Sleep Quality and Bad Dreams Mediating the Relationship Between Stress and Mental

Well-Being in University Students in the Netherlands and Germany

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Abstract

Background: University students are especially susceptible to stress, poor sleep quality and mental health problems. Hence, this study aimed to examine the relationship between stress and mental well-being in university students in Germany and the Netherlands by investigating how sleep quality and bad dreams might mediate this relationship.

Method: The survey study focused on 63 university students from both countries. The study utilised the PSQI, the PSS, the MHC-SF and two questions investigating bad dreams and nightmares. The Hayes PROCESS macro was utilised to conduct two mediation analyses. While the first analysis applied the mediator sleep quality, the second exploratory analysis applied the mediator stress in the relationship between sleep quality and mental well-being. Due to weak correlations bad dreams was excluded as mediator.

Results: Sleep quality had no significant mediation effect in the relationship between stress and mental well-being. In the exploratory mediation stress fully mediated the relationship between sleep quality and mental well-being (b = -0.07; SE = 0.02; LLCI= -0.12; ULCI = -0.03)

Conclusion: The study underscored the correlation of poor sleep quality, stress and mental well-being in university students. To mitigate the increasing number of sleep and mental well-being problems in university students, greater support for university students is needed.

Key Words: University students, cross-sectional, sleep quality, mental well-being, Pittsburgh Sleep Quality Index (PSQI), mediation analysis

Sleep Quality and Bad Dreams Mediating the Relationship Between Stress and Mental Well-Being in University Students in the Netherlands and Germany

"Sleep well feel well." It is commonly known that sleep is essential for good health and general well-being. Sleep contributes to optimal cognitive functioning, emotional regulation, stress resistance as well as quality of life in general (O'Leary et al., 2016; Weinberg et al, 2016; Nunn et al., 2016). The importance of sleep becomes tangible when sleep quality diminishes. University students are especially prone to developing sleep problems that negatively impact their sleep quality (Henrich et al., 2021; Schlarb et al., 2012).

Previous studies identified several factors that influence sleep quality in students. Firstly, nightmares are common among university students and display significant correlations to sleep quality (Schlarb, 2015). However, nightmare frequencies differ across studies (Sweileh et al., 2011; Schredl, 2003). Moreover, elevated stress levels influence sleep quality (Schlarb, 2015). Sleep problems often occur during high-stress periods which students experience regularly (Galambos et al., 2011; Schlarb, 2015). A bidirectional relationship was found between stress and sleep quality indicating that, stress can lead to diminished sleep quality and sleep problems can lead to further stress (Minkel et al., 2012). Periods of elevated stress levels can put a toll on students' well-being (Reschke et al., 2024). A national report in the Netherlands from 2023 states that "a significant share of students experienced mental health issues…" (Monitor Mentale Gezondheid En Middelengebruik Studenten Hoger Onderwijs 2023 | RIVM, n.d.). Likewise, the study by Bailer et al. (2007) investigated a German university sample and found that 22.7% fulfilled the criteria for a mental disorder.

In sum as a population group, university students are especially susceptible to poor sleep quality, bad dreams, stress, and mental health problems (Prokeš, 2023; Schlarb, 2015). Therefore, the question urges how sleep quality, bad dreams, stress and well-being are related and how they interact. Weinberg et al. (2016) investigated this question in a general sample with student share of 33.2% and found that the relationship between stress and well-being was

partly mediated by sleep quality. That means that the mediator variable sleep quality is located between stress and well-being and is the conduit through which stress mediates its effect on well-being (Igartua & Hayes, 2021).

However, so far, it is unclear if and how this mediation effect results. A deepened understanding would make targeted interventions for university students possible. Yet, as far as we know, no study investigated the relationship between stress and well-being in university students in the Netherlands and Germany by focusing on the mediators sleep quality and bad dreams. Hence, this study aims to enhance the knowledge of the interaction between stress and mental well-being in university students while contemplating the interplay of sleep quality, and bad dreams.

Sleep quality

People's evaluations of their last night's sleep differ. Research shows that people's sleep evaluation depends more on sleep quality than quantity (Weinberg et al., 2016). Sleep quality as a clinical construct is difficult to measure objectively and to define. Buysse et al (1989) attributed quantitative aspects of sleep like sleep duration, sleep latency, or the number of arousals, as well as purely subjective aspects such as "depth" or "restfulness" to sleep quality. Yet, the relative importance of the exact components varies between individuals. Factors such as employment status, age, and perceived stress have been linked to influence sleep quality (Goelema et al., 2017). Furthermore, dreams influence our sleep quality (Schlarb, 2015). Bad dreams are very disturbing dreams that, though being unpleasant, do not cause you to awaken (Zadra & Donderi, 2000). Bad dreams were found to happen around 1.56 times a week (Solomonova et al., 2021). A continuum between bad dreams and nightmares is suggested. Dreams with strong negative emotions that result in awakening from the dream and the dream plot can be recalled very vividly upon awakening were defined as nightmares (Schredl et al., 2016). Whereas Schredl (2003) found that 52.2% of students experienced nightmares once a month or more often, 12.1% reported nightmares at least once

a week. A different study discovered that 12.8% of students have nightmares 1-2 times a week, 2.5% 3-4 times a week, whereas 3.5% suffer from nightmares almost every night (Schlarb, 2015). This is evident that discovered nightmare frequencies vary. Frequent nightmares have been linked to reduced tolerance to stress (Hochard et al., 2016)

Stress

Even though stress responses are essential for survival, they can disrupt proper behaviour and biological functioning (Minkel et al., 2012). When we encounter stress, that threatens our well-being, our psychological buffers play a crucial role in helping us return to an optimal state. Chronic stress disrupts the buffers effect leading to decreased sleep quality (Weinberg et al., 2016). In general stress-related factors are crucial concomitants of sleep complaints in the general population (Buysse et al., 1989). The impact of stress on sleep quality is significant, especially when experienced before bedtime (Åkerstedt, 2006). Increased levels of stress lead to elevated physiological and psychological activity disrupting sleep which can lead to poorer sleep quality (Åkerstedt, 2006). Moreover, ongoing daily hassles and chronic stress constitute the potential onset and maintenance of sleep problems (Schlarb et al., 2012) as well as decreased well-being (Minkel et al., 2012). Furthermore, elevated stress levels increase the probability of bad dreams and nightmares which consequently impacts sleep quality (Duke & Davidson, 2002). If everyday challenges exceed an individual's coping resources, prolonged stress can result in decreased well-being (Minkel et al., 2012).

Mental well-being

The construct of well-being, its measurement and conceptualisation are a debated topic. According to Ryan and Deci (2001), well-being is defined as the concept of optimal psychological functioning and experience rather than just the absence of mental illness. Nevertheless, well-being is an interconnected concept of mental health. The definition of mental health from the World Health Organisation helps to clarify the concepts'

interconnectedness "Mental health is a state of mental well-being that enables people to cope with the stresses of life, realise their abilities, learn well and work well, and contribute to their community" (World Health Organization: WHO, 2022). Research distinguishes between hedonic and eudaimonic well-being (Keyes et al., 2002; Ryan & Deci, 2001). Mental well-being is closely related to hedonic well-being and can be described as "feeling good" (hedonic well-being), and "functioning well" (eudaimonic well-being) reflecting a positive disposition or state of resilience that enables the individual to cope more easily with the problems and challenges of daily life (Navarra-Ventura et al., 2024). Mental well-being was found to be negatively influenced by poor sleep quality (Henrich et al., 2021) as well as prolonged stress (Reschke et al., 2024) in university students.

The current study

In sum, previous studies indicate a bidirectional relationship between sleep quality and stress (Minkel et al., 2012). Moreover, a mediating effect of sleep quality and bad dreams in the relationship between stress and well-being was found in a different study (Weinberg et al., 2016). Given the rising sleep complaints and decreasing well-being in Dutch and German students (Netherlands, 2023; Schlarb, 2015) this study anticipates expanding the understanding of whether the mediating effect of sleep quality and bad dreams manifest in a student sample. We formulated three research questions to achieve this aim:

RQ1: What relationship do sleep quality, bad dreams and stress have in university students in the Netherlands and Germany?

RQ2: What relationship do sleep quality, bad dreams and mental well-being have in university students in the Netherlands and Germany?

RQ:3 To what extent do sleep quality and bad dreams mediate the relationship between stress and mental well-being in university students in the Netherlands and Germany?

Figure 1

Hypothesised Mediation Model
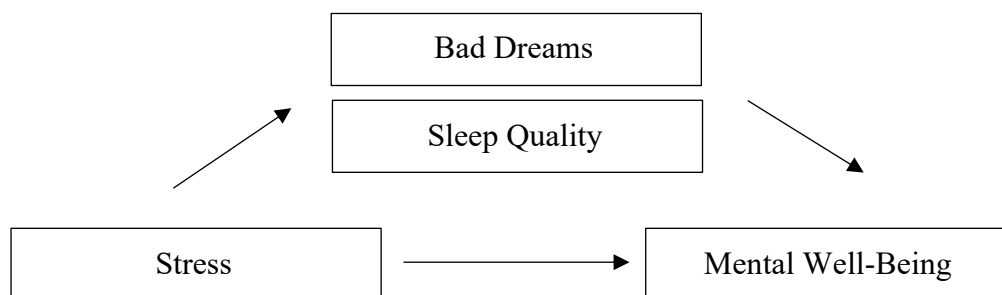
Method

Design

We applied a cross-sectional, correlational design with stress as the independent variable and mental well-being as the dependent variable. Sleep quality and bad dreams were mediating variables in the independent and dependent variables relationship.

Participants

A total of 93 participants voluntarily completed the survey. Eligibility was restricted to students in the Netherlands or Germany, who were at least 18 and without a diagnosed and ongoing sleep disorder. The dataset comprised 63 participants after removing non-eligible participants and participants with incomplete responses. All participants gave their informed consent to participate and were recruited by purposive sampling via social media and WhatsApp or SONA a Test Subject Pool System of the Behavioural, Management, and Social Science (BMS) Faculty, rewarding participants with 0.25 incentives for successful participation. The participants' age range was between 18 and 58 (*M = 23.03* and *SD = 4.93*). Other descriptive statistics can be seen in Table 1. Notably, most participants were female or from Germany.

Table 1

Socio-demographic Data of Participants N=63

	M	SD
Age, M (SD)	23.03	4.93
	n	%
Gender		
Male	14	22.2
Female	48	76.2
Non-binary / third gender	1	1.6
Prefer not to say	—	
Nationality		
German	54	85.7
Dutch	5	7.9
Other	4	6.4
Country of study		
Netherlands	43	68.3
Germany	20	31.8
University		
University of Twente	37	58.7
Other	26	41.3
Phase of study		
Bachelor year 1	8	12.7
Bachelor year 2	9	14.3
Bachelor year 3	31	49.2
Master year 1	4	6.4
Master year 2	6	9.5
Other	5	7.9
Study subject		
Psychology	36	57.1
Other	27	42.9
Study started in		
2018	2	3.2
2019	5	7.9
2020	9	14.3
2021	24	38.1
2022	11	17.5
2023	10	15.9
2024	2	3.2
Sleep disorder		
Yes	—	0

No	63	100

Note. Mean (M), Standard Deviation (SD), Frequencies (n) and percentages (%)

Materials

We used Qualtrics software to create the online survey. Demographic data was collected including gender (male, female, non-binary/third gender, prefer not to say), current age, nationality (German, Dutch, Other), country of study (Netherlands, Other), the university of study (University of Twente, Other), the phase of study (Bachelor year 1, Bachelor year 2, Bachelor year 3, Master year 1, Master year 2, Other), study subject (Psychology, Other), in what year the study was started and whether a sleep disorder is ongoing and has been diagnosed (yes, no). Three standardised scales composed the survey. The Pittsburgh Sleep Quality Index (see Appendix A), the Perceived Stress Scale (see Appendix B), and the Mental Health Continuum Short-Form (see Appendix C). Questions investigating bad dreams derived not from an existing scale but the study from Weinberg et al (2016) inspired the question designing process (see Appendix D).

Pittsburgh Sleep Quality Index (PSQI)

The Pittsburgh Sleep Quality Index (PSQI) is an instrument invented by Buysse et al. (1989) for psychiatric practice and research that assesses sleep quality and sleep disturbances over the last month of sleep (see Appendix A). The questionnaire consists of 19 self-rated items and five additional items rated by a roommate or bed partner if available. Only the 19 self-rated items are considered in the scoring process. All self-rated items belong to one of the seven components which are subject to a 0-3 Likert scale where a score of "0" indicates no difficulty and a score of "3" indicates severe difficulty.

The first component "subjective sleep quality" consists of item 6 "During the past month, how would you rate your sleep quality overall?" with scoring options ranging from

"Very good" to "Very bad". Component score "0" is attributed to "Very good" whereas "Very bad" receives the component score "3".

The second component "sleep latency" can be calculated by summing items 2 and 5a. Item 2 determines the number of minutes it took respondents to fall asleep by asking "During the past month, how long (in minutes) has it usually taken you to fall asleep" (Item 2). Response options for item 2 range from ≤ 15 minutes to > 60 minutes. Evaluation of the response can be seen in Appendix D. Item 5a administers response options ranging from "Not during the past month" to "Three or more times a week". Based on the sum of items 2 and 5a a component score is determined (see Appendix D).

The third component "sleep duration" consists of item 4 which investigates actual sleeping hours via an open question. Responses are rated from >7 hours equal component score "0" to <5 hours equal component score "3".

The fourth component "habitual sleep efficiency" contains items 1, 3 and 4. All 3 items are open questions. For example, item 1 states "During the past month, what time have you usually gone to bed?" Component scores can be assigned based on a habitual sleep efficiency quotient ranging from >85% to <65% (see Appendix D).

The fifth component "sleep disturbances" can be calculated by summing scores of items 5b-5j. As an example item 5b "During the past month, how often have you had trouble sleeping because you wake up in the middle of the night or early morning" All sleep disturbances items apply response options ranging from "Not during the past month" to "Three or more times a week."

The sixth component investigates the "use of sleeping medication" consisting of item 7 and applies scoring options from "Not during the past month" to "Three or more times a week".

The seventh component attributes "daytime dysfunction" and consists of items 8 and 9. Response options for question 8 "During the past month, how often have you had trouble

staying awake while driving, eating meals, or engaging in social activity?" range from "Never" to "Three or more times a week" and for question 9 from "No problem at all" to "A very big problem". Sum scores of the two items will be distributed to a component score as indicated in Appendix E. The Global PSQI Score can be calculated by adding the seven component scores with a minimum score of 0 (better) indicating no difficulty and a maximum score of 21 (worse) indicating severe difficulties in all areas. Global scores can be interpreted with scores ≤5 associated with good sleep quality and scores >5 associated with poor sleep quality. The discovered internal reliability was good (α = .83) and a good test-retest reliability of .85 for the entire scale (Buysse et al.,1989). A systematic review and meta-analysis by Mollayeva et al. (2016) revealed strong psychometric qualities with a good internal consistency (ranging from α = .70 to α = .83) and moderate structural validity testing in a variety of non-clinical and clinical samples. In the present study, for the PSQI we found a moderate consistency among the items (α = .69).

Bad Dream Questions

Two questions investigating bad dreams and nightmares were applied. The definition "Bad dreams are dreams with strong negative emotions that do not awaken the sleeper" was presented before asking the first question "How often have you experienced bad dreams in the past month?" Then the nightmare definition by Schredl et al. (2016) "Nightmares are dreams with strong negative emotions that result in awakening from the dreams. The dream plot can be recalled very vividly upon awakening." was provided. The subsequent question "How often have you experienced nightmares in the past month?" followed (see Appendix E). The response options with the following scoring were used: "Not in the past month" = 0, "Less than once a week" =1, "Once or twice a week" =2 and "Three or more times a week" =3. A sum score was calculated from the two questions. Sum scores ranged from 0-6 where 0 indicated no bad dreams or nightmares and 6 very frequent bad dreams or nightmares. The

calculated Spearman's correlation estimate $r(54)=.34, p < .001$ indicating a moderate

correlation among the items.

The Perceived Stress Scale (PSS)

Items of the PSS were designed to indicate the degree to which respondents perceived

their lives as unpredictable, uncontrollable, and overloading (Cohen et al., 1983). Opposed to

other stress scales the PSS investigates the experience of the past month of respondents

(Cohen et al., 1983). The PSS is a 10-item scale applying a five-point Likert scale ranging

from "0=Never", "1=Almost Never", "2=Sometimes", "3= Fairly Often", and "4= Very

Often" (see Appendix B). An example item is "In the last month, how often have you felt

difficulties were piling up so high that you could not overcome them?" The PSS scores are

obtained by reversing responses (e.g., $0 = 4, 1 = 3, 2 = 2, 3 = 1 \& 4 = 0$) to the four positively

stated items (items 4, 5, 7, & 8) and then summing across all 10 scale items (Cohen et al.,

1983). Total scores can range from 0-40 suggesting that higher scores indicate higher stress

levels. Cohen et al. (1983) found adequate test-retest reliability (r = .60) for the scale. A

psychometric analysis by Taylor (2015) revealed good internal consistency (α = .89). The

present study found a Cronbach's alpha of α= .89 suggesting high levels of internal

consistency among the items.

The Mental Health Continuum Short Form (MHC-SF)

The Mental Health Continuum Short Form is the shorter version of the Mental Health

Continuum Long Form with 40 items (see Appendix C). The MHC-SF consists of 14 items

distributed over three components.

Emotional well-being as the first component includes the first three items, for example

"During the past month, how often did you feel happy?" The second component social well-

being contains five items for example "During the past month, how often did you feel that

people are basically good?". The last component, psychological well-being, consists of six

items. "During the past month, how often did you feel confident to think or express your own

ideas and opinions?" as one example item. Possible item response options distributed from "Never=0", "Once or twice=1", "About once a week=2", "2-3 times a week=3", "Almost every day =4" to "Every day=5". The scoring of the MHC-SF involved determining a mean score by summing the scores on the three mental health dimensions and dividing it by 14 items. Higher values indicate better mental health. The short form of the MHC has shown excellent internal consistency (> .80) and discriminant validity in adolescents (ages 12-18) and adults in the U.S., in the Netherlands, and in South Africa (Keyes, 2005b, 2006; Keyes et al., 2008; Lamers et al., 2011; Westerhof & Keyes, 2009). The test-retest reliability of the MHC-SF over three successive 3-month periods averaged α = .68 and the 9-month test-retest was α = .65 (Lamers et al., 2011). The present study found for the MHC-SF a Cronbach's alpha of α = .88 indicating high levels of consistency among the items.

Procedure

Access to the online survey was provided either through SONA or a direct Qualtrics URL. Data was collected from 04.04.2024 to 22.04.2024. Participants were shortly introduced to the study's aim. After being informed that the study didn't include any known risk factors participants were asked for their consent to participate. By consenting participants were automatically forwarded to the next page and demographic data was collected. After this step, participants were redirected to the four consecutive questionnaires. Lastly, participants were thanked for their participation. Participation usually took around 15 minutes. All participants gave written informed consent prior to the study. Ethical approval for the study was provided by the Ethics Committee of the Faculty of Behavioural, Management, and Social Science of the University of Twente. The approval reference number was 240260.

Data Analysis

The data analysis was carried out using RStudio. Descriptive statistics were deducted from the demographic data the participants provided. As a next step, Pearson's correlations between the four variables were calculated. The parametric assumptions for the mediation

model were tested by means of the assumption of normality with the help of the Shapori-Wilk test, and homogeneity of variance by applying Levene's test. Then the PROCESS Macro from Hayes (Igartua & Hayes, 2021) was utilised to run the mediation analysis with applied bootstrapping samples. The mediation model was constructed to investigate the mediation effect of sleep quality on the relationship between stress and mental well-being. The mediator bad dreams was excluded from the mediation analysis because of very low correlations with sleep quality, stress and mental well-being as well as low nightmare frequencies in the sample. Frequencies of bad dreams score were very low with n=41 (around 74%) "Less than once a week" and nightmares scores with n = 55 (98%) "Less than once a week." Two regression analyses were conducted. The first regression applies the dependent variable sleep quality and the independent variable stress. For the second regression analysis the dependent variable mental well-being and the independent variable stress. Then, the exploratory mediation analysis was conducted applying the mediator stress in the relationship between sleep quality and mental well-being. Here the first regression analysis applies the dependent variable stress and the independent variable sleep quality. The second regression analysis applies the dependent variable mental well-being and the independent variable sleep quality. Assessing the mediation model's outcome involves evaluating the direct, indirect, and total effect calculated through PROCESS. Whether or not the given confidence interval contains the value zero indicates the significance of the regression analysis coefficient.

Results

The four variables' descriptive statistics and correlations are represented in Table 2. Stress and mental well-being are strongly negatively correlated. Sleep quality and stress are moderately positively correlated answering the first research question. Sleep quality and mental well-being are moderately negatively correlated answering the second research question. Bad dreams is weakly correlated to all other variables. We found a mental well-being mean score of 3.11 which can be estimated as average compared to a Dutch review

study (Westerhof, 2024). The stress mean score of 17.27 is somewhat slightly higher compared to the norm scores in that age group (*M*=16.78, *SD*= 6.86) found by a review study (Cohen & Janicki-Deverts, 2012). However, considering the large standard deviation, this difference may not be significant. A comparable mean score for sleep quality (*M*=5.64, *SD*= 2.79) was found in a U.S. college student sample (Dietch et al., 2016).

Table 2

Descriptive Statistics and Pearson's correlations for Mental Well-Being, Stress, Sleep Quality and Bad Dreams

Variable	*M*	*SD*	1	2	3	4
1. Mental Well-Being	3.11	0.77	—			
2. Stress	17.27	6.67	−.53**	—		
3. Sleep Quality	5.68	2.76	−.31*	.49**	—	
4. Bad Dreams	1.61	1.02	−.20	.28	.24	—

Note. n = 56 *p< 0.05. **p< 0.01.

Mediation Analysis

The results of the mediation analysis can be seen in Table 3.

Table 3

Results of the mediation analysis (Mental Well-Being = dependent variable, Sleep Quality = mediator and Stress = independent variable)

Dependent Variable	Estimate	*SE*	t	*p*	95% CI	
					LL	*UL*
Sleep Quality						
Constant	2.05	0.83	2.45	.016	0.40	3.71
Stress	0.21	0.04	4.58	<.001	0.12	0.30
Mental Well-Being						
Constant	4.14	0.24	17.34	<.001	3.66	4.62
Stress	−0.06	0.01	−3.97	<.001	−0.09	0.03
Sleep Quality	−0.01	0.04	−0.20	.845	−0.08	0.06

Note. n = 63, CI = confidence interval; *LL* = lower limit; *UL* = upper limit; Confidence intervals based on 5000 bootstrapped resamples

Table 3 shows the significant direct effect of stress on sleep quality (a-path Figure 2). Further, the significant direct effect of stress on mental well-being is displayed in Table 3 (c'-path Figure 2). The indirect effect of stress on mental well-being through the mediator sleep quality was not significant, indicating no mediation effect of sleep quality in the relationship between stress and mental well-being. These findings answer the third research question.

Figure 2

Results of the mediation analysis with the mediator Sleep Quality
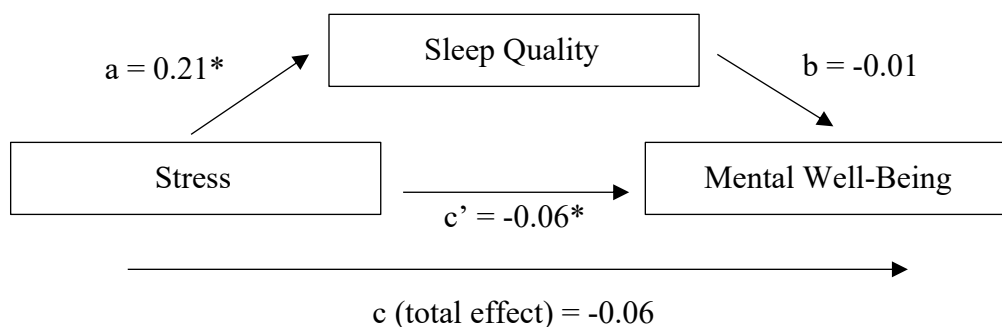
Note. *p < .001 c'= direct effect, indirect effect: b = -0.00, SE=0.01, LLCI=-0.02, ULCI=0.01

The significant direct effect of stress on mental well-being, the moderate correlation with sleep quality, and the moderate correlation between sleep quality and mental well-being led to the assumption that stress could mediate the relationship between the independent variable sleep quality and the dependent variable mental well-being. Based on this insight, we conducted an exploratory mediation analysis with the mediator variable stress. The exploratory mediation analysis found a significant mediation effect of stress (see Table 4, and Figure 3).
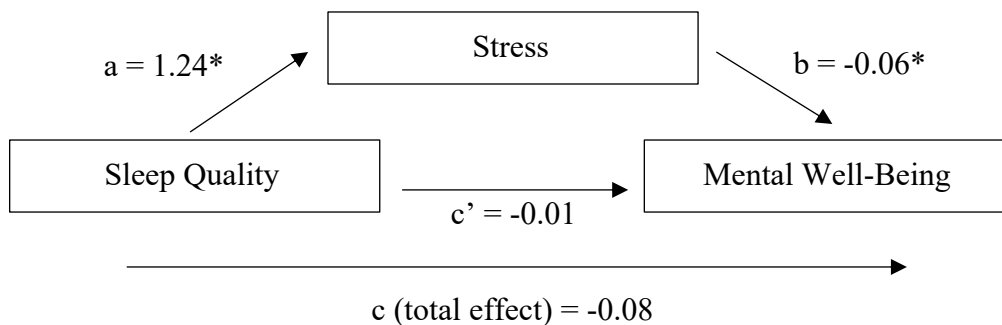
Table 4

Results of the exploratory mediation analysis (Mental Well-Being = dependent variable, Stress = mediator and Sleep Quality = independent variable)

Dependent variable	Estimate	SE	t	p	95% CI	
					LL	UL
Stress						
Constant	10.24	1.68	6.08	<.001	6.88	13.61
Sleep Quality	1.24	0.27	4.58	<.001	0.70	1.79
Mental Well-Being						
Constant	4.14	0.24	17.34	<.001	3.66	4.62
Sleep Quality	−0.01	0.04	−0.20	.845	−0.08	0.06
Stress	−0.06	0.01	−3.97	<.001	−0.09	−0.03

Note. $n = 63$, CI = confidence interval; *LL* = lower limit; *UL* = upper limit. Confidence

intervals based on 5000 bootstrapped resamples

Figure 3

Results for the direct and indirect effect of the mediation analysis for Stress

Note. *$p < .001$, c'= direct effect, indirect effect: b = -0.07; SE = 0.02; LLC I= -0.12; ULCI =

-0.03

The direct effect of sleep quality on mental well-being was not significant (see Table 4

and c'-path in Figure 3). However, the direct effect of sleep quality on stress was significant

(see Table 4 and a-path in Figure 3) as well as the direct effect of stress on mental well-being

(see Table 4 and b-path in Figure). A significant indirect effect in the absence of a significant

direct effect indicates a complete mediation effect of stress, suggesting that the relationship

between sleep quality and well-being is completely mediated by stress.

Discussion

The study aimed to investigate the mediating effect of sleep quality and bad dreams in the relationship between stress and mental well-being. The study found that bad dreams in general had weak relationships to sleep quality, stress, and mental well-being along with low frequencies in the sample and was therefore excluded from the analysis. The results indicate a relationship between stress and sleep quality suggesting that higher stress is associated with poorer sleep quality answering the first research question. The results for the second research question regarding sleep quality and mental well-being indicate a moderate negative relationship that poorer sleep quality is associated with lower mental well-being. Mental well-being and stress have the strongest relationship indicating that higher stress levels are strongly associated with lower mental well-being. Lastly, the finding that sleep quality doesn't mediate the relationship between stress and mental well-being answers the third research question. Yet, the exploratory mediation analysis identified that the relationship between sleep quality and mental well-being was mediated by stress.

Discovering no mediation effect of sleep quality is contrary to the findings of Weinberg et al. (2016) where a partial mediation effect of sleep quality was found. A potential reason for the different results might be due to the sample characteristics and the variable measurements. However, the author mentioned that sleep quality as the only mediator cannot compensate for the full mediation effect in the relationship between stress and well-being. Nevertheless, the effect of sleep quality on various aspects of mental well-being has been reported by various studies (Baglioni et al., 2011). Associated with poor sleep quality are depression and anxiety increasing the risk for diminished mental well-being.

The relationship between sleep quality and stress was found to bidirectional (Minkel et al., 2012). The bidirectional relationship complicates the investigation and interpretation of the result. Additionally, in the present study the applied measurements do not allow for implications on directionality of the variables influence. Nevertheless, because of the bidirectionality a vicious cycle can evolve where poor sleep quality increases stress and

increased stress deteriorates sleep quality (Minkel et al., 2012). In the present study a moderate relationship between sleep quality and stress was found supporting previous findings.

Regarding the findings of the exploratory mediation with the mediator stress, previous finings demonstrate that psychological and physiological mechanisms are involved through which stress mediates the relationship between sleep quality and mental well-being. Buckley and Schatzberg (2005) found that poor sleep quality can activate the hypothalamic-pituitary-adrenal (HPA) axis, resulting in increased cortisol levels. Consequently, heightened stress levels can be associated on the long term with decreased mental well-being. In addition, poor sleep quality can reduce stress resilience and impair emotional regulation (Minkel et al., 2012). Hereby, individuals not only become more susceptible to stressors and less competent to manage them effectively, but they also reported higher stress levels (Åkerstedt, 2006) which can negatively influence mental well-being.

Furthermore, previous studies found different frequencies of bad dreams and nightmares in students (Schredl, 2003; Sweileh et al., 2011) but clearly higher values than this study. Zadra and Donderi (2000) suggested that the underestimation of nightmare frequency by retrospective questionnaire may be due to motivated forgetting caused by the negative emotions of nightmares. Underrepresentation was not found by this study for dreams not having such a negative emotional tone. Moreover, retrospective self-reported measures of dreams were estimated to be insufficient measures underestimating nightmare frequency by a factor of 2.5 to 10 (Robert & Zadra, 2008), compared to the results from daily home logs. This finding could account for the underrepresentation of bad dreams and nightmares in the present study and show that even with standardised measures bad dream and nightmare investigation is difficult.

Strengths and Limitations

Utilising existing and validated scales is one of the study's notable strengths. Three out of the four scales have proven constant validity and reliability (Buysse et al. 1989, Mollayeva et al. 2016, Cohen et al., 1983, Westerhof & Keyes, 2009). Also, the present study demonstrated good reliability and validity. Even though the PSQI was developed to detect sleep disorders in psychiatric samples, the questionnaire has become a standard measure to investigate sleep quality in non-clinical samples (Dietch et al., 2016). Furthermore, with the present study we underlined the strong relationship between stress and mental well-being and moderate relationships for sleep quality and mental well-being as well as sleep quality and stress. Still, we can acknowledge multiple limitations. The representativeness of the sample is questionable because of the small, gender inequal and psychology students from the University of Twente concentrated sample (n=63) and therefore, the findings may not be generalisable to the whole university student's population. A severe limitation is that only a few participants seem to experience bad dreams or nightmares according to the applied measure. Therefore, it was not feasible to analyse the role of bad dreams further. Difficulties with investigating nightmares and bad dreams might be explained by the application of unstandardised measures and potentially resulting in an underrepresentation in the sample since previous studies found that nightmares are prevalent and common among students (Schredl, 2003; Sweileh et al., 2011). With the present study we provided empirical support that stress mediates the relationship between sleep quality and mental well-being. This outlines that stress is an important component in understanding the impact that poor sleep quality has on mental well-being. Determinants of mental well-being can be understood better by including the interaction of sleep quality and stress. The bidirectionality of the relationship shows that improving either of them positively affects the other.

Future Directions

To enhance the knowledge about causality and long-term effects of interventions aiming at enhancing sleep quality and reducing stress while improving mental well-being

longitudinal studies could be anticipated. Longer period observation can provide stronger evidence for the mediation model. Furthermore, experimental studies can be executed to observe direct effect of sleep quality and stress levels on mental well-being by a utilising manipulative study design. Controlling stress levels in students for example by building strong student support groups or trained professionals can result in deeper insights. Moreover, educating university students about how to create a sleep conducive environment can benefit their sleep quality. To investigate bad dreams and nightmare measurements other than retrospective self-reported measurements like a dream diary can help to obtain more reliable bad dreams and nightmare frequencies (Schredl, 2003). Acknowledging and investigating additional mediators like coping mechanisms or social support, could help our understanding of the complex interaction between the variables.

Conclusion

Despite no mediation effect of sleep quality in the relationship between stress and mental well-being, the study demonstrated that sleep quality mediates its effect through stress on mental well-being. Furthermore, the study underscored that sleep quality, stress and mental well-being are strong related concepts. Since students are especially susceptible to poor sleep quality, high stress levels and decreased mental well-being student support and growing awareness are necessary to mitigate the increasing numbers of sleep problems and mental health problems. Sleep well feel well.

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Appendix A

Pittsburgh Sleep Quality Index (PSQI)

Subject's Initials_____ID#_____Date_____Time_____AM PM

PITTSBURGH SLEEP QUALITY INDEX

INSTRUCTIONS:

The following questions relate to your usual sleep habits during the past month <u>only</u>. Your answers should indicate the most accurate reply for the <u>majority</u> of days and nights in the past month. Please answer all questions.

1. During the past month, what time have you usually gone to bed at night?

    BED TIME _____

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

    NUMBER OF MINUTES _____

3. During the past month, what time have you usually gotten up in the morning?

    GETTING UP TIME _____

4. During the past month, how many hours of <u>actual</u> <u>sleep</u> did you get at night? (This may be different than the number of hours you spent in bed.)

    HOURS OF SLEEP PER NIGHT _____

For each of the remaining questions, check the one best response. Please answer <u>all</u> questions.

5. During the past month, how often have you had trouble sleeping because you . . .

a) Cannot get to sleep within 30 minutes

   Not during the   Less than   Once or twice   Three or more
   past month_____   once a week_____   a week_____   times a week_____

b) Wake up in the middle of the night or early morning

   Not during the   Less than   Once or twice   Three or more
   past month_____   once a week_____   a week_____   times a week_____

c) Have to get up to use the bathroom

   Not during the   Less than   Once or twice   Three or more
   past month_____   once a week_____   a week_____   times a week_____

d)   Cannot breathe comfortably

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

e)   Cough or snore loudly

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

f)   Feel too cold

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

g)   Feel too hot

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

h)   Had bad dreams

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

i)   Have pain

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

j)   Other reason(s), please describe_____

_____

How often during the past month have you had trouble sleeping because of this?

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

6.   During the past month, how would you rate your sleep quality overall?

Very good   _____

Fairly good   _____

Fairly bad   _____

Very bad   _____

7.   During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

8.   During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

9.   During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

No problem at all   _____

Only a very slight problem   _____

Somewhat of a problem   _____

A very big problem   _____

10.   Do you have a bed partner or room mate?

No bed partner or room mate   _____

Partner/room mate in other room   _____

Partner in same room, but not same bed   _____

Partner in same bed   _____

If you have a room mate or bed partner, ask him/her how often in the past month you have had . . .

a)   Loud snoring

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

b)   Long pauses between breaths while asleep

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

c)   Legs twitching or jerking while you sleep

Not during the   Less than   Once or twice   Three or more
past month_____   once a week_____   a week_____   times a week_____

d)   Episodes of disorientation or confusion during sleep

   Not during the   Less than   Once or twice   Three or more
   past month_____   once a week_____   a week_____   times a week_____

e)   Other restlessness while you sleep; please describe_____

   _____

   Not during the   Less than   Once or twice   Three or more
   past month_____   once a week_____   a week_____   times a week_____

Appendix B

Perceived Stress Scale (PSS)

Perceived Stress Scale

The questions in this scale ask you about your feelings and thoughts **during the last month**. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

Name _____ Date _____

Age _____ Gender (*Circle*): **M   F**   Other _____

0 = Never   1 = Almost Never   2 = Sometimes   3 = Fairly Often   4 = Very Often

1. In the last month, how often have you been upset
   because of something that happened unexpectedly?................................. 0   1   2   3   4

2. In the last month, how often have you felt that you were unable
   to control the important things in your life?................................... 0   1   2   3   4

3. In the last month, how often have you felt nervous and "stressed"?........... 0   1   2   3   4

4. In the last month, how often have you felt confident about your ability
   to handle your personal problems? 0   1   2   3   4

5. In the last month, how often have you felt that things
   were going your way?.. 0   1   2   3   4

6. In the last month, how often have you found that you could not cope
   with all the things that you had to do? 0   1   2   3   4

7. In the last month, how often have you been able
   to control irritations in your life?.. 0   1   2   3   4

8. In the last month, how often have you felt that you were on top of things?.. 0   1   2   3   4

9. In the last month, how often have you been angered
   because of things that were outside of your control?................................. 0   1   2   3   4

10. In the last month, how often have you felt difficulties
    were piling up so high that you could not overcome them? 0   1   2   3   4

Please feel free to use the *Perceived Stress Scale* for your research.

Mind Garden, Inc.
info@mindgarden.com
www.mindgarden.com

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Appendix C

Mental Health Continuum – Short Form (MHC-SF)

Adult MHC-SF (ages 18 or older)

Please answer the following questions are about how you have been feeling during the past month. Place a check mark in the box that best represents how often you have experienced or felt the following:

During the past month, how often did you feel …	NEVER	ONCE OR TWICE	ABOUT ONCE A WEEK	ABOUT 2 OR 3 TIMES A WEEK	ALMOST EVERY DAY	EVERY DAY
1. happy						
2. interested in life						
3. satisfied with life						
4. that you had something important to contribute to society						
5. that you belonged to a community (like a social group, or your neighborhood)						
SEE BELOW 6. that our society is a good place, or is becoming a better place, for all people						
7. that people are basically good						
8. that the way our society works makes sense to you						
9. that you liked most parts of your personality						
10. good at managing the responsibilities of your daily life						
11. that you had warm and trusting relationships with others						
12. that you had experiences that challenged you to grow and become a better person						
13. confident to think or express your own ideas and opinions						
14. that your life has a sense of direction or meaning to it						

Note: The original wording for item 6 was "that our society is becoming a better place for people like you." This item does not work in all cultural contexts. However, when validating the MHC-SF, test both versions of item 6 to see which one works best in your context.

Appendix D

Form Administration Instructions, References, and Scoring Pittsburgh Sleep Quality Index (PSQI)

Form Administration Instructions

The range of values for questions 5 through 10 are all 0 to 3.

Questions 1 through 9 are not allowed to be missing except as noted below. If these questions are missing then any scores calculated using missing questions are also missing. Thus it is important to make sure that all questions 1 through 9 have been answered.

In the event that a range is given for an answer (for example, '30 to 60' is written as the answer to Q2, minutes to fall asleep), split the difference and enter 45.

Reference

Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ: The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research* 28:193-213, 1989.

Scores – reportable in publications

On May 20, 2005, on the instruction of Dr. Daniel J. Buysse, the scoring of the PSQI was changed to set the score for Q5J to 0 if either the comment or the value was missing. This may reduce the DISTB score by 1 point and the PSQI Total Score by 1 point.

PSQIDURAT   **DURATION OF SLEEP**
IF Q4 $\geq$ 7, THEN set value to 0
IF Q4 < 7 and $\geq$ 6, THEN set value to 1
IF Q4 < 6 and $\geq$ 5, THEN set value to 2
IF Q4 < 5, THEN set value to 3
Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQIDISTB   **SLEEP DISTURBANCE**
IF Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) = 0, THEN set value to 0

IF Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) $\geq$ 1 and $\leq$ 9, THEN set value to 1

IF Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) > 9 and $\leq$ 18, THEN set value to 2

IF Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j (IF
Q5JCOM is null or Q5j is null, set the value of Q5j to 0) > 18, THEN
set value to 3

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQILATEN   **SLEEP LATENCY**
First, recode Q2 into Q2new thusly:
IF Q2 $\geq$ 0 and $\leq$ 15, THEN set value of Q2new to 0
IF Q2 > 15 and $\leq$ 30, THEN set value of Q2new to 1
IF Q2 > 30 and $\leq$ 60, THEN set value of Q2new to 2
IF Q2 > 60, THEN set value of Q2new to 3
Next
IF Q5a + Q2new = 0, THEN set value to 0
IF Q5a + Q2new $\geq$ 1 and $\leq$ 2, THEN set value to 1
IF Q5a + Q2new $\geq$ 3 and $\leq$ 4, THEN set value to 2
IF Q5a + Q2new $\geq$ 5 and $\leq$ 6, THEN set value to 3

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQIDAYDYS   **DAY DYSFUNCTION DUE TO SLEEPINESS**
IF Q8 + Q9 = 0, THEN set value to 0
IF Q8 + Q9 $\geq$ 1 and $\leq$ 2, THEN set value to 1
IF Q8 + Q9 $\geq$ 3 and $\leq$ 4, THEN set value to 2
IF Q8 + Q9 $\geq$ 5 and $\leq$ 6, THEN set value to 3
Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQIHSE   **SLEEP EFFICIENCY**
Diffsec = Difference in seconds between day and time of day Q1 and
day Q3
Diffhour = Absolute value of diffsec / 3600
newtib =IF diffhour > 24, then newtib = diffhour – 24
      IF diffhour $\leq$ 24, THEN newtib = diffhour
(NOTE, THE ABOVE JUST CALCULATES THE HOURS
BETWEEN GNT (Q1) AND GMT (Q3))
tmphse = (Q4 / newtib) * 100

IF tmphse $\geq$ 85, THEN set value to 0
IF tmphse < 85 and $\geq$ 75, THEN set value to 1
IF tmphse < 75 and $\geq$ 65, THEN set value to 2
IF tmphse < 65, THEN set value to 3
Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQISLPQUAL   **OVERALL SLEEP QUALITY**
Q6
Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQIMEDS   **NEED MEDS TO SLEEP**
Q7
Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQI   **TOTAL**
DURAT + DISTB + LATEN + DAYDYS + HSE + SLPQUAL +
MEDS

Minimum Score = 0 (better); Maximum Score = 21 (worse)
Interpretation: TOTAL $\leq$ 5 associated with good sleep quality
            TOTAL > 5 associated with poor sleep quality

Appendix E

Questions investigating Bad Dreams and Nightmares

UNIVERSITY OF TWENTE.

INSTRUCTIONS:

The following questions relate to your experience of dreams during the <u>past month only</u>. Your answers should indicate the most accurate reply for the <u>majority</u> of days and nights in the past month. Please answer all questions.

Definition: Bad dreams are dreams with strong negative emotions that do <u>not</u> awaken the sleeper.

1. How often have you experienced "bad dreams" in the past month?

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
○	○	○	○

Definition: Nightmares are dreams with strong negative emotions that result in awakening from the dreams. The dream plot can be recalled very vividly upon awakening.

2. How often have you experienced nightmares in the past month?

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
○	○	○	○

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