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Mediators of the Insomnia-Suicidality Association

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ABSTRACT

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The severity of insomnia symptoms, including difficulty falling asleep and returning to sleep when awakened in the night, are major risk factors for more severe suicidality including suicidal ideation, suicide attempts, and death by suicide. There are several commonly observed gaps in the literature studying the association between insomnia and suicidality including little exploration of potential mediators, limited assessments of insomnia and suicidality, and a lack of sample diversity and representativeness. As such, the models that explain the association between insomnia and suicidality remain unclear and understudied. Evidence suggests that insomnia severity is related to suicidality severity, even when accounting for common risk factors of suicidality such as depression. Neurocognitive models propose that insomnia prevents natural recuperative functions of sleep, thereby contributing to daytime impairment such as emotion dysregulation. Joiner's suicide risk model may also outline potential psychosocial components that facilitate the association between insomnia and suicidality severity including thwarted belongingness and perceived burdensomeness. The purpose of this study is to investigate potential mediators that are associated with both insomnia severity and suicidality severity including emotion dysregulation, thwarted belongingness, and perceived burdensomeness with the use of validated measures in a nationally representative sample.

We collected data on demographics, insomnia severity, depression, anxiety, suicidality severity, emotional regulation, thwarted belongingness, and perceived burdensomeness from 428 participants through an online survey. Our first aim was to replicate previous findings of the insomnia-suicidality severity association through regression analyses between self-reported insomnia and suicidality severity whilst controlling demographic variables, self-reported depression severity, and self-reported anxiety severity. Our second aim is to understand the role emotion dysregulation, thwarted belongingness, and perceived burdensomeness play in the insomnia and suicidal severity association, even when accounting for depression, through testing our proposed mediation models using structural equation modeling.

Insomnia severity was related to greater suicidality, but not when accounting for depression severity. Emotion dysregulation and perceived burdensomeness partially mediated the association between insomnia severity and suicidality severity. When accounting for depression severity, emotion dysregulation and perceived burdensomeness fully mediated the association between insomnia severity and suicidality severity. Depression, perceived burdensomeness, and emotion dysregulation may explain the association between insomnia and suicidality severity. These difficulties may serve as potent markers for suicide risk and potential targets for treatment and suicide prevention.

Keywords: insomnia, suicidality, suicidal ideation, interpersonal theory of suicide, emotion regulation

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Mediators of the Insomnia-Suicidality Association

Rationale

Symptoms of insomnia, including difficulty going to sleep and going back to sleep when awakened in the night, are problems endorsed by nearly one-third of adults (American Psychiatric Association, 2013) and are commonly found in those who experience suicidality including suicidal ideation, suicide attempts, and death by suicide (Bernert et al., 2015; Roth, 2007). Concurrent with the rise in insomnia, the rate of suicide mortality in the United States has increased by 35% between 1999 and 2018 (Hedegaard et al., 2020). Given the association between symptoms of insomnia and suicidality, as well as the increased incidence rate of suicide, exploring potential mediators of the insomnia suicidality association may lead to a sleep-specific target for suicide prevention.

We propose three potential mediators that may play a role in the association of the insomnia-suicidality severity association: emotion dysregulation, thwarted belongingness, and perceived burdensomeness. Emotion regulation, as described by Gratz and Roemer (2004), is a multifaceted construct involving "the (a) awareness and understanding of emotions, (b) acceptance of emotions, (c) ability to control impulsive behaviors and behave in accordance with desired goals when experiencing negative emotions, and (d) ability to use situationally appropriate emotion regulation strategies flexibly to modulate emotional responses as desired in order to meet individual goals and situational demands" (p. 42). They further posit that the absence of any or all of these facets of emotion regulation indicates emotion dysregulation. Emotion dysregulation has been associated with both insomnia (Green et al., 2007; Jollant et al., 2011; Lanius et al., 2003; Mochcovitch et al., 2014) and suicidality (Anestis et al., 2011; Hatkevich et al., 2019; Heffer & Willoughby, 2018; Neacsiu et al., 2018; Rajappa et al., 2011)

and may play a role in the insomnia-suicidality association. The Joiner suicide risk model proposed several components that implicate risk for suicidality, including thwarted belongingness and perceived burdensomeness (Joiner, 2005; Van Orden et al., 2010). Thwarted belongingness is described as the basic human need of social connectedness being unmet and has been associated with insomnia (Chu et al., 2016; Chu et al., 2017; Hom et al., 2017) and suicidality (Barzilay et al., 2015; Christensen et al., 2013; Chu, Buchman-Schmitt, et al., 2017; Van Orden et al., 2006; Van Orden et al., 2008). Perceived burdensomeness is defined as one's perception of their burden on family members or other loved ones and has also been associated with insomnia (Hom et al., 2017; Hom et al., 2019) and suicidality (Barzilay et al., 2015; Christensen et al., 2013; Chu, Buchman-Schmitt, et al., 2017; Van Orden et al., 2006; Van Orden et al., 2008). These potential mediators warrant further investigation to understand the role they play in the insomnia-suicidality severity association.

This study aims to fill several commonly observed gaps in the literature on the association between symptoms of insomnia and suicidality. Many authors have suggested the importance of exploring other underlying causal factors (Franic et al., 2014; Hom et al., 2019; Woznica et al., 2015). Some authors have specifically recommended examining mediation of affective regulatory processes such as emotion regulation (Bozzay et al., 2016; Goldstein et al., 2008; Woosley et al., 2014), thwarted belongingness (Chu et al., 2016), and perceived burdensomeness (Hom et al., 2017; Nadorff et al., 2014) between insomnia and suicidality. Given that few models exist that attempt to explain the association between insomnia and suicidality, further investigation may inform targeted treatment for suicide prevention. In response to this gap in the literature, the current study aims to investigate emotion regulation,

perceived burdensomeness, and thwarted belongingness as previously sparsely explored potential mediators of the insomnia-suicidality association.

Several studies also noted being constrained by limited suicidality assessments (Bernert et al., 2015; Guo et al., 2017; Wong et al., 2016; Woosley et al., 2016) and insomnia assessments (Goldstein et al., 2008; Guo et al., 2017; Kay, Karim, et al., 2016; Kearns et al., 2018). Many cite the use of single-item assessments of these constructs as particularly problematic, as they may not fully or validly capture the constructs of interest. These authors suggest replication of their findings in the insomnia and suicidality association with validated measures that more accurately represent the constructs being tested. The use of one-to-few item measures with poor construct validity can be troublesome when interpreting findings and may introduce bias that limits the utility of the results. This study proposes the use of validated and widely used measures of suicidality and insomnia severity. Lastly, many authors point out the lack of diversity and representativeness of their samples (Becker et al., 2018; Chu, Hom, et al., 2017; Hom et al., 2019; Kearns et al., 2018; McCall et al., 2013) and recommend replication of their findings with more diverse and representative samples. Gathering a more diverse and representative sample will aid in preventing sampling bias and improve the generalizability of the findings.

In response to these gaps in the literature, this study collected validated measures of insomnia and suicidality severity in a large (n = 428), nationally representative sample to account for demographic variables and their association with symptoms of insomnia and suicidality to test potential mediators in this association. As insomnia is a common and modifiable risk factor for suicide, further investigation is needed to understand the nature of this relationship to inform effective targets of intervention for suicide prevention. This study aims to replicate previous findings of the insomnia and suicidality association while also filling gaps cited by previous

studies including investigating potential mediators for the insomnia and suicidality association that have received little attention, limited assessment of insomnia and suicidality, and lack of sample diversity and representativeness. Lastly, the models that explain the association between insomnia and suicidality remain unclear, and more research is needed to find potential neurocognitive and psychosocial mediators, such as emotion dysregulation, thwarted belongingness, and perceived burdensomeness in this relationship. The present study is needed as it aims to provide clarity on the relationship between insomnia and suicidality, informing effective treatment that may prevent suicide.

Literature Review

Insomnia and Suicidality

The relationship between symptoms of insomnia and suicidality has been specifically reported in peer-reviewed journals since at least 1975 (Barraclough & Pallis, 1975). In their meta-analysis of studies between 1975-2011 reporting on the relationship between sleep disturbance and suicidality, Pigeon et al. found overwhelming evidence suggesting that symptoms of insomnia are related to suicidal ideation and suicidal behavior (Pigeon et al., 2012). The following will briefly review the current literature concerning insomnia and suicidality as well as include an investigation of the association between symptoms of insomnia and suicidality.

Insomnia

Insomnia is a sleep disorder characterized by a marked difficulty with falling asleep, staying asleep, or waking up too early and being unable to return to sleep. To meet criteria for insomnia disorder, these sleeping difficulties must be associated with impairment in daily

function and must occur at least 3 days a week, for at least 3 months. This persistent difficulty with sleep must not be associated with inadequate opportunity for sleep nor any medical condition or drug use (American Psychiatric Association, 2013). About one-third of adults report having some symptoms of insomnia, and 6-10% of adults meet criteria for insomnia disorder. Of those who meet criteria for insomnia disorder, 45-75% of those go on to experience chronic insomnia in 1–7-year follow-ups (American Psychiatric Association, 2013). Insomnia disorder is second only to all anxiety disorders combined in 12-month prevalence across all mental disorders (Wittchen et al., 2011). Further, recent estimates suggest that between 40-50% of patients with insomnia also have a comorbid mental disorder (American Psychiatric Association, 2013). Cognitive-behavioral therapy for insomnia (CBT-I) is the frontline treatment for insomnia disorder and has shown to be effective when compared to pharmacological interventions (Jacobs et al., 2004; Morin et al., 1999; Omvik et al., 2008; Sivertsen et al., 2006) and controls (Edinger et al., 2007; Okajima et al., 2011; van Straten et al., 2014) on randomized controlled trials. Further, there is evidence to suggest that treatment of insomnia through CBT-I can reduce symptomatology of other comorbid mental disorders (Ashworth et al., 2015; Cassidy-Eagle et al., 2018; Clarke et al., 2015; Steinan et al., 2014). In all, insomnia is a common and treatable sleep disorder that is associated with an increased risk for negative psychological outcomes.

Insomnia has been associated with certain neurocognitive and psychosocial outcomes such as emotion dysregulation, thwarted belongingness, and perceived burdensomeness. Evidence suggests that certain brain regions are not naturally recuperated in those who experience symptoms of insomnia as explained by the local sleep deprivation model (Kay et al., 2016). These brain regions have implications for daytime impairments, such as emotion regulation (Green et al., 2007; Jollant et al., 2011; Lanius et al., 2003; Mochcovitch et al., 2014).

Those who experience emotion dysregulation may lack executive resources to effectively manage difficult feelings and may fantasize about or seek alternative methods to escape them (e.g., suicidal ideation or suicidal behaviors). Further, previous research suggests that symptoms of insomnia are associated with thwarted belongingness (Chu et al., 2016; Chu et al., 2017; Hom et al., 2017). Those who experience symptoms of insomnia may experience increased loneliness due to being awake when others are typically asleep. Daytime impairment due to symptoms of insomnia may also lead to difficulty engaging in meaningful social connections and create a sense of thwarted belonging. Finally, some evidence suggests an association between symptoms of insomnia and perceived burdensomeness (Hom et al., 2017; Hom et al., 2019). Daytime impairments due to symptoms of insomnia may lead to difficulty in accomplishing tasks related to work, school, or home responsibilities. This may create a sense of perceived liability or burden in those who experience symptoms of insomnia. Emotion regulation, thwarted belongingness, and perceived burdensomeness are associated with insomnia and may serve as important components to understand the association between insomnia and suicidality.

Suicidality Severity

Suicidality severity refers to a continuum of suicidality that includes, in order of increasing severity, suicidal ideation, suicidal behavior, and death by suicide. Suicidal ideation, as described by Harmer et al. (2021) is, “contemplations, wishes, and preoccupations with death and suicide” (p. 1). For this study, suicidal ideation also includes effortful thought about how one may take their own life (i.e., suicide plans). We define suicidal behavior as preparations for, attempts of, and deaths by suicide. Across 17 countries and 84,850 adults, one study reported a 9.2 % lifetime prevalence of suicidal ideation, 3.1% suicidal plans, and 2.7% suicide attempts (Nock et al., 2008). Further, this study found that 60% of those who experience suicidal ideation

will attempt suicide within a year of suicidal ideation onset (Nock et al., 2008). In a study of 506 adolescents and young adults, Miranda et al. (2014) reported that suicidal ideation frequency uniquely predicted suicide attempts, even after controlling for mental health diagnoses and previous suicide attempts after a 4–6-year follow-up when compared with other dimensions of suicidal ideation. This evidence suggests that the frequency of suicidal ideation is a key indicator of suicidality severity. Crucial to the treatment of suicidality is recognizing and understanding the associated risk factors including history of suicide attempts, mental disorders, chronic pain, and family history of suicidality (National Institute of Mental Health, 2021). Further exploration of risk factors for suicidality, especially frequency of suicidal ideation, is needed to inform interventions for the prevention of suicide.

Like insomnia, suicidality has also been associated with emotion dysregulation, thwarted belongingness, and perceived burdensomeness. Studies have reported that emotion dysregulation is associated with suicidal ideation severity (Anestis et al., 2011; Heffer & Willoughby, 2018; Neacsiu et al., 2018; Rajappa et al., 2011) and suicidal ideation presence (Hatkevich et al., 2019). These findings suggest that those who have difficulty managing their negative emotions are at increased risk of experiencing suicidal ideation. Evidence also suggests that thwarted belongingness and perceived burdensomeness are associated with suicidal ideation severity (Barzilay et al., 2015; Christensen et al., 2013) and suicidal behavior (Chu, Buchman-Schmitt, et al., 2017; Van Orden et al., 2006; Van Orden et al., 2008). Thwarted belongingness and perceived burdensomeness may lead to increased social isolation, separating an individual from the social support that may meet their interpersonal needs and that may serve as a buffer against suicidality. Emotion dysregulation, thwarted belongingness, and perceived burdensomeness may

have implications for suicidality and can potentially serve as targets for intervention of suicide prevention.

Insomnia and Suicidality Severity

Insomnia is a well-established risk factor for suicide and is associated with suicidality severity. One study found that in a community sample of early adolescents, problems falling asleep and staying asleep were associated with suicidal ideation presence (Franic et al., 2014). Further, in a brief longitudinal study, researchers found evidence to suggest that the significant relationship between symptoms of insomnia and suicidal ideation was unidirectional (symptoms of insomnia predicting suicidal ideation severity, but not vice-versa) (Zuromski et al., 2017). In a 14-year follow-up of a prospective cohort in Japan, Fujino et al. (2005) reported that the severity of the insomnia symptom of difficulty maintaining sleep was associated with an over two-fold increase in risk of death by suicide (*OR* = 2.4). In another sample of depressed middle-aged and older adults, Kay et al. (2016) found insomnia symptom severity to be associated with suicide attempts. Lastly, in a nationwide population-based retrospective cohort study of recently hospitalized suicide attempters, Lin et al. (2018) reported that the patients with insomnia were at 3.5 times higher suicide risk than patients without insomnia as measured by the International Classification of Diseases, Ninth Revision (ICD-9). Evidence suggests that insomnia confers risk for both suicidal ideation and behavior.

Further, there is evidence that the association between insomnia and suicidality persists even when accounting for depression and other common risk factors for suicidality. A study using a nationally representative survey found that the relationship between symptoms of insomnia and suicidal ideation frequency was not moderated by depression (Simmons et al., 2020). Two other studies reported that the statistically significant relationship between insomnia

and suicidal ideation severity persisted, even when accounting for depressive symptoms (Krakow et al., 2011; McCall et al., 2010). In non-treatment samples, reports have suggested the significant relationship between symptoms of insomnia and suicidal behavior (i.e., suicide attempts and death by suicide), even after accounting for psychiatric disorders that confer risk for suicidality (Becker et al., 2018; Carli et al., 2011; Fujino et al., 2005; Goldstein et al., 2008; Ribeiro et al., 2012; Wong et al., 2016). Interestingly, one study reported finding that symptoms of insomnia were stronger predictors of suicide attempt than depression and hopelessness in a military sample (Ribeiro et al., 2012). In a 10-year population-based study of elderly individuals, Bernert et al. (2014) reported that even after controlling for depressive symptoms, baseline sleep quality was associated with risk for death by suicide. Similarly, Bjørngaard et al. (2011) found in their 20-year follow-up study of Norwegian adults that self-reported sleep problems at baseline were associated with subsequent suicide risk, ranging from nearly two times to over four times the risk depending on the severity when compared to those with no sleeping problems (*OR* = 1.9-4.3). In their study, those who self-reported severe insomnia symptoms were independently at risk for suicide, even when controlling for mental disorders and alcohol use. In patients with depressive disorders, Chellappa & Araujo (2007) found that patients with comorbid insomnia were at greater risk for active suicidal ideation and specific suicide plans than compared to patients with depression and no significant insomnia complaints. Similarly, our research teams' recent research found that in psychiatric patients, self-reported insomnia was associated with suicide attempts and death by suicide. These results remained significant even after controlling for demographic features and psychiatric disorders commonly associated with suicidality (Simmons et al., 2021). In recently hospitalized suicide attempters, Ferentinos et al. (2016) reported that insomnia proximally predicted suicidal intent, even after adjusting for demographic

variables, medication use, psychiatric diagnoses, previous suicidality, time since last suicide attempt, and drug use. Given that the insomnia-suicidality association may persist when controlling for depression and other major risk factors for suicidality, further research is needed to explore other potential explanatory variables in this association.

Emotion Dysregulation as a Potential Neurocognitive Explanation of the Insomnia and Suicidality Association

Neurocognitive factors point to specific cognitive function impairment due to insomnia. Using local sleep deprivation as a model, we posit that nocturnal symptoms of insomnia (i.e., difficulty going to sleep and going back to sleep) prevent regional sleep restoration resulting in regional neurocognitive consequences related to the daytime impairment reported by individuals with insomnia. In their recent study comparing glucose metabolism rates in individuals with primary insomnia and good sleeper controls, Kay et al. (2016) found that patients with insomnia had less NREM sleep-wake differences in their relative glucose metabolism in the left middle frontal gyrus, left parietal cortex, fusiform/lingual/occipital gyri, posterior cingulate cortex, and precuneus when compared to good sleeper controls. Other fMRI studies of patients with insomnia have also found that activity and connectivity in the cingulate cortex (Dai et al., 2014; Li et al., 2014), fusiform gyrus (Dai et al., 2014) frontal gyrus (Dai et al., 2014; Li et al., 2014; Son et al., 2018), and precuneus (Li et al., 2014) significantly differ from healthy controls. The brain regions outlined here have implications for decision-making, integration of self-referential thought, memory, and affective processes. Studies have also found evidence that there are structural and functional differences in these brain regions, including the cingulate cortex (Benedetti et al., 2011; Pan et al., 2011; Pan et al., 2013; Peng et al., 2014; Shu et al., 2020;

Wagner et al., 2011), fusiform gyrus (Soloff et al., 2012), frontal gyrus (Giakoumatos et al., 2013; Hwang et al., 2010; Sarkinaite et al., 2021; Shu et al., 2020), precuneus (Shu et al., 2020), lingual gyrus (Giakoumatos et al., 2013), occipital gyrus (Benedetti et al., 2011), and parietal cortex (Giakoumatos et al., 2013; Hwang et al., 2010; Peng et al., 2014) in suicidal patients compared to controls. This overlap in brain regions between patients with insomnia and suicidal patients may have implications for the relationship between insomnia and suicidal ideation, suicidal behaviors, and suicide risk.

There is evidence to suggest that deficits in the brain regions affected by insomnia may also lead to emotion dysregulation. In their review of the neurophysiology of emotion dysregulation in patients with bipolar disorder, Green et al. (2007) found that cingulate regions of the brain inhibited emotional and cognitive control. Similarly, another study found that cingulate gyrus activation played a significant role in working memory, attention to negative stimuli, and rumination (Jollant et al., 2011). In patients with PTSD, Lanius et al. (2003) found that the patients showed significantly less activation of the cingulate gyrus in memory recall of traumatic, sad, and anxious experiences compared to controls. In another review of fMRI studies of patients with generalized anxiety disorder, Mochcovitch et al. (2014) found that the patients with anxiety exhibited hypoactivation in the cingulate cortex during emotion regulation tasks. Thus, evidence suggests that those who experience insomnia are at greater risk for emotion dysregulation. This association may reflect consequences of insomnia due to local sleep deprivation in brain regions governing emotion regulation. Given the overlap between brain regions affected by insomnia, suicidality, and emotional dysregulation, we posit that further investigation is warranted to determine to what extent emotional dysregulation plays a role in this relationship.

Interpersonal Needs as Potential Psychosocial Explanations of the Insomnia and Suicidality Association

Joiner's suicide risk model may outline potential psychosocial models that facilitate the association between insomnia and suicidality. The interpersonal theory of suicide (IPTS) posits that three major factors contribute to the risk of suicidality: thwarted belongingness, perceived burdensomeness, and acquired capability (Joiner, 2005; Van Orden et al., 2010). Thwarted belongingness refers to the basic human need of social connectedness being unmet. Thwarted belonging is further characterized as comprising of loneliness and a lack of caring interpersonal relationships. Perceived burdensomeness refers to one's perception of their burden on family members or other loved ones. According to Van Orden et al. (2010), this could refer to someone seeing themselves as a liability to others, as well as self-hatred. Van Orden et al. (2010), describe thwarted belongingness and perceived burdensomeness as a "dynamic cognitive-affective state[s]" that can be influenced by both interpersonal and intrapersonal factors (p. 10). Thwarted belongingness and perceived burdensomeness are psychosocial phenomena related to unmet interpersonal needs that may confer risk for suicidality.

Thwarted belongingness and perceived burdensomeness are described as psychological mechanisms contributing to suicidality. Van Orden et al. (2006; 2008), demonstrated that self-reported thwarted belongingness and perceived burdensomeness have a significant association with suicidal ideation severity and suicidal behavior. Further, these two risk factors in conjunction with hopelessness that these perceptions will never change, are posited to increase the risk of a desire to die by suicide. A recent meta-analysis' results suggested a modest but significant effect size for thwarted belongingness and perceived burdensomeness being

associated with suicidal ideation as well as prior suicide attempts (Chu et al., 2017). Some other studies have also suggested that thwarted belongingness and perceived burdensomeness predict suicidal ideation (Barzilay et al., 2015; Christensen et al., 2013). In a study of the role of thwarted belongingness in the insomnia and suicidal ideation association, Chu et al. (2016) found that insomnia led to increased risk of loneliness and that loneliness may play a role in explaining the between insomnia and suicidality. Thwarted belongingness and perceived burdensomeness are risk factors for suicidality that warrant further investigation into their role in the insomnia suicidality association.

Further research has begun to explore if the psychological mechanisms described in the IPTS explain the association between insomnia and suicidality. In two studies with a sole focus on the mediating effect of thwarted belongingness on the association between insomnia and suicidality, both found that thwarted belongingness mediated the relationship between insomnia and suicidality. These two studies also reported that greater insomnia severity was associated with greater self-reported severity of thwarted belongingness and suicidality, even after accounting for symptoms of anxiety (Chu et al., 2016; Chu, Hom, et al., 2017). With their longitudinal design, Chu et al. (2017) also found that insomnia did not mediate the relationship between thwarted belongingness and suicidality, further supporting the specificity of this relationship. A couple of studies found that thwarted belongingness and perceived burdensomeness accounted for the relationship between insomnia and suicidal ideation cross-sectionally, but that this relationship was not consistent in their longitudinal model (Hom et al., 2017; Hom et al., 2019). The second study found that the relationship between insomnia and suicidal behavior was not directly mediated by thwarted belongingness and perceived burdensomeness, instead, insomnia was related directly to depression which was indirectly

related to increased risk of suicidal behavior through thwarted belongingness and perceived burdensomeness (Britton et al., 2019). There is evidence to suggest that thwarted belongingness and perceived burdensomeness play a role in the insomnia and suicidality association, but further research is needed to replicate and extend these findings.

Aims and Hypotheses

Aim 1

Our first aim is to replicate previous findings of the association between insomnia and frequency of suicidal ideation in a large, nationally representative sample with validated measures.

Hypothesis 1

We hypothesize that insomnia as measured by the Insomnia Severity Index (ISI), and severity of suicidality, as measured by the Frequency of Suicidal Ideation Index (FSII), will be significantly associated even after accounting for demographic variables and self-reported depression (PROMIS-Depression) and anxiety (PROMIS-Anxiety) severity.

Aim 2

Our second aim is to understand if emotion dysregulation, thwarted belongingness, and perceived burdensomeness play a mediating role in the insomnia-suicidal ideation severity association, even when accounting for depression.

Hypothesis 2a

We hypothesize that greater insomnia severity, as measured by the Insomnia Severity Index (ISI), will be associated with suicidal ideation severity, as endorsed on the Frequency of Suicidal Ideation Index (FSII). We further hypothesize that this association will be partially

mediated by emotion dysregulation, as measured by the Difficulties in Emotion Regulation Scale (DERS), thwarted belongingness, as measured by a component score on the Interpersonal Needs Questionnaire (INQ), and perceived burdensomeness, as measured by a component score on the Interpersonal Needs Questionnaire (INQ) (Figure 1).

Hypothesis 2b

We hypothesize that the partial mediation of emotion dysregulation, thwarted belongingness, and perceived burdensomeness in the association between insomnia severity and suicidality severity will persist after accounting for depression, as measured by the Patient-Reported Outcomes Measurement Information System (PROMIS) Emotional Distress – Depression – Short Form (Figure 2).

Methods

Participants

We collected data from 428 participants in an online survey through Qualtrics. This number of participants was determined through previous study designs as well as power analyses. Previous cross-sectional mediational studies investigating the role components of the IPTS play in the association between insomnia symptoms and suicidality have used sample sizes of 552 college students (Chu et al., 2016), 937 United States (U.S.) military service members, 3,386 Army recruiters, 417 military veterans (Hom et al., 2017), 469 U.S. undergraduate students, 352 adult mental health outpatients, 858 U.S. firefighters (Chu, Hom, et al., 2017), 747 undergraduate students, 604 undergraduate students (Nadorff et al., 2014), and 151 adolescent psychiatric inpatients (Zullo et al., 2017). Further, our power analysis found that a sample of 400 participants would allow us to distinguish small to medium effect sizes ($f^2 = 0.04$) with .85

power (see figures 3 and 4) (G*Power 3). Given previous studies' sample sizes and sample make-up and our power analyses, we suggest that a nationally representative sample of 400 individuals is sufficient for our study and offers a meaningful addition to the literature.

We collected four separate groups of at least 100 participants for each of the four levels of insomnia severity according to the ISI. The only inclusion criterion for this study was being an adult (18 years and older) to increase the generalizability of our findings. Participants who endorsed having been diagnosed with sleep apnea were excluded from the study to increase the likelihood that self-reported insomnia severity is measuring insomnia instead of sleep apnea. Participants were recruited by a Qualtrics team and placed into one of four groups: no clinically significant insomnia (ISI = 0-7) (n = 106), subthreshold insomnia (ISI = 8-14) (n = 107), clinical insomnia (moderate severity) (ISI =15-21) (n = 108), or clinical insomnia (severe) (ISI = 22-28) (n = 103). This recruitment methodology allowed us to maximize the variability of insomnia severity in our sample. The Qualtrics team ensured that demographic features were stratified across all four groups to avoid sampling bias. The Qualtrics team also gathered a sample that was nationally representative by age, race, and gender based on United States census data to increase the generalizability of our findings. Table 1 shows demographic features in the overall sample as well as across insomnia severity groups. The total sample size was 424 after removing four participants for completing the survey in notably short times (<490 seconds). In the sample, 52% identified as female, 12% endorsed Hispanic, Latino, or Spanish origin, 58% were white, and 46% endorsed never being married. Participants with education levels from less than a high school diploma to doctorate and professional degrees, ages from 18-89, and an annual income from <$10,000 to >$190,000 were represented.

Procedures

Participants were required to agree to an electronic informed consent form to respond to an anonymous survey that explained the risks of the survey, namely, that responding to items about their mental health may be troubling or distressing. To protect the participants, we provided national suicide prevention hotlines and texting services at the beginning and end of the survey. The sample was then administered several measures through the Qualtrics survey that collected data on demographics, insomnia severity, suicidality severity, emotional regulation, thwarted belongingness, and perceived burdensomeness as described below.

Measures

Main Variables of Interest

Insomnia Severity. Participants' insomnia severity was measured with the ISI as the main independent variable for all analyses. The ISI is a 7-item self-report measure of the severity of nocturnal symptoms of insomnia as well as daytime impairment due to their current sleeping difficulties within the last two weeks (i.e., "How satisfied/dissatisfied are you with your current sleep pattern?"). All items are scored on a Likert scale from 0 to 4, with higher responses indicating greater insomnia severity. Total scores are calculated by summing the responses of the 7 items together. The ISI total score was used as the main independent variable to determine insomnia severity for all analyses.

In their validation study, Bastien et al. (2001) reported in their first of two studies an acceptable internal consistency at a .74 alpha coefficient. They cited acceptable item-total correlations with an average correlation of .54. In their second study, they reported a mean item-total correlation of .56 at pretreatment, .69 at post-treatment, and .72 at follow-up. They further reported good internal consistency with alpha coefficients ranging from .76 at baseline to .78 at

follow-up. Regarding convergent validity, ISI items were compared to corresponding sleep diary variables (i.e., sleep-onset, wake after sleep onset, early morning awakenings, and total score vs. sleep efficiency) and correlations between the two ranged from $r = 0.32$-0.55 pre-treatment to $r = 0.50$-0.91 post-treatment ($p < 0.05$ for all variables). Another study reported that the ISI total score significantly correlated with the Pittsburgh Sleep Quality Index (PSQI) total score at $r = .80$, $p < 0.005$, also suggesting acceptable convergent validity (Morin et al., 2011). Bastien et al. (2001) also reported that ISI scores were sensitive to change using sleep diary change over time as a reference for all corresponding sleep diary variables at both pre-treatment and follow-up ($p < 0.05$ for all sleep diary variables). Further, Morin et al. (2011) reported that ISI scores for patients receiving treatment pre-and post-treatment found that patients who were rated as "moderately improved" reported an average decrease of 8.4 points (95% CI: -7.2, -9.5) while those who were rated as "markedly improved" reported an average decrease of 9.9 points (95% CI: -8.7, -11.0). In their principal components analysis, Bastien et al. (2001) reported three components (impact, severity, and satisfaction) that explained 72% of the variance in ISI scores.

Emotion Regulation. Participants' emotion regulation was measured through the DERS to understand its role in the insomnia-suicidal ideation association. The DERS is a 36-item self-report measure that asks participants to indicate the frequency of experiences they have that are related to emotion regulation (i.e., "I am clear about my feelings," or "When I'm upset, I acknowledge my emotions"). All items are scored on a Likert scale from 1 ("almost never") to 5 ("almost always"). There are several reversed scored items, with higher scores indicating greater difficulty with emotion dysregulation. Six subscales are calculated through the sum of a subset of items. These subscales are nonacceptance of emotional responses, difficulty engaging in goal-directed behavior, impulse control difficulties, lack of emotional awareness, limited access to

emotion regulation strategies, and lack of emotional clarity. For this study, total scores from the DERS were used as a mediator variable to determine how emotion regulation difficulties play a role in the insomnia and suicidal ideation frequency association.

Gratz & Roemer (2004) completed an exploratory factor analysis and found evidence that six factors accounted for 56% of the variance of the measured variables. They further reported that the DERS had excellent internal consistency, citing an alpha coefficient of 0.93. All but two items on the DERS were cited as having item-total correlations above $r = 0.30$. Regarding convergent validity, the DERS total score was found to correlate with the Negative Mood Regulation Scale (a commonly used measure of emotion regulation) at $r = 0.69$, $p < 0.01$. Gratz & Roemer (2004) also reported acceptable predictive validity for the DERS by citing DERS total score correlating with measures of self-harm ($r = 0.20$, $p < 0.01$ for women, $r = 0.26$, $p < 0.05$ for men) and intimate partner abuse ($r = 0.34$, $p < 0.01$ for men). Lastly, Gratz & Roemer (2004) demonstrated good test-retest reliability over 4-8 weeks for DERS total score ($\rho = .88$, $p < 0.01$).

Interpersonal Needs (Thwarted Belongingness and Perceived Burdensomeness). Participants' level of thwarted belongingness and perceived burdensomeness were measured through the INQ to determine the role of interpersonal needs in the insomnia-suicidal ideation association. The INQ is a 15-item self-report measure that asks participants questions about how they think about themselves and other people (i.e., "The days, the people in my life would be better off if I were gone," and "These days, I feel disconnected from other people"). All items are scored on a Likert scale from 1 ("Not at all true for me") to 7 ("Very true for me"). Several items on the INQ are reversed scored. The sum of the first 6 items creates a subscale for perceived burdensomeness, while the last 9 items create a subscale for thwarted belongingness. Higher scores indicate greater perceived burdensomeness or thwarted belongingness. The sum of these

two separate subscales were used as a mediator variable to gauge how interpersonal needs play a role in the insomnia and suicidal ideation frequency association.

Van Orden et al. (2012) reported in three separate samples the goodness of fit of the confirmatory factor analysis of the INQ, citing CFI values between 0.864 and 0.915, TLI between 0.838 and 0.898, RMSEA between 0.055 and 0.075, and SRMR between 0.052 and 0.072. Van Orden et al. (2012) also reported convergent validity for both thwarted belongingness and perceived burdensomeness in a sample of younger adults. They noted that thwarted belongingness significantly correlated with all four similar constructs (lonely $r = 0.914$, social support $r = -0.756$, self-liking $r = -0.466$, and relatedness $r = -0.842$). They further reported that perceived burdensomeness correlated with three of the four similar constructs (autonomy $r = -0.176$, responsibility to family $r = -0.153$, and self-competence $r = -0.261$). They reported that only perceived burdensomeness displayed discriminant validity in this sample, only significantly correlating with one of the four dissimilar constructs. Similar findings were reported with a sample of older adults, indicating supporting evidence for convergent validity, and some evidence for divergent validity for both subscales. Lastly, Van Orden et al. (2012) reported that those who endorsed greater odds of suicidal ideation also had an associated increase in both thwarted belongingness ($OR = 1.59$, $p < 0.01$) and perceived burdensomeness ($OR = 2.21$, $p < 0.01$). Further, they found that INQ scores predicted higher suicidality scores a month later for both thwarted belongingness (95% CI $IRR = 1.007\text{-}1.009$) and perceived burdensomeness (95% CI $IRR = 1.04\text{-}1.90$).

Frequency of Suicidal Ideation. Participants' frequency of suicidal ideation was measured through the FSII to act as the dependent variable for all analyses. The FSII is a 5-item self-report measure that asks participants to assess the frequency of suicidal ideation-related

experiences (i.e., “Over the past year, how often have you thought about hurting yourself?” or “Over the past year, how often have you wished that you did not exist?”). Items are scored on a Likert scale from 1 (“Never”) to 5 (“Almost every day”). Higher scores are indicative of more frequent suicidal ideation. Total scores of this measure were used to act as the dependent variable in our analyses to understand the association between insomnia and frequency of suicidal ideation.

In their principal-axis factor analysis, Chang & Chang (2016) found a single factor (suicidal ideation frequency) which accounted for 86.96% of the total variance with all items loading at >.85 onto the factor. They also reported great internal consistency with an alpha coefficient of 0.96. Chang & Chang (2016) noted that the FSII displayed excellent convergent validity as it correlated with various suicide risk measures (Adult Suicidal Ideation Questionnaire $r = 0.88$, $p < 0.001$, Suicidal Behaviors Questionnaire-Revised $r = 0.85$, $p < 0.001$, and the Beck Depression Inventory $r = 0.54$, $p < 0.001$) and negatively correlated with suicide protective measures (Positivity Scale $r = -0.47$, $p < 0.001$, Flourishing Scale $r = -0.45$, $p < 0.001$, and the Positive Affectivity Scale $r = -0.32$, $p < 0.001$). Lastly, Chang & Chang reported moderate test-retest reliability over a 6-week period ($\rho = 0.61$).

Potential Confounding Variables

Demographics. Demographic data included gender (woman, man, non-binary, other), age (18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, 85-89), Hispanic, Latino, or Spanish origin, race (American Indian/Alaska Native, Asian, Black/African American, Native Hawaiian or Other Pacific Islander, White, from multiple races, other), education (less than a high school diploma, high school degree or equivalent (e.g., GED), some college, associate degree, bachelor’s degree, master’s degree, professional degree, doctorate), income (<$10,000,

>$10,000-$40,000, $40,001-$90,000, $90,001-$190,000, >$190,000), and marital status (never married, married, widowed, divorced, separated). Participants were asked to report the medications they are currently taking in a fill-in-the-blank format and any mental disorders they are currently and formally diagnosed with (depressive, psychotic, anxiety, personality, substance use, bipolar, neurodevelopmental, neurocognitive, trauma-related, obsessive-compulsive, and somatic disorders) from a multi-selection item. Demographic variables were used as control variables in our regression analysis.

Depression. The Patient-Reported Outcomes Measurement Information System (PROMIS) Emotional Distress – Depression – Short Form was used to measure depression severity to control for this confounding variable. This 8-item self-report measure was created to monitor treatment progress in clinical settings and asks participants to indicate the frequency of face-valid depressive symptoms they have experienced throughout the past 7 days (i.e., "I felt worthless," or "I felt that I had nothing to look forward to"). Items are measured on a 5-point Likert scale (0 is "never", 5 is "always"). Raw scores are determined by summing all 8 responses together. A t-score conversion table is provided with the measure to determine depression severity. The total score from this measure was used to determine depression severity and control for this confounding variable in our regression and mediational analyses.

Pilkonis et al. (2011) report exceptional internal consistency of this measure, citing a .83 mean adjusted item-total correlation and a .95 alpha coefficient. They further cited excellent model fit in their one-factor confirmatory factor analysis (CFI = 0.99, TLI = 0.99, RMSEA = 0.11). Regarding convergent validity, Pilkonis et al. (2011) reported the PROMIS Emotional Distress – Depression – Short Form had a correlation value of r = .83 when using the Center for Epidemiologic Studies Depression Scale (CES-D) as the convergent measure, indicating good

convergent validity. Schalet et al. (2016) found that the PROMIS Emotional Distress – Depression – Short Form was also sensitive to change in intervention studies when therapy and/or psychotropic medications were used in treatment, citing an average of 6.7-point decrease in the major depressive disorder group (n = 196) scores ($p \leq .001$) after a 3-month follow up. Further, in patients who had cancer that worsened throughout treatment (n = 38), there was an average of 3.0-point increase in scores ($p \leq .001$) after a 6–12-week follow-up.

Anxiety. The PROMIS Emotional Distress – Anxiety – Short Form was used to measure anxiety severity to control for this confounding variable. This 7-item self-report measure was created to monitor treatment progress in clinical settings and asks participants to indicate the frequency of face-valid anxiety symptoms they have experienced throughout the past 7 days (i.e., "I felt fearful," or "I felt anxious"). Items are measured on a 5-point Likert scale (0 is "never", 5 is "always"). Raw scores are determined by summing all 7 responses together. A t-score conversion table is provided with the measure to determine anxiety severity. The total score from this measure was used to determine anxiety severity and control for this confounding variable in our regression analysis.

Pilkonis et al. (2011) report exceptional internal consistency of this measure, citing a .79 mean adjusted item-total correlation and a .93 alpha coefficient. They further cited excellent model fit in their one-factor confirmatory factor analysis (CFI = .99, TLI = .99, RMSEA = .05). Regarding convergent validity, Pilkonis et al. (2011) reported the PROMIS Emotional Distress – Anxiety – Short Form had a correlation value of r = .80 when using the Mood and Anxiety Symptom Questionnaire (MASQ) as the convergent measure, indicating good convergent validity. Schalet et al. (2016) found that the PROMIS Emotional Distress – Anxiety – Short Form was also sensitive to change in intervention studies when therapy and/or psychotropic

medications were used in treatment, citing an average of 6.3-point decrease in the major depressive disorder group (n = 196) scores ($p \leq .001$) after a 3-month follow-up. Further, in patients who had cancer that worsened throughout treatment (n = 38), there was an average of 1.9-point increase in scores ($p < 0.05$) after a 6–12-week follow-up (Schalet et al., 2016).

Analyses

Multiple regression analyses between self-reported insomnia and suicidality severity were used to gauge the strength of this relationship whilst controlling for demographic variables, depression, and anxiety. We used structural equation modeling to perform an uncontrolled mediational analysis to understand the role emotion regulation, thwarted belongingness, and perceived burdensomeness play in the relationship between insomnia severity and suicidality severity. We then used a controlled mediational model to account for depression in the previously described analysis (see figures 1 & 2). The mediational models are saturated. All analyses were completed in STATA 17 (StataCorp. 2021. *Stata Statistical Software: Release 17*. College Station, TX: StataCorp LLC).

Results

Aim 1

Hypothesis 1

Results for the uncontrolled and controlled multiple regression models of aim 1 analyses are found in Table 2. In both analyses, we controlled for demographic variables (age, gender, race-ethnicity, educational attainment, and marital status). In the controlled model of aim 1, we controlled for demographic variables as well as depression and anxiety severity. In our uncontrolled model ($F_{(32,391)} = 5.39$, $p < 0.001$, $R^2 = 0.306$), we found that insomnia severity was associated with increased suicidality severity when accounting for demographic variables ($p <$

0.001, *CI* = 0.19 – 0.31). Further, endorsing an age of 55-64 ($p = 0.039$, *CI* = -3.92 – -0.10), 65-74 ($p = 0.004$, *CI* = -5.03 – -0.96), or 75-84 ($p = 0.017$, *CI* = -6.03 – -0.61) was associated with a decrease in suicidality severity. Lastly, endorsing Black/African American as race-ethnicity was associated with a decrease in suicidality severity ($p = 0.037$, *CI* = -2.71 – -0.09).

In the controlled model ($F_{(32,389)} = 11.37$, $p < 0.001$, $R^2 = 0.498$), insomnia was not significantly associated with suicidality severity when controlling for anxiety and depression severity ($p = 0.836$, *CI* = -0.06 – 0.08). As such, evidence for hypothesis 1 is only partially supported. Further, endorsing American Indian/Alaska Native ($p = 0.009$, *CI* = 0.91 – 6.37) or multiple races ($p = 0.042$, *CI* = 0.07 – 3.92) as race-ethnicity was associated with an increase in suicidality severity. Depression severity was also associated with an increase in suicidality severity ($p < 0.001$, *CI* = 0.32 – 0.50).

Aim 2

Hypothesis 2a

Results for the structural equation models of aim 2 analyses are found in Figures 1 and 2. In both models, we tested whether the association between insomnia severity and suicidality severity was mediated by emotion regulation, thwarted belongingness, and perceived burdensomeness using structural equation modeling with maximum likelihood estimation. In the controlled model for aim 2, we accounted for depression severity in addition to emotion regulation, thwarted belongingness, and perceived burdensomeness. Chi-squared fit statistics for the uncontrolled model was $\chi^2 (10, N = 424) = 1195.79$, $p < 0.001$ and the controlled model was, $\chi^2 (15, N = 424) = 1705.86$, $p < 0.001$. Both the uncontrolled and controlled models were saturated. We report unstandardized beta values.

Regarding the direct effects in the uncontrolled model, insomnia severity was significantly associated with emotion regulation ($\beta = 1.95$, $p < 0.001$), thwarted belongingness ($\beta = 0.73$, $p < 0.001$), and perceived burdensomeness ($\beta = 0.52$, $p < 0.001$). Further, emotion regulation ($\beta = 0.03$, $p < 0.001$) and perceived burdensomeness ($\beta = 0.35$, $p < 0.001$) were significantly associated with suicidality severity while thwarted belongingness ($\beta = 0.02$, $p = 0.137$) was not. The indirect effects for emotion regulation ($\beta = 0.06$, $p = 0.001$) and perceived burdensomeness ($\beta = 0.18$, $p < 0.001$) were significant while the indirect effect for thwarted belongingness ($\beta = 0.02$, $p = 0.142$) was not. Regarding the association between insomnia and suicidality severity, the direct effect ($\beta = 0.05$, $p = 0.033$), indirect effect ($\beta = 0.26$, $p < 0.001$), and the total effect ($\beta = 0.30$, $p < 0.001$) were significant. The ratio of the indirect effect to the total effect between insomnia severity and suicidality severity was 0.84, suggesting that 84% of the variance in the total effect was explained by the mediator variables. These results suggest that the association between insomnia severity and suicidality severity is partially mediated by emotion regulation and perceived burdensomeness, partially supporting hypothesis 2a.

Hypothesis 2b

Regarding the direct effects in the controlled model, insomnia severity was significantly associated with emotion regulation ($\beta = 0.38$, $p = 0.010$), but not with thwarted belongingness ($\beta = -0.01$, $p = 0.931$) nor perceived burdensomeness ($\beta = -0.04$, $p = 0.570$). Further, emotion regulation ($\beta = 0.02$, $p = 0.044$) and perceived burdensomeness ($\beta = 0.34$, $p < 0.001$) were significantly associated with suicidality severity, while thwarted belongingness ($\beta = 0.01$, $p = 0.411$) was not. The indirect effects in the insomnia-suicidality severity path for emotion regulation ($\beta = 0.01$, $p = 0.111$), thwarted belongingness ($\beta = 0.00$, $p = 0.931$), and perceived burdensomeness were not significant ($\beta = -0.01$, $p = 0.570$).

The direct effect between insomnia severity and depression severity ($\beta = 0.77$, $p < 0.001$) was significant. Further, the direct effects between depression severity and suicidality severity ($\beta = 0.10$, $p < 0.001$), emotion regulation ($\beta = 2.05$, $p < 0.001$), thwarted belongingness ($\beta = 0.96$, $p < 0.001$), and perceived burdensomeness ($\beta = 0.73$, $p < 0.001$) were significant. The indirect effect in the insomnia-suicidality path through depression was significant ($\beta = 0.08$, $p = 0.001$). The indirect effects in the insomnia-mediator paths through depression were significant for emotion regulation ($\beta = 1.57$, $p < 0.001$), thwarted belongingness ($\beta = 0.73$, $p < 0.001$), and perceived burdensomeness ($\beta = 0.56$, $p < 0.001$). The indirect effects for the depression-suicidality paths through the mediator variables were significant for emotion regulation ($\beta = 0.04$, $p = 0.045$) and perceived burdensomeness ($\beta = 0.24$, $p < 0.001$), but not thwarted belongingness ($\beta = 0.01$, $p = 0.412$).

Regarding the association between insomnia and suicidality severity, the direct effect ($\beta = 0.01$, $p = 0.624$) was not significant while the indirect effect ($\beta = 0.29$, $p < 0.001$) and the total effect ($\beta = 0.30$, $p < 0.001$) were significant. The ratio of the indirect effect to the total effect between insomnia severity and suicidality severity was 0.96, suggesting that 96% of the variance in the total effect was explained by the mediator variables. These results suggest that the association between insomnia severity and suicidality severity is mediated by emotion regulation and perceived burdensomeness through depression severity, partially supporting hypothesis 2b.

Discussion

Our first aim was to replicate previous findings of the association between insomnia and frequency of suicidal ideation in a large, nationally representative sample with validated measures. We hypothesized that insomnia and suicidality severity would be significantly

associated even after accounting for demographic variables and self-reported depression and anxiety severity. We found that insomnia severity was associated with suicidality severity when controlling for demographic features, but not when accounting for depression severity. Our findings partially support our first hypothesis. Our second aim was to understand if emotion dysregulation, thwarted belongingness, and perceived burdensomeness played a mediating role in the insomnia-suicidality severity association, even when accounting for depression. First, we hypothesized that the association between insomnia and suicidality severity would be partially mediated by emotion dysregulation, thwarted belongingness, and perceived burdensomeness. We found that only emotion regulation and perceived burdensomeness partially mediated the association between insomnia severity and suicidality severity, indicating partial support for this hypothesis. Lastly, we hypothesized that the partial mediation of emotion dysregulation, thwarted belongingness, and perceived burdensomeness in the association between insomnia and suicidality severity would persist after accounting for depression severity. We found that depression severity accounted for the association between insomnia and suicidality severity. However, depression, emotion regulation, and perceived burdensomeness fully mediated the association between insomnia and suicidality severity. These results indicate partial support for our second hypothesis of our second aim.

Findings from our uncontrolled mediation model suggest a partial mediation in that insomnia, perceived burdensomeness, and emotion dysregulation played a role in increasing suicidality severity. In our controlled mediation model, we found evidence for full mediation suggesting that depression, emotion regulation, and perceived burdensomeness may explain the association between insomnia and suicidality severity and may play key roles in conferring risk for suicidality severity. Unsurprisingly, depression played a major role in the association

between insomnia severity and suicidality severity. The association between depression and suicidality has been extensively explored and depression has consistently been found to be a major risk factor for suicidality (Franklin et al., 2017). Emotion dysregulation also contributed to explaining the association between insomnia and suicidality. We posit that this may be partially explained by the overlap in brain regions affected by insomnia, suicidality, and emotion dysregulation (Green et al., 2007; Jollant et al., 2011; Lanius et al., 2003; Mochcovitch et al., 2014). Lastly, we found that perceived burdensomeness played a part in explaining the association between insomnia severity and suicidality severity, consistent with previous findings (Barzilay et al., 2015; Christensen et al., 2013; Chu, Buchman-Schmitt, et al., 2017; Van Orden et al., 2006; Van Orden et al., 2008; Zullo et al., 2017). Perceived burdensomeness has been associated with a sense of liability and may contribute to three notable risk factors for suicide: family conflict, unemployment, and physical illness (Van Orden et al., 2010). We suggest that daytime impairment due to insomnia may also contribute to this sense of liability and affect crucial daily activities such as social interaction, productivity, and health. In conjunction, insomnia severity and perceived burdensomeness may confer risk for suicidality.

These results suggest that insomnia severity may be a notable risk factor for suicidality severity, though it may be accounted for by depression. It is notable that in both our regression and mediational analyses depression accounted for the association between insomnia and suicidality severity. While insomnia is a well-established risk factor for suicidality (Franic et al., 2014; Fujino et al., 2005; Kay, Dombrovski, et al., 2016; Lin et al., 2018; Zuromski et al., 2017), even above and beyond depression severity (Becker et al., 2018; Bjorngaard et al., 2011; Bozzay et al., 2016; Carli et al., 2011; Chellappa & Araujo, 2007; Ferentinos et al., 2016; Fujino et al., 2005; Goldstein et al., 2008; Krakow et al., 2011; McCall et al., 2010; Ribeiro et al., 2012;

Simmons et al., 2021; Simmons et al., 2020; Wong et al., 2016), there is also evidence that depression severity may account for the association between insomnia symptoms and suicide risk (Bishop et al., 2019; Bryan et al., 2015; Nadorff et al., 2013; Pompili et al., 2013; Zullo et al., 2017). This may be the case as insomnia is a symptom of depression and is often comorbid with depressive disorders (American Psychiatric Association, 2013). As such, insomnia and depression severity may be difficult to distinguish, especially in a cross-sectional sample.

In our past research, we presented data that suggested that insomnia may be more specifically related to suicidal behavior rather than suicidal ideation (Simmons et al., 2021; Simmons et al., 2020). This could be due to the impact that insomnia confers on brain processes related to cognition, memory, and affect. Evidence suggests that patients with insomnia have a decreased relative glucose metabolism in the left middle frontal gyrus, left parietal cortex, fusiform/lingual/occipital gyri, posterior cingulate cortex, and precuneus (Kay, Karim, et al., 2016). These brain regions are implicated in decision-making, self-referential thought, memory, and affective processes. Further, research in patients with a history of suicide attempts has found decreased activity in the middle and superior frontal gyri (Cao et al., 2016), increased activity in the anterior and posterior cingulate cortices (van Heeringen et al., 2014), increased volume in right and left orbitofrontal cortices (Monkul et al., 2007), dorsolateral prefrontal cortex (van Heeringen et al., 2011), caudate nuclei, and rectal and superior temporal gyri (van Heeringen et al., 2014), and an increase in right amygdala volumes (Monkul et al., 2007) compared to non-suicidal individuals. These brain regions implicated in patients with suicidality have been associated with impulsive behavior (Cao et al., 2016; Monkul et al., 2007; van Heeringen et al., 2014), emotion dysregulation (Jollant et al., 2011), and impaired decision-making (Monkul et al., 2007; van Heeringen et al., 2011). We note that overlap in brain regions adversely affected in

those with insomnia and suicidality and suggest that deficits in these brain regions may be due in part to "localized sleep deprivation." Localized sleep deprivation refers to certain brain areas that are not sufficiently rejuvenated due to disturbed sleep which may affect executive functioning, self-referential thinking, and affect (Kay, Dombrovski, et al., 2016). Deficits in these brain regions may play a role in increasing risk for suicidality due to their impact on cognition, memory, and affective processes. However, further research is necessary to understand the association between localized sleep deprivation due to insomnia and suicidality and to understand if insomnia may specifically confer risk for suicidal behavior rather than general suicidality.

In both mediational models, thwarted belongingness did not mediation the association between insomnia and suicidality severity. Two previous studies found that thwarted belongingness mediated insomnia and suicidality cross-sectionally (Chu, Buchman-Schmitt, et al., 2017; Chu et al., 2016) but not longitudinally (Chu, Hom, et al., 2017). Another study found that thwarted belongingness explained the association between insomnia and suicidality severity only through depression (Britton et al., 2019). As collective results are inconclusive, further study, especially with longitudinal methodologies, is necessary to understand the mediating effects of thwarted belongingness in this association. Our findings suggest that perceived burdensomeness, but not thwarted belongingness, mediates the association between insomnia and suicidality severity. While insomnia severity was associated with thwarted belongingness, thwarted belongingness did not explain the association between insomnia and suicidality severity. It is possible that the association is better accounted for by perceived burdensomeness. As mentioned earlier, daytime impairment associated with insomnia may confer increased risk for perceived burdensomeness through deficits in daily activities such as social interaction,

productivity, and health, leading to increased risk for suicidality. Such an association may not be tied between insomnia severity and thwarted belongingness in a way that increases risk for suicidality.

We note several limitations of the current study. We acknowledge the potential statistical biases introduced by implementing mediational analyses with cross-sectional data. Maxwell and Cole (2007) reported that cross-sectional approaches can lead to statistical biases that can significantly overestimate and underestimate the effects, even under ideal circumstances. Thus, we note that our cross-sectional data, gathered due to limits of time and resources, may introduce bias into our data and is a notable limitation. Further, there are several considerations worth noting with the sole use of data collection via an online survey. Some limitations include the possibility of a non-naïve sample, a non-standardized and non-monitored administration environment, and less flexibility with the administration of behavioral measures. However, some strengths include the ability to gather a large sample quickly, less cost, and access to a nationally representative sample. Further, there is evidence to suggest that data collected via online surveys for behavioral research is an effective methodology.

Several studies have performed research on the data quality of online surveys by collecting professional panel data, student sample data, and laboratory data to compare to online survey data. Data quality, as measured by rejection rates, statistical power, distributions, and participant involvement, was of similar or better quality in the online survey samples (Kees et al., 2017; Sprouse, 2011). Further, in their examination of the utility of online survey research in populations with psychopathology, Shapiro et al. (2013) found that the high quality of the psychometrics of the measures, acceptable validity of self-reported symptoms, and increased comfort with disclosing symptomatology through the online survey provided evidence that

online surveys may be a useful resource for behavioral research in clinical populations. Due to the nature of our data collection process, we acknowledge that we had little control over the frequency and severity of suicidality of participants in this study. Because of Qualtrics' limitations for screening, we were unable to assess for suicidality prior to including participants. However, we do note that in patients who experience sleep disturbance, there is a 1.95-2.95 times increased likelihood of risk for suicidality (Pigeon et al., 2012). Despite the limitations presented by the use of online surveys in behavioral research, there is evidence to suggest the effectiveness and relative strengths of this methodology.

This study has several strengths, including a diverse, nationally representative sample, a large sample size, and the use of validated measures. This study is also the first of its kind in that it examines a previously unexplored mediator in the insomnia-suicidality association. Lastly, this study clarifies the association between insomnia and suicidality and offers a steppingstone for further research.

This study highlights the importance of gauging suicidality risk through assessment and treatment of perceived burdensomeness and emotion dysregulation, especially in patients with insomnia. A previous review of the IPTS suggested that perceived burdensomeness is alterable and may best be treated by addressing perceived burdensomeness through assessment and direct intervention pertaining to social connectedness and contributions (Van Orden et al., 2010). Evidence suggests that treatment of emotion dysregulation through dialectical behavioral therapy skills leads to greater emotion regulation and a decrease in suicidal behaviors (Neacsiu et al., 2010). Lastly, insomnia symptoms are also a modifiable risk factor for suicidality (Kay, Dombrovski, et al., 2016). Research indicates that cognitive behavior therapy for insomnia, the

front-line treatment for insomnia, may not only be effective in treating insomnia but also in decreasing suicidality (Manber et al., 2011; Trockel et al., 2015).

In conclusion, symptoms of insomnia, perceived burdensomeness, and emotion dysregulation may play key roles in suicidality severity. These difficulties may serve as potent markers for suicide risk and potential targets for treatment and suicide prevention. Further research should focus on replicating these results with a longitudinal methodology and explore other potential mediators of interest in the insomnia-suicidality association. Future research is also needed to determine the mechanisms through which insomnia and suicidality are related.

Table 1. Demographic and psychological features across insomnia severity groups.

Characteristic	Overall sample (*n* = 424)	NI (*n* = 106)	SI (*n* = 107)	CIM (*n* = 108)	CIS (*n* = 103)
Gender					
Man	195(46%)	35(33%)	56(52%)	65(60%)	39(38%)
Woman	221(52%)	71(67%)	49(46%)	39(36%)	62(60%)
Non-binary	7(2%)	0(0%)	2(2%)	3(3%)	2(2%)
Other	1(0%)	0(0%)	0(0%)	1(1%)	0(0%)
Age					
18-24	57(13%)	16(15%)	12(11%)	15(14%)	14(14%)
25-34	68(16%)	14(13%)	14(13%)	14(13%)	26(25%)
35-44	77(18%)	15(14%)	23(22%)	25(23%)	14(14%)
45-54	60(14%)	11(10%)	18(17%)	19(18%)	12(12%)
55-64	70(17%)	19(18%)	11(10%)	17(16%)	23(22%)
65-74	68(16%)	20(19%)	22(21%)	15(14%)	11(11%)
75-84	23(5%)	11(10%)	6(6%)	3(3%)	3(3%)
85-89	1(0%)	0(0%)	1(1%)	0(0%)	0(0%)
Hispanic, Latino, or Spanish origin	52(12%)	13(12%)	18(17%)	16(15%)	5(5%)
Race					
American Indian/Alaska Native	11(3%)	4(4%)	2(2%)	3(3%)	2(2%)
Asian	38(9%)	17(16%)	13(12%)	6(6%)	2(2%)
Black/African American	91(21%)	36(34%)	21(20%)	22(20%)	12(12%)
Native Hawaiian or Other Pacific Islander	3(1%)	1(1%)	1(1%)	1(1%)	0(0%)
White	244(58%)	38(36%)	62(58%)	64(59%)	80(77%)
From multiple races	21(5%)	4(4%)	4(4%)	6(6%)	7(7%)
Other	16(4%)	6(6%)	4(4%)	6(6%)	0(0%)
Education					
Less than high school diploma	20(5%)	6(6%)	4(4%)	7(6%)	3(3%)
High school degree or equivalent	125(29%)	25(24%)	39(36%)	30(28%)	31(30%)
Some college, no degree	110(26%)	27(25%)	20(19%)	26(24%)	37(36%)
Associate’s degree	51(12%)	14(13%)	10(9%)	17(16%)	10(10%)
Bachelor’s degree	81(19%)	18(17%)	25(23%)	20(19%)	18(17%)
Master’s degree	29(7%)	11(10%)	9(8%)	5(5%)	4(4%)

Professional degree	4(1%)	1(1%)	0(0%)	3(3%)	0(0%)
Doctorate	4(1%)	4(4%)	0(0%)	0(0%)	0(0%)
Income					
<$10,000	69(16%)	17(16%)	18(17%)	15(14%)	19(18%)
$10,000 – $40,000	164(39%)	46(43%)	32(30%)	46(43%)	40(39%)
$40,001 – $90,000	131(31%)	29(27%)	32(30%)	34(31%)	36(35%)
$90,001 – $190,000	48(11%)	8(8%)	21(20%)	12(11%)	7(7%)
>$190,000	12(3%)	6(6%)	4(4%)	1(1%)	1(1%)
Marital Status					
Divorced	52(12%)	15(14%)	5(5%)	15(14%)	17(17%)
Married	152(36%)	42(40%)	44(41%)	38(35%)	28(27%)
Never married	196(46%)	40(38%)	56(52%)	50(46%)	50(49%)
Separated	10(2%)	3(3%)	1(1%)	2(2%)	4(4%)
Widowed	14(3%)	6(6%)	1(1%)	3(3%)	4(4%)
Suicidality severity	10(6)	6(3)	9(5)	10(5)	13(6)
Depression severity	21(9)	12(5)	20(9)	24(8)	29(7)
Anxiety severity	19(8)	12(5)	18(7)	22(6)	25(6)
Emotion dysregulation	89(28)	66(19)	85(24)	98(25)	106(28)
Thwarted belonging	33(14)	25(13)	31(13)	35(13)	41(14)
Perceived burdensomeness	15(10)	9(6)	14(10)	15(10)	21(12)

Note. NI=no clinically significant insomnia, SI=subthreshold insomnia, CIM=clinical insomnia (moderate severity), CIS=clinical insomnia (severe), *M(SD), n(%*).

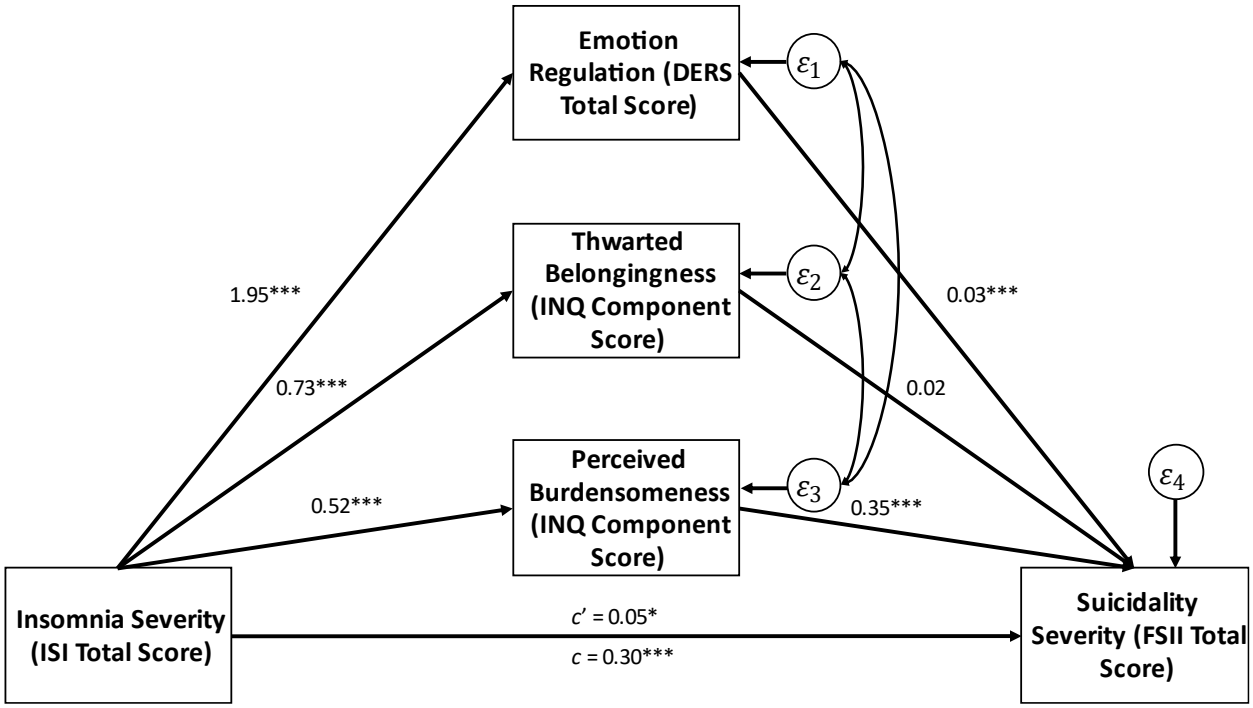
Table 2. Insomnia severity as a predictor of suicidality severity.

	Model 1		Model 2	
	p	*95% CI*	*p*	*95% CI*
Insomnia severity	>0.001***	0.19-0.31	0.836	-0.06 – 0.08
Age (18-24)				
25-34	0.703	-1.45 – 2.15	0.955	-1.58 – 1.49
35-44	0.262	-2.81 – 0.77	0.376	-2.22 – 0.84
45-54	0.654	-2.35 – 1.48	0.741	-1.37 – 1.92
55-64	0.039*	-3.92 – -0.10	0.222	-2.66 – 0.62
65-74	0.004**	-5.03 – -0.96	0.452	-2.48 – 1.10
75-84	0.017*	-6.03 – -0.61	0.258	-3.70 – 0.99
85-89	0.391	-14.53 – 5.69	0.746	-10.06 – 7.22
Gender (Man)				
Woman	0.400	-1.51 – 0.61	0.585	-1.16 – 0.66
Non-binary	0.798	-4.62 – 3.55	0.491	-4.72 – 2.27
Other	0.475	-6.18 – 13.23	0.330	-4.19 – 12.42
Race-ethnicity (White)				
American Indian/Alaska Native	0.152	-0.86 – 5.52	0.009**	0.91 – 6.37
Asian	0.205	-3.15 – 0.68	0.260	-2.57 – 0.70
Black/African American	0.037*	-2.71 – -0.09	0.279	-1.74 – 0.50
Native Hawaiian/Pacific Islander	0.586	-7.18 – 4.06	0.762	-5.54 – 4.06
From multiple races	0.093	-0.32 – 4.19	0.042*	0.07 – 3.92
Other	0.245	-4.06 – 1.04	0.417	-3.08 – 1.28
Educational attainment (Less than high school degree)				
High school degree or equivalent	0.915	-2.47 – 2.21	0.870	-1.84 – 2.17
Some college, no degree	0.470	-3.28 – 1.52	0.361	-3.00 – 1.10
Associate’s degree	0.492	-3.56 – 1.72	0.280	-3.50 – 1.01
Bachelor’s degree	0.521	-3.38 – 1.72	0.480	-2.96 – 1.39
Master’s degree	0.305	-4.55 – 1.43	0.437	-3.56 – 1.54
Professional degree	0.923	-5.75 – 5.21	0.361	-6.86 – 2.50
Doctorate degree	0.820	-6.07 – 4.81	0.925	-4.88 – 4.44
Income (<$10,000)				
$10,000 - $40,000	0.579	-1.89 – 1.06	0.851	-1.38 – 1.14

$40,001 - $90,000	0.057	-3.13 – 0.04	0.329	-2.04 – 0.68
$90,001 - $190,000	0.565	-2.70 – 1.47	0.561	-1.26 – 2.32
>$190,000	0.334	-4.92 – 1.67	0.962	-2.75 – 2.89
Marital status (Never married)				
Divorced	0.746	-1.40 – 1.95	0.425	-0.85 – 2.01
Married	0.448	-1.73 – 0.77	0.853	-1.17 – 0.97
Separated	0.187	-1.04 – 5.29	0.297	-1.27 – 4.45
Widowed	0.787	-3.26 – 2.47	0.485	-3.31 – 1.58
Depression severity	-	-	>0.001***	0.32 – 0.50
Anxiety severity	-	-	0.320	-0.17 – 0.06

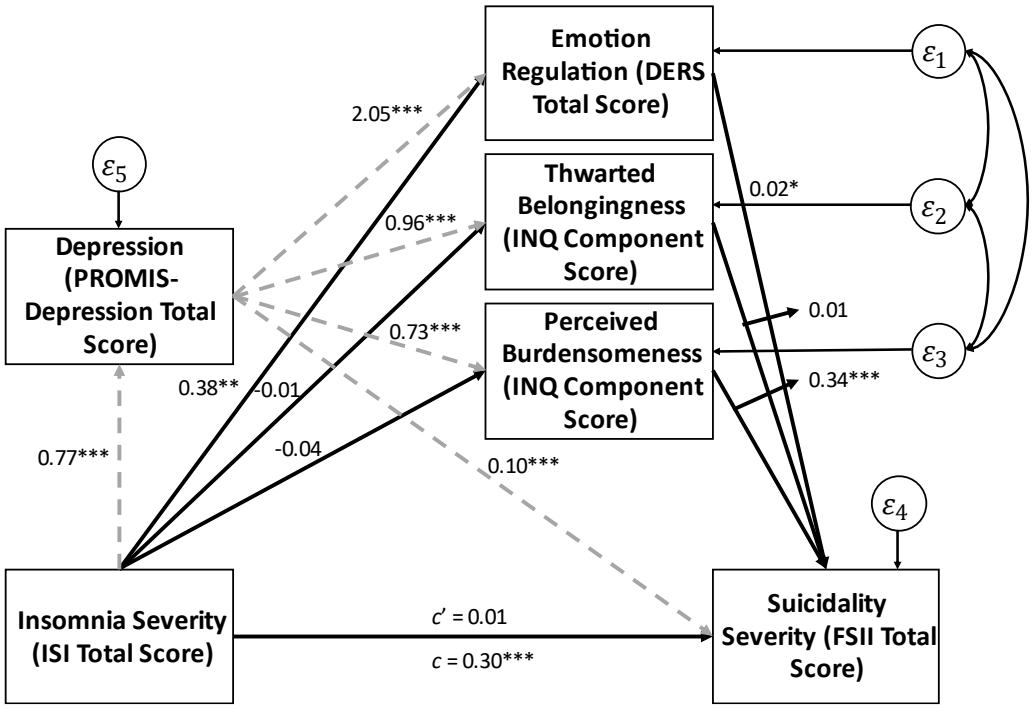
Note: Model 1 controls for demographic variables. Model 2 controls for demographic variables, anxiety severity, and depression severity. *p<0.05, **p<.01, ***p<.001.

Figure 1. Uncontrolled Mediational Model for Emotion Regulation, Thwarted Belongingness, and Perceived Burdensomeness in the Insomnia-Suicidality Severity Association



Note: ISI: Insomnia Severity Index, DERS: Difficulties in Emotion Regulation Scale, INQ: Interpersonal Needs Questionnaire, FSII: Frequency of Suicidal Ideation Inventory.

Figure 2. Controlled Mediational Model for Emotion Regulation, Thwarted Belongingness, and Perceived Burdensomeness in the Insomnia-Suicidality Severity Association



Note: ISI: Insomnia Severity Index, DERS: Difficulties in Emotion Regulation Scale, INQ: Interpersonal Needs Questionnaire, PROMIS-Depression: The Patient-Reported Outcomes Measurement Information System Emotional Distress – Depression – Short Form FSII: Frequency of Suicidal Ideation Inventory.

Figure 3. Power analysis predicting power give total sample size

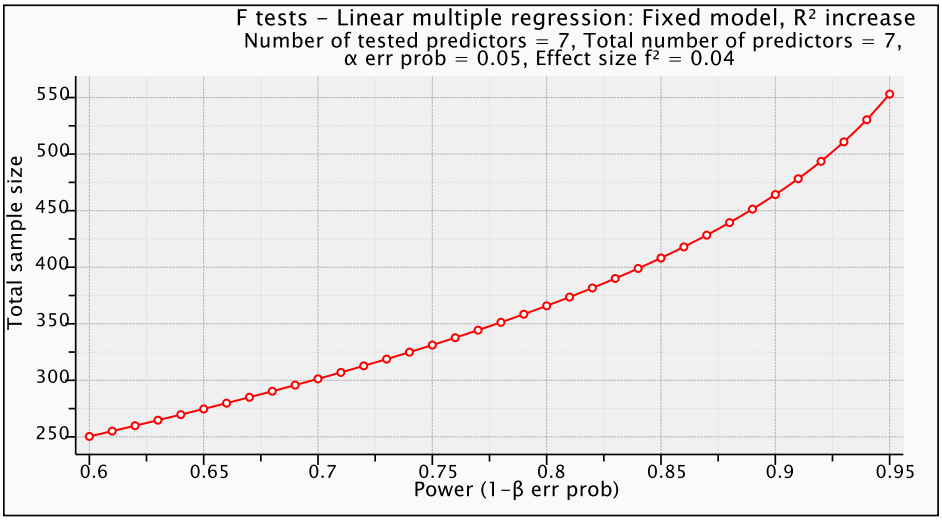
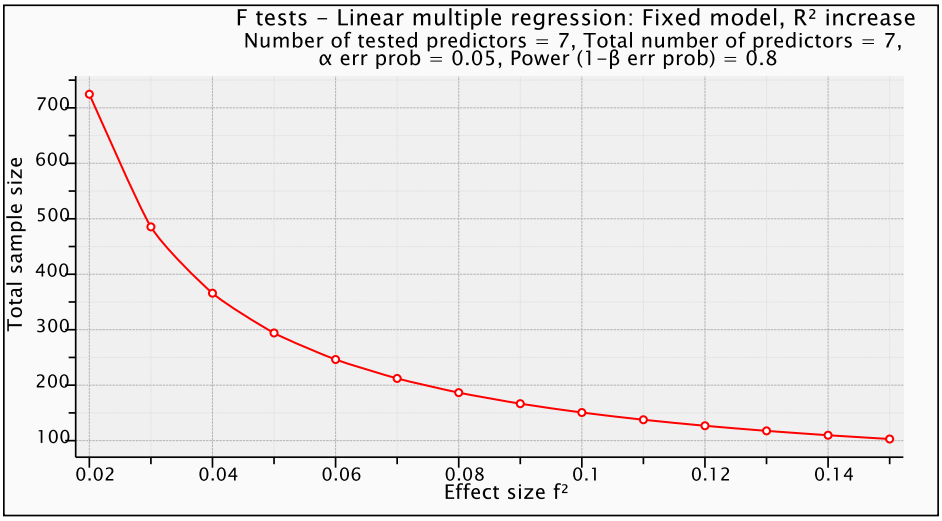


Figure 4. Power analysis predicting detectable effect sizes given total sample size



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