Serial Mediation Analysis of Psychological Inflexibility and Daytime Insomnia Rumination in the Relationship Between Dysfunctional Beliefs About Sleep and Insomnia in College Students

Guadalupe G. San Miguel1

Mercedes G. Woolley1

Eric B. Lee2

Brooke M. Smith3

Demi Culianos1

Michael E. Levin1

Michael P. Twohig1

1Department of Psychology, Utah State University, Logan, UT, United States of America

2Department of Psychology, Southern Illinois University, Carbondale, IL

3Department of Psychology, Western Michigan University, Kalamazoo, MI

Corresponding author:

Guadalupe G. San Miguel

Department of Psychology

2810 Old Main Hill

Logan, UT 84322-2810

[gabe.sanmiguel@usu.edu](mailto:gabe.sanmiguel@usu.edu)

Declarations of interest: None

Abstract

Emerging research suggests that psychological inflexibility may be a factor contributing to the development and maintenance of insomnia. However, less is known about the potential cognitive pathways that may explain this relationship. In this study, we investigated the serial mediating effects of psychological inflexibility and daytime insomnia related rumination on the association between dysfunctional beliefs and attitudes about sleep (DBAS) and insomnia symptoms. The sample included 490 college students who underwent assessments at two time points over a one-month period. The results of our mediational tests yielded significant indirect effects, supporting the prediction that psychological inflexibility and daytime insomnia rumination serially mediate the relationship between DBAS and insomnia. The study provides insights into potential mechanisms for insomnia, emphasizing the role of psychological inflexibility in perpetuating maladaptive cognitive processes associated with insomnia. Future researchers should explore other maladaptive responses to insomnia related concerns and distress, such as worry and safety behaviors, and replicate findings in clinically elevated insomnia samples.

Key words: Insomnia, psychological inflexibility, rumination, college students, dysfunctional beliefs and attitudes about asleep, serial mediation

Cognitive-behavioral therapy for insomnia (CBT-I) has been established as the gold-standard intervention for insomnia, informed by the widely accepted cognitive model of insomnia (Harvey, 2002a; Qaseem et al., 2016). Despite this, not all individuals respond to CBT-I, and issues with adherence and premature drop-out remain significant (Perils et al., 2004; Muench et al., 2022). These challenges have spurred interest in exploring additional processes that could enhance treatment outcomes for insomnia.

A few studies to date have identified psychological inflexibility as one such process serving as a maintenance factor and possible treatment target among those suffering from insomnia (Kato et al., 2016). Psychological inflexibility is best known for its role as the core process of change in acceptance and commitment therapy (ACT; Hayes et al., 2006), Broadly, psychological inflexibility is thought to contribute to the development and persistence of various psychological problems, due to its characteristic of promoting excessive control over internal experiences through strategies like avoidance (Levin et al., 2014). Research has begun to unveil the role of psychological inflexibility specifically in insomnia, A study of 159 adults receiving treatment for chronic pain, who also experience marked symptoms of insomnia, revealed that dimensions of psychological flexibility, notably the acceptance of pain and commitment to personal values, were positively correlated with improved sleep quality indicators (McKracken et al., 2011). Another, study of Japanese college students found that psychological inflexibility was associated with higher levels of sleep difficulty even after controlling for depressive symptoms (Kato et al., 2016). Top of FormBottom of FormAs emerging research underscores the contribution of psychological inflexibility to insomnia, studies are needed to explicate how this relationship occurs, especially in light of preliminary work piloting ACT for insomnia (Paulos-Guarnieri et al., 2022).

Psychological inflexibility intersects with key components of the cognitive model of insomnia, such as the use of avoidance and thought control strategies, alongside dysfunctional beliefs and attitudes about sleep ([DBAS]), contributing to the persistence of insomnia (Harvey, 2002b; Woodley & Smith, 2006). The cognitive model of insomnia postulates that insomnia arises from DBAS ( e.g., "if I don't get enough sleep tonight, I won't be able to function tomorrow” or “I must cancel my plans for tomorrow to catch-up on sleep”) and sleep related worries broadly which contribute to arousal and persistent wakefulness (Lundh & Broman, 2000; Harvey; 2002). Attempts to combat sleep related beliefs and the associated distress inadvertently perpetuate sleep challenges experienced by those suffering from insomnia. This concept mirrors rigid reactions to dysfunctional thoughts linked with experiential avoidance, a cognitive effort to manage distress that constitutes one of the fundamental aspects of psychological inflexibility (Hayes et al., 1996). When one adheres rigidly to experiential avoidance, there is typically short-term relief, but more often it leads to a higher frequency of unwanted thoughts and feelings in the long-term. This phenomenon has been documented in undergraduate students, where a perceived higher need to use sleep related safety behaviors predicted greater levels of DBAS and avoidance of fatigue (Hood et al., 2011).

Supporting the idea that psychological inflexibility may be a link between DBAS and unhelpful attempts to combat sleep related distress, Ong and colleagues’ (2012) proposed a refined model of insomnia informed by the concept of metacognition (i.e., the awareness of one’s cognitions). Their model highlights that insomnia is maintained by a primary and secondary level of cognitive arousal. The primary level involves cognitions about the inability to sleep, which consequently hinder sleep, and beliefs about the daytime consequences of inadequate sleep. The secondary level involves interpretations of one’s cognitions (e.g. the meaning one applies to thoughts and their emotional valance). The overall model theorizes when thoughts about sleep are negatively or rigidly interpreted this can intensify dysfunctional beliefs about sleep and lead to increased arousal. For example, a belief about needing enough sleep can produce further arousal ultimately perpetuating insomnia. Their model highlights that inflexible responses to DBAS may serve to maintain the disorder. This idea aligns with theory supporting cognitive fusion, that is, it is not merely a dysfunctional thought that leads to psychopathology, but the dysfunctional way in which an individual responds to their thought (e.g., Rawal et al., 2010). Said another way, the Ong et al., (2012) two-level model reflects how psychological inflexibility promotes a rigid attachment with DBAS, leading the individual to go to great lengths to control the ensuing internal distress, even if it contributes to difficulties in functioning and quality of life (e.g., cancelling ones plans the next day to catch up on sleep).

While individuals with insomnia may use a number of strategies to combat sleep related concerns (e.g., safety behaviors and thought control strategies), our current study focuses on rumination about daytime consequences of insomnia as this construct appears to be especially unique to those suffering from insomnia. Historically, rumination has been conceptualized as relating to a maintenance model of depression, wherein engaging in ruminative thinking functions as an attempt to problem solve why one feels the way that they do. Rumination may represent a step toward solving one’s problem but typically there is no action toward positive change (Nolen-Hoeksema, 1991). That said, rumination has since transcended the depression literature, and has received attention as a transdiagnostic factor maintaining anxiety disorders (e.g., Abbott & Rapee, 2004, Ehlers & Clark, 2000). Among those with insomnia, rumination appears to be specific to the experience and symptoms of the disorder. Supporting this notion, Carney et al., 2013 found that rumination about daytime consequences of insomnia predicted greater levels of insomnia, whereas depression-specific rumination did not. Examples of ruminative thinking among those with insomnia specifically include fixation consequences of lack of sleep such as thinking about how tired one feels or that one does not have enough energy to get through the day. These types of repetitive negative cognitive response patterns to concerns about sleep are thought to be central to sustaining sleep disruptions as they promote emotional arousal keeping one’s mind alert (Espie, 2002; Harvey; 2002a). Theoretically, psychological inflexibility may help to explain daytime insomnia rumination as a cognitive response to DBAS, where in psychological inflexibility leads individuals to repeatedly analyze their sleep problems and the related day time consequences as an attempt to control the problem.

The theory underlying Ong and colleagues’ (2012) meta-cognitive model gains additional insight when considered alongside the tendency to fuse with the daytime consequence of a lack of sleep and dissolve into ruminative thinking. Following this theory, when individuals are able to respond flexibly to DBAS through processes aimed at addressing psychological inflexibility, such as acceptance and defusion, they may exhibit fewer attempts to control or react rigidly to dysfunctional thoughts about sleep. The result will be an overall reduction of insomnia like symptoms.

While psychological inflexibility may functionally link DBAS and maladaptive cognitive processes in insomnia, there are no studies to provide empirical evidence for the theoretical mediating role of psychological inflexibility in reported changes in insomnia symptoms. An investigation of this nature is crucial to support treatment enhancement to help those with insomnia. Building on established cognitive models of insomnia, we posit a connection between DBAS and insomnia, explained through psychological inflexibility and subsequent cognitive response patterns, namely daytime insomnia rumination.

**Current Study**

This study utilized a sample of college students with self-report data collected at two time points (baseline and 1-month follow up). The goal was to examine the relationship between DBAS and insomnia symptoms through a mediating pathway involving psychological inflexibility and daytime insomnia rumination. Specifically, we predict sequential mediation of psychological inflexibility and daytime insomnia rumination in the association between DBAS and insomnia. To address possible confounding factors, this model was also fit controlling for depression (Jager et al., 2008). Likewise, because this study took place during the COVID-19 pandemic, fear of COVID-19 was controlled for to address any effects the pandemic may have had on psychological symptoms and sleep disturbance (Sharif Nia et al., 2022).

Method

**Participants & Procedures**

Eligible participants needed to be enrolled in at least one class at a 2- or 4-year university, be older than 18 years of age, and have access to the internet. We did not require the presence of insomnia symptoms for inclusion in the study. This approach was chosen to enable a greater variation in insomnia symptom scores as the dependent variable and to increase the likelihood of achieving a normal distribution, rather than constraining the range of scores through inclusion criteria. Exclusion criteria included the presence of another self-reported sleep-related disorder, such as sleep-related breathing disorders. Initially, 950 students responded to the eligibility survey. Of those, 660 completed the baseline survey, and 490 completed the survey at both the initial and follow-up time points.

Participants were recruited across three public universities in the United States. Recruitment began at the start of each semester (Fall 2021 and Spring 2022) by notifying students during class announcements. Longitudinal data were collected from participants via a unique link hosted by REDCap that guided them a consent form and questionnaires. First, agreeing participants completed a screener and if deemed eligible by a member of the researcher team the participant was emailed a unique link (via REDCap) to the consent and baseline questionnaires. Participants who completed the questionnaires at baseline were asked to complete the same questionnaires at a 1-month follow-up. As compensation, participants were given 0.5 SONA credits for each questionnaire sets they complete (total of 1 SONA credit for baseline and follow-up). In addition, students who completed both baseline questionnaires were eligible to participate in an electronic gift card raffle (twenty electronic Amazon gift cards, priced at $50 each).

**Measures**

***Insomnia Severity Index (ISI; Morin, 1993)****.* This self-reported 7-item measure is designed to assess insomnia symptomology. Each item is scored on a 5-point scale ranging from 0 – 4. Total scores range from 0 – 28, with cutoffs including: no clinically significant insomnia (0-7), subthreshold insomnia (8-14), moderate severity (15-21), severe (22-28). Higher scores indicate a higher insomnia symptomology. The ISI is a recommended assessment to measure insomnia severity (Buysse et al., 2006), and has shown sufficient internal consistency and good discriminant validity (Bastien et al., 2001). At baseline, internal reliability for this measure was good (α = 0.84).

***Depression Anxiety Stress Scale-21 (DASS-21; Lovibond & Lovibond, 1995).*** The DASS is an assessment composed of 21 self-reported items. The measure is used to assess anxiety and depression symptomology and overall distress, which includes 3 subscales (anxiety, depression distress) rated on a 4-point scale ranging from 0 (never) – 4 (almost always). Each subscale is scored individually with each having its own cut-off score categorized from normal to extremely severe. The DASS short form (21 items) has shown to be reliable and valid compared to the original 42-item version (Antony et al., 1998). The depression scale demonstrated excellent internal reliability at baseline (α = 0.91).

**D*ysfunctional Beliefs and Attitudes About Sleep (DBAS; Morin et al., 2007).*** The DBAS is ashortened version of the original 30-item self-reported measure (Morin, 1993) designed to assess insomnia related cognitions. This 16-item version contains four subscales (perceived consequences of insomnia, worry/helplessness about insomnia, sleep expectations, and medication) with individuals responding to each item on a visual analog scale that ranges from 0 (strongly disagree) to 10 (strongly agree). An exemplar item from the DBAS is thinking that “one poor night’s sleep disturbs the whole week”. The DBAS has shown to have adequate and acceptable convergent and construct validity (Morin et al., 2007). Internal reliability for this measure was good (α = 0.84).

***Daytime Insomnia Symptom Response Scale (DISRS; Carney et al., 2013).*** The DISRS is a 20-item self-reported measure designed to assess daytime rumination related to sleep. Seven of the items stems from the Symptom-Focused Rumination Subscale (Bagby et al., 2004) of the Response Styles Questionnaire (Nolen-Hoeksema & Morrow, 1991) with an additional 12-items added with the assistance of insomnia experts. Individuals are asked about their behavior when they were tired using a 4-point scale ranging from 1 (almost never) to 4 (almost always) accumulating in a total score ranging from 20 to 80. Example items include "I think I won’t be able to work because I feel very bad” and “I can’t get rid of this feeling”. Higher scores indicate higher levels of rumination. The DISRS has shown to have great internal consistency (α > 0.90) across two different samples (Carney et al., 2013). Internal reliability for this measure was excellent (α = 0.95).

***Fear of COVID-19 Scale (FCV-19S; Ahorsu et al., 2022).*** The FCV-19S is a 7-item self-reported scale developed to capture fears regarding COVID-19. Each item is rated on a 5-point scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Total scores range from 7 to 35 with higher scores indicating a greater fear of COVID-19. The FCV-19S has shown strong psychometric properties among a general Iranian sample (Ahorsu et al., 2022) and later validated among a US college sample (Perz et al., 2022). Items one and seven were altered to reflect common American English expressions highlighted by Perz and colleagues (2022). The internal reliability for this measure was good at baseline (α = 0.86).

***Multidimensional Psychological Flexibility Inventory-Inflexibility (MPFI-Inflexbility; Rolffs et al., 2016).*** The MPFI shortened version – from the original 60-item measure – is a self-reported questionnaire designed to assess psychological flexibility (12-items) and inflexibility (12-items). The MPFI inflexibility items from the measure were included in the present study. These item span experiential avoidance, lack of contact with the present moment, self-as-content, fusion, lack of contact with values and present moment. Items from the measure include statements like “it was very easy to get trapped into unwanted thoughts and feelings” (fusion) and “when unpleasant memories came to me, I tried to put the amout of my mind” experiential (avoidance). Each item is rated on a 6-point scale ranging from 1 (never true) to 6 (always true). Higher scores correspond to higher global composite scores. The MPFI has shown good validity and reliability (Rogge et al., 2019; Rolffs et al., 2016; Seidler et al., 2020). Internal reliability for the inflexibility subscale was excellent at baseline (α = 0.90).

**Statistical Analyses**

All analysis including descriptive statistics, correlations, and mediation were conducted using the R statistical environment (R Core Team, 2023). Serial mediation was conducted using the ‘semTools’ package (Jorgensen et al., 2022). A serial mediation model with four factors was applied to examine whether the link between DBAS and insomnia was mediated by psychological inflexibility and daytime insomnia rumination. Regression coefficients were estimated to examine paths between variables in the serial mediation model. In each path, fear of COVID-19 and depression was used as control variables. First, an indirect effect was calculated to examine the hypothesized serial mediation pathway, which involved examining psychological inflexibility (M1) and daytime insomnia rumination (M2) sequentially on the relationship between DBAS (*X*) and insomnia (*Y*). Two additional indirect effects were calculated to examine the effects of psychological inflexibility (M1) and rumination (M2) as independent mediators in the relationship between DBAS (*X*) and insomnia (*Y*). A total effect (c) was calculated by combing the three indirect effects and one direct effect ([c’] *X* predicting *Y* while controlling for both mediating variables). The full conceptualized model can be seen in Figure 1. A mediating effect is present when the indirect effect is significant (i.e., 95% confidence interval does not include zero; Hayes, 2017).

To account for change over time, 1-month follow up scores was regressed onto baseline scores for DBAS, psychological inflexibility, daytime insomnia rumination, insomnia, fear of COVID-19 and depression. The residuals from these regressions were used in the serial mediation model. Ideally, mediation includes data collected over multiple measurement waves. However, Cole and Maxwell (2003) have suggested that measurement over a minimum of two waves, while less ideal, is adequate for preliminary investigations.

As outlined by Hayes (2017), mediation analyses hinges on the assumption that variables in the model are accurately assessed and independent from each other. To examine potential multicollinearity within our model, we performed an initial multiple regression using residuals for DBAS, psychological inflexibility, and daytime insomnia rumination as predictors with the residual insomnia variable as the outcome in order to examined variance inflation factor (VIF) values. Across variables, VIF values ranged from 1.13 to 1.20, suggesting negligible multicollinearity among the predictors in the model. Additionally, the normal distribution assumption was met, based on visual inspection of quantile-quantile plots for each variable. Prior to recruitment, we estimated a requisite sample size using G\*Power to ensure adequate power for mediation. It was determinate that 410 participants were required for analysis to detect correlations of *r* .40 between the predicting, dependent, and mediating variables (Schoemannet et al., 2017), with 80% statistical power.

Item-level missing data was accounted for using multiple imputation in the sample of 490 participants who completed both assessment time points. In this process, measurement items underwent multiple imputations using chained equations with predictive mean matching (van Buuren & Groothuis-Oudshoorn, 2011). The imputation process involved 10 cycles and five copies (Graham et al., 2007). Scoring for each measure carried out using the imputed values. The highest percentage of missing data for any one item that did not include demographics was 1.8%.

Results

*Participants*

Participants were 490 university students, with a mean age of 20.60 years (*SD* = 4.10). The majority of the sample were full-time students (94.7%). Students were primarily female (75.1%), and White (83.7%). On average students who participated in the study had completed 1.3 years (SD = 1.2) of college at the time of study enrollment. A detailed summary of demographic information can be seen in Table 1. On average the sample reported sub-threshold levels of insomnia (*M* = 10.91, *SD =* 5.26) on the ISI. Mean scores on the DASS-D revealed the sample experienced mild levels of depression (*M* = 5.87, *SD* = 5.07). Means and standard deviations for all measures are displayed in Table 2.

*Correlations*

Pearson’s correlations between all measures at baseline were examined (see Table 2). Psychological inflexibility, DBAS, daytime insomnia a rumination, and insomnia were all significantly positively correlated (*p* < .001). Additionally, depression was significantly positively correlated with insomnia symptoms, DBAS, and daytime insomnia rumination (*p* < .001). Fear of COVID-19 was also positively related to all insomnia-specific variables (*p* < .010).

*Serial mediation*

Standardized beta coefficients for the paths between variables in the serial mediation model are presented in Figure 2. In the first path, higher DBAS predicted increases in psychological inflexibility (*β* = 0.15, CI: 0.081, 0.208), after controlling for the effect of fear of COVID-19 (*β* = 0.00, CI: -0.029, 0.016) and depression (*β* = 0.07, CI: 0.050, 0.086). In the next path, psychological inflexibility significantly predicted increased daytime insomnia rumination (*β* = 2.49, CI: 1.418, 3.562), after controlling for the effect of DBAS (*β* = 1.46, CI: 0.681, 2.238) and control variables (fear of COVID-19: *β* = 0.02, CI: -0.200, 0.229, depression: *β* = 0.88, CI: 0.647, 1.109). In the final path, daytime insomnia rumination predicted increases in insomnia symptomology (*β* = 0.06, CI: 0.026, 1.00). This association was significant even after controlling for the effect of DBAS (*β* = 0.58, CI: 0.256, 0.913), control variables (fear of COVID-19: *β* = - 0.02, CI: -0.107, 0.072, depression: *β* = 0.23, CI: 0.127, 0.330) and psychological inflexibility, which was notably no longer significant in the final pathway (*β = -0.41,* CI: -0.865, 0.046).

Each indirect path is presented in Table 4. The indirect effect of psychological inflexibility and daytime insomnia rumination on the relations between BBAS and insomnia severity, representing the serially mediated pathway () was significant (*β* = 0.02, *p* = .025, CI: 0.003, 0.042). Examining single mediators, the indirect effect of psychological inflexibility on the relationship between DBAS and insomnia was found to be statistically significant (*β* = 0.36, *p* = .002, CI: 0.136, 0.585). Similarly, the indirect effect of daytime insomnia rumination on the relationship between DBAS and insomnia was significant (*β* = 0.01, *p* = .010, CI: 0.002, 0.016). These significant indirect effects indicate psychological inflexibility and insomnia rumination serially and independently explain the relationship between DBAS and insomnia.

Discussion

The current study sought to investigate a potential explanatory cognitive pathway through which psychological inflexibility might influence the symptoms of insomnia in a college student sample. As predicted, our results revealed that psychological inflexibility and daytime insomnia rumination mediate the link between DBAS and insomnia symptoms. These findings suggests that psychological inflexibility may play a role in insomnia through its connection to maladaptive insomnia related cognitions.

We found that psychological inflexibility was positively correlated with insomnia symptoms, consistent with previous findings (McKracken et al., 2011; Kato, 2016; Kato; 2012). Psychological inflexibility was also associated with insomnia-related DBAS (e.g., believing one needs to catch up on sleep loss) and daytime insomnia ruminative response patterns (e.g., ruminating on how irritable one feels) in the expected directions. These correlations are theoretically consistent, given that the need to control and fusion with unhelpful beliefs tends to be associated with higher levels of mental health challenges generally (Gloster et al., 2017). Accordingly, our results demonstrate that these associations could be specific to insomnia-related sleep disruptions as well.

The results of the hypothesized multiple-step mediation model suggests that the link between DBAS and insomnia symptoms was mediated by psychological inflexibility and the frequency of ruminative thoughts about the daytime consequences of insomnia, as evidence by a significant indirect effect (Hayes, 2017). Specifically, psychological inflexibility emerged as a mediator in the impact of DBAS on the frequency of daytime insomnia rumination. Furthermore, there is evidence that psychological inflexibility may contribute to insomnia symptoms by heightening the frequency of daytime insomnia rumination. Importantly, these mediating effects remain statistically significant even when accounting for the potential influences of depression and fear of COVID-19, indicating a robust and independent relationship between the variables in the model.

Notably, psychological inflexibility independently mediated the relationship between DBAS and insomnia, aligning with the theoretical model proposed by Ong et al. (2012) that insomnia is perpetuated as a result of a metacognitive process of one’s interpretation and response to beliefs about sleep. Moreover, our finding that psychological inflexibility explained the pathway from DBAS to insomnia is promising, especially given the research demonstrating the limited impact of CBT-I on dysfunctional sleep-related metacognitions specifically (see Galbiati et al., 2021). This finding suggests that the metacognitive approach used in ACT to promote flexible responses to dysfunctional thoughts, may be beneficial in the psychological treatment of insomnia. Supporting this, there are at least eleven published trials that demonstrate the effectiveness of ACT in managing insomnia symptoms (see Paulos-Guarnieri et al., 2022),

Our results also revealed a significant indirect effect of rumination about the daytime consequences of insomnia on the connection between DBAS and insomnia. This finding supports the cognitive model of insomnia, where DBAS, coupled with maladaptive cognitive responses, contributes to increased insomnia (Harvey, 2002a). However, this relational pathway becomes clearer when considered alongside the serially mediated pathway, which demonstrates that the relationship between DBAS and daytime insomnia rumination (leading to insomnia) is explained by psychological inflexibility. This finding supports the idea that becoming fused with unhelpful beliefs or perceiving a need to avoid, or control associated distress can lead to negative repetitive thinking, thus feeding the insomnia cycle. It underscores a potential pathway through which enhancing psychological flexibility toward DBAS might reduce perseverative thoughts about the consequences of insomnia. For instance, a therapist subscribing to ACT may encourage defusion or flexible attention to the present moment when DBAS arise, providing an alternative to rumination.

It is important to highlight that daytime insomnia rumination is likely one of many ways individuals with insomnia attempt to combat their problems (Woodley et al., 2006; Carney et al. 2013). Research points to other control strategies such as worry (e.g., “how can I function tomorrow if I don’t get enough sleep) and behaviors like cancelling plans to catch up on sleep and frequent napping. Future research should examine the relationship between psychological inflexibility and other potential maladaptive cognitive and behavioral responses to sleep related concerns. From an ACT framework, such insights may help tailor the therapy to be specific for clients with sleep related difficulties (e.g., helping a client engage with values driven plans even when the client believes they should cancel next day plans to catch up on sleep).

Curiously, each variable in the hypothesized model had a significant effect on insomnia symptoms, with the exception of psychological inflexibility. This finding was unexpected given our broader prediction but may have to do with a couple issues regarding the measurement of psychological inflexibility. Firstly, all other measures included content specific to the symptoms of insomnia (e.g., DBAS and daytime insomnia rumination), with the exception of covariates. Historically, context-specific adaptations of measures of psychological inflexibility, incorporating items reflecting disorder-specific experiences, have demonstrated improved performance in terms of incremental validity compared to global measures of psychological inflexibility (Ong et al., 2020). Future studies should consider utilizing measures like the Sleep Problem Acceptance Questionnaire (Botheluis et al., 2015), designed for individuals with sleep difficulties, as they might yield a different outcome. Moreover, the conceptualization and measurement of psychological inflexibility have been subjects of debate, with some suggesting that measures of psychological inflexibility exhibit poor discriminant validity and are more likely capturing constructs such as neuroticism, negative affect, and overall distress (Gámez et al., 2011; Francis et al., 2016; Kashdan et al., 2020). Considering this, it is possible that controlling for depression and fear of COVID-19 may have diluted the direct effect of psychological inflexibility on insomnia symptoms. Nevertheless, the indirect effect of psychological inflexibility linking DBAS to insomnia was significant, thus supporting our mediational hypothesis.

Drawing attention to limitations, this study used convenience sampling to recruit a university student sample, which was highly homogeneous with respect to race and sexual orientation. Moreover, this sample reported lower levels of insomnia symptoms compared to clinical samples of individuals diagnosed with insomnia (Morin et al., 2011), likely attributable to the lack of inclusion criteria requiring the presence of insomnia symptoms for participation. Additionally, the levels of depression in our sample, measured by the DASS-21, were lower than expected for individuals typically diagnosed with insomnia (Puzino et al., 2020). Given the commonly observed co-occurrence of insomnia and depression and related conditions (Staner et al., 2010), our sample may, in fact, be generally healthier than typical insomnia samples. In light of generalizability concerns, we consider the current study to be a preliminary step towards testing our proposed model. Therefore, our study should be replicated in more diverse samples with clinically elevated insomnia, particularly treatment seeking samples for whom this research is most relevant. Despite this, university students face sleep challenges varying from healthy samples and even samples of adults with insomnia due to a college culture that fosters screen use, stimulants to promote wakefulness, and alcohol use (Hershner & Chervin, 2014), putting them at increased risk to develop insomnia disorder (Buboltz et al., 2001; Coren, 1994). Thus, for the purposes of the current study, college students constitute a suitable sample. Nonetheless, this study opens avenues for further research on its generalizability, especially concerning the broader adult population outside the university setting and whether results are robust across gender identities.

Several methodological considerations warrant attention. Firstly, due to the data being collected at only two time points, it is challenging to ascertain the influence of potential intervening events on the change in responses over time. While we have made efforts to control for distress potentially associated with the COVID-19 pandemic, the impact of other unmeasured events cannot be discounted. Secondly, although our study surpasses the methodological rigor of some mediation studies by at least collecting data at two distinct time points rather than relying on cross-sectional data (Cain et al., 2018), our mediational analysis relies on changes observed over a one-month period for each variable in the model. This can be problematic considering the assumption of temporal precedence for mediation, typically requiring a minimum of three waves of data to demonstrate temporal sequencing of the predictor, mediator, and outcome at distinct time intervals (Fairchild & McQuillin, 2010). When exploring mediational processes expected to occur within the interval between two waves of data collection, it is posited that two time points can provide an adequate basis for preliminary studies that may by limited time or financial constraints (Cole & Maxwell, 2003). This approach sets the stage for subsequent longitudinal studies that include a series of measurement points for a stronger test of temporal precedence.

Although this study includes methodological limitations that warrant its replication, it serves as an initial attempt to broaden current theoretical conceptualizations of insomnia (i.e., the cognitive model of insomnia). Moreover, these findings strengthen theoretical understandings of the potential functional role of psychological inflexibility in insomnia. Replication of results in clinical samples would demonstrate the central function of psychological inflexibility.as a potential treatment target in addressing DBAS and daytime insomnia rumination. Furthermore, replication may offer empirical support for employing psychotherapeutic strategies that enhance psychological flexibility to address the cognitive pathways associated with insomnia.

Top of Form

Bottom of Form

References

Abbott, M. J., & Rapee, R. M. (2004). Post-event rumination and negative self-appraisal in social phobia before and after treatment. *Journal of abnormal psychology*, *113*(1), 136–144. <https://doi.org/10.1037/0021-843X.113.1.136>

Ahorsu, D. K., Lin, C. Y., Imani, V., Saffari, M., Griffiths, M. D., & Pakpour, A. H. (2022). The Fear of COVID-19 Scale: Development and Initial Validation. *International journal of mental health and addiction*, *20*(3), 1537–1545. <https://doi.org/10.1007/s11469-020-00270-8>

Antony, M. M., Bieling, P. J., Cox, B. J., Enns, M. W., & Swinson, R. P. (1998). Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and a community sample. *Psychological Assessment, 10*(2), 176–181. [https://doi.org/10.1037/1040-3590.10.2.176](https://psycnet.apa.org/doi/10.1037/1040-3590.10.2.176)

Bagby, R. M., Rector, N. A., Bacchiochi, J. R., & McBride, C. (2004). The Stability of the Response Styles Questionnaire Rumination Scale in a Sample of Patients With Major Depression. *Cognitive Therapy and Research, 28*(4), 527–538. [https://doi.org/10.1023/B:COTR.0000045562.17228.29](https://psycnet.apa.org/doi/10.1023/B:COTR.0000045562.17228.29)

Bastien, C. H., Vallières, A., & Morin, C. M. (2001). Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep medicine*, *2*(4), 297–307. <https://doi.org/10.1016/s1389-9457(00)00065-4>

Bothelius, K., Jernelöv, S., Fredrikson, M., McCracken, L. M., & Kaldo, V. (2015). Measuring Acceptance of Sleep Difficulties: The Development of the Sleep Problem Acceptance Questionnaire. *Sleep*, *38*(11), 1815–1822. <https://doi.org/10.5665/sleep.5170>

Buboltz, W. C., Jr, Brown, F., & Soper, B. (2001). Sleep habits and patterns of college students: a preliminary study. *Journal of American college health : J of ACH*, *50*(3), 131–135. <https://doi.org/10.1080/07448480109596017>

Buysse, D. J., Ancoli-Israel, S., Edinger, J. D., Lichstein, K. L., & Morin, C. M. (2006). Recommendations for a standard research assessment of insomnia. *Sleep*, *29*(9), 1155–1173. <https://doi.org/10.1093/sleep/29.9.1155>

Cain, M. K., Zhang, Z., & Bergeman, C. S. (2018). Time and Other Considerations in Mediation Design. *Educational and psychological measurement*, *78*(6), 952–972. <https://doi.org/10.1177/0013164417743003>

Carney, C. E., Harris, A. L., Moss, T. G., & Edinger, J. D. (2010). Distinguishing rumination from worry in clinical insomnia. *Behaviour research and therapy*, *48*(6), 540–546. <https://doi.org/10.1016/j.brat.2010.03.004>

Carney, C. E., Harris, A. L., Falco, A., & Edinger, J. D. (2013). The relation between insomnia symptoms, mood, and rumination about insomnia symptoms. *Journal of clinical sleep medicine : JCSM : official publication of the American Academy of Sleep Medicine*, *9*(6), 567–575. <https://doi.org/10.5664/jcsm.2752>

Cole, D. A., & Maxwell, S. E. (2003). Testing Mediational Models With Longitudinal Data: Questions and Tips in the Use of Structural Equation Modeling. *Journal of Abnormal Psychology, 112*(4), 558–577. [https://doi.org/10.1037/0021-843X.112.4.558](https://psycnet.apa.org/doi/10.1037/0021-843X.112.4.558)

Ehlers, A., & Clark, D. M. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour research and therapy*, *38*(4), 319–345. <https://doi.org/10.1016/s0005-7967(99)00123-0>

Coren S. (1994). The prevalence of self-reported sleep disturbances in young adults. *The International journal of neuroscience*, *79*(1-2), 67–73. <https://doi.org/10.3109/00207459408986068>

Espie C. A. (2002). Insomnia: conceptual issues in the development, persistence, and treatment of sleep disorder in adults. *Annual review of psychology*, *53*, 215–243. <https://doi.org/10.1146/annurev.psych.53.100901.135243>

Fairchild, A. J., & McQuillin, S. D. (2010). Evaluating mediation and moderation effects in school psychology: A presentation of methods and review of current practice. *Journal of School Psychology*, *48*(1), 53–84. https://doi.org/10.1016/j.jsp.2009.09.001

Francis, A. W., Dawson, D. L., & Golijani-Moghaddam, N. (2016). The development and validation of the Comprehensive assessment of Acceptance and Commitment Therapy processes (CompACT). *Journal of Contextual Behavioral Science, 5*(3), 134-145.

<https://doi.org/10.1016/j.jcbs.2016.05.003>

Galbiati, A., Sforza, M., Scarpellino, A., Salibba, A., Leitner, C., D'Este, G., Mombelli, S., Ferini-Strambi, L., & Castronovo, V. (2021). "Thinking About Thinking" in Insomnia Disorder: The Effect of Cognitive-Behavioral Therapy for Insomnia on Sleep-Related Metacognition. *Frontiers in psychology*, *12*, 705112. <https://doi.org/10.3389/fpsyg.2021.705112>

Gámez, W., Chmielewski, M., Kotov, R., Ruggero, C., & Watson, D. (2011). Development of a measure of experiential avoidance: the Multidimensional Experiential Avoidance Questionnaire. *Psychological assessment*, *23*(3), 692–713. https://doi.org/10.1037/a0023242

Gloster, A. T., Meyer, A. H., & Lieb, R. (2017). Psychological flexibility as a malleable public health target: Evidence from a representative sample. *Journal of Contextual Behavioral Science, 6*(2), 166–171. [https://doi.org/10.1016/j.jcbs.2017.02.003](https://psycnet.apa.org/doi/10.1016/j.jcbs.2017.02.003)

Graham, J. W., Olchowski, A. E., & Gilreath, T. D. (2007). How many imputations are really needed? Some practical clarifications of multiple imputation theory. *Prevention science: the official journal of the Society for Prevention Research*, *8*(3), 206–213. <https://doi.org/10.1007/s11121-007-0070->9

Harvey A. G. (2002a). A cognitive model of insomnia. *Behaviour research and therapy*, *40*(8), 869–893. <https://doi.org/10.1016/s0005-7967(01)00061-4>

Harvey A. G. (2002b). Identifying safety behaviors in insomnia. *The Journal of nervous and mental disease*, *190*(1), 16–21. https://doi.org/10.1097/00005053-200201000-00004

Hayes, A.F. (2017) Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach. Guilford Press, New York.

Hayes, S. C., Luoma, J. B., Bond, F. W., Masuda, A., & Lillis, J. (2006). Acceptance and commitment therapy: model, processes and outcomes. *Behaviour research and therapy*, *44*(1), 1–25. <https://doi.org/10.1016/j.brat.2005.06.006>

Hayes, S. C., Wilson, K. G., Gifford, E. V., Follette, V. M., & Strosahl, K. (1996). Experiential avoidance and behavioral disorders: A functional dimensional approach to diagnosis and treatment. *Journal of Consulting and Clinical Psychology, 64*(6), 1152–1168. [https://doi.org/10.1037/0022-006X.64.6.1152](https://psycnet.apa.org/doi/10.1037/0022-006X.64.6.1152)

Hershner, S. D., & Chervin, R. D. (2014). Causes and consequences of sleepiness among college students. *Nature and science of sleep*, *6*, 73–84. <https://doi.org/10.2147/NSS.S62907>

Hood, H. K., Carney, C. E., & Harris, A. L. (2011). Rethinking safety behaviors in insomnia: examining the perceived utility of sleep-related safety behaviors. *Behavior therapy*, *42*(4), 644–

654. <https://doi.org/10.1016/j.beth.2011.02.004>

Jager, K. J., Zoccali, C., Macleod, A., & Dekker, F. W. (2008). Confounding: what it is and how to deal with it. *Kidney international*, *73*(3), 256–260. <https://doi.org/10.1038/sj.ki.5002650>

Jorgensen, T. D., Pornprasertmanit, S., Schoemann, A. M., & Rosseel, Y. (2022). semTools: Useful tools for structural equation modeling. R package version 0.5-6. Retrieved from <https://CRAN.R-project.org/package=semTools>

Kashdan, T. B., Disabato, D. J., Goodman, F. R., Doorley, J. D., & McKnight, P. E. (2020). Understanding psychological flexibility: A multimethod exploration of pursuing valued goals despite the presence of distress. *Psychological assessment*, *32*(9), 829–850. <https://doi.org/10.1037/pas0000834>

Kato T. (2016). Impact of psychological inflexibility on depressive symptoms and sleep difficulty in a Japanese sample. *SpringerPlus*, *5*(1), 712. <https://doi.org/10.1186/s40064-016-2393-0>

Lancee, J., Eisma, M. C., van Straten, A., & Kamphuis, J. H. (2015). Sleep-Related Safety Behaviors and Dysfunctional Beliefs Mediate the Efficacy of Online CBT for Insomnia: A Randomized Controlled Trial. *Cognitive behaviour therapy*, *44*(5), 406–422. <https://doi.org/10.1080/16506073.2015.1026386>

Levin, M. E., MacLane, C., Daflos, S., Seeley, J., Hayes, S. C., Biglan, A., & Pistorello, J. (2014). Examining psychological inflexibility as a transdiagnostic process across psychological disorders. *Journal of contextual behavioral science*, *3*(3), 155–163. <https://doi.org/10.1016/j.jcbs.2014.06.003>

Lovibond, S. H., & Lovibond, P. F. (1995). *Depression Anxiety Stress Scales (DASS--21, DASS--42)* [Database record]. APA PsycTests.[https://doi.org/10.1037/t01004-000](https://psycnet.apa.org/doi/10.1037/t01004-000)

McCracken, L. M., Williams, J. L., & Tang, N. K. (2011). Psychological flexibility may reduce insomnia in persons with chronic pain: a preliminary retrospective study. *Pain Medicine, 12*(6), 904-912. <https://doi.org/10.1111/j.1526-4637.2011.01115.x>

Morin, C. M. (1993). *Insomnia: Psychological assessment and management.* Guilford Press.

Morin, C. M., Vallières, A., & Ivers, H. (2007). Dysfunctional beliefs and attitudes about sleep (DBAS): validation of a brief version (DBAS-16). *Sleep*, *30*(11), 1547–1554. <https://doi.org/10.1093/sleep/30.11.1547>

Morin, C. M., Belleville, G., Bélanger, L., & Ivers, H. (2011). The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep*, *34*(5), 601–608. <https://doi.org/10.1093/sleep/34.5.601>

Nolen-Hoeksema, S., & Morrow, J. (1991). *Response Styles Questionnaire* [Database record]. APA PsycTests. <https://doi.org/10.1037/t03823-000>

Ong, C. W., Pierce, B. G., Petersen, J. M., Barney, J. L., Fruge, J. E., Levin, M. E., & Twohig, M. P. (2020). A psychometric comparison of psychological inflexibility measures: Discriminant validity and item performance. *Journal of Contextual Behavioral Science*, *18*, 34–47. <https://doi.org/10.1016/j.jcbs.2020.08.007>

Ong, J. C., Ulmer, C. S., & Manber, R. (2012). Improving sleep with mindfulness and acceptance: a metacognitive model of insomnia. *Behaviour research and therapy*, *50*(11), 651–660. <https://doi.org/10.1016/j.brat.2012.08.001>

Paulos-Guarnieri, L., Linares, I. M. P., & El Rafihi-Ferreira, R. (2022). Evidence and characteristics of Acceptance and Commitment Therapy (ACT)-based interventions for insomnia: A systematic review of randomized and non-randomized trials. *Journal of Contextual Behavioral Science, 23*, 1-14. https://doi.org/10.1016/j.jcbs.2021.11.001

Perz, C. A., Lang, B. A., & Harrington, R. (2022). Validation of the Fear of COVID-19 Scale in a US College Sample. *International journal of mental health and addiction*, *20*(1), 273–283. <https://doi.org/10.1007/s11469-020-00356-3>

Puzino, K., Amatrudo, G., Sullivan, A., Vgontzas, A. N., & Fernandez-Mendoza, J. (2020). Clinical Significance and Cut-Off Scores for the Pre-Sleep Arousal Scale in Chronic Insomnia Disorder: A Replication in a Clinical Sample. *Behavioral sleep medicine*, *18*(6), 705–718. <https://doi.org/10.1080/15402002.2019.1669604>

Qaseem, A., Kansagara, D., Forciea, M. A., Cooke, M., Denberg, T. D., & Clinical Guidelines Committee of the American College of Physicians (2016). Management of Chronic Insomnia Disorder in Adults: A Clinical Practice Guideline From the American College of Physicians. *Annals of internal medicine*, *165*(2), 125–133. <https://doi.org/10.7326/M15-2175>

R Core Team (2023). *R: A Language and Environment for Statistical Computing.* R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>

Rawal, A., Park, R. J., & Williams, J. M. (2010). Rumination, experiential avoidance, and dysfunctional thinking in eating disorders. *Behaviour research and therapy*, *48*(9), 851–859. <https://doi.org/10.1016/j.brat.2010.05.009>

Rolffs, J. L., Rogge, R. D., & Wilson, K. G. (2016). Disentangling Components of Flexibility via the Hexaflex Model Development and Validation of the Multidimensional Psychological Flexibility Inventory (MPFI). *Assessment, 25*(4), 458–482. <https://doi.org/10.1177/1073191116645905>.

Rogge, R. D., Daks, J. S., Dubler, B. A., & Saint, K. J. (2019). It's all about the process: Examining the convergent validity, conceptual coverage, unique predictive validity, and clinical utility of ACT process measures. *Journal of Contextual Behavioral Science, 14,* 90–102. [https://doi.org/10.1016/j.jcbs.2019.10.001](https://psycnet.apa.org/doi/10.1016/j.jcbs.2019.10.001)

Saldaña, K. S., McGowan, S. K., & Martin, J. L. (2023). Acceptance and Commitment Therapy as an Adjunct or Alternative Treatment to Cognitive Behavioral Therapy for Insomnia. *Sleep medicine clinics*, *18*(1), 73–83. <https://doi.org/10.1016/j.jsmc.2022.09.003>

Seidler, D., Stone, B., Clark, B. E., Koran, J., & Drake, C. E. (2020). Evaluating the factor structure of the Multidimensional Psychological Flexibility Inventory: An independent replication and extension. *Journal of Contextual Behavioral Science*, *17*, 23-31. <https://doi.org/10.1016/j.jcbs.2020.04.007>

Sharif Nia, H., She, L., Kaur, H., Boyle, C., Khoshnavay Fomani, F., Hoseinzadeh, E., ... & Rahmatpour, P. (2022). A predictive study between anxiety and fear of COVID-19 with psychological behavior response: the mediation role of perceived stress. *Frontiers in Psychiatry*, *13*, 851212. <https://doi.org/10.3389/fpsyt.2022.851212>

Staner L. (2010). Comorbidity of insomnia and depression. *Sleep medicine reviews*, *14*(1), 35–46. https://doi.org/10.1016/j.smrv.2009.09.003

van Buuren, S., & Groothuis-Oudshoorn, K. (2011). mice: Multivariate Imputation by Chained Equations in R. *Journal of Statistical Software*, *45*(3), 1–67. <https://doi.org/10.18637/jss.v045.i03>

Woodley, J., & Smith, S. (2006). Safety behaviors and dysfunctional beliefs about sleep: testing a cognitive model of the maintenance of insomnia. *Journal of psychosomatic research*, *60*(6), 551–557. <https://doi.org/10.1016/j.jpsychores.2006.03.002>

Figure 1.

*The Conceptual Model of Serial Mediation*

A black background with blue rectangles

Description automatically generated

Figure 2.

*The Serial Mediation of Psychological Inflexibility and Daytime Insomnia Rumination*

A black background with blue rectangles

Description automatically generated

*Note. \*\*p* < 0.001, \**p* < 0.05.

|  |  |  |
| --- | --- | --- |
| Table 1.  *Demographics* | | |
| Age *M (SD)* | *20.60* | *(4.10)* |
| n = 490 |  |  |
| Student Status | n | % |
| full-time | 463 | 94.68% |
| part-time | 26 | 5.31% |
| NA | 1 | 0.20% |
|  | | |
| Undergraduate | 488 | 99.80% |
| Graduate | 1 | 0.20% |
| NA | 1 | 0.20% |
| Gender |  | |
| Male | 109 | 22.24% |
| Female | 368 | 75.10% |
| Transgender | 1 | 0.20% |
| Nonbinary | 6 | 1.22% |
| Other | 4 | 0.82% |
| NA | 2 | 0.41% |
| Sexual Orientation |  | |
| Heterosexual | 392 | 80.00% |
| Bisexual | 68 | 13.88% |
| Gay or Lesbian | 10 | 2.04% |
| Other | 16 | 3.27% |
| NA | 4 | 0.82% |
| Race |  | |
| Native American/American Indian/Alaska Native/Indigenous | 4 | 0.82% |
| Middle Eastern/North African (Non-White) | 3 | 0.61% |
| Pacific Islander/Native Hawaiian | - | - |
| Asian | 16 | 3.27% |
| Black | 16 | 3.27% |
| White | 410 | 83.67% |
| Latinx/Hispanic (Non-White) | 22 | 4.49% |
| Multiracial | 16 | 3.27% |
| Other | 1 | 0.20% |
| NA | 2 | 0.41% |
| Family Income |  |  |
| $0 - $20,000 | 48 | 9.80% |
| $20,001 - $40,000 | 60 | 12.24% |
| $40,001 - $80,000 | 123 | 25.10% |
| $80,001 - $120,000 | 135 | 27.55% |
| $120,001 - $200,000 | 82 | 16.73% |
| More than $200,000 | 31 | 6.33% |
| NA | 11 | 2.24% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 2.  *Correlations for Variables at Baseline* | | | | | | | | |
|  |  | *M* (*SD*) | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | Insomnia | 10.91 (5.26) | - | 0.48\*\*\* | 0.56\*\*\* | 0.12\*\* | 0.57\*\*\* | 0.43\*\*\* |
| 2 | DASS-D | 5.87 (5.07) |  | - | 0.44\*\*\* | 0.19\*\*\* | 0.67\*\*\* | 0.63\*\*\* |
| 3 | DBAS | 4.91 (1.37) |  |  | - | 0.27\*\*\* | 0.58\*\*\* | 0.42\*\*\* |
| 4 | Fear of COVID-19 | 12.10 (5.08) |  |  |  | - | 0.30\*\*\* | 0.25\*\*\* |
| 5 | Insomnia rumination | 46.83 (13.40) |  |  |  |  | - | 0.67\*\*\* |
| 6 | Psychological Inflexibility | 3.08 (0.90) |  |  |  |  |  | - |
|  | *Note*:  *DASS-D = Depression Anxiety Stress Scale-Depression, DBAS = Dysfunctional Beliefs and Attitudes About Sleep.* \**p* < .05, \*\*p < .01, \*\*\*p < .001 | | | | | | | |

Table 3.

*Indirect Effects for serial mediation paths.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Mediator | Path | *β* | *SE* | *t* | *p* | 95% CI |
| Psychological Inflexibility |  | 0.36 | 0.12 | 2.14 | .002 | [0.136, 0.585] |
| Insomnia Rumination |  | 0.01 | 0.00 | 2.59 | .010 | [0.002, 0.016] |
| Psychological Inflexibility and Insomnia Rumination |  | 0.02 | 0.01 | 2.25 | .025 | [0.003, 0.042] |
| Total Effect |  | 0.09 | 0.28 | 0.33 | < .001 | [0.571, 1.382] |
| *Note: MPFI = Multidimensional Psychological Flexibility Inventory, DBAS = Dysfunctional Beliefs and Attitudes about Sleep. All effects we significant at p < .05.* | | | | | | |