Bachelor Thesis

Sleep Quality in University Students during the COVID-19 Pandemic

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Abstract

Introduction: The COVID-19 pandemic has caused enormous disruptions to peoples' everyday life, which seems to have increased psychological distress, especially with regard to problems in sleep. Since existing literature lacks representative research on the student population in terms of sleep, this study aimed at investigating university students' sleep quality during the pandemic, also considering possible influential factors (gender, previous infection with SARS-CoV-2). Besides, literature suggests a link between sleep quality and stress, which is why stress was included as an additional measure.

Methods: The study was conducted in form of a web-based cross-sectional survey. Participants (N=214) were recruited by means of convenience sampling and answered demographic questions as well as questions about sleep quality (Pittsburgh Sleep Quality Index (PSQI)) and perceived stress (Perceived Stress Scale-10 (PSS-10)). For the survey creation, Qualtrics software was used, and analyses were conducted using SPSS (Version 26). T-tests were performed to explore group differences in terms of sleep and stress, and a Pearson correlation was conducted to investigate the connection between stress and sleep.

Results: This work found no significant difference between male and female students ($t(210) = -1.63$, $p = 0.11$) and neither between students who already contracted SARS-CoV-2 and students who did not ($t(212) = 1.51$, $p = 0.13$). However, a correlation for stress and sleep quality was found ($r(212) = 0.48$, $p < 0.01$) and good sleepers differed significantly in their perceived stress level from bad sleepers ($t(212) = 7.14$, $p < 0.05$).

Conclusions: Findings suggest a relatively bad sleep quality and moderate stress level among students. The present study highlights the need for i) further research to draw a clearer picture of the pandemic's impact and to identify a more precise relation between sleep and further well-being aspects and ii) interventions to minimise brief and long-term consequences in terms of sleep.

Keywords: Sleep Quality, Perceived Stress, University Students, COVID-19 Pandemic

Contents

1. Sleep Quality in University Students during the COVID-19 Pandemic

The novel Coronavirus disease (COVID-19), which is caused by the Severe-Acute-Respiratory-Syndrome-Corona-Virus-2 (SARS-CoV-2), portrays one of the greatest public challenges since World War 2, affecting countries all across the globe (Chakraborty & Maity, 2020; Rajkumar, 2020). It was first noticed in December 2019 in Wuhan, China, and declared a pandemic by the World Health Organization in March 2020 (Rajkumar, 2020; WHO, 2020). More than one year later (as of June 25, 2021), there have been 179.686.071 reported COVID-19 cases worldwide, from which 3.899.172 people have lost their lives (WHO, 2021). Due to these massive numbers of critically ill patients and deaths attributable to the virus, governments from all over the world were forced to take action (Kecojevic et al., 2020). Therefore, politicians not only introduced safety regulations such as wearing face masks and keeping a 1.5-meter distance from one another (Zacher & Rudolph, 2020), but also imposed restrictions on general public rules, including limitations in private social contact and travelling, as well as close-downs of institutions and shops, for example (Kecojevic et al., 2020; Santabárbara et al., 2021; Zacher & Rudolph, 2020). In many countries around the world, people are not used to these kinds of limitations (Santabárbara et al., 2021), which is why it can be claimed that the COVID-19 pandemic has caused, and still causes, enormous disruptions to peoples' everyday life (Kecojevic et al., 2020).

Especially due to these circumstances, and of course the ever-present fear of catching the virus (Grupta et al., 2020), many researchers have devoted their attention to diverse physical and psychological consequences in the general population (Ammar et al., 2020; Santabárbara et al., 2021). One subject that has been investigated in many studies, is the impact of the COVID-19 pandemic on sleep, as sleep is considered essential for maintaining mental and physical health (Jahrami, 2021). In fact, recent literature on the topic suggests that the pandemic appears to have a strong and mostly negative influence on people's sleep behaviours (Partinen et al., 2021; Sher, 2020). More specifically, a systematic review and meta-analysis by Jahrami (2021) has shown that the prevalence of sleep problems during the COVID-19 pandemic is high, affecting approximately 40% of people from general and health care populations. To elaborate, Li et al. (2020) support these findings in their study, in which people indeed reported lower sleep quality since the SARS-CoV-2 outbreak, and Mandelkorn et al. (2021) even reported that self-reported sleeping pill consumption appears to have increased by 20% since the start of the pandemic. In addition, other studies have argued that lower sleep quality appears to be a problem, especially during lockdown periods, where pre-/post-lockdown measures have

underlined that people indeed experienced a decrease in sleep quality (Cellini et al., 2020; Gupta et al., 2020). Besides, Wang et al. (2021) also found that people in quarantine showed higher symptoms of insomnia in contrast to individuals who were not in quarantine. However, in contrast to these results, fewer studies reported that some people even experienced improved sleep quality during the pandemic (Kocevska et al., 2020). Thus, according to Rajkumar (2020), there is a strong need for more representative research from affected countries and from, particularly, vulnerable populations to draw a clearer picture of the pandemic's impact on sleep. In fact, many researchers have argued that the detection of sleep disturbances is important in order to identify a possible need for sleep-monitoring interventions and therefore minimize the short-term as well as long-term consequences of the pandemic (Casagrande et al., 2020; Marelli et al, 2021).

Kecojevic et al. (2020) proposed that especially university students portray a population that might be vulnerable to sleep disturbances during the COVID-19 pandemic. According to Hersher & Chervin (2014) and Li et al. (2017), students are generally prone to insufficient sleep duration as well as irregular and late sleep timing, which is why it can be suggested that sleep problems or irregular sleep patterns might not be uncommon during the pandemic. In fact, this population is strongly affected by the COVID-19 related governmental regulations, as higher-education institutions have rapidly switched from in-person to online learning, which portrayed a sudden and dramatic change in students' lives (Gewin, 2020; Kecojevic et al., 2020). Thus, studies which have already investigated university students' sleeping patterns, have reported that students indeed suffer from lower sleep quality during the COVID-19 pandemic (Wang et al. 2020). More specifically, a study by Cellini et al. (2020) found that people went to bed and woke up later, spent more time in bed, and experienced lower quality of sleep. In addition, Martínez-Lezaun et al. (2020) reported that students seemed to experience more problems with falling asleep and getting back to sleep after waking up at night. Nevertheless, according to Wang et al. (2020), the concept of sleep quality portrays an important subject that appears to be still understudied in the student population. Thus, while only few studies have examined the construct of sleep quality among university students yet (Kecojevic et al., 2020; Wang et al, 2020), and most of these have exclusively focused on sleep quality during a specific lockdown period (Cellini et al., 2020; Martínez-Lezaun et al., 2020), this study aims at investigating sleep quality within a bigger time frame to explore sleep quality during the overall pandemic situation and to eliminate effects that might result from home confinement only.

Beside this focus on sleep, many studies have also shown that the COVID-19 pandemic is strongly associated with different aspects of psychological distress. To elaborate, people from

all over the world have reported lower levels in mental well-being, with increased feelings of depression, anxiety and stress since the SARS-CoV-2 outbreak (Ammar et al., 2020; Partinen et al., 2021; Santabárbara et al., 2021). With regard to the general population, a systematic review and meta-analysis by Salari et al. (2020) has shown that the prevalence of stress, anxiety, and depression, as a result of the pandemic, is 29.6, 31.9 and 33.7% respectively. In addition, other researchers even concluded that especially perceived stress levels seem to have increased significantly since the start of the pandemic, which can, among other aspects, be attributed to the continuous change in public health policies (Pedrozo-Pupo et al., 2020).

Since further relevant literature suggests that university students again comprise a population that is considered particularly vulnerable to mental health concerns in general, and that the ongoing COVID-19 pandemic appears to be a trigger for decreasing well-being and increasing levels of stress in especially this population (Cao et al., 2020; Rajkumar, 2020; Son, et al., 2020), this contribution will take into account the concept of perceived stress as an additional measure. In fact, according to Benham (2020) and Rajkumar (2020), perceived stress appears to be one of many common psychological reactions to the COVID-19 pandemic and may even be associated with problems in sleep. In line with this assumption, Cellini et al. (2020) found that participants who experienced higher levels in stress, indeed reported more difficulties in sleep.

Finally, recent studies on the subject have also focused on factors that might be linked to or even portray at-risk factors for experiencing more psychological distress and problems in sleep quality (Kokou-Kpolou et al., 2020; Santabárbara et al., 2021; Zacher & Rudolph, 2020). To elaborate, recent findings suggest that especially younger people and women portray vulnerable categories, experiencing a higher risk for suffering from psychological distress and even symptoms of insomnia (Marelli et al., 2020; Zhou et al., 2020). As an example, a study by Mandelkorn et al. (2021) has shown that females indeed reported a worsening of sleep quality during the pandemic, and Xiong et al. (2020) have found that female sex also appears to be associated with higher levels in perceived stress. These results are in line with previous study findings indicating that females generally tend to experience higher perceived stress levels and are more prone to sleep problems than males (Brougham et al., 2009). Besides, much research has already taken into account the influence of fear of contagion or present-suffering from COVID-19, with both aspects appearing to be linked to higher psychological distress and lower sleep quality (Kokou-Kpolou et al., 2020; Zhang et al., 2020). As an example, a study by Wang et al. (2021) already found that quarantined individuals suffered from worse sleep quality than individuals who were not in quarantine. However, not many studies have yet focused on the

experience with past-suffering of COVID-19 and its relation to symptoms of insomnia (Kokou-Kpolou et al., 2020). Thus, this paper will also take into account the additional factors of gender and previous COVID-19 illness in order to determine clearer connections between these factors and sleep quality among the student population.

Overall, this study primarily aims at exploring university students' sleep quality during the ongoing COVID-19 pandemic, as existing literature seems to lack representative data on this population in terms of sleep. Besides, past research on COVID-19 and sleep has exclusively focused on sleep quality during specific lockdown or quarantine time periods, which is why this contribution aims at collecting data about sleep within a one-year time frame to better represent the overall pandemic situation. As a secondary objective, this study also investigates possible influential factors such as gender and previous infection with SARS-CoV-2 as well as the additional construct of perceived stress. Thus, the main research questions are:

RQ_1: Is there a significant difference in sleep quality among male and female university students during the COVID-19 pandemic?

RQ_2: Is there a significant difference in sleep quality among university students who already did contract and who did not contract SARS-CoV-2?

RQ_3: What is the relationship between perceived stress and sleep quality in university students?

RQ_4: Do university students who experience good and who experience bad sleep quality differ significantly in their perceived stress level during the COVID-19 pandemic?

Based on these research questions and findings from recent studies on the COVID-19 pandemic, the following alternative hypotheses are formulated:

H_1: There is a significant difference in sleep quality between male and female students.

H_2: There is a significant difference in sleep quality between students who already did contract and who did not contract SARS-CoV-2.

H_3: Students who perceive higher stress levels experience worse sleep quality than students who perceive lower stress levels.

H_4: There is a significant difference in perceived stress between students who experience good and who experience bad sleep quality.

2. Methods

2.1 Participants

In total, 362 participants were recruited by means of convenience sampling. Inclusion criteria for the analysis were the minimum age of 18 years, the enrolment in a university or applied university, the consent to participation (see Appendix A) and the completeness of answers to the different questionnaires. Based on these criteria, 214 participants were included in the final analysis and 148 participants, among which 80.4% had missing data, were excluded from the data set. The Ethics Committee of the University of Twente has approved the research[1] before the start of the data collection on April 9th, 2021, and the data collection process ended on May 7th, 2021.

2.2 Materials

The survey was conducted using Qualtrics software, Version [May, 2021] of the Qualtrics Research Suite.

2.2.1 Socio-Demographic Items

Socio-demographic data was collected by means of four closed questions concerning age, gender, degree of education and nationality. Further questions asked whether participants have ever contracted SARS-CoV-2, have searched for treatment in the past or have ever been diagnosed with a mental disorder. An example for these items is: *"Have you ever sought psychological or pharmacological treatment for any mental health concerns (e.g. anxiety, depression, eating disorders)?"*. Answer options to these questions were *"Yes"* or *"No"*, whereby subjects were able to further indicate the type of mental health concern when answering with *"Yes"*. A list of all demographic questions included in the online survey can be found in Appendix B.

2.2.2 Sleep Quality

To assess university students' overall sleep quality, an adapted version of the "Pittsburgh Sleep Quality index" (PSQI) was employed (Buysse et al., 1989), as this instrument has shown good psychometric properties and proven to be valid for the adult population (Carpenter & Andrykowski, 1998). Psychometric evaluation supports construct validity, as well

[1] Request number: 210233

as internal consistency of the questionnaire, with Cronbach's Alpha ranging from 0.80 – 0.83 (Beck et al., 2004; Carpenter & Andrykowski, 1998; Owen et al., 1999). Generally, this scale measures sleep quality over the last month by measuring seven components of sleep, namely subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. The original instrument contains 19 self-rated items and 5 questions rated by a partner or roommate. However, only self-rated items are included in this study's scoring. Overall, the different self-rated items are combined to form the score for each component (see Table 2). As an example, item 2 and 5a create the Sleep Latency component. Scores for each component can range from 0-3, whereby 0 is considered as 'no difficulty' and 3 as 'severe difficulty' (Buysse et al., 1989). Finally, the seven scores are added to form the total score, which can range from 0-21, with higher scores indicating more severe difficulties in sleep and a total score of > 5 indicating sleep disturbances (Smyth, 1999). To make this measurement scale more suitable for this study, participants were asked to rate the items with regard to the last year instead of the last month, as it covers the pandemic situation on a more concrete level. An example of an adapted PSQI item is: *"Since the pandemic has started, how often have you had trouble sleeping because you wake up in the middle of the night or early morning?".* An illustration of the PSQI items used in this study and the according response options can be found in Appendix C.

2.2.3 Perceived Stress

The "Perceived Stress Scale-10" (PSS-10) was used to assess students' level of perceived stress during the ongoing pandemic. The PSS-10 is a self-report instrument and has shown satisfactory psychometric properties, with different studies reporting high internal consistency (Cronbach's $\alpha = 0.84$) and items loading on one factor only (Bastianon et al., 2020; Maroufizadeh, 2018; Smith et al., 2014). The scale consists of 10 items and measures respondents' perception on how unpredictable, uncontrollable, and overloaded they find their lives (Cohen & Williamson, 1988). Each item is rated on a 5-point Likert scale ranging from 0 (never) to 4 (very often). More specifically, PSS-10 scores are obtained by reversing the scores on the four positive-stated items (item 4,5,7 and 8) and then summing up the scores of all items to form one total score. Total scores can range from 0-40 with higher scores indicating a higher perceived stress level (Cohen & Williamson, 1988; Mind Garden, n.d.). More specifically, scores between 0 and 13 indicate low perceived stress levels, scores ranging from 14 to 26 indicate moderate perceived stress levels, and high perceived stress levels are assumed with

scores ranging from 27 to 40 (Swaminathan et al., 2016). An example of a PSS-10 item is: *"In the past month, how often have you been unable to control things in your life?"*.

2.3 Design

The study was conducted in form of a web-based cross-sectional survey that included questionnaires about sleep quality (PSQI) and perceived stress (PSS-10). For the first research question, there was one independent variable (*gender*) with two levels (*male* and *female*). The dependent variable was *sleep quality*, with the total score obtained from the PSQI. For the second research question, there was one independent variable (*previously infected*) with two levels (*infected* and *not infected*). The dependent variable was again *sleep quality*, with the total score obtained from the PSQI. For the third research question, there were two variables (*perceived stress* and *sleep quality*), with the total scores obtained from the PSS-10 and PSQI. For the last research question, there was one independent variable (*sleep quality*) with two levels (*good* and *bad*). The dependent variable was the *perceived stress level*, with the total score obtained from the PSS-10.

2.4 Procedure

Participants were recruited by means of different platforms. Some received a link via WhatsApp Messenger, whereas others could enter the platform via a link provided on Instagram. Finally, the study was also published on Sona Systems, where participants were granted 0.25 credits for taking part in the research.

Before filling out the questionnaire, subjects were introduced to the research and had to give their consent to participating in the study on a voluntary basis and their data being anonymously used for research purposes (see Appendix A). Next, they were presented with demographic questions about age, gender, nationality, former mental health issues, treatment-seeking and previous COVID-19 illness. Subsequently, participants were faced with the items of the PSQI to assess sleep quality among the population. After filling out the PSQI, students were asked to complete the PSS-10 to grasp an understanding of their perceived stress level during the COVID-19 pandemic. In general, participants had to answer all items before they were able to get to the next page.

2.5 Data Analysis

Statistical analyses were performed by using IBM SPSS Statistics (Version 26). In total, 214 responses were included in the final analysis. Single-item, component and total scores to

the two questionnaires were calculated on the basis of the original scoring schemes (Buysse et al., 1989; Cohen & Williamson, 1988). With regard to the PSQI, 7 new variables were created for the illustration of each component score. Subsequently, two continuous variables for the total scores to each of the two questionnaires were added in the SPSS data set. Besides, an additional categorical variable for sleep quality was created, with bad sleep quality being coded as "0" and good sleep quality as "1".

After the preparation of the data set, descriptive statistics were used to get insight into the proportion of responses for each item/component and an overview of the range of total scores of both questionnaires. Next, a Shapiro-Wilk Test was conducted to check for normality. The PSS-10 scores were normally distributed $W(214) = 0.99$, $p = 0.37$. The component scores of the PSQI were not normally distributed $W(214) = 0.94$, $p = 0.00$. However, with regard to the large sample size (N=214) and the Normal Q-Q Plot of the PSQI scores (see Appendix D), the data appears to not deviate significantly from a normal distribution, which is why parametric tests could still be used.

To answer the first two research questions about whether there is a significant difference between male and female students, as well as between students who already contracted and who did not contract the virus, two independent samples t-tests were performed.

For the investigation of the third research question concerning the relationship between perceived stress and sleep quality, a Pearson's correlation coefficient was computed, with the resulting coefficient indicating to what extent perceived stress is connected to sleep quality.

To answer the last research question about whether there is a significant difference in perceived stress between students experiencing good and bad sleep quality, an independent samples t-test was performed to assess differences between the two groups.

As a final step, Cronbach's Alpha was computed to re-check internal consistency of the questionnaires, also because the PSQI was slightly adapted. For the PSS-10, Cronbach's Alpha was found to be 0.87, which can be considered as good. For the PSQI, an alpha of 0.79 was computed, indicating good internal consistency for this questionnaire, as well.

3. Results

3.1 Sample Description

Table 1 illustrates the sociodemographic characteristics of included participants. What has to be noted is that most subjects were female (72%), German (70.1%) and currently involved with their Bachelor degree (88.3%). The age ranged from 18-32 years, whereby most

participants were between 21 and 23 years old. Besides, the majority of subjects was indeed German or Dutch, however, students from different countries such as Turkey or Poland, also participated in the study. In addition, only a small number of participants indicated to have contracted SARS-CoV-2 in the past (8.9%) and only the minority of the sample has previously searched for psychological or pharmacological treatment (17.3%) or has been diagnosed with a mental health condition in the past (13.8%).

Table 1

Sociodemographic Characteristics of Participants

Variable	Level		
		M	SD
Age	(Years)	21.75	2.03
		N (n=214)	%
Gender	Male	58	27.1
	Female	154	72
	Other	2	0.9
Country of Origin	Germany	150	70.1
	The Netherlands	31	14.5
	Other	33	15.4
Current Degree	Bachelor	189	88.3
	Master	23	10.8
	PhD	2	0.9
Former Infection with SARS-CoV-2 [a]		19	8.9
Previous Psychological or Pharmacological Treatment [a]		37	17.3

Previous Diagnosis with Mental Health Condition [a]	28	13.1

[a] Reflects the number and percentage of participants who answered "Yes" to this question.

3.2 Descriptive Statistics

To highlight overall results of the PSQI and PSS-10, means and standard deviations of single items and total scores are illustrated below.

3.2.1 PSQI

As displayed in Table 2, the mean global score for the PSQI was 6.67 (SD = 3.09). Mean component scores ranged from 0.29 (SD = 0.73) for the Sleep Medication component to 1.60 (SD = 0.92) for the Sleep Latency component.

Table 2

PSQI Item and Component Overview and Descriptives of PSQI Mean Component Scores and Mean Global Score with Standard Deviations

Component	Item Combination	M	SD
Subjective Sleep Quality	Item 6	1.12	0.71
Sleep Latency	Item 2 and 5a	1.60	0.92
Sleep Duration	Item 4	0.36	0.60
Habitual Sleep Efficiency	Item 1, 3 and 4	0.52	0.85
Sleep Disturbances	Item 5b – 5j	1.25	0.57
Use of Sleep Medication	Item 7	0.29	0.73
Daytime Dysfunction	Item 8 and 9	1.53	0.76
Global Score		6.67	3.10

3.2.2 PSS-10

As can be seen in Table 3, the mean total score for the PSS-10 in this sample was 21.52 (SD = 7.02). The mean item scores ranged from 1.91 (SD = 1.23) for Item 10 to 2.65 (SD = 1.04) for Item 3.

Table 3

PSS-10 Item Overview and Descriptives of Mean Item Scores and Mean Total Score with Standard Deviations

Item Number	Item Formulation	M	SD
1	In the last month, how often have you been upset because of something that happened unexpectedly?	2.07	1.03
2	In the last month, how often have you felt that you were unable to control the important things in your life?	2.28	1.1
3	In the last month, how often have you felt nervous and "stressed"?	2.65	1.04
4	In the last month, how often have you felt confident about your ability to handle your personal problems?	1.85	0.93
5	In the last month, how often have you felt that things were going your way?	2.06	0.92
6	In the last month, how often have you found that you could not cope with all the things that you had to do?	2.28	1.11
7	In the last month, how often have you been able to control irritations in your life?	1.92	0.87
8	In the last month, how often have you felt that you were on top of things?	2.27	0.98
9	In the last month, how often have you been angered because of things that were outside of your control?	2.23	1.04
10	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	1.91	1.23
Total PSS-10 Score		21.52	7.02

3.3 Hypotheses Testing

In contrast to H_1, there was no significant difference between male (M = 6.09, SD = 3.14) and female (M = 6.87, SD = 3.08) students with regard to the total scores on the PSQI, M = -0.78, 95% CI [-1.72, 0.16], $t(210) = -1.63$, $p = 0.11$.

In contrast to H_2, there was no significant difference between students who already did contract (M=7.68, SD=4.0) and students who did not contract (M = 6.56, SD = 2.99) SARS-CoV-2 with regard to the total scores on the PSQI, M = 1.12, 95% CI [-0.34, 2.58], $t(212) = 1.51$, $p = 0.13$.

In line with H_3, Perceived Stress and Sleep Quality were found to be moderately positively correlated, $r(212) = 0.48$, $p < 0.01$, with higher scores in the PSQI indicating worse sleep quality.

In line with H_4, there was a significant difference between students who experience good (M = 17.79, SD = 5.66) and students who experience bad (M = 24.07, SD = 6.73) sleep quality with regard to the total scores on the PSS-10, M = 6.28, 95% CI [4.54, 8.01], $t(212) = 7.14$, $p < 0.05$.

4. Discussion

While the impact of the COVID-19 pandemic on mental well-being has been widely investigated in the general population (Ammar et al., 2020; Jahrami, 2021; Santabárbara et al., 2021), there does not seem to be enough representative literature on the impact on the student population (Wang et al., 2020). Especially with regard to the aspect of sleep quality, students seem to have experienced unique sleep habits even before the SARS-CoV-2 outbreak (Attal et al., 2021; Hersher & Chervin, 2014; Li et al., 2017). Thus, this study specifically focused on university students' sleep quality during the ongoing pandemic, without limiting research to specific lockdown periods. Since existing literature also suggests that sleep quality might be connected to stress (Benham, 2020; Cellini et al., 2020; Rajkumar, 2020), perceived stress was taken into account as an additional measure.

As hypothesised, present findings indicate a correlation between perceived stress and sleep quality. In fact, students who perceived more stress indeed reported suffering from lower sleep quality, and students experiencing good sleep quality differed significantly from students experiencing bad sleep quality in terms of stress. These results are in line with findings from the study of Cellini et al. (2020), in which participants who perceived higher stress indeed

indicated to have more problems with sleep. As an explanation, a study conducted by Saeed et al. (2016) found that higher stress levels in daily life are closely linked to the feeling of restlessness, which in return could lead to problems in sleep. Nevertheless, it needs to be noted that the present study only searched for a correlation between both variables, which is why further research is needed to check for causality and other influencing factors to sustain a relationship between stress and sleep and rule out the influence of additional variables. Generally speaking, establishing a clearer connection between stress and sleep is necessary to be able to properly address problems in both aspects in the future.

In contrast to expectations, this study did not confirm a significant difference in sleep quality between male and female students. This result contrasts with several other studies, in which female sex frequently portrayed an at-risk factor for insomnia and psychological distress during the pandemic (Mandelkorn et al., 2021; Marelli et al., 2020; Zhou et al., 2020). However, it could be argued that the pandemic might have such a strong impact on the student population that gender might indeed have become a quite insignificant factor with regard to sleep. Thus, it could be the case that due to the enormous life changes, for instance the introduction of online lessons, students might generally have acquainted different sleeping patterns. Nevertheless, it needs to be noted that in the present study, female students still scored averagely higher on the PSQI than male subjects, which is it why further research should aim at clarifying the role of gender with regard to sleep quality during the ongoing pandemic.

Besides, statistical analyses did also not confirm a significant difference in sleep quality between students who already did contract and students who did not contract SARS-CoV-2. However, Kokou-Kpolou et al. (2020) and Zhang et al. (2020) suggest that it is often the actual fear of contracting the virus or the present infection with SARS-CoV-2, which portrays an at-risk factor for psychological distress and problems in sleep. Thus, it could be argued that a former infection with the virus might indeed not be as connected to bad sleep quality as previously expected. However, this finding might still portray a quite interesting occurrence, as it could again be suggested that a previous infection with the virus might be meaningless in terms of sleep quality since the pandemic itself might have such strong effects already. Thus, further research needs to investigate whether it is the fear of the virus itself, the actual infection, or previous contraction with SARS-CoV-2 that leads to problems in sleep, or whether it is the pandemic in general that causes these effects.

Looking at more general findings from the present study, PSQI results overall indicate a relatively bad sleep quality among students during the past year. These findings are in line with the results from the study conducted by Cellini et al. (2020), in which participants indeed

reported worse sleep quality since the start of the pandemic. As argued by Kecojevic et al. (2020), this disruption in sleep quality could indeed be the case due to significant changes in students' everyday lives, such as the closing of universities and switching to online lessons. To elaborate, especially this distance education has shown to lead to less routine and at the same time more need for self-discipline (Chen et al., 2020; Li, 2002; Muñoz-Fernández & Rodríguez-Meirinhos, 2021) since lessons take place on a more irregular basis and individuals are often left on their own due to less social contact with other students (Kecojevic et al., 2020). This situation might therefore be interpreted in different ways. On the one hand, it might be the case that this general disruption in daily routines led to more problems in sleep quality, as daily regularity has shown to be linked to better sleep (Zisberg, Gur-Yaish, & Shochat, 2010). However, it could also be the case that the situation increased psychological distress in general and therefore decreased sleep quality at the same time (Cellini et al., 2020; Kecojevic et al., 2020). In fact, Kecojevic et al. (2020) found that students generally reported more worrying or anxiety since the start of the online lessons, which in return could portray one reason for the disruption in sleep quality, as one never really feels at ease. However, further research is needed to clarify the actual cause for the disruption in sleep quality to create a basis for possible future interventions aiming at improving sleep among the student population.

Finally, participating students seemed to experience most problems with falling asleep, however not as many problems with the need for sleep medication. The latter finding is surprising insofar as Mandelkorn et al. (2021) previously reported a significantly higher intake of sleeping pills since the start of the pandemic. Nevertheless, it needs to be noted that this study did not investigate the abuse of other substances apart from sleeping pills, which students might be vulnerable to when experiencing some kind of psychological distress (Holahan et al., 2001). In fact, Digdon & Landry (2013) even identified the use of alcohol as a coping mechanism among bad sleepers in their study. Thus, future research needs to address this aspect by taking into account a larger number of substances to explore whether students do indeed not have the tendency to engage in any kind of pharmacological support for better sleep quality during the pandemic.

4.1 Strengths and Limitations

Strengths of the study were the good internal consistency of the two questionnaires, the consistent scoring of the PSQI as well as the exclusion of ambiguous data. As an example, in case participants indicated to have slept longer than they have spent in bed, their data was

completely excluded from the final analysis. In addition, the relatively large sample size can also be considered as a strength of the study, as it allows for more reliable results.

However, the sample was imbalanced in terms of gender, since it was predominantly female (see Table 1). In addition, there was also an imbalance between the group who already contracted SARS-CoV-2 and the group who did not, as only a small number of students indicated to already have suffered from the virus. Therefore, it has to be noted that these imbalances between groups could also have led to the insignificant group differences found in this study. Nevertheless, such imbalances are not unusual in psychology research and can for example be explained by the convenience sampling method, which was used in the present study. Still, it might be advisable for future research to look into more balanced samples in terms of gender and further sociodemographic aspects to allow for a generalization of results.

Finally, it needs to be noted that the present findings might not be unique to the pandemic situation. In fact, students are generally prone to exceptional sleeping patterns and have often indicated to experience problems in sleep before the pandemic already (Attal et al., 2021; Hersher & Chervin, 2014; Li et al., 2017). Thus, further research should aim at collecting more data, comparing university students' sleep situation before and during the COVID-19 pandemic to isolate the effect of the pandemic on sleep quality and investigate whether these sleep difficulties are indeed the result of the pandemic.

4.2 Recommendations for Future Research

Since this contribution found no significant difference with gender and previous infection with SARS-CoV-2 in terms of sleep, further research needs to devote more attention to other factors. More specifically, future studies could also investigate differences between bachelor and master students for example, or look for group differences within the single PSQI components to investigate sleeping patterns on a more detailed level.

Further, this study only took into account the additional variable of perceived stress. However, there are several other factors, which might also influence sleep quality to some extent or even operate as mediators or moderators for the relationship between perceived stress and sleep quality. Thus, future research should also consider factors such as physical activity, alcohol consumption, depression and anxiety, as all of these aspects were already found to play a role in people's well-being during the ongoing pandemic (Ammar et al., 2020; Santabárbara et al., 2021).

Lastly, future studies should also focus on populations other than students, since this population has shown to be fairly unique in terms of sleep (Attal et al., 2021; Hersher &

Chervin, 2014; Li et al., 2017). Hence, further research could possibly investigate the current sleep situation in elderly or children for example, to provide a clearer picture of the pandemic's impact on sleep quality.

5. Conclusions

Overall, the present study found a positive correlation between perceived stress and sleep quality, and good and bad sleepers differed significantly in their perceived stress levels, with good sleepers indicating lower levels in perceived stress and vice versa. However, further research is needed to establish a clearer picture between sleep quality and stress to allow for proper problem-tackling in the future. In addition, this finding implies that there seems to be an interplay between sleep and other well-being aspects, also stressing the need for further research taking into account possible moderator or mediator variables such as anxiety or alcohol consumption to rule out additional effects. Besides, statistical analyses did not indicate a significant difference in sleep quality between male and female students and neither between students who already contracted SARS-CoV-2 and students who did not. Hence, further research is needed for a proper identification of at-risk factors for bad sleep and other aspects of psychological distress to be able to provide help and thereby prevent brief and long-term consequences for vulnerable individuals. However, this finding might still portray a fairly pervasive occurrence, suggesting that the pandemic might have had such a strong influence on sleep quality in general that factors such as gender or previous infection with SARS-CoV-2 might not have played such a significant role. Thus, future research needs to address these results by investigating whether the pandemic has indeed such strong effects. Overall, more general study findings indicate a relatively bad sleep quality among university students during the COVID-19 pandemic. On a practical level, this finding might raise the need for sleep-monitoring interventions to improve general well-being and everyday functioning in times of political and social change. Finally, results also suggest a moderate stress level among students, which does not seem to portray an alarming result for this population, but should still be investigated further to be able to detect a worsening of the situation.

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Appendix A
Informed Consent

Welcome!
You are invited to participate in a research study titled “Exploring the impact of COVID-19 on students’ mental wellbeing”. This study is conducted by Marius Schulte-Frankenfeld, Emma Simons, Lia Landwehr, Buket Korkut and Laura Holzwarth from the Faculty of Behavioural, Management and Social Sciences at the University of Twente.

The purpose of this research study is twofold. On the one hand, the study aims at exploring the impact of the COVID-19 pandemic on different aspects of mental well-being. On the other hand, the purpose is also to explore the influence of protective factors on well-being during the pandemic. Generally, the survey will take you approximately 20 minutes to complete. The data will be used for research purposes only.

Your participation in this study is entirely voluntary and you can withdraw at any time. **Please be aware that all of your data will be treated confidentially, and your responses are anonymous!**

We believe there are no known risks associated with this research study; however, as with any online related activity the risk of a breach is always possible. To minimize your risks, no identifying information about you will be collected and survey data will only be stored on a password-protected computer.

For further information, please contact: […]

The supervisors of the study are Alexandra Ghita […] and Sofia Bastoni […].

By clicking "I agree" below you are indicating that you are at least 18 years old, have read and understood the consent form and agree to participate in this research study.

- o I agree
- o I don’t agree

Appendix B

Demographic Questions

Item	Response Options		
What is the degree you are currently working on?	Bachelor	Master	PhD
What is your age?		Open Question	
What is your country of origin?		Open Question	
What is your gender?	Male	Female	Other
Have you ever sought psychological or pharmacological treatment for any mental health concerns (e.g. anxiety, depression, eating disorders)?	Yes (Please indicate)		No
Have you ever been diagnosed with a mental health condition?	Yes (Please indicate)		No

Appendix C

Version Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits **during the past year**. As this is a fairly broad period of time, your answers should indicate the most accurate reply for the **majority** of days and nights since the start of the pandemic.

Item	Response Options			
1) Since the pandemic has started, when have you usually gone to bed at night? (e.g. 11 p.m., 1 a.m.)	Open question			
2) Since the pandemic has started, how long (in minutes) has it usually taken you to fall asleep?	≤ 15 min	16-30 min	31-60 min	> 60 min
3) Since the pandemic has started, when have you usually gotten up in the morning? (e.g. 9 a.m., 12 p.m.)	Open Question			
4) Since the pandemic has started, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed)	Open Question			
5a) Since the pandemic has started, **how often have you had trouble sleeping because you** cannot get to sleep within 30 minutes?	No	Less than once a week	Once or twice a week	More than three times a week
5b) … wake up in the middle of the night or early morning?	No	Less than once a week	Once or twice a week	More than three times a week
5c) … have to get up to use the bathroom?	No	Less than once a week	Once or twice a week	More than three times a week
5d) … cannot breathe comfortably?	No	Less than once a week	Once or twice a week	More than three times a week

5e) … cough or snore loudly?	No	Less than once a week	Once or twice a week	More than three times a week
5f) … feel too cold?	No	Less than once a week	Once or twice a week	More than three times a week
5g) … feel too hot?	No	Less than once a week	Once or twice a week	More than three times a week
5h) … had bad dreams?	No	Less than once a week	Once or twice a week	More than three times a week
5i) … have pain?	No	Less than once a week	Once or twice a week	More than three times a week
5d) … other reasons?	No	Less than once a week	Once or twice a week	More than three times a week
6) Since the pandemic has started, how would you rate your overall sleep quality?	Very good	Fairly good	Fairly bad	Very bad
7) Since the pandemic has started, how often have you taken medicine (prescribed or "over the counter") to help you sleep?	Very good	Fairly good	Fairly bad	Very bad
8) Since the pandemic has started, how often have you had trouble staying awake while driving, eating meals or engaging in social activity?	No	Less than once a week	Once or twice a week	More than three times a week
9) Since the pandemic has started, 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

Appendix D

Q-Q-Plot for PSQI Scores