Moderating Role of Perseverative Negative Cognitions in the Association Between Academic Stress and Sleep

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Abstract

Quality sleep is paramount for the mental and physical health of university students and for their academic success. Stress was found to be a precipitator and a maintaining factor of poor sleep. Moreover, vulnerabilities in the student population may maintain and/or exacerbate a possible association between stress and sleep quality; one of which is the development or the existence of poor coping strategies to deal with stress, such as a propensity to engage in perseverative negative cognitions (PNCs). This study examined whether an increase in academic stress was related to a decrease in the sleep quality of university students. Additionally, moderation by two different PNCs (i.e., excessive worry and rumination) were expected, with high levels of PNCs associated with an exacerbation of the relationship between academic stress and sleep quality. Lastly, the unique contribution of the two PNCs for the moderation effect was explored. Cross-sectional data from 49 university students were obtained using a series of questionnaires (M_{age} = 19.6 years, female = 95.9%). A simple regression analysis failed to indicate that an increase in academic stress predicts a decrease in sleep quality (p = .30). In addition, a hierarchical multiple regression failed to establish that PNCs moderate the relationship between academic stress and sleep quality (p = .18), suggesting that high levels of PNCs may not be associated with an exacerbation of the relationship. Furthermore, this study did not find evidence for the individual contribution of both types of PNCs to the moderation effect of PNCs in the association between academic stress and sleep quality (p = .28 for worry as a moderator; p = .47 for rumination as a moderator). These findings inform that academic stress might not share the same link with sleep difficulties as other types of stress have demonstrated. Furthermore, there is the possibility of additional concomitant difficulties (i.e., depression and anxiety) being relevant for the associations investigated, either as subsequent outcomes or as determinants of these associations. These findings provide a basis for future research on possible resistances experienced by this population and inform interventions that could help ameliorate sleep quality in university students.

Keywords: academic stress, excessive worry, negative perseverative cognitions, rumination, sleep quality

Layman's Abstract

Quality sleep is vital for the mental and physical health of university students and for their academic success. Stress was found to be a precipitator and a maintaining factor of poor sleep. Moreover, vulnerabilities on the student population may maintain and/or exacerbate a possible association between stress and sleep quality. One possible vulnerability could be the development or the existence of poor coping strategies to deal with stress, such as a tendency to engage in perseverative negative cognitions (PNCs; e.g., excessive worry and rumination). An interaction of PNCs with situational/acute stress might explain sleep difficulties.

This study examined whether academic stress was related to the sleep quality of university students. Additionally, the influence of two different PNCs (i.e., excessive worry and rumination) was investigated. Finally, the unique influence of the two PNCs in the relationship under investigation were explored. Data from 49 university students obtained using a series of questionnaires were used (M_{age} = 19.6 years, female = 95.9%).

The analysis failed to demonstrate that an increase in academic stress leads to a decrease in sleep quality. In addition, it failed to show that PNCs influence the relationship between academic stress and sleep quality, suggesting that high levels of PNCs may not be associated with an exacerbation of the relationship between academic stress and sleep quality. Furthermore, this study did not find evidence for the individual influence of both types of PNCs in the association between academic stress and sleep quality.

These findings inform that academic stress might not share the same link with sleep difficulties as other types of stress have demonstrated (e.g., general stress). Furthermore, there is the possibility of additional concomitant difficulties (i.e., depression and anxiety) being relevant for the associations investigated, either as subsequent outcomes or as determinants of these associations.

This study provides a basis for future research to focus on possible resistances in dealing with academic stress faced by this population and informs future research on interventions that could help ameliorate sleep quality in university students.

The Moderating Role of Preservative Negative Cognitions in the association between Academic Stress and Sleep

Sleep difficulties, such as insomnia and short sleep duration, have been indicated as a major public health problem (Barnes & Drake, 2015). Insomnia disorder, defined by the Diagnostic and Statistical Manual of Mental Disorders, 5th ed. (DSM-5; American Psychiatric Association, 2013) as dissatisfaction with sleep quality or quantity, is associated with several adverse physical and mental health outcomes (Tang et al., 2017). One population of interest when considering sleep difficulties is university students, considering that poor sleep quality has detrimental consequences for students' concentration (van der Heijden et al., 2018) and is associated with decreased academic achievement (Baert et al., 2015; Genzel et al., 2013; Wong et al., 2013), in addition to poor health outcomes. A systematic review by Jiang et al. (2015) has found a prevalence of insomnia in university students of 18.5%, compared to a prevalence of insomnia in the general population of 7.4%. Given the prevalence of insomnia in university students and its association with poor educational and health outcomes, quality sleep becomes paramount for this population.

Research has found stress to be a precipitator and a maintaining factor of poor sleep in young adults (Saruhanjan et al., 2021) and increasing levels of stress are reported by a significant number of university students (Thorley, 2017). Evidence suggests that stress and sleep share a bidirectional association (Kalbach et al., 2018), with daytime stressors possibly having an influence on sleep and, in turn, experiencing poor sleep possibly impairing daytime functioning. Nevertheless, it is important to mention that stronger effects are found in the direction of stress to sleep (Garefelt et al., 2020). Although the link between stress and sleep quality has been described in the literature, limited studies have been conducted with the university student population. For the student population, several factors may contribute for university being a stressful environment, such as the transition to university level studies and lifestyle, possible financial strain, and academic demands, including overlapping deadlines and late working hours, between others (Gardani et al., 2022). Lund et al. (2010) found that during times of increased stress, such as exam periods, the quality of sleep of university students decreases. Shaheen and Albqoor (2022) found stress to be a significant predictor of sleep quality in university students, alongside with gender, marital status, employment status, and sleep hygiene. A systematic review and meta-analysis by Gardani et al. (2022) found moderate effects for the association between sleep quality and stress in undergraduate students.

In addition, there is limited research on possible vulnerabilities in university students that might maintain and/or exacerbate the association between academic stress and sleep difficulties (Benham, 2021). According to the diathesis-stress model of insomnia, some trait characteristics might predispose individuals to experience sleep difficulties. One such vulnerability could be the presence of poor coping strategies in this population, in the form of a propensity to engage in perseverative negative cognitions (PNCs) (Benham, 2021; Lund et al., 2010). According to the cognitive model of insomnia (Harvey, 2002), there appears to be an association between PNCs and sleep difficulties. As

described in the perseverative cognition hypothesis (Brosschot et al., 2006), a perseverative cognition is any type of stress-related negative, repetitive thought, such as excessive worry or rumination. Perseverative negative cognitions are also known as "repetitive negative thinking". It is important to mention that some forms of repetitive thinking can be constructive (McNeill & Dunlop, 2016; Watkins, 2008). PNCs, however, are dysfunctional; these cognitions are unproductive, intrusive, and it is difficult to disengage from them (Ehring et al., 2011). Albeit sharing a common process, worry and rumination appear to be temporally distinct, with excessive worry being more future-oriented and rumination more past and present oriented (McEvoy et al., 2018; Nolen-Hoeksema et al., 2008).

Research had demonstrated that PNCs are associated with poor sleep quality (Galbiati et al., 2018; Slavish & Graham-Engeland, 2015; Takano et al., 2012; Weise et al., 2013), including a meta-analysis by Clancy et al. (2020) that found an association between PNCs and sleep difficulties, reporting that high levels of PNCs could lead to worse sleep. Clancy et al. (2020) found that PNCs in general are associated with poorer sleep quality, and that both rumination and worry, independently, are associated with poorer sleep quality. There is, however, evidence that worry and rumination can influence sleep quality to different extents: rumination appears to be more strongly associated with poorer sleep quality than worry. It could be that PNCs, as a poor coping strategy used by university students to cope with academic stress, exacerbate the relationship between academic stress and sleep quality. In an adult sample, Clancy et al. (2022) did not find PNCs to moderate the relationship between self-perceived stress and three different constructs of sleep (sleep onset latency, duration, and quality). However, three other studies (Benham, 2021; Guastella & Moulds, 2007; Zoccola et al., 2009) offer some evidence for an interaction of PNCs with situational/acute stress predicting sleep difficulties.

Considering the above-mentioned literature, this study aims to investigate the relationship between academic stress and sleep quality in a non-clinical university student sample. In addition, this study aims to ascertain if PNCs moderate the relationship between academic stress and sleep quality. Furthermore, this study aims to investigate if different types of PNCs (i.e., worry and rumination) have a different contribution as a moderator in the association between academic stress and sleep quality. From this, three hypotheses follow. First, an increase in academic stress predicts a decrease in sleep quality. Second, PNCs (i.e., worry and rumination) moderate the relationship between academic stress and sleep quality such that high levels of PNCs are associated with an exacerbation of the association between academic stress and sleep quality. Third, both types of PNCs (i.e., worry and rumination) contribute individually to the moderation effect of PNCs in the association between academic stress and sleep quality.

Methods

Design

This study was part of a larger research that employed an observational cohort survey design. Investigators followed the same group of students longitudinally within the same academic semester.

The data was collected at two time points: firstly, during a non-exam week and, secondly, during an exam week. Data collected during a non-exam week served as a baseline, while data collected during an exam week served as data where respondents are expected to experience increased stress levels. The respondents were asked to fill-in the same questionnaires at both data points. This specific research focused on the cross-sectional data collected during baseline (i.e., the non-exam week).

Sample

The sample consisted of 49 students from Leiden University. Of these, 4.1% were male ($N = 2$) and 95.9% were female ($N = 47$). The mean age of the respondents was 19.6 years ($SD = 2.35$), the youngest being 17 years old and the oldest 30 years old. Regarding the respondents' nationality, most of the respondents had Dutch (34.7%, $N = 17$) and German nationality (18.4%, $N = 9$). In terms of education level, 87.8% of the respondents were Bachelor students ($N = 43$) and 12.2% were Master students ($N = 6$). Initially, there were 68 respondents; of these, 11 respondents dropped out of the study, 1 respondent was excluded due to completing the survey in less than 5 minutes which was deemed too little time to complete the survey, and 7 respondents were excluded following the exclusion criteria of answering any of the three exclusion questions (1. Have you ever been (including currently) diagnosed with or used medication for a depressive disorder (e.g., major depressive disorder, dysthymia)? 2. Have you ever been (including currently) diagnosed with or used medication for an anxiety disorder (e.g., social anxiety disorder, obsessive-compulsive disorder)? 3. Have you ever been (including currently) diagnosed with or used medication for a sleep-wake disorder (e.g., insomnia, narcolepsy)?) as 'yes'.

Measures

Sleep Quality was assessed with the Pittsburgh Sleep Quality Index questionnaire (PSQI; Buysse et al., 1989). This questionnaire evaluates sleep quality during the previous month and entails 19 self-report questions (e.g., "During the past month, how many hours of actual sleep did you get at night?" and "During the past month, how would you rate your sleep quality overall?"), comprising 7 components, each weighted equally on a scale from 0 to 3. The seven components are subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. The seven components were summed to obtain the total score for the PSQI, with a range from 0 to 21. A high score indicated the respondent suffered from poor sleep quality and vice-versa. A total score of ≥5 suggested clinically significant sleep difficulties. Buysse et al. (1989) indicated that the seven components scores had an overall reliability coefficient (Cronbach's α) of .83, which indicates a high degree of internal consistency. This study found this questionnaire to have a good degree of internal consistency, as determined by a Cronbach's alpha of .70.

Academic Stress was assessed using The Perception of Academic Stress Scale (PAS; Bedewy & Gabriel, 2015). Consisting of 18 items, the questionnaire includes items such as: "I can make academic decisions easily", "I fear failing courses this year", "Competition with my peers for grades is

quite intense". Five items (10, 11, 13, 14, and 15) were reverse scored and needed to be recoded before calculating the total score. The 18 items were summed to obtain the total score for the PASS, with a range from 18 to 90. A high score indicated that higher stress was experienced by the respondents and vice-versa. Bedewy and Gabriel (2015) indicated that the 18 items had an overall reliability coefficient (Cronbach's α) of .70, which indicates a good degree of internal consistency. This study found this questionnaire to have a good degree of internal consistency, as determined by a Cronbach's alpha of .84.

Excessive Worry was assessed with the Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990). This is a self-report instrument, constructed to assess worry as a trait. The PSWQ entails 16 questions (e.g., "My worries overwhelm me") rated on a 1-5-point scale (1 = *not at all typical of me* to 5 = *very typical of me*). Five items (1, 3, 8, 10, and 11) are reverse scored (e.g., "I do not tend to worry about things") and needed to be recoded before calculating the total score. The 16 questions were summed to obtain the total score for the PSWQ, with a range from 16 to 80. A high total score indicates the respondent suffers from high worry and vice-versa. Meyer et al. (1990) indicated that the 16 items had an overall reliability coefficient (Cronbach's α) of .97, which indicates a high degree of internal consistency. This study also found this questionnaire to have a high degree of internal consistency, as determined by a Cronbach's alpha of .95.

Rumination was assessed using The Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991; Treynor et al., 2003). Consisting of 22 items, such as: "I think I won't be able to do my job if I don't snap out of this", "I think about how sad I feel", "I think: Why can't I get going?". The 22 items were summed to obtain the total score for the RRS, with a range from 22 to 88. A high total score suggested use of excessive rumination as a response and vice-versa. Treynor et al. (2003) indicated that the 22 items had an overall reliability coefficient (Cronbach's α) of .90, which indicates a high degree of internal consistency. This study also found this questionnaire to have a high degree of internal consistency, as determined by a Cronbach's alpha of .91.

Procedure

Respondents registered to this study via Leiden University's research participation system (SONA) and were asked to fill in the survey using their own electronic devices. The respondents were informed about the topic of investigation as well as the exclusion criteria at the beginning of the survey (in the information letter and consent form). Furthermore, they were informed that the participation in the study was entirely voluntary and that they could stop at any time.

At the beginning of the Qualtrics survey, respondents were asked three questions that informed on the exclusion criteria (see above). This was followed by demographic questions (e.g., year of birth, nationality). After this, respondents were presented with the questionnaires that composed the survey in the following order: 1) Attentional control scale (ACS; Derryberry & Reed, 2002), 2) Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990), 3) The Anxiety and Preoccupation about Sleep Questionnaire (APSQ; Tang & Harvey, 2004; Jansson-Frojmark et al.,

2011), 4 Depression, Anxiety, Stress Scales (21-item version) (DASS; Lovibond & Lovibond, 1995), 5) The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989), 6) The Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991; Treynor et al., 2003), 7) The Perception of Academic Stress Scale (PAS; Bedewy & Gabriel, 2015), and 8) Clance Imposter Syndrome Scale (Chrisman et al., 1995).

The respondents completed the questionnaire in approximately 20 minutes. At the end of the first-time participation, respondents were provided with a thank you for participating. At the end of the second time participation (i.e., end of the study), respondents were provided with a debriefing letter including detailed information about the variables assessed in the study.

Statistical Analysis

Statistical analysis was conducted using IMB-SPSS 28. Data was checked for missing and incorrect data by visual inspection, frequencies and descriptives. PAS, PSQI, RRS, and PSWQ total scores were calculated. Assumptions for linear (multiple regression) were assessed. Prior to analysis, all independent variables (i.e., academic stress, worry, and rumination) were centred on the mean.

To check hypothesis 1, a simple linear regression was calculated for academic stress (PAS total score – centred) as the independent variable and sleep quality (PSQI total score) as the dependent variable. To confirm hypothesis 1, an increase in academic stress should significantly ($p < .05$) predict a decrease in sleep quality.

To check hypotheses 2 and 3, a hierarchical multiple linear regression with two interaction terms (worry*academic_stress; rumination*academic_stress) was conducted, with academic stress as the independent variable, worry and rumination as moderators, and sleep quality as the dependent variable. To confirm hypothesis 2, the complete model (with both PNCs) had to significantly ($p < .05$) indicate an exacerbation in the association between academic stress and sleep difficulty. To confirm hypothesis 3, each interaction term should be able to explain part of the exacerbation in the association between academic stress and sleep difficulty with statistical significance ($p < .05$).

Results

Assumptions for linear multiple regression were checked. There was independence of residuals, as assessed by a Durbin-Watson statistic of 2.06. Linearity was established by visual inspection of the scatterplot generated between the dependent variable and the three independent variables and visual inspection of the scatterplots generated between the dependent variable and each of the independent variables. There was no evidence of multicollinearity, as demonstrated by no tolerance values below 0.29. When assessing the existence of significant outliers, high leverage points or highly influential points, two outliers were found to be more than two standard deviations above the mean: participant 17 ($SD = 2.16$) and participant 37 ($SD = 2.13$). In addition, two leverage points were found to be above the calculated threshold of 0.37: participant 36, with a leverage point of 0.48 and participant 2, with a leverage point of 0.59. No influential points were found. Since respondents considered outliers were not the same respondents with high leverage points, and taking into

consideration the small sample size, it was decided to keep all respondents. There was homoscedasticity, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values. Finally, the assumption of normality was violated. Data for the dependent variable was transformed in correction of a moderate positive skewness. After this, the studentized residuals were normally distributed, as assessed by Shapiro-Wilk's test ($p < .05$).

Descriptives for continuous variables (academic stress, worry, rumination, and sleep quality) are presented in table 1. With a mean sleep quality score of 6.38 ($SD = 3.43$), 61.3% of the respondents met the proposed cut-off of ≥5 for poor quality sleep (Buysse et al., 1989).

Table 1

Descriptive Statistics

Variable	Min.	Max.	*M*	*SD*	*N*
Sleep quality	0	14	6.4	3.4	48
Academic stress	22	65	48.6	9.8	49
Worry	20	77	49.6	14.1	49
Rumination	22	81	39	11.5	49

A simple linear regression was run to examine the relationship between academic stress and sleep quality (H1). A non-significant association was found between academic stress and sleep quality ($F(1, 46) = 1.09$, $p = .30$), with an adjusted R^2 of .02. Respondents' average sleep quality score increased .012 points for each additional point in their academic stress score ($b = .01$, $SE = .01$, $p = .30$).

A hierarchical multiple linear regression was then conducted to determine if the addition of two interaction terms (academic stress*worry and academic stress*rumination) would moderate the relationship between academic stress and sleep quality (H2 and H3). Refer to table 2 for an overview of the results of the hierarchical multiple regression analysis.

In the first model, three predictors were included: academic stress, worry, and rumination. There was not a significant variance in sleep quality ($F(3, 44) = 2.28$, $p = .09$), with an adjusted R^2 of .08 and a Cohen's f^2 of .15 that indicates a small size effect according to Cohen (1988). Academic stress was not significantly associated with sleep quality ($b = -.004$, $t(44) = -.32$, $p = .75$). Worry was also not significantly associated with sleep quality ($b = .013$, $t(44) = 1.54$, $p = .13$). Finally, rumination was also not significantly associated with sleep quality ($b = .014$, $t(44) = 1.29$, $p = .21$).

In the complete model, two interaction terms (academic stress*worry and academic stress*rumination) were included. The complete model was not significant ($F(2, 42) = 1.6$, $p = .18$), with an adjusted R^2 of .06 and a Cohen's f^2 of .19 that indicates a small effect size according to Cohen (1988). The interaction terms (academic stress*worry and academic stress*rumination) did not

account for a significant proportion of the variance in sleep quality, with an adjusted ΔR^2 change of .026 in the model ($\Delta F(2, 42) = .65$, $p = .53$). The coefficient of the first interaction term (academic stress*worry) was not statistically significant ($b = -.001$, $t(42) = -1.097$, $p = .28$), indicating that worry might not moderate the relationship between academic stress and sleep quality. The coefficient of the second interaction term (academic stress*rumination) was not statistically significant ($b = .001$, $t(42) = .724$, $p = .47$), indicating that rumination might not moderate the relationship between academic stress and sleep quality.

Table 2

Hierarchical Multiple Regression Analyses predicting Sleep Quality from Academic Stress, Worry, Rumination, Academic Stress*Worry, and Academic Stress*Rumination

Predictor	B	SE	β	R^2	ΔR^2	F	ΔF
Model 1				.075		2.28	
Constant	2.42	.105					
Academic stress	-.004	.013	-.052				
Worry	.013	.009	.248				
Rumination	.014	.011	.214				
Model 2				.06	.026	1.60	.647
Constant	2.42	.129					
Academic stress	-.002	.014	-.027				
Worry	.010	.009	.186				
Rumination	.015	.012	.217				
AS*worry	-.001	.001	-.182				
AS*rumination	.001	.001	.126				

Note. $N = 48$, Model 2 = complete model

Discussion

This study aimed to investigate the association between academic stress and sleep quality in healthy university students during a non-exam week of the academic year. No association was found between academic stress and sleep quality; the first hypothesis could not be confirmed. Additionally, this study aimed to ascertain if PNCs moderated the relationship between academic stress and sleep quality, such that high levels of PNCs would be associated with an exacerbation of the association between

academic stress and sleep quality. The current study did not find evidence for the moderation effect of PNCs in the relationship between academic stress and sleep quality. In this sample, both PNCs (i.e., excessive worry and rumination) do not appear to interact with academic stress predicting sleep difficulties; the second and third hypothesis could not be confirmed.

The missing association between academic stress and sleep quality appears to contradict previous research (Gardani et al, 2022; Lund et al., 2010; Shaheen & Albqoor, 2022). One explanation for this contradictory finding could be that most studies that have investigated this relationship have done so with a variety of (non-specific) stress measures, while this study assessed specifically academic stress as a predictor of sleep quality. It is possible that this specific measure of stress is not associated with increased sleep difficulties in this sample, more so if we also consider that this study analyzed data from a non-exam week, where stress levels associated with academic demands are assumed to be lower than stress levels during an exam-week (Lund et al., 2010). Furthermore, this study examined a sample of university students following exclusion criteria for two disorder groups (i.e., anxiety disorder and depressive disorder) that are closely associated with sleep difficulties: sleep difficulties is a typical feature of several psychological disorders in the DSM-5 (American Psychiatric Association, 2013) and is distinctly linked with depressive and anxiety disorders. It could be that depression and/or anxiety may to some extent be relevant for the association investigated (Clancy et al., 2022). For instance, it could be that suffering from depressive and/or anxiety disorders may contribute to an incapacity to deal adequately with stress, which might in turn lead an increase in sleep difficulties (Harvey, 2002; Clancy et al., 2022; Zhang et al., 2020). In addition, it could be that the absence of depression and/or anxiety might signify there are potential protective factors that are preventing a poor coping response to the stress experienced. Adequate self-regulation, which is associated with meta-affective variables such as coping strategies or meta-motivational variables such as resilience, could offer protection against academic stress (De la Fuente et al., 2020).

PNCs do not appear to moderate the relationship between academic stress and sleep quality. Rumination has been associated with depression (Noelen-Hoeksema, 2000) and excessive worry is one of the core symptoms of Generalized Anxiety Disorder (GAD) and successfully discriminates GAD from other anxiety disorders (American Psychiatric Association, 2013). This finding appears to concord with a similar investigation in an adult sample, where one explanation offered for the absence of moderation was that depression and/or anxiety, which were also not considered for this study, may to some extent be relevant for the associations investigated and/or be subsequent outcomes or determinants of these associations (Clancy et al., 2022). One other possible explanation for this finding is that different aspects of PNCs might be implicated in its moderating effect. On the meta-analysis by Clancy et al. (2020) it is noted that sleep related worry is more strongly associated with sleep difficulties: worry that is related to sleep (for instance, worry about sleep or right before sleep) is most consistently related to sleep difficulties (worse sleep quality) in both clinical and community samples, which could be an explanation for the lack of moderation found in this study, as a trait measure of worry was used. In the case of

rumination, Treynor et al. (2003) offered evidence that brooding is the component which leads to higher maladaptive cognitions. It could be that the brooding aspect of this construct is more strongly associated with sleep difficulties, with reflection (another aspect of rumination) being a possible adaptative component.

This study faced some limitations. First, measures of sleep quality were subjective. It is understood that pairing both subjective and objective measures provide more reliable information, as it was found that, for example, females tend to report higher subjective sleep difficulties when compared to objective measures of the same individuals, such as those obtained via actigraphy (Clancy et al., 2020). Secondly, we must be cautious with inferences about causality given the correlational design of this study. Thirdly, data was gathered in a non-exam week, which, as mentioned previously, might have undermined the associations between academic stress and sleep quality. It could be that levels of stress and sleep quality during this measurement period were adequate, in contrast to what could be expected from an exam week, in which stress is usually increased and the sleep quality of students decreases (Lund et al., 2010).

This study also introduced some strengths: studying these relationships in a non-clinical sample such as university students might help in generalizing the results to students with no diagnosed sleep complaints. Furthermore, it may help to create valuable early interventions programs to avoid the development of insomnia and therefore possibly improve associated mental health outcomes. Finally, this is one of the few studies to directly test PNCs as a moderator in the relationship between academic stress and sleep quality, with the intent of informing on possible vulnerabilities in university students that might maintain and/or exacerbate this association. Finally, this study's sample was composed mostly by females. Clancy et al. (2020), suggests that females may be able to improve the effect of PNCs on their sleep by employing effective coping strategies; these strategies could help inform interventions to better the sleep of university students.

Future studies in university samples could evaluate if there is indeed an association between academic stress and sleep quality, by using self-report and objective measures of sleep quality (such as actigraphy or polysomnography), by considering the extent of the construct of stress and its varied ways of measurement (self-report, biological measuring, etc) and by employing a longitudinal approach throughout the academic year. It is suggested by Clancy et al. (2022) that stress management interventions may be more effective in reducing adverse health outcomes than targeting perseverative cognitions. Nevertheless, future studies could further investigate if different aspects of PNCs are a possible moderator between academic stress and sleep quality.

Quality sleep is paramount for both mental and physical health of university students. This study aimed to expand the literature on sleep, helping clarify the relationship between academic stress and sleep quality and aiming to demonstrate the moderating effect of PNCs as a possible vulnerability experienced by this population. These findings could provide a basis for future research and

interventions that could help ameliorate sleep quality in university students by targeting stress and by developing sleep specific interventions.

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