3. Sleep quality variability	4. NSSI behavior presence+	5. Emotion reactivity	6. Expressive suppression	7. Negative urgency	8. Emotion awareness	9. Age
1.	-	.08	.07	.19*	.12	-.16	.04	-.19	-.01
2.		-	-.29	-.10	0	-.05	.09	.08	-.08
3.			-	-.04	-.23*	-.06	-.08	.08	.09
4.				-	.08	.01	.22*	.17	-.24**
5.					-	-.10	.42	-.05	-.18
6.						-	-.08	.05	-.04
7.							-	.05	-.23*
8.								-	-.20
9.									-
Mean (SD) or Frequency (% and n)	43.22% (51/118)	6.90 (1.62) n=116	1.71 (1.06) n=97	34.75% (41/118)	49.25 (16.93) n=114	16.28 (5.52) n=116	12.61 (2.28) n=114	7.69 (2.63) n=108	15.72 (1.77) n=112

Note. NSSI = nonsuicidal self-injury; SD = standard deviation; n = number of observation; +Spearman rho correlation; *p < .05; **p < .01**

Aim 1

Our hypotheses for aim 1 were partially supported (see Table 5 for full model results including model effect sizes). Results revealed that poorer average sleep quality (OR = .86, *p* = .22) and average variability in sleep quality (OR = .88, *p* = .56) were not significantly associated with presence of NSSI behavior. However, nightmare presence was significantly and positively associated with presence of NSSI behavior (OR = 2.33, *p* = .04). Overall, our results suggest that presence of a specific sleep problem, nightmares, was associated with increased likelihood of engaging in NSSI behavior.

Table 5

Between-person associations between sleep problems and NSSI behavior likelihood (Sample 1)

	Outcome: NSSI behavior		
Predictors	*OR*	*95% CI*	*p*
Model 1			
(Intercept)	**.52**	**.34 – .78**	**.002**
Average sleep quality	.86	.66 – 1.10	.23
Age	**.73**	**.57 – .93**	**.01**
Observations	110		
R^2 Tjur	.07		
Model 2			
(Intercept)	.69	.44 – 1.05	.09
Sleep quality variability	.89	.59 – 1.32	.56
Age	**.77**	**.59 – .98**	**.04**
Observations	93		
R^2 Tjur	.05		
Model 3			
(Intercept)	**.34**	**.19 – .60**	**<.001**
Nightmares	**2.33**	**1.03 – 5.37**	**.04**
Age	**.73**	**.57 – .93**	**.01**
Observations	112		
R^2 Tjur	.09		

Note. OR = odds ratio; *p* = *p*-value; *95% CI* = 95% confidence interval; NSSI = nonsuicidal self-injury; Age and continuous sleep problem variables were grand-mean centered. Bold values indicate statistically significant difference ($p < .05$).

Aim 2

Our hypotheses for aim 2 were not supported (see Table 6 for full model results including effect sizes). Higher trait-level negative urgency, higher trait-level emotion reactivity, higher trait-level expressive suppression, and lower trait-level emotional awareness at baseline did not significantly predict poorer sleep quality or presence of nightmares during the daily diary study period. Contrary to hypothesis, higher emotion reactivity was significantly associated with *less* sleep variability (B = -.01, p = .04). No other emotion regulation variables were significantly associated with sleep variability.

Aim 3

Our hypotheses for aim 3 were not supported (see Table 7 for full model results including effect sizes). Specifically, higher trait-level negative urgency, higher trait-level emotion reactivity, higher trait-level expressive suppression, and lower trait-level emotional awareness at baseline did not predict significantly increased likelihood of NSSI behavior during the daily diary study period.

Table 6

Between-person associations between trait-level emotion regulation constructs and sleep problems (Sample 1)

	Outcome: Average sleep quality			**Outcome: Sleep quality variability**			**Outcome: Nightmares**		
Predictors	*Estimate*	*95% CI*	*p*	*Estimate*	*95% CI*	*p*	*OR*	*95% CI*	*p*
Model 1									
(Intercept)	**6.86**	**6.55 – 7.18**	**<.001**	**1.75**	**1.53 – 1.97**	**<.001**	.80	.55 – 1.17	.25
Emotion reactivity	.00	-.02 – .02	.98	**-.01**	**-.02 – -.0004**	**.04**	1.01	.99 – 1.04	.27
Age	-.07	-.25 – .11	.46	.03	-.10 – .16	.70	1.04	.84 – 1.30	.72
Observations	108			92			110		
R^2 / R^2 adjusted	.005 / -.014			.053 / .031			.012[a]		
Model 2									
(Intercept)	**6.85**	**6.54 – 7.17**	**<.001**	**1.74**	**1.51 – 1.96**	**<.001**	.77	.53 – 1.12	.18
Expressive suppression	-.01	-.07 – .04	.61	-.01	-.05 – .03	.50	.95	.89 – 1.02	.17
Age	-.07	-.25 – .10	.42	.06	-.07 – .18	.40	.99	.80 – 1.23	.93
Observations	110			93			112		
R^2 / R^2 adjusted	.008 / -.01			.013 / -.009			.017[a]		
Model 3									
(Intercept)	**6.86**	**6.54 – 7.17**	**<.001**	**1.74**	**1.51 – 1.97**	**<.001**	.80	.55 – 1.17	.25
Negative urgency	.08	-.06 – .23	.27	-.03	-.12 – .07	.61	1.08	.90 – 1.28	.41
Age	-.04	-.22 – .14	.64	.05	-.08 – .18	.49	1.04	.84 – 1.30	.71
Observations	108			92			110		
R^2 / R^2 adjusted	.017 / -.002			.01 / -.01			.007[a]		
Model 4									
(Intercept)	**6.86**	**6.54 – 7.18**	**<.001**	**1.75**	**1.53 – 1.98**	**<.001**	.75	.50 – 1.11	.16
Emotion awareness	.03	-.09 – .16	.61	.04	-.05 – .13	.39	.86	.73 – .1.01	.06
Age	-.03	-.21 – .15	.74	.04	-.09 – .17	.55	.95	.76 – 1.19	.67
Observations	102			88			104		
R^2 / R^2 adjusted	.005 / -.016			.011 / -.013			.033[a]		

Note. OR = odds ratio; *p* = *p*-value; *95% CI* = 95% confidence interval; Age and trait-level emotion regulation constructs were grand-mean centered; [a]Effect size measure of logistic regression models is R^2 Tjur; Bold values indicate statistically significant difference ($p < .05$).

Table 7

Between-person associations between trait-level emotion regulation constructs and NSSI behavior likelihood (Sample 1)

	Outcome: NSSI behavior		
Predictors	*OR*	*95% CI*	*p*
Model 1			
(Intercept)	**.52**	**.34 – .78**	**.002**
Emotion reactivity	1.01	.99 – 1.04	.45
Age	**.76**	**.60 – .96**	**.03**
Observations	110		
R^2 Tjur	.058		
Model 2			
(Intercept)	.51	.34 – .76	.001
Expressive suppression	1.00	.93 – 1.08	.93
Age	**.74**	**.58 – .93**	**.01**
Observations	112		
R^2 Tjur	.057		
Model 3			
(Intercept)	**.48**	**.31 – .73**	**.001**
Negative urgency	1.21	.99 – 1.49	.06
Age	**.76**	**.59 – .97**	**.03**
Observations	110		
R^2 Tjur	.096		
Model 4			
(Intercept)	.55	.36 - .84	.006
Emotion awareness	1.16	.99 – 1.38	.08
Age	**.74**	**.57 – .94**	**.02**
Observations	104		
R^2 Tjur	.107		

Note. OR = odds ratio; *p* = *p*-value; *95% CI* = 95% confidence interval; NSSI = nonsuicidal self-injury; Age and trait-level emotion regulation constructs were grand-mean centered. Bold values indicate statistically significant difference ($p < .05$).

Data reduction for within-person models

For within-person analyses (aims 4-5), data were required to be available on consecutive days (day one predicting day two) given the study aims. Therefore, if either the predictor variable (previous night's nightmare presence or poor sleep quality) or the outcome variable (next-day NSSI behavior presence or frequency) is missing, that day's data were not included in the model. Out of 118 participants who completed the study, 89 participants had at least one set of paired data. To ensure participants have enough data for within-person analyses, an a priori decision was made to limit analyses to only include participants with at least three pairs of consecutive days of daily diary data and age assessed at baseline. This resulted in a sample size of 48 participants for the subsequent multilevel analyses.

ICCs and descriptives for multilevel data

Repeated measure correlations, ICCs, and RMSSDs for main study variables for multilevel analyses are presented in Table 8. A significant within-person negative correlation was found between the primary predictors, presence of nightmares and sleep quality (r = -.16, p < .001), suggesting that presence of nightmares was associated with poorer sleep quality. Significant within-person positive correlations were also found between presence of NSSI behavior and NSSI behavior frequency (r = .59, p < .001; of note, these data and related correlations for NSSI behavior include overlapping information). In addition, presence of nightmares and NSSI behavior frequency (r = .14, p < .001) were significantly positively associated. Lastly, ICCs ranged from .26 to .41 indicating that a large amount of variance in variables is attributable to within-person level differences, supporting the suitability of multilevel modeling as an analytic approach.

Table 8

Repeated measure correlations, ICCs, and RMSSD statistics for multilevel data (Sample 1)

	1. NSSI behavior presence	2. NSSI behavior frequency	3. Nightmares	4. Sleep quality
1.	–	.59***	.06	-.06
2.		–	.14***	-.03
3.			–	-.16***
4.				–
ICC [95% CI]	.40 (.32 – .50)	.41 (.33 – .51)	.26 (.18 – .35)	.33 (.25 – .42)
RMSSD (*M, SD*)		.56 (.90)		2.20 (1.46)

Notes. NSSI = nonsuicidal self-injury; ICC = intraclass correlation; 95% CI = 95% confidence interval; RMSSD = root mean square of successive differences; M = mean; SD = standard deviation; ***$p < .001$

Aim 4

To test aim 4, we first attempted to analyze multilevel models with random intercepts and random slopes, however, these models did not converge due to singularity errors. Instead, we opted to use models with random intercepts and fixed slopes to test aim 4. Our hypotheses for aim 4 were not supported (see Table 9 for all random intercepts, fixed slopes model results and model effect sizes). During the daily diary study, within-person poorer sleep quality did not significantly predict increased likelihood of next-day NSSI behavior (OR = .84, p = .08) or increased frequency of next-day NSSI behavior (B = -.05, p = .09). Of note, these effects are trending towards significance in the hypothesized direction. Similarly, during the daily diary study, nightmare presence did not predict increased likelihood of next-day NSSI behavior (OR = 1.51, p = .38) or increased frequency of next-day NSSI behavior (B = .15, p = .26).

Table 9

Within-person analyses of prior-day sleep problems predicting likelihood and frequency of next-day NSSI behavior (Sample 1)

	Outcome: Next-day NSSI behavior presence			**Outcome: Next-day NSSI behavior frequency**		
Predictors	*OR*	*95% CI*	*p*	*Estimate*	*95% CI*	*p*
Model 1						
(Intercept)	**.11**	**.05 – .28**	**<.001**	**.41**	**.18 – .64**	**<.001**
Sleep quality	.84	.69 – 1.02	.08	-.05	-.10 – .01	.09
Age	.63	.39 – 1.03	.06	**-.21**	**-.36 – -.06**	**.006**
Random Effects						
σ^2	**3.29**			**.66**		
τ_{00}	**4.11**			**.51**		
ICC	.56			.43		
N_{ID}	48			48		
Observations	280			280		
Marginal R^2 / Conditional R^2	.082 / .592			.098 / .490		
Model 2						
(Intercept)	**.11**	**.05 – .27**	**<.001**	.38	.15 – .61	**.001**
Nightmares	1.51	.60 – 3.78	.38	.15	-.12 – .42	.26
Age	.64	.40 – 1.01	.06	**-.21**	**-.36 – -.06**	**.005**
Random Effects						
σ^2	**3.29**			**.65**		
τ_{00}	**3.80**			**.49**		
ICC	.54			.43		
N_{ID}	48			48		
Observations	291			291		
Marginal R^2 / Conditional R^2	.068 / .568			.091 / .481		

Note. *OR* = odds ratio; *p* = *p*-value; *95% CI* = 95% confidence interval; ICC = intraclass correlation; N_{ID} = number of participants; NSSI = nonsuicidal self-injury; Results presented are random intercepts, fixed slope models. Sleep quality is a day-level variable and was person-mean centered. Age is a person-level variable and was grand-mean centered. Bold values indicate statistically significant difference ($p < .05$).

Aim 5

To test aim 5, we first attempted to analyze multilevel models with random intercepts and random slopes for the lowest level of data, in line with recommendations when conducting cross-level interactions. Majority of the models did not converge due to singularity errors. One model did converge, however likelihood ratio testing revealed that the random slope model did not fit significantly better than the fixed slope model. Therefore, all model results presented are random intercepts fixed slope models. Our hypotheses were aim 5 were not supported (see Table 10 and Table 11 for all random intercepts, fixed slopes model results and model effect sizes). Trait-level (person-level) emotion regulation constructs did not moderate the relationship between within-person poorer sleep quality and NSSI behavior likelihood during the daily diary study. In addition, trait-level (person-level) emotion regulation constructs did not moderate the relationship between nightmare presence and NSSI behavior likelihood during the daily diary study.

Table 10

Within-person analyses of prior-day sleep quality and emotion regulation measures predicting likelihood of next-day NSSI behavior (Sample 1)

	Outcome: Next-day NSSI behavior presence		
Predictors	*OR*	*95% CI*	*p*
Model 1			
(Intercept)	**.11**	**.05 – .28**	**<.001**
Sleep quality	.85	.69 – 1.04	.11
Emotion reactivity	.99	.95 – 1.04	.66
Emotion reactivity*Sleep quality	1.00	.99 – 1.01	.79
Age	.62	.38 – 1.02	.06
Random Effects			
σ^2	**3.29**		
τ_{00}	**4.04**		
ICC	.55		
N_{ID}	48		
Observations	280		
Marginal R^2 / Conditional R^2	.081 / .587		
Model 2			
(Intercept)	**.11**	**.05 – .28**	**<.001**
Sleep quality	.85	.70 – 1.03	.10
Expressive suppression	1.04	.90 – 1.20	.58
Expressive suppression*Sleep quality	.98	.94 – 1.02	.29
Age	.62	.38 – 1.01	.05
Random Effects			
σ^2	**3.29**		
τ_{00}	**4.04**		
ICC	.55		
N_{ID}	48		

Table 10 Continued

Observations	280		
Marginal R^2 / Conditional R^2	.089 / .591		
Model 3			
(Intercept)	**.11**	**.05 – .28**	**<.001**
Sleep quality	.84	.69 – 1.03	.09
Negative urgency	.86	.63 – 1.17	.34
Negative urgency*Sleep quality	1.05	.96 – 1.15	.30
Age	**.59**	**.36 – .97**	**.04**
Random Effects			
σ^2	**3.29**		
τ_{00}	**3.95**		
ICC	.55		
N_{ID}	48		
Observations	280		
Marginal R^2 / Conditional R^2	.104 / .593		
Model 4			
(Intercept)	**.10**	**.04 – .28**	**<.001**
Sleep quality	.87	.70 – 1.08	.20
Emotion awareness	1.09	.83 – 1.43	.54
Emotion awareness*Sleep quality	.99	.91 – 1.07	.77
Age	.65	.39 – 1.09	.11
Random Effects			
σ^2	**3.29**		
τ_{00}	**4.48**		
ICC	.58		
N_{ID}	47		
Observations	276		
Marginal R^2 / Conditional R^2	.084 / .612		

Note. OR = odds ratio; *p* = *p*-value; *95% CI* = 95% confidence interval; ICC = intraclass correlation; N_{ID} = number of participants; NSSI = nonsuicidal self-injury; Results presented are random intercepts, fixed slope models. Sleep quality is a day-level variable and was person-mean centered. Age and trait-level emotion regulation constructs are person-level variables and were grand-mean centered. Bold values indicate statistically significant difference ($p < .05$).

Table 11

Within-person analyses of prior-day nightmare presence and emotion regulation measures predicting likelihood of next-day NSSI behavior (Sample 1)

	Outcome: Next-day NSSI behavior presence		
Predictors	*OR*	*95% CI*	*p*
Model 1			
(Intercept)	**.11**	**.05 – .28**	**<.001**
Nightmares	1.42	.55 – 3.71	.47
Emotion reactivity	1.00	.95 – 1.04	.84
Emotion reactivity*Nightmares	.98	.92 – 1.05	.63
Age	.63	.39 – 1.02	.06
Random Effects			
σ^2	**3.29**		
τ_{00}	**3.74**		
ICC	.53		
N_{ID}	48		
Observations	291		
Marginal R^2 / Conditional R^2	.067 / .564		
Model 2			
(Intercept)	**.12**	**.05 – .28**	**<.001**
Nightmares	1.54	.61 – 3.88	.36
Expressive suppression	1.05	.91 – 1.20	.52
Expressive suppression*Nightmares	1.01	.82 – 1.23	.96
Age	**.63**	**.40 – .99**	**.04**
Random Effects			
σ^2	**3.29**		
τ_{00}	**3.61**		
ICC	.52		
N_{ID}	48		
Observations	291		

Table 11 Continued

Marginal R^2 / Conditional R^2	.072 / .557		
Model 3			
(Intercept)	**.11**	**.05 – .27**	**<.001**
Nightmares	1.37	.52 – 3.60	.52
Negative urgency	.94	.69 – 1.28	.68
Negative urgency*Nightmares	.60	.35 – 1.02	.06
Age	**.62**	**.38 – .99**	**.04**
Random Effects			
σ^2	**3.29**		
τ_{00}	**3.61**		
ICC	.52		
N_{ID}	48		
Observations	291		
Marginal R^2 / Conditional R^2	.108 / .575		
Model 4			
(Intercept)	**.10**	**.04 – .28**	**<.001**
Nightmares	1.31	.49 – 3.47	.59
Emotion awareness	1.05	.80 – 1.38	.72
Emotion awareness*Nightmares	1.18	.80 – 1.73	.41
Age	.65	.39 – 1.09	.10
Random Effects			
σ^2	**3.29**		
τ_{00}	**4.46**		
ICC	.58		
N_{ID}	47		
Observations	287		
Marginal R^2 / Conditional R^2	.076 / .608		

Note. OR = odds ratio; *p* = *p*-value; *95% CI* = 95% confidence interval; ICC = intraclass correlation; N_{ID} = number of participants; NSSI = nonsuicidal self-injury; Results presented are random intercepts, fixed slope models. Age and trait-level emotion regulation constructs are person-level variables and were grand-mean centered. Bold values indicate statistically significant difference ($p < .05$).

CHAPTER V

STUDY 2 RESULTS

Data reduction for between-person models

For between-person models (aim 1), pair-wise deletion was used to maximize available data and limit biases to parameter estimates, and it was assumed data were missing completely at random. Regarding the sleep variables assessed at baseline, out of 48 participants who completed the study and have useable EMA data, two participants were missing DDNSI data, and one participant was missing ISI data. The data were checked for outliers prior to analyses using the "boxplot.stats" function from the *grDevices* package (R Core Team, 2022) in R which identifies any observations that are more than 1.5 times the interquartile range below the first quartile, or more than 1.5 times the interquartile range above the third quartile as outliers. No outliers were identified.

Correlations and between-person descriptives

Between-person descriptives and correlations between main study variables assessed at baseline are included in Table 12.

Table 12

Bivariate (between-person) correlations of main study variables assessed at baseline (Sample 2)

	1. SI Past Month Severity	2. SI Past Month (Yes/No) +	3. SI Past week (SSI Total Score)	4. NSSI Past Month (Yes/No) +	5. ISI Total Score	6. DDNSI Total Score	7. Age
1.	–	.52	.06	.09	.08	-.19	.02
2.		–	.13	.20	.23	-.04	-.01
3.			–	.37*	.21	.11	.00
4.				–	.20	.29	.34*
5.					–	.34*	.01
6.						–	.17
7.							–
Mean (SD) or Frequency (% and n)	3.77 (1.63)	91.67% (44/48)	8.98 (8.03)	58.33% (28/48)	13.72 (5.22) n=47	10.35 (9.04) n=46	14.96 (1.60)

Note. SI = suicidal ideation; SSI = Scale for Suicide Ideation; NSSI = nonsuicidal self-injury; ISI = Insomnia Severity Index; DDNSI = Disturbing Dreams and Nightmares Severity Index; SD = standard deviation; n = number of observations; +Spearman rho correlation; *$p < .05$

Aim 1

Our hypotheses for aim 1 were not supported (see Tables 13 and 14 for full model results and effect sizes). Greater insomnia symptom severity was not significantly associated with increased likelihood of past month presence of SI (OR = 1.23, $p = .10$) or NSSI behavior (OR = 1.10, $p = .13$), or past month SI severity (B = .03, $p = .60$). Similarly, greater frequency and distress associated with experiencing nightmares was not significantly associated with increased likelihood of past month presence of SI (OR = .98, $p = .79$) or NSSI behavior (OR = 1.06, $p = .12$), or past month SI severity (B = -.03, $p = .22$).

We also opted to use the total score from the SSI as a measure of SI, given that the SSI assessed more recent (past-week) SI. Results were unchanged (see Table 14 for full model results and effect sizes).

Table 13

Between-person associations between sleep problems and past-month SI presence and past-month NSSI behavior presence (Sample 2)

	Outcome: Past-month SI presence			Outcome: Past-month NSSI behavior presence		
Predictors	*OR*	*95% CI*	*p*	*OR*	*95% CI*	*p*
Model 1						
(Intercept)	**16.90**	**5.29 – 116.80**	**<.001**	1.57	.84 – 3.08	.17
ISI	1.23	.99 – 1.67	.10	1.10	.97 – 1.25	.13
Age	1.05	.50 – 2.23	.89	**1.65**	**1.09 – 2.69**	**.03**
Observations	47			47		
R^2 Tjur	.131			.170		
Model 2						
(Intercept)	**14.90**	**5.31 – 67.99**	**<.001**	1.53	.81 – 3.01	.20
DDNSI	.98	.85 – 1.13	.79	1.06	.99 – 1.15	.12
Age	.87	.38 – 1.87	.71	1.54	1.02 – 2.46	.05
Observations	46			46		
R^2 Tjur	.005			.168		

Note. *OR* = odds ratio; *p* = *p*-value; *95% CI* = 95% confidence interval; SI = suicidal ideation; NSSI = nonsuicidal self-injury; ISI = Insomnia Severity Index; DDNSI = Disturbing Dreams and Nightmares Severity Index; Age and sleep problem variables were grand-mean centered. Bold values indicate statistically significant difference ($p < .05$).

Table 14

Between-person associations between sleep problems and recent SI (Sample 2)

	Outcome: Past-month SI severity			Outcome: SSI Total Score		
Predictors	*Estimate*	*95% CI*	*p*	*Estimate*	*95% CI*	*p*
Model 1						
(Intercept)	**3.74**	**3.25 – 4.23**	**<.001**	**9.15**	**6.79 – 11.52**	**<.001**
ISI	.03	-.06 – .12	.60	.32	-.14 – .78	.17
Age	.04	-.27 – .35	.78	-.13	-1.64 – 1.37	.85
Observations	47			47		
R^2 / R^2 adjusted	.008 / -.037			.04 / .00		
Model 2						
(Intercept)	**3.83**	**3.36 – 4.29**	**<.001**	**9.35**	**6.93 – 11.77**	**<.001**
DDNSI	-.03	-.09 – .02	.22	.10	-.17 – .38	.45
Age	.01	-.28 – .31	.94	-.09	-1.63 – 1.44	.90
Observations	46			46		
R^2 / R^2 adjusted	.036 / -.009			.013 / -.033		

Note. *p* = *p*-value; *95% CI* = 95% confidence interval; SI = suicidal ideation; SSI = Scale for Suicide Ideation; ISI = Insomnia Severity Index; DDNSI = Disturbing Dreams and Nightmares Severity Index; Age and sleep problem variables were grand-mean centered. Bold values indicate statistically significant difference ($p < .05$).

ICCs and descriptives for multilevel data

Repeated measure correlations, ICCs, and RMSSDs for main study variables included in multilevel analyses are presented in Tables 15 and 16. At the observation-level, significant within-person correlations emerged between average SI and NSSI thought intensity ($r = .17$, $p < .001$), average negative affect intensity and average SI ($r = .38$, $p < .001$), and average negative affect intensity and NSSI thought intensity ($r = .17$, $p < .001$). In addition, at the day-level, a significant within-person negative correlation was found between sleep quality and nightmare presence ($r = -.19$, $p < .001$) suggesting that presence of nightmares was associated with poorer sleep quality. Lastly, ICCs ranged from .09 to .52 indicating that a large amount of variance in variables is attributable to within-person level differences, supporting the suitability of multilevel modeling as an analytic approach.

Table 15

Repeated measure correlations, ICCs, and RMSSD statistics for observation-level multilevel data (Sample 2)

	1. Suicidal thought intensity	2. NSSI thought intensity	3. Negative affect intensity
1.	–	.17***	.38***
2.		–	.17***
3.			–
ICC [95% CI]	.46 (.37 - .58)	.09 (.06 - .15)	.52 (.43 - .63)
RMSSD (*M, SD*)	.55 (.44)	.71 (.34)	.79 (.69)

Note. NSSI = nonsuicidal self-injury; ICC = intraclass correlation; 95% CI = 95% confidence interval; RMSSD = root mean square of successive differences; M = mean; SD = standard deviation; ***p < .001

Table 16

Repeated measure correlations, ICCs, and RMSSD statistics for day-level multilevel data (Sample 2)

	1. Sleep quality	2. Nightmare presence
1.	–	-.19***
2.		–
ICC [95% CI]	.32 (.23 - .43)	.30 (.22 – .42)
RMSSD (*M, SD*)	1.07 (.47)	.35 (.27)

Note. ICC = intraclass correlation; 95% CI = 95% confidence interval; RMSSD = root mean square of successive differences; M = mean; SD = standard deviation; ***p < .001

Aim 2

Our hypotheses for aim 2 were partially supported (see Table 17 for full model results and effect sizes). First, we attempted to test hypotheses Aim 2a and 2b with random intercepts and random slopes multilevel models, however, models to test these hypotheses did not converge due to singularity errors. Instead, we opted to use random intercept and fixed slope models to test hypotheses Aim 2a and 2b. Results from models testing hypotheses Aim 2a and 2b revealed that poorer within-person sleep quality did not significantly predict higher next-day worst-point NSSI thought intensity (B = -.05, p = .29) or greater next-day worst-point SI (B = -.02, p = .52).

Models testing hypotheses 2c and 2d converged with random intercepts and random slopes. Nightmare presence did not significantly predict higher next-day worst-point NSSI thought intensity (B = .28, p = .10) in the random slope model, and findings from the likelihood ratio test indicate that inclusion of random slopes substantially improves model fit, $\chi^2(2) = 8.19$, p = .02. Nightmare presence did not significantly predict greater next-day worst-point SI (B = .12, p = .19) in the random slope model, however, findings from the likelihood ratio test indicate inclusion of random slopes did not substantially improve model fit, $\chi^2(2) = 5.34$, p = .07. Results from the fixed slope model revealed that nightmare presence significantly predicted higher next-day worst-point SI (B = .14, p = .04). These results should be interpreted with caution given the marginally significant slope estimate for nightmares, and the minimally non-significant likelihood ratio test. Overall, our results suggest that presence of a specific sleep problem, nightmares, may significantly predict worst-point next-day suicidal thoughts.

Table 17

Within-person analyses of prior-day sleep problems predicting next-day worst-point NSSI thought intensity and suicidal thought intensity (Sample 2)

	Outcome: Next-day worst-point NSSI thought intensity			**Outcome: Next-day worst-point suicidal thought intensity**		
Predictors	*Estimate*	*95% CI*	*p*	*Estimate*	*95% CI*	*p*
Model 1						
(Intercept)	**.39**	**.25 – .52**	**<.001**	**.67**	**.47 – .87**	**<.001**
Sleep quality	-.05	-.14 – .04	.29	-.02	-.07 – .04	.52
Age	.07	-.01 – .16	.10	.03	-.10 – .15	.68
Random Effects						
σ^2	**1.05**			**.41**		
τ_{00}	**.15**			**.47**		
ICC	.12			.53		
N_{ID}	48			48		
Observations	737			737		
Marginal R^2 / Conditional R^2	.013 / .133			.003 / .533		
Model 2						
(Intercept)	**.35**	**.20 – .50**	**<.001**	**.64**	**.45 – .84**	**<.001**
Nightmares	.28	.02 – .46	.08	**.14**	**.003 – .29**	**.04**
Age	.07	-.01 – .17	.09	.03	-.10 – .15	.66
Random Effects						
σ^2	**1.03**			**.41**		
τ_{00}	**.13**			**.45**		
τ_{11}	**.35**			N/A		
ρ_{01}	.20			N/A		
ICC	.17			.53		
N_{ID}	48			48		
Observations	738			738		
Marginal R^2 / Conditional R^2	.021 / .186			.006 / .528		

Note. p = *p*-value; *95% CI* = 95% confidence interval; ICC = intraclass correlation; N_{ID} = number of participants; NSSI = nonsuicidal self-injury; N/A = not applicable because fixed slopes were used. Sleep quality is a day-level variable and was person-mean centered. Age is a person-level variable and was grand-mean centered. Model of nightmare presence predicting NSSI thought intensity was a random intercepts, random slopes model. Bold values indicate statistically significant difference ($p < .05$).

Aim 3

Our hypotheses for aim 3 were partially supported (see Table 18 for full model results and effect sizes). All models to test hypotheses for aim 3 converged with random intercepts and random slopes. Poorer within-person sleep quality significantly predicted higher next-day highest-point negative affect intensity (B = -.08, p = .03) in the random slope model, and findings from the likelihood ratio test indicate that inclusion of random slopes substantially improve model fit, $\chi^2(2) = 11.15$, p = .004. Poorer within-person sleep quality did not significantly predict next-day negative affect variability (B = -.03, p = .28) in the random slope model and findings from the likelihood ratio test indicate that inclusion of random slopes may substantially improve model fit, $\chi^2(2) = 15.63$, $p < .001$.

Nightmare presence did not significantly predict next-day highest-point negative affect intensity (B = -.04, p = .74) or negative affect variability (B = .006, p = .89) in random slope models. Findings from the likelihood ratio tests indicate that the inclusion of random slopes in the model predicting worst-point negative affect intensity may substantially improve model fit ($\chi^2(2) = 14.51$, $p < .001$), whereas the inclusion of random slopes in the model predicting negative affect variability did not substantially improve model fit ($\chi^2(2) = .50$, p = .78). Results from the fixed slope model revealed that nightmare presence did not predict negative affect variability (B = .004, p = .91). Overall, results suggest poorer within-person sleep quality predicts higher next-day negative affect intensity.

Table 18

Within-person analyses of prior-day sleep problems predicting next-day negative affect intensity and next-day negative affect variability (Sample 2)

	Outcome: Next-day negative affect intensity			**Outcome: Next-day negative affect variability**		
Predictors	*Estimate*	*95% CI*	*p*	*Estimate*	*95% CI*	*p*
Model 1						
(Intercept)	**1.22**	**1.00 – 1.44**	**<.001**	**.51**	**.45 – .57**	**<.001**
Sleep quality	**-.08**	**-.16 – -.01**	**.03**	-.03	-.07 – .02	.27
Age	.01	-.12 – .14	.90	-.00	-.04 – .03	.83
Random Effects						
σ^2	**.39**			**.09**		
τ_{00}	**.58**			**.04**		
τ_{11}	**.02**			**.01**		
ρ_{01}	-.43			-.39		
ICC	.61			.33		
N_{ID}	48			47		
Observations	737			633		
Marginal R^2 / Conditional R^2	.005 / .608			.004 / .330		
Model 2						
(Intercept)	**1.23**	**1.01 – 1.46**	**<.001**	**.50**	**.44 – .57**	**<.001**
Nightmares	-.04	-.27 – .19	.74	.004	-.07 – .08	.91
Age	.02	-.12 – .16	.75	.00	-.04 – .04	.99
Random Effects						
σ^2	**.39**			.10		
τ_{00}	**.57**			.04		
τ_{11}	**.24**			N/A		
ρ_{01}	.10			N/A		
ICC	.62			.26		
N_{ID}	48			47		
Observations	738			634		
Marginal R^2 / Conditional R^2	.002 / .619			.00 / .263		

Note. p = *p*-value; *95% CI* = 95% confidence interval; ICC = intraclass correlation; N_{ID} = number of participants; Sleep quality is a day-level variable and was person-mean centered. Age is a person-level variable and was grand-mean centered. Model of nightmare presence predicting negative affect variability was a random intercepts, fixed slope model. Bold values indicate statistically significant difference ($p < .05$).

Aim 4

Our hypotheses for aim 4 were fully supported (see Tables 19 and 20 for full model results and effect sizes). All models to test hypotheses for aim 4 converged with random intercepts and random slopes. Regarding contemporaneous models, higher within-person negative affect intensity significantly predicted higher NSSI thought intensity (B = .24, $p < .001$) and SI (B = .37, $p < .001$) in random slope models. Results from likelihood ratio tests indicate that inclusion of random slopes in contemporaneous models substantially improve model fit for both NSSI thought intensity ($\chi^2(2) = 114.83$, $p < .001$) and SI ($\chi^2(2) = 341.79$, $p < .001$).

Regarding lagged effect models, higher within-person negative affect intensity significantly predicted higher next-point NSSI thought intensity (B = .09, $p = .03$) and SI (B = .20, $p < .001$) in random slope models. Results from likelihood ratio tests indicate that inclusion of random slopes in contemporaneous models substantially improve model fit for both NSSI thought intensity ($\chi^2(2) = 10.62$, $p = .005$) and SI ($\chi^2(2) = 88.87$, $p < .001$).

Altogether, results suggest that higher within-person negative affect intensity predicts higher self-injurious thoughts, both contemporaneously and at the next time-point.

Table 19

Within-person analyses of negative affect intensity predicting contemporaneous NSSI thought intensity and suicidal thought intensity (Sample 2)

	Outcome: NSSI thought intensity			**Outcome: Suicidal thought intensity**		
Predictors	*Estimate*	*95% CI*	*p*	*Estimate*	*95% CI*	*p*
Model 1						
(Intercept)	**.20**	**.11 – .29**	**<.001**	**.49**	**.33 – .64**	**<.001**
Negative affect	**.24**	**.13 – .34**	**<.001**	**.37**	**.27 – .48**	**<.001**
Age	-.00	-.05 – .04	.95	-.01	-.08 – .06	.78
Random Effects						
σ^2	**.43**			**.23**		
τ_{00}	**.09**			**.29**		
τ_{11}	**.10**			**.12**		
ρ_{01}	**.72**			**.74**		
ICC	.24			.60		
N_{ID}	48			48		
Observations	2735			2735		
Marginal R^2 / Conditional R^2	.038 / .267			.089 / .634		

Note. p = *p*-value; *95% CI* = 95% confidence interval; ICC = intraclass correlation; N_{ID} = number of participants; Negative affect intensity is an observation-level variable and was person-mean centered. Age is a person-level variable and was grand-mean centered. Bold values indicate statistically significant difference ($p < .05$).

Table 20

Within-person analyses of negative affect intensity predicting next-point NSSI thought intensity and suicidal thought intensity (Sample 2)

	Outcome: Next-point NSSI thought intensity			**Outcome: Next-point suicidal thought intensity**		
Predictors	*Estimate*	*95% CI*	*p*	*Estimate*	*95% CI*	*p*
Model 1						
(Intercept)	**.21**	**.08 – .34**	**.002**	**.48**	**.32 – .63**	**<.001**
Negative affect	**.09**	**.02 – .16**	**.02**	**.20**	**.10 – .30**	**<.001**
Age	-.03	-.09 – .03	.37	-.01	-.08 – .06	.75
Random Effects						
σ^2	**.41**			**.27**		
τ_{00}	**.20**			**.28**		
τ_{11}	**.03**			**.09**		
ρ_{01}	**.92**			**.77**		
ICC	.34			.54		
N_{ID}	48			48		
Observations	1776			1776		
Marginal R^2 / Conditional R^2	.009 / .347			.027 / .550		

Note. p = *p*-value; *95% CI* = 95% confidence interval; ICC = intraclass correlation; N_{ID} = number of participants; Negative affect intensity is an observation-level variable and was person-mean centered. Age is a person-level variable and was grand-mean centered. Bold values indicate statistically significant difference ($p < .05$).

Aim 5

Our hypotheses for aim 5 were partially supported (see Table 21 for full model results and effect sizes). All models to test hypotheses for aim 5 converged with random intercepts and random slopes (see Appendix H for R analytic code).

Poorer within-person sleep quality did not significantly moderate the association between negative affect intensity and NSSI thought intensity (B = .01, p = .81), or negative affect intensity and SI in random slope models (B = -.00, p = .98). Results from likelihood ratio tests indicate that inclusion of random slopes in substantially improve model fit for both NSSI thought intensity ($\chi^2(2) = 62.98$, $p < .001$) and SI ($\chi^2(2) = 202.09$, $p < .001$).

Nightmare presence significantly moderated the relation between negative affect intensity and NSSI thought intensity (B = .15, p = .03), but not negative affect intensity and SI (B = .05, p = .36). Results from likelihood ratio tests indicate that inclusion of random slopes in substantially improve model fit for both NSSI thought intensity ($\chi^2(2) = 71.02$, $p < .001$) and SI ($\chi^2(2) = 186.73$, $p < .001$).

We used the "simple_slopes" function from the *reghelper* package (Hughes & Beiner, 2022) in R to probe the significant interaction between nightmare presence and negative affect intensity predicting NSSI thought intensity. Since nightmare presence was a dichotomous (yes/no) variable, the slope of the relation between negative affect intensity and NSSI thought intensity was tested at each level of nightmare presence (yes/no; Aiken & West, 1991; Bauer & Curran, 2005). Results revealed that not only was negative affect intensity significantly associated with NSSI thought intensity when nightmares were present (B = .37, SE = .08, t = 4.79, $p < .001$), but also when nightmares were absent (B = .22, SE = .05, t = 4.07, $p < .001$).

Altogether, these findings suggest that presence of nightmares may strengthen the proximal association between negative affect and NSSI thought intensity.

Table 21

Sleep problems as a moderator of the contemporaneous negative affect-SITB relationship (Sample 2)

	Outcome: NSSI thought intensity			**Outcome: Suicidal thought intensity**		
Predictors	*Estimate*	*95% CI*	*p*	*Estimate*	*95% CI*	*p*
Model 1						
(Intercept)	**.20**	**.10 – .29**	**<.001**	**.46**	**.31 – .62**	**<.001**
Negative affect	**.24**	**.14 – .34**	**<.001**	**.33**	**.23 – .42**	**<.001**
Sleep quality	.00	-.04 – .04	.99	.03	-.01 – .06	.14
Age	.00	-.04 – .05	.87	-.01	-.09 – .06	.72
Negative affect*Sleep quality	.01	-.05 – .06	.81	-.00	-.04 – .04	.98
Random Effects						
σ^2	**.36**			**.14**		
τ_{00} (Day)	**.07**			**.10**		
τ_{00} (Subject)	**.09**			**.28**		
τ_{11}	**.08**			**.09**		
ρ_{01}	**.76**			**.72**		
ICC	.35			.75		
N_{Day}	737			737		
$N_{Subject\_ID}$	48			48		
Observations	2184			2184		
Marginal R^2 / Conditional R^2	.038 / .375			.068 / .767		
Model 2						
(Intercept)	**.17**	**.07 – .26**	**<.001**	**.44**	**.29 – .60**	**<.001**
Negative affect	**.22**	**.11 – .33**	**<.001**	**.32**	**.22 – .42**	**<.001**
Nightmares	**.16**	**.06 – .26**	**.001**	**.10**	**.01 – .19**	**.03**
Age	.00	-.04 – .04	.91	-.01	-.09 – .06	.70
Negative affect*Nightmares	**.15**	**.01 – .29**	**.03**	.05	-.05 – .14	.36
Random Effects						
σ^2	**.37**			**.14**		
τ_{00} (Day)	**.07**			**.10**		
τ_{00} (Subject)	**.08**			**.28**		

Table 21 Continued

τ_{11}	**.09**	**.09**
ρ_{01}	**.81**	**.71**
ICC	.33	.75
N_{Day}	738	738
$N_{Subject\_ID}$	48	48
Observations	2188	2188
Marginal R^2 / Conditional R^2	.049 / .365	.072 / .765

Note. Negative affect intensity is an observation-level variable and was person-mean centered prior to analyses. Sleep quality is a day-level variable and was person-mean centered. Age is a person-level variable and was grand-mean centered. Bold values indicate statistically significant difference ($p < .05$).

Aim 6

Our hypotheses for aim 6 were not supported (see Table 22 for all model results and effect sizes). All models to test hypotheses for aim 6 converged with random intercepts and random slopes.

Poorer within-person sleep quality did not significantly moderate the association between negative affect intensity and next-point NSSI thought intensity (B = .01, p = .70), or negative affect intensity and next-point SI in random slope models (B = .01, p = .71). Findings from the likelihood ratio tests indicate that the inclusion of random slopes in the model predicting next-point SI may substantially improve model fit ($\chi^2(2) = 18.61$, $p < .001$), whereas the inclusion of random slopes in the model predicting NSSI thought intensity did not substantially improve model fit ($\chi^2(2) = 5.07$, $p = .08$). Results from the fixed slope model predicting NSSI thought intensity revealed that within-person sleep quality did not significantly moderate the association between negative affect intensity and next-point NSSI thought intensity (B = -.00, p = .93).

Similarly, nightmare presence did not significantly moderate the association between negative affect intensity and next-point NSSI thought intensity (B = -.05, p = .48), or negative affect intensity and next-point SI in random slope models (B = -.07, p = .24). Findings from the likelihood ratio tests indicate that the inclusion of random slopes in the model predicting next-point SI may substantially improve model fit ($\chi^2(2) = 20.16$, $p < .001$), whereas the inclusion of random slopes in the model predicting NSSI thought intensity did not substantially improve model fit ($\chi^2(2) = 4.43$, $p = .11$). Results from the fixed slope model predicting NSSI thought intensity revealed that nightmare presence did not significantly moderate the association between negative affect intensity and next-point NSSI thought intensity (B = -.06, p = .43).

As shown in Tables 21 and 22, the number of observations included in the contemporaneous models (Aim 5) versus the lagged effect models (Aim 6) differ substantially. For lagged effect models, observations are required to be consecutive, and within-day, for each participant. Further, participants are required to have valid sleep diary data to be included in these analyses. Consequently, the number of observations and participants with valid data for lagged effect models is less than those for contemporaneous models. These differences likely impact statistical power, and it may be that the current lagged effect models are underpowered.

Table 22

Sleep problems as a moderator of the lagged negative affect-SITB relationship (Sample 2)

	Outcome: Next-point NSSI thought intensity			**Outcome: Next-point suicidal thought intensity**		
Predictors	*Estimate*	*95% CI*	*p*	*Estimate*	*95% CI*	*p*
Model 1						
(Intercept)	**.20**	**.05 – .35**	**.008**	**.47**	**.31 – .63**	**<.001**
Negative affect	.05	-.01 – .10	.09	**.09**	**.02 – .17**	**.01**
Sleep quality	-.03	-.08 – .01	.13	.01	-.03 – .06	.62
Age	.03	-.06 – .13	.50	-.02	-.10 – .07	.66
Negative affect*Sleep quality	.00	-.06 – .06	.93	.01	-.04 – .06	.71
Random Effects						
σ^2	**.33**			**.15**		
τ_{00} (Day)	**.05**			**.14**		
τ_{00} (Subject)	**.24**			**.27**		
τ_{11}	N/A			**.03**		
ρ_{01}	N/A			**.72**		
ICC	.46			.73		
N_{Day}	633			633		
$N_{Subject\_ID}$	47			47		
Observations	1447			1447		
Marginal R^2 / Conditional R^2	.008 / .462			.008 / .735		
Model 2						
(Intercept)	**.18**	**.04 – .31**	**.009**	**.45**	**.29 – .61**	**<.001**
Negative affect	**.06**	**.00 – .12**	**.049**	**.11**	**.03 – .19**	**.005**
Nightmares	.10	-.01 – .21	.06	.10	-.01 – .21	.08
Age	.03	-.05 – .11	.49	-.02	-.11 – .06	.61
Negative affect*Nightmares	-.06	-.20 – .08	.43	-.07	-.15 – .05	.24
Random Effects						
σ^2	**.36**			.15		
τ_{00} (Day)	**.05**			.14		
τ_{00} (Subject)	**.18**			.27		
τ_{11}	N/A			.03		
ρ_{01}	N/A			.73		
ICC	.39			.73		
N_{Day}	634			634		
$N_{Subject\_ID}$	47			47		
Observations	1450			1450		
Marginal R^2 / Conditional R^2	.009 / .399			.011 / .734		

Note. Negative affect intensity is an observation-level variable and was person-mean centered prior to analyses. Sleep quality is a day-level variable and was person-mean centered prior to analyses. Age is a person-level variable and was grand-mean centered prior to analyses. Models predicting NSSI thought intensity were random intercepts, fixed slope models. Bold values indicate statistically significant difference ($p < .05$).

CHAPTER VI

DISCUSSION

The overall purpose of the present study was to investigate the emotion regulation mechanisms linking nightmares and SITBs in high-risk youth, utilizing secondary data from two real-time monitoring studies. This master's thesis research aimed to fill four major gaps in the literature. First, most research has focused on sleep problems more broadly and their association to SITBs, with a limited number of studies examining the link between *nightmares* and SITBs specifically. Second, most of this research was conducted in adult samples, and far less is known about the nightmare-SITB link in youth. Third, most existing studies are limited by their retrospective study design and temporally insensitive methodology, restricting our understanding of the prospective relation between nightmares and SITBs. Fourth, little is known about potential mechanisms linking nightmares and SITBs in youth, which is particularly critical for developing effective interventions to reduce SITBs. In addition to a specific focus on nightmares, we secondarily examined sleep quality as a continuous measure of transdiagnostic sleep problems in both samples. To facilitate interpretation and integration of findings in this section, nightmares and sleep quality will collectively be referred to as "sleep problems".

The findings of this master's thesis research are organized conceptually, first by discussing the association between sleep problems (poorer sleep quality, nightmares) and SITBs, second by presenting findings on the association between sleep problems and emotion regulation difficulties, third by elucidating associations between emotion regulation difficulties and SITBs, and last, by describing preliminary evidence for emotion regulation as the mechanism linking sleep problems and SITBs.

Sleep problems and SITBs

First, we examined the association between sleep problems (poorer sleep quality, nightmares) and SITBs across two samples using both between-person and within-person analytic approaches. Results from between-person analyses revealed that presence of nightmares was significantly associated with increased likelihood of engaging in NSSI behavior among adolescents hospitalized for serious self-injury risk (Sample 1). This suggests that on a between-person level, adolescents who experienced nightmares were more likely to endorse NSSI behavior engagement. Contrary to hypothesis, sleep quality was unrelated to NSSI behavior in Sample 1. Likewise, between-person analyses in Sample 2 which examined youth during the high-risk period following discharge from acute psychiatric care for suicide risk revealed both insomnia symptoms and nightmares (frequency and distress associated with nightmares) were unrelated to NSSI behavior and suicide ideation.

Some of the findings in Sample 1 were consistent with literature which has demonstrated a cross-sectional association between presence of nightmares and likelihood of engaging in NSSI behavior (Ennis et al., 2017; Liu et al., 2017). However, the vast majority of between-person analyses across both study samples yielded no significant association between sleep problems and SITBs. These findings are somewhat surprising given the substantial literature reporting longitudinal associations between sleep problems and SITBs (Harris et al., 2020; Liu et al., 2020; Pigeon et al., 2016). To date, much of the research investigations into sleep problems and SITBs includes adult samples, and far less is known about this association in youth. In addition, our clinical samples of youth were extremely high-risk (i.e., currently hospitalized for self-harm risk or recent acute psychiatric care), differing from community samples of youth, which likely impacts observed associations. It is possible, therefore, that the utility of sleep problems as a predictor of SITBs may vary depending on the clinical severity sample, however future research is needed to evaluate this claim.

The discrepancy between our findings and prior research could also be attributed to a mismatch of time frames associated with measures assessing sleep problems and SITBs at baseline, particularly in Sample 2. SITB outcomes were assessed over the past month, whereas sleep problems (predictors) were assessed over the lifetime (nightmares) or past two weeks (insomnia). It may be that better convergence of time frame across measures may allow for a more precise examination of the association between sleep problems and SITBs. Although assessment of insomnia at baseline more strongly aligns with SITBs assessed at baseline, our assessment of nightmares at baseline is a lifetime history. Therefore, this temporal mismatch may account for our null findings linking nightmares and SITBs.

Further, assessing these variables over shorter time frames may yield stronger effects according to meta-analytic evidence from Harris et al. (2020) and Liu et al. (2020). Specifically, Harris et al. (2020) found evidence indicating that associations between sleep problems and SITBs were strongest when the study follow-up time period was 6 months or less for SITB outcomes. Moreover, Liu et al. (2020) noted a similar finding such that studies with a follow-up period of less than one year yielded significantly larger effects than did those with follow-ups of one year or more, specifically for suicide ideation. To address meta-analytic findings, we explored proximal links between sleep problems and SITBs, which are discussed next.

Regarding within-person analyses, findings from Sample 1 which employed a daily diary study design demonstrated no association between sleep problems (sleep quality, nightmares) and likelihood of next-day NSSI behavior presence or next-day NSSI behavior frequency. Interestingly, in Sample 2 which involved EMA study design, presence of nightmares significantly predicted higher next-day worst-point suicide ideation, but not NSSI thought intensity. Sleep quality was unrelated to next-day worst-point suicide ideation or NSSI thought intensity in Sample 2.

It is important to note that the findings related to nightmares and suicide ideation from the current study are consistent with results reported in a previously published manuscript with this dataset (Glenn et al., 2022). The aims of the previous study were to generally explore the facets of sleep problems related to suicide ideation, and the previous study employed an advanced machine learning approach, LASSO, to achieve this goal. Furthermore, the prior study was an exploratory examination of the association between various sleep problems and suicide ideation. The current study aims to extend these previous study findings in novel ways. First, the current study examined additional SITB outcomes (e.g., NSSI thought intensity) and their association with nightmares. Second, the current study investigated mechanisms (emotion regulation) linking nightmares and SITBs, which has not previously been conducted.

It should be mentioned that there are notable differences between Sample 1 and Sample 2 in terms of clinical nature of the sample and methodology that may account for the divergence in findings. Specifically, Sample 1 includes adolescents who were hospitalized for serious self-injury risk, and data were collected while participants were on the inpatient unit. It may be that NSSI behavior was less prevalent during this period, and therefore less instances of NSSI were reported during daily diary surveys. Additionally, although participants were told daily diary responses would be kept confidential (and not shared with unit staff), it is possible that participants underreported the extent of NSSI behavior engagement. Notably, 34.75% of participants reported engaging in NSSI behavior at least once while on the inpatient unit, suggesting that the safety check-in practices on the inpatient unit may have limited efficacy in preventing NSSI behavior during hospitalization. Critically, future research centered on identifying short-term risk factors for NSSI behavior is imperative and may help inform clinical practice during high-risk periods.

Sample 2 includes youth who completed an EMA study and in the current study self-injurious thoughts were the primary SITB variables of interest. Self-injurious thoughts are more commonly endorsed than self-injurious behaviors. Furthermore, the EMA study (Sample 2) employed a continuous measure of self-injurious thought intensity, as opposed to presence versus absence of thoughts. Our differences in findings may be due to methodological and measurement differences across the two samples, given that Sample 1 only assessed NSSI behavior, and Sample 2 focused on suicidal and non-suicidal thought intensity.

Altogether, the current study presents some evidence for both between-person and within-person associations between nightmares, a specific sleep problem, and SITB outcomes.

Sleep problems and emotion regulation difficulties

Second, we investigated the relation between sleep problems (sleep quality, nightmares) and emotion regulation difficulties. Due to the nature of the existing datasets, in Sample 1, we tested these associations using between-person analytic approaches, whereas in Sample 2 we used within-person analytic approaches.

Findings indicate that on a between-person level, there was a small inverse relation between sleep quality variability and emotion reactivity in Sample 1. Higher than average emotion reactivity was associated with less sleep quality variability (more consistent sleep quality from night to night) in Sample 1. This finding is unexpected, although bivariate correlations revealed the same pattern of results such that higher emotion reactivity was correlated with less sleep quality variability. However, given that the association between sleep quality variability and emotion reactivity is not robust, this finding should be interpreted with caution. No associations between trait-level emotion regulation constructs and poorer average sleep quality or presence of nightmares was found in Sample 1.

In Sample 2, within-person analyses demonstrate that poorer sleep quality predicted next-day highest-point negative affect intensity, but not next-day negative affect variability. Presence of nightmares was unrelated to next-day highest-point negative affect intensity or next-day negative affect variability. To describe these results further, poorer-than-usual sleep quality predicted higher next-day negative affect intensity. This finding is consistent with other intensive longitudinal examinations in adolescents and adds to a growing area of literature revealing a proximal association between various indices of sleep problems and heightened negative affect (Chiang et al., 2017; Evans et al., 2023; Kirshenbaum et al., 2022; Kouros & El-Sheikh, 2015; for review see Konjarski et al., 2018). Further, computed affect variables such as highest-point negative affect or negative affect variability are facets of emotion dynamics that are increasingly being used in EMA studies (Bentley et al., 2021; Evans et al., 2023; Silk et al., 2003; Silk et al., 2011), underscoring the promise of uncovering real-time variations and patterns of affect among youth. Altogether, implementing these methodological techniques should be undertaken to help clarify the dynamic proximal association between sleep problems and negative affect in youth.

Emotion regulation difficulties and SITBs

Third, we tested the association between emotion regulation and SITBs using between-person analyses in Sample 1, and within-person analyses in Sample 2, again due to the differing nature of existing datasets.

In Sample 1, between-person analyses evidenced no association between emotion regulation difficulties and NSSI behavior. These null findings are discrepant with previous studies which suggest that emotion regulation difficulties may increase risk for engagement in NSSI (Fox et al., 2015; Wolff et al., 2018). A possible explanation for this might be a broad range of measures that did not adequately assess difficulties with emotion regulation. Although the measures utilized in the current study assessed various facets of the emotion regulation process (reactivity, awareness), adequate assessment of specific difficulties with emotion regulation may be warranted to help clarify associations with NSSI. One specific measure that may be better suited to illuminate these nuances is the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004), which is a comprehensive assessment of six facets of emotion dysregulation. The DERS has been found to be significantly associated with depression, anxiety, and suicidal ideation in youth (Weinberg & Klonsky, 2009). A consideration for future research may be the utilization of a measure similar to the DERS that better encapsulates difficulties with emotion regulation. Furthermore, as previously noted with regards to Sample 1, since data were collected while adolescents were on an inpatient unit, there may be underreporting of NSSI behavior in this sample, which could impact the strength of observed associations between emotion regulation difficulties and NSSI behavior.

Within-person analyses from Sample 2 indicated that higher negative affect intensity predicted higher suicide ideation and NSSI thought intensity contemporaneously and at the next time-point (lagged effect). To further explain, higher-than-usual negative affect intensity was significantly associated with higher suicidal thought intensity and NSSI thought intensity at the same time point. Moreover, higher-than-usual negative affect intensity predicted higher suicidal thought intensity and NSSI thought intensity at the next time point. These findings corroborate the plethora of existing research substantiating a robust proximal association between negative affect intensity, and suicidal thought intensity and NSSI thought intensity (Dillon et al., 2021; Kuehn et al., 2022; Victor & Klonsky, 2014; Victor et al., 2019).

To summarize, we did not find evidence for between-person associations linking emotion regulation difficulties and NSSI behavior in Sample 1, whereas we did find support for a within-person association between negative affect intensity, and suicide ideation and NSSI thought intensity in Sample 2. One consideration for this divergence may be the difference between trait-level versus state-level emotion measurement and experiences. Sample 1 made use of trait-level emotion regulation measures which were collected at the baseline assessment, however, these measures are time-invariant and may only be distally linked to our SITB outcome of interest. In Sample 2, negative affect intensity was assessed using a real-time monitoring approach allowing for repeated, within day assessments that are time-varying and proximally linked to SITB outcomes. In addition, characterizing one's trait-level emotion regulation may differ from the in the moment state-level emotion experiences. It would be important for future research to explore the integration of distal and proximal measurement of emotion regulation and to clarify how these constructs can be most accurately assessed, especially as they relate to prediction of SITBs.

Emotion regulation as the mechanism linking sleep problems and SITBs

Last, we examined emotion regulation as a mechanism linking sleep problems (sleep quality, nightmares) and SITBs using within-person analytic approaches in both samples.

In Sample 1, we found no evidence for emotion regulation as a mechanism linking sleep problems and likelihood of engaging in NSSI behavior. Specifically, trait-like emotion regulation measures did not moderate the association between sleep problems and next-day NSSI behavior.

In Sample 2, findings were mixed. Results from contemporaneous models were somewhat consistent with hypotheses, such that on days when youth experienced nightmares, the contemporaneous association between within-person negative affect intensity and NSSI thought intensity was strengthened. It is possible that the presence of nightmares intensifies the existing link between negative affect and NSSI thought intensity. However, nightmares did not significantly moderate the relation between negative affect intensity and suicide ideation in contemporaneous models. Although nightmare presence and negative affect intensity are independently associated with suicide ideation in this sample, we did not find evidence for an interactive effect. The lack of interactive effect suggests that the link between negative affect intensity and suicide ideation is not dependent on presence of nightmares in this sample. In other words, higher within-person negative affect intensity significantly predicts higher suicidal thought intensity, regardless of the presence (or absence) of nightmares.

Further, no significant moderation effects were found when examining lagged effects between negative affect intensity, and suicide ideation and NSSI thought intensity. These null results are likely related to the number of observations included in lagged effect analyses and reduced statistical power to detect effects. Given that these aims were exploratory, it is promising that a preliminary investigation into this mechanistic relationship yielded significant findings for contemporaneous effects.

Limitations and future directions

The preliminary findings from the current study should be viewed in the context of several important limitations.

First, the sleep variables assessed in this study were exclusively derived from self-report sleep diary responses. In future research, it may be important to consider employing objective measurement of sleep patterns, such as actigraphy (a gold standard ambulatory assessment method for sleep, Meltzer et al., 2012). Utilization of an actigraphy device may allow for more refined assessment of specific sleep parameters such as total sleep time (actual time slept during a sleep period; Buysse et al., 2006) or sleep onset latency (time it takes to fall asleep, starting from the intention to fall asleep; Buysse et al., 2006). These additional sleep parameters may be relevant to further understanding the link between sleep problems and suicidal thoughts (Bernert et al., 2017; Hamilton et al., 2023; Littlewood et al., 2019) as indicated by other real-time monitoring studies using actigraphy.

Second, emerging research indicates that studies should consider moving beyond single-day assessments of sleep problems, and instead focus on how sleep over multiple, consecutive days may impact affect, and by extension SITBs. Importantly in youth, cumulative sleep debt, or restricted sleep over multiple consecutive days with limited opportunity to catch up on sleep, may have a deleterious effect on next-day affect (Shen et al., 2021). As a follow-up to null findings related to sleep problems and affect in the current study, future studies could also examine sleep problems over the course of multiple days (e.g., persistence of nightmares) to clarify the proximal association between sleep and affect in youth. Relatedly, studies that focus not only on the presence (or absence) of sleep problems, but also examine the intensity of sleep problems (e.g., nightmare intensity), may help uncover the impact of sleep problems on next-day functioning.

Third, both study samples consisted of participants who were predominantly female and white, limiting the generalizability of our findings to more diverse samples. A critical area for future research is to conduct studies designed specifically to understand the sleep-suicide risk association among youth who identify as racial/ethnic and gender/sexual minorities. Rates of suicide risk among racial/ethnic minority youth (Goldstein et al., 2021; Lindsey et al., 2019; Xiao et al., 2021) and gender/sexual minority youth (Liu et al., 2020; Pollitt & Mallory, 2021) are high and increasing, reflecting an imperative need to address significant mental health disparities impacting diverse youth. In addition, emerging research reflects findings suggesting greater sleep problems among racial/ethnic (El-Sheikh et al., 2022; Yip et al., 2022) and gender/sexual minority youth (Levenson et al., 2021), pointing to the importance of enhancing our understanding of potential mechanisms underlying the sleep-suicide association, particularly in diverse youth (Goldstein et al., 2021).

Finally, an analytical limitation of the current study was our inability to utilize advanced analytic techniques (e.g., multilevel structural equation modeling) to examine negative affect as a mediator of the association between sleep problems and SITBs in one integrative model, specifically in Sample 2. This approach was not used in this study due to limited statistical power in the current sample. Implementation of this analytic approach would allow for enhanced temporal granularity with regards to testing sleep problems as a true predictor of negative affect, and future research should aim to utilize this analytic approach in larger samples. Furthermore, in the current study, we assumed data were missing completely at random. It is possible that missing data could be related to person-level or day-level factors, which may bias results.

Clinical implications

Overall, our findings underscore the importance of examining mechanisms linking sleep problems and SITBs. Preliminary results point to sleep problems and negative affect intensity as potential proximal, modifiable risk factors for SITBs, and importantly, these risk factors may be amenable to intervention.

For example, evidence-based sleep interventions such as cognitive behavioral therapy for insomnia (CBT-I; Blake et al., 2017; Clarke et al., 2015) or the transdiagnostic sleep and circadian intervention (TranS-C; Dong et al., 2020; Harvey et al., 2018) are therapeutic approaches that target a range of sleep and circadian difficulties in youth. In addition, imagery rehearsal therapy (IRT) may be useful to address nightmares as a specific sleep problem. Although these sleep interventions have broadly shown promise in reducing sleep problems in youth (Blake et al., 2017; Clarke et al., 2015; De Bruin et al., 2015; Dong et al., 2020), and in some cases depression and anxiety symptoms (Blake et al., 2017; Clarke et al., 2015), no research to date has tested sleep interventions in youth with SITB outcomes (Blake & Allen, 2020).

Moreover, interventions targeting emotion regulation skills (managing negative affect intensity) may be beneficial for youth who experience frequent and intense emotional states, and exhibit difficulty managing these intense emotions. Dialectical behavior therapy (DBT) is a promising therapeutic intervention that targets difficulties with emotion regulation as an integral component of treatment. DBT has been implemented with high-risk adolescent populations, and initial findings from randomized clinical trials (RCT) indicate DBT may be efficacious in reducing suicide attempts and NSSI (McCauley et al., 2018; Mehlum et al., 2014). In a recent RCT, DBT was shown to impact emotion regulation as a mechanism through which DBT is hypothesized to lead to reductions in self-injurious behavior (Asarnow et al., 2021). Difficulties with emotion regulation appear to be a critical target for SITB prevention and intervention in youth.

CHAPTER VII

CONCLUSIONS

The overall goal of this study was to characterize the proximal associations between sleep problems and SITBs in two clinically high-risk samples by conducting secondary data analyses using data from two real-time monitoring studies. Results of this study provide more fine-grained evidence supporting the link between sleep problems and SITBs among high-risk youth.

Specifically, this is the first study to examine nightmares and NSSI (thoughts and behavior) using a temporally sensitive methodological approach in clinically high-risk youth. Most notably, this study found some preliminary support for emotion regulation as a mechanism linking sleep problems and SITBs in high-risk youth. Results revealed that presence of nightmares, a specific sleep problem, moderated the contemporaneous association between negative affect and NSSI thought intensity. Future research should attempt to replicate these findings in larger samples and may want to consider alternative analytical techniques to further explicate mechanisms linking sleep problems and SITBs in high-risk youth.

Ultimately, findings from this research using a real-time monitoring approach could help inform proximal, modifiable targets for intervention to reduce SITB risk in youth.

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APPENDIX A

UPPS-P SHORT-FORM MEASURE

The items that comprise the negative urgency subscale used in this study are listed below. Prior to computing the total subscale score, all items in this subscale will be recoded according to Cyders et al., 2014 such that 1=4, 2=3, 3=2, and 4=1.

Instructions: Below are a number of statements that describe ways in which people act and think. For each statement, please indicate how much you agree or disagree with the statement.

		Agree Strongly	Agree Some	Disagree Some	Disagree Strongly
6.	When I feel bad, I will often do things I later regret in order to make myself feel better now.	1	2	3	4
8.	Sometimes when I feel bad, I can't seem to stop what I am doing even though it is making me feel worse.	1	2	3	4
13.	When I am upset I often act without thinking.	1	2	3	4
15.	When I feel rejected, I will often say things that I later regret.	1	2	3	4

APPENDIX B

EMOTION REACTIVITY SCALE

Instructions: This questionnaire asks different questions about how you experience emotions on a regular basis. When you are asked about being ‘emotional,’ this may refer to being angry, sad, excited, or some other emotion. Please rate the following statements.

		Not at all like me	A little like me	Somewhat like me	A lot like me	Completely like me
1.	When something happens that upsets me, it's all I can think about it for a long time.	0	1	2	3	4
2.	My feelings get hurt easily.	0	1	2	3	4
3.	When I experience emotions, I feel them very strongly/intensely.	0	1	2	3	4
4.	When I'm emotionally upset, my whole body gets physically upset as well.	0	1	2	3	4
5.	I tend to get very emotional very easily.	0	1	2	3	4
6.	I experience emotions very strongly.	0	1	2	3	4
7.	I often feel extremely anxious.	0	1	2	3	4
8.	When I feel emotional, it's hard for me to imagine feeling any other way.	0	1	2	3	4
9.	Even the littlest things make me emotional.	0	1	2	3	4
10.	If I have a disagreement with someone, it takes a long time for me to get over it.	0	1	2	3	4
11.	When I am angry/upset, it takes me much longer than most people to calm down.	0	1	2	3	4
12.	I get angry at people very easily.	0	1	2	3	4

13.	I am often bothered by things that other people don't react to.	0	1	2	3	4
14.	I am easily agitated.	0	1	2	3	4
15.	My emotions go from neutral to extreme in an instant.	0	1	2	3	4
16.	When something bad happens, my mood changes very quickly. People tell me I have a very short fuse.	0	1	2	3	4
17.	People tell me that my emotions are often too intense for the situation.	0	1	2	3	4
18.	I am a very sensitive person.	0	1	2	3	4
19.	My moods are very strong and powerful.	0	1	2	3	4
20.	I often get so upset it's hard for me to think straight.	0	1	2	3	4
21.	Other people tell me I'm overreacting.	0	1	2	3	4

APPENDIX C

EMOTION REGULATION QUESTIONNAIRE FOR CHILDREN AND ADOLESCENTS

The items that comprise the expressive suppression subscale used in this study are listed below.

Instructions: Read each statement and respond using the boxes below. Select the response that best describes how you typically feel.

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
2. I keep my feelings to myself.	1	2	3	4	5	6	7
4. When I am feeling happy, I am careful not to show it.	1	2	3	4	5	6	7
6. I control my feelings by not showing them.	1	2	3	4	5	6	7
9. When I'm feeling bad (e.g., sad, angry, or worried), I'm careful not to show it.	1	2	3	4	5	6	7

APPENDIX D

COMPREHENSIVE INVENTORY OF MINDFULNESS EXPERIENCES-ADOLESCENTS

The items that comprise the awareness of internal experiences subscale used in this study are listed below.

Instructions: Select the answer that fits you best based on the last two weeks.

		Never true	Rarely true	Sometimes true	Often true	Always true
1.	When my mood changes, I notice it straight away.	1	2	3	4	5
12.	When I talk to other people I notice what emotions I am feeling (for example, if I am angry or happy).	1	2	3	4	5
26.	I notice the emotions I am feeling as they are happening.	1	2	3	4	5

APPENDIX E

DISTURBING DREAMS AND NIGHTMARE SEVERITY INDEX

The items that comprise the Disturbing Dreams and Nightmare Severity Index used in this study are listed below.

1. How often do you have disturbing dreams and/or nightmares?
    a. *Never*
    b. *Yearly*
        i. How many nights in a year do you have disturbing dreams and/or nightmares?
        ii. How many disturbing dreams and/or nightmares do you have in a year?
    c. *Monthly*
        i. How many nights in a month do you have disturbing dreams and/or nightmares?
        ii. How many disturbing dreams and/or nightmares do you have in a month?
    d. *Weekly*
        i. How many nights in a week do you have disturbing dreams and/or nightmares?
        ii. How many disturbing dreams and/or nightmares do you have in a week?
2. Please estimate the number of months or years you have had disturbing dreams and/or nightmares: ____________ *months* ___________ *years*
3. On average, do your nightmares wake you up?
    a. *Never/Rarely (0)*
    b. *Occasionally (1)*
    c. *Sometimes (2)*
    d. *Frequently (3)*
    e. *Always (4)*
4. How would you rate the severity of your disturbing dreams and/or nightmare problem?
    a. *No Problem (0)*
    b. *Minimal Problem (1)*
    c. *Mild Problem (2)*
    d. *Moderate Problem (3)*
    e. *Severe Problem (4)*
    f. *Very Severe Problem (5)*
    g. *Extremely Severe Problem (6)*
5. How would you rate the intensity of your disturbing dreams and/or nightmares?
    a. *Not Intense (0)*
    b. *Minimal Intensity (1)*
    c. *Mild Intensity (2)*
    d. *Moderate Intensity (3)*
    e. *Severe Intensity (4)*
    f. *Very Severe Intensity (5)*
    g. *Extremely Severe Intensity (6)*

APPENDIX F

INSOMNIA SEVERITY INDEX

Instructions: For each question, please circle the number/response that best describes your answer. Please rate the current (i.e. last two weeks) severity of your insomnia problem(s).

	None	Mild	Moderate	Severe	Very severe
1. Please rate the current severity of your insomnia problem: Difficulty falling asleep.	0	1	2	3	4
2. Please rate the current severity of your insomnia problem: Difficulty staying asleep.	0	1	2	3	4
3. Please rate the current severity of your insomnia problem: Problems waking up too early.	0	1	2	3	4
4. How satisfied/dissatisfied are you with your current sleep pattern?	0 (Very Satisfied)	1 (Satisfied)	2 (Moderately satisfied)	3 (Dissatisfied)	4 (Very dissatisfied)
5. To what extent do you consider your sleep problem to interfere with your daily functioning (e.g., daytime fatigue, ability to function at school/work, concentration, memory, mood, etc.)?	0 (Not at all interfering)	1 (A little)	2 (Somewhat)	3 (Much)	4 (Very much interfering)
6. How noticeable to others do you think your sleeping problem is in terms of impairing the quality of your life?	0 (Not at all noticeable)	1 (Barely)	2 (Somewhat)	3 (Much)	4 (Very much noticeable)

7.	How worried/distressed are you about your current sleep problem?	0 (Not at all)	1 (A little)	2 (Somewhat)	3 (Much)	4 (Very much)

APPENDIX G

SUICIDAL THOUGHTS VARIABLE

The items that comprise the suicidal thoughts composite variable used in this study are listed below.

Variable	Question	Scale
Suicide desire	How intense is your desire to kill yourself right now?	0 = Absent/no desire, 1 = Present, but not at all intense to 5 = Extremely intense
Suicide intent	How strong is your intent to kill yourself right now?	0 = Absent/no intent, 1 = Present but not at all strong to 5 = Extremely strong

APPENDIX H

R ANALYTIC CODE FOR MULTILEVEL MODERATION ANALYSIS

The R analytic code included below was used to test Aim 5 (specifically hypothesis 5c) in Sample 2, which examined whether presence of nightmares moderated the relation between negative affect intensity and NSSI thought intensity. This model consists of three levels: observation (level 1), day (level 2), person (level 3). Negative affect intensity (predictor) and NSSI thought intensity (outcome) were included as observation-level variables and nightmare presence (moderator) was included as a day-level variable. We conducted a cross-level interaction (between negative affect intensity and nightmare presence) to test the moderation effect. Models were analyzed using random intercepts and random slopes (observation-level slopes were allowed to vary randomly at the person-level).

Package: lme4

Function: lmer()

Code: NSSI_thought_int_now ~ Nightmare_YN + NA_person_c + Nightmare_YN *NA_person_c + age_grand_c + (1|ID_day) + (NA_person_c|Subject_ID), REML = TRUE, data = data

Variable descriptions: NSSI_thought_int_now = NSSI thought intensity (continuous); Nightmare_YN = nightmares (absent = 0, present = 1); NA_person_c = negative affect intensity (continuous, person-centered); age_grand_c = Age at baseline (continuous, grand-mean centered); ID_day = day label variable for each subject; Subject_ID = subject ID variable that indicates membership at the person-level; REML = restricted maximum likelihood estimation

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Ph.D.	**Virginia Consortium Program in Clinical Psychology**, Norfolk, VA Clinical Psychology, 2026 (Expected)
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Background

Kinjal K. Patel is a third-year graduate student in the Virginia Consortium Program in Clinical Psychology. She is currently pursuing her Master's Degree in Psychology and in Spring 2026 her Ph.D. in Clinical Psychology. Kinjal is a graduate student in the Youth Risk and Resilience Lab of Dr. Catherine R. Glenn. Her current research interests are centered around identifying modifiable risk factors (e.g., sleep problems, emotion regulation) for youth suicide to better inform targeted interventions to reduce risk.

Selected Presentations

Patel, K.K., Kleiman, E.M., Glenn, C.R. (2023, May). *Negative affect is associated with self-injurious thoughts: A real-time monitoring study with high-risk adolescents*. Poster presentation at the 2023 Association for Psychological Science Convention, Washington, DC.

Luce, A.J., **Patel, K.K.,** Klonsky, E.D., Glenn, C.R. (2023, May). *Examining the Relationship Between Facets of Emotion Regulation and Non-Suicidal Self-Injury.* Poster presentation at the 2023 Association for Psychological Science Convention, Washington, DC.

Patel, K.K., Kleiman, E.M., Kearns, J.C., Glenn, C.R. (2023, April). *Sleep Problems and Self-Injurious Thoughts Among High-Risk Adolescents: Exploring the Role of Negative Affect Intensity*. Poster presentation at the 2023 Annual Meeting of the Society for Research on Adolescence, San Diego, CA.

Patel, K.K., Kleiman, E.M., Kearns J.C., Glenn, C.R. (2022, May). *Nightmares and Self-Injury Among High-Risk Adolescents: Examining the Role of Emotion Regulation.* Poster presentation at the 2022 Association for Psychological Science Convention, Chicago, IL.