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SLEEP DIFFICULTIES IN COLLEGE STUDENTS: THE ROLE OF STRESS, AFFECT AND COGNITIVE PROCESSES

Ana Paula Amaral^{a,b}, Maria João Soares^b, Ana Margarida Pinto^b, Ana Telma Pereira^b, Nuno Madeira^{b,c}, Sandra Carvalho Bos^b, Mariana Marques^b, Carolina Roque^{b,c}, António Macedo^{b,c}

^aESTESC -Coimbra Health School, Polytechnic Institute of Coimbra, Coimbra, Portugal

^bDepartment of Psychological Medicine, Faculty of Medicine, University of Coimbra, Coimbra, Portugal

^cCoimbra Hospital and University Centre, Coimbra, Portugal

anaamaral@estescoimbra.pt

apamaral.22@gmail.com

***Corresponding author: Ana Paula Amaral.** ESTESC - Coimbra Health School, Rua 5 de Outubro, S. Martinho do Bispo, Apartado 7006, 3046-854 Coimbra, Portugal. Tele: +351 239 802 430; Fax: +351 239 813 395

Abstract

Previous research indicates that sleep difficulties and stress are prevalent in college students. The main aim of the current study was to investigate the role of repetitive negative thinking (RNT), cognitive emotion regulation, and negative affect as mediators of the relationship between stress and sleep difficulties. We also intended to analyse the associations between all these variables and the gender differences. A sample of 549 college students completed self-report measures assessing the mentioned variables. Descriptive and correlational analyses showed significant differences between genders. In total sample, sleep difficulties were positively associated with perceived stress, negative affect, RNT and cognitive emotional strategies (rumination, self-blaming, catastrophizing, and acceptance). Mediation analyses suggested that in addition to the direct effect of stress on sleep difficulties, rumination and negative affect were important mediators in this relationship (after controlling gender). RNT did not mediate this association; however it was significantly associated to rumination and/or negative affect. These findings suggest that the effect of stress on sleep difficulties is strengthened by rumination and/or negative affect. The negative impact of RNT (content free) only occurs if associated to rumination and/or negative affect.

Keywords: sleep difficulties; stress; rumination; repetitive thinking; negative affect

1. Introduction

Sleep disturbances are amongst the most prevalent health complaints in late adolescents and young adults, with students reporting insufficient sleep and difficulties with falling asleep or maintaining sleep (Yang et al., 2003). Research has consistently demonstrated that variable sleep patterns, along with other students' practices such as high media usage, contribute significantly to poor sleep hygiene and sleep problems (Tavernier and Willoughby, 2014). Additionally, entering college constitutes a major life transition, often entailing leaving home, encountering demanding classes and facing new social contexts. This transitional period is often related to increased levels of stress which, in turn, can elicit profound and lasting effects on sleep (Akerstedt, 2006). Indeed, empirical studies suggest that emotional and academic stress have a negative impact on sleep (Lund et al., 2010), resulting in fewer hours of sleep, more sleep disturbances, and later rise times, especially in periods of high stress (Galambos et al., 2013). A qualitative study of Abdulghani et al. (2014) reported that sleep deprivation, homesickness, and stress are important factors for academic success of college students. For decades, research has consistently showed a relationship between stress, sleep and negative affect (e.g., Folkman, 2013; Nyer et al., 2013).

The negative effect of stress is associated with the prolonged activation of the stress response, which can be exacerbated or, in turn, downregulated by psychological processes such as repetitive negative thinking (RNT) (Brosschot et al., 2006) and cognitive emotion regulation strategies (Gross, 2009). Previous studies suggest that pre-sleep negative cognitive activities following a stressful event are associated with poor sleep quality (Takano et al., 2014). Lancee et al. (2017) found that only night-time sleep-related worry, when compared with daytime repetitive thinking, was consistently associated with sleep impairment. In fact, RNT seems to play an important role in the onset and maintenance of insomnia (Takano et al., 2012) and is related to shorter sleep duration and delayed sleep timing (Nota and Coles, 2015). Besides sleep difficulties, RNT is also associated with a wide range of emotional problems and it constitutes a significant predictor of psychological distress (Ehring and Watkins, 2008; Macedo et al., 2015). Thus, to understand the transdiagnostic nature of RNT (also defined as perseverative negative thinking) we need to focus on its characteristics as a disorder independent process (Ehring et al., 2011).

Cognitive emotion regulation (CER) can be defined as the mental processes responsible for monitoring, evaluating, and modifying emotional reactions. These processes are inextricably associated to human life and help people managing their

emotions after stressful events (Garnefski and Kraaij, 2006). Previous studies suggested that the use of cognitive styles such as rumination, catastrophizing, and self-blame may increase the liability of the individual to experience emotional problems while the use of more functional cognitive styles (e.g., positive reappraisal) is associated with positive outcomes and may protect against the onset and maintenance of psychological distress (Garnefski et al., 2004; Garnefski and Kraaij, 2006). Moreover, a growing body of research has demonstrated an association between rumination and poor sleep quality or sleep disturbances, and between negative emotions and sleep disturbances (Thomsen et al., 2003; Takano et al., 2012).

Several studies reported that females tend to report more sleep problems and more emotional distress (e.g., Rose and Rudolph's, 2006; Lund et al., 2010). Chow et al. (2017) found that females reported higher co-rumination and depressive symptoms, both of which were related to more sleep problems.

To our knowledge, the role of the RNT as a potential mediator between perceived stress and sleep difficulties, measured with an instrument which is content free and consequently more adequate to a transdiagnostic perspective has not been explored yet and this is a strength of the present study.

Therefore, our main objectives are threefold: a) explore the existence of gender differences in sleep difficulties, perceived stress, repetitive negative thinking, cognitive emotion regulation strategies and negative affect; b) examine the associations between these variables; c) test whether the effect of perceived stress on sleep difficulties occurs through repetitive negative thinking, cognitive emotion regulation strategies and negative affect, when controlling for gender differences, if applicable.

2. Methods

2.1. Procedures and participants

Students from several higher education institutions in the Centre and North of Portugal were recruited at the beginning of the first semester and invited to participate in a cross sectional study. The research project was approved by the Ethics Committee of the Faculty of Medicine, University of Coimbra. The study and its aims were explained to participants at class sessions and their informed consent was obtained. All ethical and deontological assumptions were followed throughout the study.

The sample comprised 549 university students, of which 80.1% ($n = 440$) were females. The sociodemographic characteristics of the sample are listed on Table 1.

2.2. Measures

The *Cognitive Emotion Regulation Questionnaire* (CERQ; Garnefski et al., 2001) is a 36-item multidimensional questionnaire designed to measure specific cognitive emotion regulation strategies used in response to threatening or stressful life events. Items are rated on a 5-point Likert scale (from 1 “almost never” to 5 “almost always”).

The factorial structure of the Portuguese validated version (Castro et al., 2013) significantly overlaps with the original, evaluating 8 conceptually distinct subscales: positive reappraisal/planning, positive refocusing, rumination, blaming-others, putting into perspective, self-blame, acceptance and catastrophizing.

Both the original and the Portuguese versions of the scale presented good psychometric properties, specifically good internal consistency (from 0.75 to 0.86 for the original version and from 0.74 to 0.89 for the Portuguese version). In the present study the internal consistencies varied from acceptable ($\alpha = 0.63$) to good ($\alpha = 0.85$).

The *Perseverative Thinking Questionnaire* (PTQ-15; Ehring et al., 2011) is a 15 item content-independent self-report questionnaire that assesses the core characteristics of perseverative negative thinking. Each item is rated on a 5-point Likert scale (from 0 “never” to 4 “almost always”). The Portuguese version (Chaves et al., 2013) includes two factors, namely repetitive thought and cognitive interference and unproductiveness.

Both versions of the scale presented good psychometric properties (internal consistencies from 0.77 to 0.95 for the original version and from 0.87 and 0.93 for the Portuguese version). In the present study, only the total score was used ($\alpha = 0.93$).

The *Perceived Stress Scale* (PSS-10, Cohen et al., 1983) is a 10 item self-report questionnaire developed to measure perceived stress. Items are rated using a 5-point Likert scale (from 0 “never” to 4 “very often”). The portuguese version (Amaral et al., 2014) has two factors: perceived distress; and perceived coping.

Both versions of the scale presented good psychometric properties, with internal consistencies of total score’s ranging between 0.78 and 0.91 across samples for the original version (Cohen and Janicki-Deverts, 2012) and from 0.75 to 0.87 for the

Portuguese version (Amaral et al., 2014). In the present study, only the total score was used ($\alpha = 0.87$).

The *Profile of Mood States* (PoMS, McNair et al., 1971; Azevedo et al., 1991) is a self-report scale that allows the assessment of transient, fluctuating feelings, and enduring affect states. It comprises 65 items/adjectives, rated by subjects on a 5-point scale (from 0 “not at all” to 4 “extremely”) and evaluating 6 mood-states: tension-anxiety, depression-dejection, anger-hostility, confusion-bewilderment, fatigue-inertia, and vigor-activity. The original version of the PoMS presented good psychometric properties (internal consistencies from 0.63 to 0.96). A previous study (Azevedo et al., unpublished data) conducted in a sample of college students revealed that negative affect presented a high internal consistency ($\alpha = 0.97$).

In this study the confusion-bewilderment dimension was not assessed and therefore only the remaining 58 items were used. Moreover, a total score reflecting negative affect was calculated by summing the scores of depression-dejection, tension-anxiety, anger-hostility dimensions ($\alpha = 0.96$).

Sleep difficulties. Three questions were used to assess sleep difficulties: 1) “*Have you had a lot of difficulties falling asleep?*” (difficulties initiating sleep); 2) “*Have you woke up often during the night?*” (difficulties maintaining sleep) and 3) “*Have you woke up too early in the morning (spontaneously)?*” (early morning awakening). Responses were given in a dichotomous format (“yes/no”). The sleep difficulties index (SDI) was calculated by summing the scores obtained in each item. We found an internal consistency of 0.57 for the sleep difficulties index.

2.3. Statistical analyses

The SPSS, version 21 (IBM, 2012) was used to perform the statistical analyses. Descriptive statistics were performed and parametric and non-parametric tests were selected depending on whether the variables met or not the normality assumption. Chi-square test, Mann-Whitney U and Student t-test were applied in order to examine the existence of significant gender differences regarding the variables under consideration. Pearson’s correlation coefficients as well as the effect size statistics were calculated and the Cohen’s criteria were applied to interpret their magnitude: 0.10 - small, 0.30 - medium, 0.50 - large (criteria to interpret correlation coefficients, phi coefficient and

approximate value of r) and 0.01 - small, 0.06 - moderate, 0.14 - large (criteria to interpret eta squared values) (Cohen, 1988).

Using PROCESS macro for SPSS a serial multiple mediation analysis was performed to explore the influence of perceived stress on overall sleep difficulties, using perseverative thinking, rumination and negative affect as serial mediators. The indirect effects and its 95% bias-corrected bootstrap confidence intervals (CI) were calculated based on 5000 bootstrap samples. The effects were considered significant if the 95% CI did not contain zero.

3. Results

3.1. Descriptive analyses and gender differences

The occurrence of at least one of the sleep difficulties (difficulties initiating sleep, difficulties maintaining sleep or early morning awakening) were described by 52.3% of the students (total sample).

Means, standard deviations and gender differences are summarized in Table 2.

Females reported higher levels of sleep difficulties and were almost two times more likely to describe difficulties in maintaining sleep and early morning awakenings. Also, females described higher levels of global perceived stress and perseverative thinking than males and a tendency to report higher negative affect.

In contrast, males engaged more in cognitive emotion regulation strategies related to self-blaming and blaming-others when compared to females.

The effect sizes of the differences reported ranged from small to large (Cohen, 1988).

3.2. Intercorrelations between variables

Correlation analyses (Table 3) showed that sleep difficulties are associated with perceived stress, perseverative thinking, rumination, self-blame, acceptance, catastrophizing and negative affect with magnitudes ranging from small to moderate both in female and total sample. Additionally, sleep difficulties are modestly correlated with blaming others, in females. In males, sleep difficulties were only significantly associated with perceived stress and negative affect.

Both female and total sample presented significant and small to large correlations between perceived stress and perseverative thinking, all cognitive emotion regulation strategies (except for putting into perspective in total sample) and negative affect. In males, perceived stress is poorly to highly associated with perseverative thinking, negative affect, and only with a few cognitive emotion regulation strategies, namely positive reappraisal/planning, rumination, blaming others, self-blame and catastrophizing.

Female and total sample showed small to moderate associations between perseverative thinking and all cognitive emotion regulation strategies (except acceptance in both samples and positive refocusing in total sample) and moderate/large correlations between perseverative thinking and negative affect. In males, perseverative thinking was only significantly associated (moderate to large correlations) with rumination, catastrophizing and negative affect. All samples presented small to moderate associations between negative affect and the majority of cognitive emotion regulation strategies. The only exception was the lack of association between negative affect and putting into perspective (for males and females) and positive refocusing (for males only).

3.3. Mediators in perceived stress and sleep difficulties association

A serial multiple mediator analysis was performed to analyse if the effect of perceived stress on sleep difficulties occurred via perseverative thinking, rumination and negative affect (Figure 1). Only the CERQ variables with highest correlation coefficients (of 0.25 or over) were explored as mediators in the link between perceived stress and sleep difficulties. Since gender differences were found for some of the variables under study, the effect of gender on the model was controlled for. The total, direct and indirect effects are listed in table 4.

The model was statistically significant ($F(5,401) = 26.584, p < 0.001$), explaining 25% of sleep difficulties' variance. The total effect of perceived stress on sleep difficulties was significant, with a confidence interval between 0.0588 and 0.0882.

The direct effect of perceived stress in sleep difficulties was positive and significant and there was evidence of an indirect effect of perceived stress on sleep difficulties through rumination, through negative affect and through rumination → negative affect. Only the indirect effect of perseverative thinking proved to be non-significant.

4. Discussion

Sleep difficulties are frequent in college students; with over 60% of them having poor sleep quality (Lund et al., 2010) and 1 out of 4 being at risk for at least one sleep disorder (Gaultney et al., 2010). Similar results were obtained in our study with 52.3% of the students reporting sleep difficulties. To clarify the mechanisms and factors involved we sought to explore not only the association between perceived stress, perseverative thinking, cognitive emotion regulation, negative affect and sleep difficulties but also the pathways by which stress impacts on sleep. Descriptive analyses pointed to the existence of some gender differences in terms of sleep-related complaints, with females reporting more sleep problems than males. According to Voderholzer et al. (2003), this difference may be related with a disparity between males and females in the prevalence rates of anxiety and depressive symptoms. Females also exhibited higher levels of perceived stress, negative affect and perseverative thinking, when compared to males. Surprisingly, no gender differences were found in cognitive emotion regulation, with the exception of the dimensions blaming-others and self-blaming, in which males scored higher than females. Although females scored higher than males in most of the cognitive emotion regulation strategies, in our study these differences did not reach statistical significance. Our results do not confirm previous findings (e.g., Garnefski et al., 2004) in which these gender differences were found.

Regarding correlation analyses, small to moderate associations were found between sleep difficulties, perceived stress, negative affect, perseverative thinking and certain CER strategies, specifically rumination, self-blame, catastrophizing, and acceptance. These findings provide support for the crucial role that repetitive negative thinking and cognitive emotion regulation strategies play in sleep difficulties and psychological wellbeing. In line with our results, other studies have shown that elevated levels of RNT are causally involved in the initiation and maintenance of emotional problems (Ehring and Watkins, 2008), and RNT is a significant predictor of psychological distress, mediating the relationship between perceived stress, personality traits and psychological distress (Macedo et al., 2015). In addition, converging evidence suggests that the pre-sleep cognitive activity of individuals with insomnia is excessive, uncontrollable, negatively toned, and covers a broad range of topics (e.g., Harvey, 2000). According with Takano et al. (2012) the perseverative thinking seems to be important in the onset and maintenance of insomnia.

Relatively to CER strategies, our findings are in line with those reported by Garnefski and Kraaij (2006), who found rumination, self-blame and catastrophizing, lack of positive reappraisal, and acceptance to be the only strategies associated with depressive symptoms, which in turn are commonly related to sleep difficulties (e.g. Bower et al., 2010; Koffel and Watson, 2009). As expected, the magnitude of correlations between sleep difficulties, perceived stress and negative affect was stronger in females.

Concerning mediation results, our study suggests that in addition to the direct effect of stress on sleep difficulties, a fact that is already well known from the literature (Lund et al., 2010), rumination and negative affect mediated this association. An interesting and innovating result was that perseverative thinking only mediated this relation when associated with rumination (i.e., *thinking about the feelings and thoughts associated with the negative event*) and/or negative affect, adding further perspective to previous studies on such correlations (Harvey and Greenall, 2003; Stoia-Caraballo et al., 2008; Thomsen et al., 2003). This finding is in accordance with the view of Stoia-Caraballo et al. (2008), that rumination plays an important role in the development and maintenance of sleep difficulties. Brosschot et al. (2006) found that worry and rumination moderates the health consequences of stressors, as they can prolong stress-related affective and physiological activation, both in advance of and following stressors. Mitchell et al. (2012) found that insomnia was associated with negative emotionality (combination of worry, somatic anxious arousal and rumination). Some thoughts can be experienced as intrusive and unwelcome, yet they are not necessarily dysfunctional. It is not the thoughts per se that are untypical or pathological, but the meaning and concern attributed to them (Macphee et al., 2006).

Given our results, psychological interventions should therefore consider the importance of emotion processing and its cognitive regulation in the maintenance of psychological distress and consequently in sleep difficulties. They should also address specific negative cognitive emotional strategies (in particular rumination), without forgetting any metacognitive components that reinforce its maintenance, as some individuals find some value in ruminative thinking, believing this strategy helps them correct past mistakes and anticipate future problems (Macedo et al., 2015). The work of Pennebaker with patients with anxiety disorders and chronic worry, has highlighted the importance of taking into consideration emotion processing and regulation and not

merely focusing in cognitions and behaviors (Arigo and Smyth, 2012; Mooney et al., 2009).

A major limitation of the present study is its cross sectional nature, and in a near future we will examine this model using a longitudinal design. Another limitation is the low internal consistency of the sleep difficulties index. An improvement of future research would be considering the evaluation of sleep difficulties, using other self-reported instruments often applied in sleep studies, such as the Pittsburgh Sleep Quality Index. Despite the inclusion of the PoMS scale, the absence of formal psychopathology measures might limit the robustness of our model, and posterior studies could assess the influence of such variables. Future studies are also needed to replicate these results in different samples, for example wide age ranges and in clinical samples.

To conclude, the results outlined demonstrate that the effect of perseverative thinking in the relationship between perceived stress and sleep difficulties only exists if mediated by rumination and/or negative affect, in addition to the direct effect of stress on sleep difficulties. These findings confirm the importance of taking into consideration the interplay between cognitions and affect when examining the factors that may contribute to the etiology and maintenance of sleep difficulties. Although these results require further exploration, they seem to suggest that psychological interventions for the treatment of sleep difficulties can benefit from the inclusion of strategies that help people deal with cognitive and emotion regulation processes associated with negative events and perseverative thinking.

Conflicts of interest

None.

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Figure 1 Serial multiple mediator model diagram on the influence of perceived stress in overall sleep difficulties.

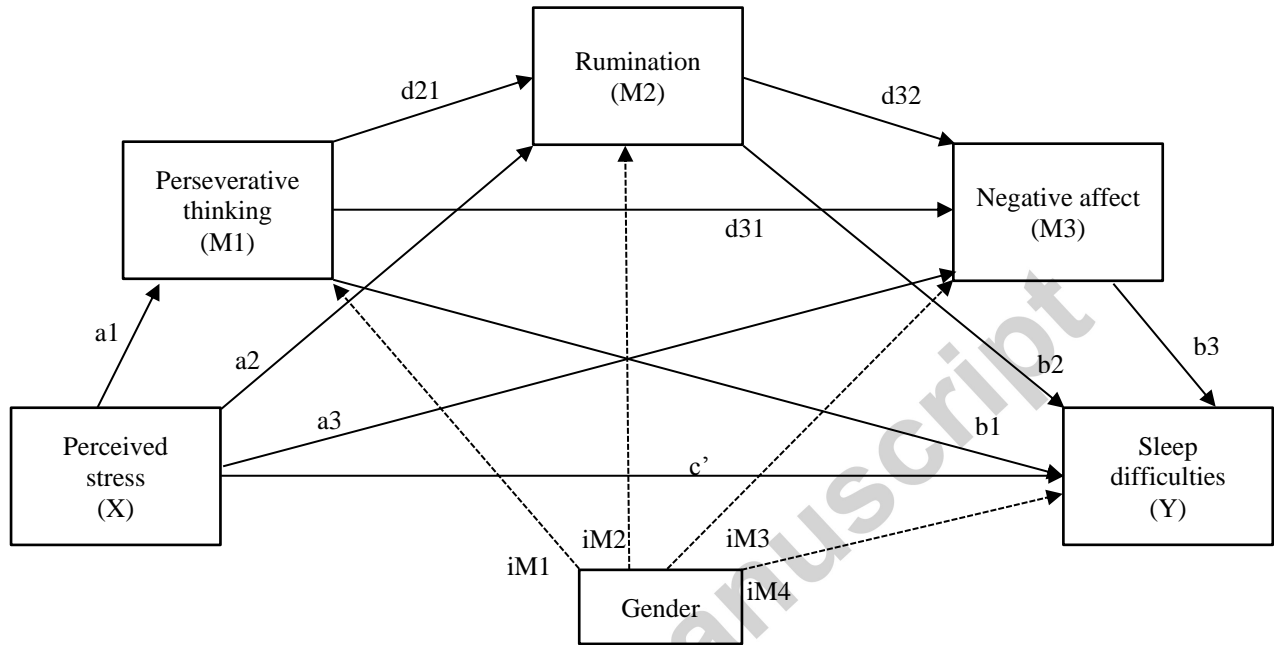


Table 1 Socio-demographic characteristics of the sample

	Males <i>n</i> =109 (19.9%) <i>M</i> (<i>SD</i> ; range)	Females <i>n</i> = 440 (80.1%) <i>M</i> (<i>SD</i> ; range)	Total <i>n</i> =549 <i>M</i> (<i>SD</i> ; range)
Age (years)	21.27 (6.56; 17-57)	20.31 (4.29; 17-48)	20.50 (4.83; 17-57)
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
17-25	98 (92.5)	409 (93.8)	507 (93.5)
26-30	3 (2.8)	12 (2.8)	15 (2.8)
31-40	1 (.9)	8 (1.8)	9 (1.7)
41-57	4 (3.9)	7 (1.6)	11 (2.0)
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Civil status			
Single	101 (93.5)	427 (97.0)	528 (96.4)
Married	5 (4.6)	7 (1.6)	12 (2.2)
Other	2 (1.8)	6 (1.4)	8 (1.5)
Nationality			
Portuguese	91 (83.5)	395 (89.8)	486 (88.5)
Course level			
1	44 (40.4)	235 (53.4)	279 (50.8)
2	8 (7.3)	78 (17.7)	86 (15.7)

3	41 (37.6)	3 (22.3)	139 (25.3)
4-6	16 (14.7)	29 (6.6)	45 (8.2)

Note. *M* = Mean. *SD* = Standard deviation.

Table 2 Means (*M*), standard deviations (*SD*) and gender differences for the variables under study

Variable	Total <i>M</i> (<i>SD</i>)	Female <i>M</i> (<i>SD</i>)	Male <i>M</i> (<i>SD</i>)	<i>t</i> (<i>df</i>)	η^2
Perceived stress	19.99 (6.26)	20.71 (5.91)	17.03 (6.80)	-5.44*** (511)	0.63
Negative affect	37.47 (24.15)	38.26 (23.74)	34.40 (25.57)	18259.00 §	--
Perseverative thinking	26.25 (9.14)	26.84 (8.98)	23.80 (9.41)	-3.07** (351)	0.02
Positive reap/ planning	23.04 (5.61)	22.90 (5.61)	23.68 (5.62)	13858.50 §	--
Positive refocusing	13.88 (3.95)	13.88 (4.16)	13.88 (4.18)	1.06(472)	--
Rumination	14.17 (3.95)	14.27 (3.92)	13.73 (4.06)	15782.00 §	--
Blaming-others	7.07 (2.71)	6.87 (2.65)	7.99 (2.78)	3.46** (465)	0.03
Putting into perspective	12.54 (3.52)	12.49 (3.57)	12.73 (3.29)	0.555(449)	--
Self-blame	6.09 (2.32)	5.97 (2.29)	6.62 (2.37)	13826.50* §	$z=-2.58$ $r=0.01$ §
Acceptance	11.48 (3.01)	11.44 (3.00)	11.65 (3.04)	0.597 (453)	--
Catastrophizing	8.04 (3.04)	7.97 (2.99)	8.33 (3.27)	1687.50 §	--
Sleep difficulties	0.88 (1.00)	0.94 (1.03)	0.63 (.87)	19334.00*** §	$z=-2.77$ $r=0.12$ §
Difficulties in initiating sleep	n (%) 29.8%	n (%) 31.3%	n (%) 23.6%	χ^2 2.41	ϕ --
Difficulties in maintaining sleep	27.9%	30.3%	17.8%	6.77**	0.112
Early morning awakening	30.9%	33.2%	21.5%	5.50*	0.101

Note. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$. § = Mann-Whitney *U*, § = approximate value of *r*

Table 3 Intercorrelations between variables in total sample, males and females

Total sample	1	2	3	4	5	6	7	8	9	10	11
1. Sleep difficulties											
2. Perceived stress	0.37**										
3. Perseverative thinking	0.23**	0.52**									
4. Positive reappraisal/ planning	-0.04	-0.22**	-								
5. Positive refocusing	-0.08	-0.13**	-0.09	0.57**							
6. Rumination	0.29**	0.45**	0.47**	0.19*	0.09						
7. Blaming-others	0.09	0.10*	0.23**	0.06	0.15**	0.32**					
8. Putting into perspective	-0.04	-0.09	-	0.70**	0.53**	0.17**	0.07				
			0.11	**	**	**	**				

9. Self-blame	0.20 **	0.26**	0.29 **	0.00	0.01	0.41 **	0.40 **	-0.03			
10. Acceptance	0.11 **	0.12*	0.04	0.43 **	0.25 **	0.49 **	0.19 **	0.41 **	0.24 **		
11. Catastrophizing	0.23 **	0.38**	0.40 **	- 0.11	0.02	0.49 **	0.47 **	-0.05	0.41 **	0.22 **	
12. Negative affect	0.40 **	0.69 **	0.50 **	- 0.18 **	- 0.14 **	0.48 **	0.27 **	- 0.13 *	0.35 **	0.16 **	0.47 **
Males	1	2	3	4	5	6	7	8	9	10	11
1. Sleep difficulties											
2. Perceived stress	0.20 *										
3. Perseverative thinking	0.13	0.57**									
4. Positive reappraisal/planning	-0.07	-0.28*	-0.14								
5. Positive refocusing	-0.15	0.08	0.16	0.31 **							
6. Rumination	0.15	0.55**	0.52 **	0.22 *	0.31 **						
7. Blaming-others	-0.01	0.26*	0.13	-0.18	0.11	0.22 *					
8. Putting into perspective	-0.04	-0.03	0.13	0.59 **	0.46 **	0.23 *	-0.02				
9. Self-blame	0.08	0.41**	0.21	-0.06	0.16	0.42 **	0.47 **	-0.02			
10. Acceptance	0.13	0.21	0.20	0.32 **	0.32 **	0.50 **	0.12	0.35 **	0.24 *		
11. Catastrophizing	0.03	0.47**	0.37 **	- 0.24 *	0.14	0.42 **	0.57 **	0.06	0.52 **	0.09	
12. Negative affect	0.25 *	0.70**	0.45 **	- 0.27 *	0.00	0.41 **	0.38 **	-0.08	0.36 **	0.24 *	0.33 **
Females	1	2	3	4	5	6	7	8	9	10	11
1. Sleep difficulties											
2. Perceived stress	0.39 **										
3. Perseverative thinking	0.25 **	0.49**									
4. Positive reappraisal/planning	-0.03	-0.20**	- 0.17 **								
5. Positive refocusing	-0.08	-0.20**	- 0.14 **	0.65 **							
6. Rumination	0.32 **	0.43**	0.45 **	0.21 **	0.05						
7. Blaming-others	0.14 **	0.12*	0.28 **	0.08	0.14 **	0.36 **					
8. Putting into perspective	-0.04	-0.14**	- 0.15 **	0.74 **	0.55 **	0.15 **	0.07				
9. Self-blame	0.25	0.26**	0.33	0.00	-0.03	0.40	0.36	-0.04			

	**		**			**	**				
10. Acceptance	0.12	0.11*	0.01	0.46	0.23	0.48	0.19	0.43	0.21		
	*			**	**	**	**	**	**		
11. Catastrophizing	0.24	0.39**	0.42	-0.09	-0.00	0.49	0.47	-0.05	0.39	0.23	
	**		**			**	**		**	**	
12. Negative affect	0.43	0.68**	0.44	-0.14	-0.15	0.49	0.27	-0.10	0.36	0.19	0.45
	**		**	**	**	**	**		**	**	**

Note. * $p < 0.05$. ** $p < 0.01$

Table 4: Summary of the serial mediation model

Total and Direct Effects																
Antecedent	M1 (Perseverative thinking)			M2 (Rumination)			M3 (Negative affect)			Y (Sleep difficulties)						
	Coeff	SE	t	Coeff	SE	t	Coeff	SE	t	Coeff	SE	t				
Total effect										c	0.074	9.822				
X (Perceived stress)	0.74	0.06	11.812	a2	0.21	0.03	6.612	a3	2.31	0.16	13.707	c'	0.04	0.01	4.052	
M1 (Perseverative thinking)	--	--	--	d2	0.12	0.02	5.855	d3	0.33	0.11	2.909*	b1	-0.00	0.00	-0.536	
M2 (Rumination)	--	--	--	--	--	--	--	d3	0.93	0.25	3.754*	b2	0.03	0.01	2.863	
M3 (Negative affect)	--	--	--	--	--	--	--	--	--	--	--	b2	0.00	0.00	2.673	
Gender	0.42	1.00	0.422ns	-0.6	0.43	-1.491	-4.75	2.21	-2.152r	0.22	0.11	1.881				
Constant	iM	10.8	2.02	5.357*	iM	7.78	0.91	8.497*	iM	-22.6	4.95	-4.541*	iY	-1.09	0.27	-4.020
Model summary	R ² =0.269			R ² =0.283			R ² =0.534			R ² =0.248						
	F(2, 404)=74.342, p<			F(3, 403)=52.93, p<			F(4, 402)=114.960, p<			F(5, 401)=26.58, p<						
				p<0.001						p<0.001						
Indirect Effects																
	Effect	SE	Lower	Upper												
Total indirect effect	0.0295	0.0077	0.0141	0.0442												
IE1: X-M1-Y	-0.0024	0.0045	-0.0116	0.0064												
IE2: X-M1-M2-Y	0.0037	0.0015	0.0012	0.0072												
IE3: X-M1-M3-Y	0.0017	0.0009	0.0004	0.0043												
IE4: X-M1-M2-M	0.0006	0.0003	0.0002	0.0015												
IE5: X-M2-Y	0.0082	0.0032	0.0027	0.0154												
IE: X-M2-M3-Y	0.0014	0.0006	0.0005	0.0031												
IE7: X-M3-Y	0.0164	0.0061	0.0046	0.0286												

Note. * $p < 0.05$; ** $p < 0.01$, *** $p < 0.001$. ns = non-significant. M = mediator. IE = indirect effect.

Highlights

- Stress has a direct effect (after gender control) on sleep difficulties
- Rumination mediates the effect of repetitive thinking in sleep difficulties
- Negative affect mediates the effect of repetitive thinking in sleep difficulties