

## Factors associated with sleep quality in university students

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**Abstract** *To investigate factors associated with poor sleep quality. A cross-sectional study was conducted in 2019 with random sampling. Information on sleep was obtained using the Mini Sleep Questionnaire (MSQ). Independent variables included sociodemographic, behavioural, academic and psychological health characteristics. Adjusted analyzes were performed using Poisson regression. A total of 996 undergraduate students participated in the study. The poor sleep quality affected 23.1% of the sample (95%CI 20.5-25.9), ranging from 13.4% for those with little concern about violence in the neighbourhood to 36.5% for those with less social support. In the adjusted analysis, female sex [PR] 1.81; (95%CI 1.33-2.45), concern about violence in the neighbourhood [PR] 2.21; (95%CI 1.48-3.28), discrimination at university [PR] 1.42; (95%CI 1.08-1.86) and food insecurity [PR] 1.45; (95%CI 1.11-1.89) were associated with the presence of poor sleep quality, as well as having less social support and income and suffering psychological distress. The results highlight socioeconomic and mental health factors that affect sleep quality and demonstrate the need for reflection and interventions capable of minimizing this problem.*

**Key words** *Sleep, Behaviour, Mental health, Epidemiology*

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## Introduction

Sleep is essential for the maintenance of life and can be defined as the period in which wakefulness is suspended, with a reduction in metabolic activities, muscle relaxation and a decrease in sensory activities<sup>1</sup>. It acts as a restorative process, allowing the body and brain to recover from moments of activity throughout wakefulness<sup>2</sup>. Healthy sleep improves cognitive processes such as reasoning and language skills<sup>3,4</sup>, contributes to creative processes<sup>5</sup> and reduces emotional stress<sup>6</sup>.

Sleep disorders are associated with significant medical conditions, such as adverse metabolic, endocrine<sup>7</sup> and immune<sup>8</sup> issues. Inadequate sleep can increase oxidative stress<sup>9</sup>, cardiovascular disease<sup>10</sup> and obesity<sup>11</sup>, compromise cognitive and learning performance<sup>4,12,13</sup> and harm mental health<sup>14</sup>. Sleep problems have economic and social effects<sup>15</sup> that range from the risk of motor vehicle accidents to reduced work capacity<sup>16</sup>.

Recent studies have shown that sleep problems and dissatisfaction with sleep are prevalent and increasing among college students<sup>17,18</sup>. Throughout academic training, the increase in responsibilities, including the high demands of studies and extracurricular activities, generate great psychological pressure<sup>19</sup>, making students more vulnerable to sleep problems<sup>20</sup>. Irregularities in the sleep-wake cycle, generated by academic demands, increase anxiety and reduce sleep quality among university students<sup>20,21</sup>. Their sleep quality is related to factors including lifestyle and physical inactivity<sup>22</sup>, obesity<sup>11</sup>, alcohol consumption<sup>23</sup>, stress, anxiety and depression<sup>22,24,25</sup>.

Despite the importance of sleep disorders in university populations, studies are sparse, particularly in low and middle-income countries (LMICs). LMICs differ from high-income countries in both education and employment systems and may lead to different experiences of sleep, as well as health and performance outcomes. Identifying and describing the determinants of sleep quality in this population may contribute to the understanding of factors involved in the deterioration of sleep quality, consequences and potential interventions.

Thus, the present study aimed to investigate sleep quality and possible associations with sociodemographic, behavioural and psychological health factors in students at a university in Southern Brazil.

## Methods

### Study design and sampling

This cross-sectional study was conducted at the Federal University of Rio Grande (FURG) in 2019 (period before the COVID-19 pandemic) and approved by the Committee of Ethics in Health Research (CEPAS) of FURG under protocol number 196/2019 and certificate of presentation of ethical assessment (CAAE) number 24520719.3.2003.5016.

More than 9,000 undergraduate students are enrolled in FURG, which is located in Rio Grande, Rio Grande do Sul, which is a port municipality in the extreme south of Brazil, with a population of approximately 200,000 inhabitants (IBGE, 2010). The target audience of this study was university students aged 18 years or older who were on campus and taking classes in person during the second half of 2019. Students who had withdrawn at the time of the study or who dropped out during the semester were not included.

The sample size calculation was performed based on several factors associated with mental health (outcome of interest of the main study), using an estimated prevalence of 15%, an exposed/nonexposed ratio of 1 to 4, a prevalence ratio of 2.0, and 80% power and 5% significance levels. Multiplying by 1.5 to compensate for the design effect and adding 15% for confounders, a minimum sample size of 980 students was determined. The estimated prevalence of 15% was based on the literature for suicidal ideation (one of the main outcomes of a series of studies using the present sample). The ratio 1 to 4 was chosen because the independent variable could have a proportion of 20% of exposed versus 80% of nonexposed individuals to the outcome, according to the literature. To mitigate possible losses and refusals, an additional 10% was added to the sample size for a total of 1,089 students.

Sampling was performed in a random manner and systematically by clusters. A class, defined as a group of individuals enrolled in the same subject, was considered a cluster. All classes were obtained from the university system in the year 2019. It was estimated that 55 classes were needed to reach the sample size (on average, there were 20 students per class). The selection of clusters was performed by assigning each class a number, then a sampling interval was calculated and classes systematically selected. With the classes selected, all students present on the day

of collection and who agreed to participate answered the questionnaire.

### Procedures

After defining the sampling plan, contact was made with the university students in the classroom. The self-administered questionnaire was previously tested in a pilot study conducted at another higher education institution in the same municipality. The instrument was completed by the students in the classroom and supervised by a properly trained team. Each class received at least two visits from the team, and if there were classes with more than ten losses, a third visit was performed. Students who were not present for any of the visits, who had difficulty interpreting and answering the instrument alone, or who refused to participate in the study were considered to be lost and excluded from analysis. The fieldwork lasted three months, from September through November 2019.

### Outcome

The Mini Sleep Questionnaire (MSQ) was used to assess sleep<sup>26</sup>. This instrument includes 10 questions and comprehensively evaluates aspects that configure the sleep pattern, such as difficulty falling asleep, waking up in the middle of the night or early in the morning, use of sleep medication, nonrestorative sleep, excessive daytime sleepiness and snoring. The frequency with which such aspects occur is measured using a *Likert scale* with seven options, ranging from 1 to 7 points (never=1/always=7), generating a score that can vary from 10 to 70 points, with higher scores indicating poorer sleep quality<sup>26</sup>.

Although the instrument has been validated in Brazil<sup>26</sup>, we chose to evaluate the outcome of poor sleep quality through quartiles, with the MSQ scores of university students in ascending order and subsequently categorized into quartiles. The group of interest for this study was individuals in the highest quartile, i.e., the 25% of the sample with the poorest sleep quality.

### Independent variables

The independent variables were sex (male, female); age group (18-20, 21-24 years, 25 years or older); income (in quartiles, increasing the proportion of income), year of the course (1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> year or more) and satisfaction with the course (no, yes). Data on concern about violence

in the neighbourhood and discrimination of any kind at the university were obtained through the questions: “How much fear or concern do you have about violence by bandits, robberies or other types of crime in the neighbourhood where you live?” and “Have you ever felt wronged due to discrimination at the university, such as being discouraged from continuing your studies?”, with possible responses: none/a little, average, a lot/extremely, and no or yes. Information on food insecurity (FI) was collected through the following question: “Did the residents of your household worry that food would run out before they could buy or receive more food?”, FI was confirmed when the answer was yes. Information on social support was collected using the Social Support Scale developed by the Medical Outcome Study-Social Support Scale, MOS-SSS<sup>27</sup> (categorized into quartiles).

Physical activity performed during leisure time was measured using the International Physical Activity Questionnaire (IPAQ) and categorized as (0 minutes/week, <150 minutes/week and 150 minutes/week or more) based on the recommendations of the World Health Organization (WHO)<sup>28</sup>. Information about tobacco use (no, yes), drug use and alcohol abuse (during the past 30 days, including frequency and amount consumed in this period) were obtained. BMI was obtained using self-reported weight and height and calculated as recommended by the WHO into three categories: normal weight (up to 24.9 kg/m<sup>2</sup>); overweight (25.0 to 29.9 kg/m<sup>2</sup>); and obesity (above 29.9 kg/m<sup>2</sup>).

To measure the students' mental health, a mental health cluster was created using the analysis proposed by Bacher *et al.*<sup>29</sup> with the total scores of the instruments that measured stress, anxiety and depression. The Perceived Stress Scale (PSS) was used to assess stress<sup>30</sup>, which measures the frequency with which stressful situations occurred in the past 30 days. Data on anxiety were obtained using the Generalized Anxiety Disorder (GAD-7)<sup>31</sup>, a brief instrument for the evaluation and screening of generalized anxiety symptoms. The Patient Health Questionnaire-9 (PHQ-9) was used to identify individuals with depressive symptoms<sup>32</sup>.

The cluster analysis was performed in two stages and aimed to divide the sample into different groups of “mental distress”, forming groups of individuals very similar to each other and as different as possible from the individuals in the other groups. The scores ranged from 0 to 1; the closer to 1 a cluster scored, the less likely that the

variation of a variable between clusters is due to chance. The three groups were generated and defined with the following labels: Cluster 1 (great psychological distress), Cluster 2 (intermediate psychological distress), Cluster 3 (low psychological distress).

### Statistical analysis

Data analysis was performed using Stata® 16.1 software. First, a description of the sample was performed, presenting absolute and relative frequencies of all categorical variables. The quantitative variables were described as the mean, median, standard deviation (SD), interquartile range (IQR) and minimum and maximum values. Second, crude and adjusted analyzes were performed to verify the association of poor sleep quality with the independent variables. Poisson regression was used for this analysis, and the prevalence ratios (PRs) and 95% confidence intervals (95% CIs) were determined. The *p* value was also presented considering a significance level of 5%.

Multivariate analysis was conducted based on the hierarchical model developed to control for possible confounders. In this model, socioeconomic variables (sex and income) were first-level variables, satisfaction with the course; concern about neighbourhood violence, discrimination at the university, severe food insecurity and social support were second-level variables; and physical activity, smoking, nutritional status and mental health clusters were third-level variables. In the adjusted analysis, each variable was controlled for variables at the same or higher levels. The significance level to remain in the model was  $p < 0.20$ .

### Results

Of the 1,169 students eligible to participate in the study, 996 undergraduates participated, resulting in a response rate of 85.2%. Of these, 944 answered the questions about sleep. Of the 173 (14.8%) who did not respond to the questionnaire, 12.3% were not located, and 2.5% refused to participate. According to the characteristics of the sample, shown in Table 1, most participants were women (64.2%), 41.2% were between 21 and 24 years old, one-third (33.7%) were in their first year, and approximately half (52.9%) were satisfied with their course. Regarding lifestyle, approximately one-fifth (18.5%) were smokers,

39.0% did not perform physical activity, and 40.1% were overweight. Approximately a quarter reported discrimination at the university, were food insecure and drank alcohol frequently. Regarding mental health, 23.1% of university students were in Cluster 1 (great psychological distress). The mean income was BRL 1,822.17, and the median was BRL 1,200 ([IQR] 699.5-2000). (R\$ 998 was the national minimum wage the year of the study).

The findings of this study show a mean of 33 points (SD=9.9), median of 32.5 points ([IQR] 25.5-40) and minimum value of 10 and maximum 67 points on the students' MSQ. Students in the last quartile had a mean score of 46.5 (95%CI 45.8-47.3) points, while those in the first quartile had 21.0 (95%CI 20.6-21.5) points.

The presence of poor sleep quality reached 23.1% of the sample (95%CI 20.5-25.9), ranging from 13.4% for individuals with little or no concern about violence in the neighbourhood to 36.5% for those in the quartile with the lowest social support (Table 2). The individuals higher prevalence of poor sleep quality were female, financially disadvantaged, dissatisfied with their course, very concerned about violence in their neighbourhood, physically inactive, smokers, obese, food insecure and those who reported discrimination and low social support. Only 33 (3.4%) students were underweight (<18.5); therefore, they were included in the eutrophic category for the purposes of analysis.

Age group, undergraduate year, frequent alcohol consumption and drug use showed no association in the crude or adjusted analysis (Table 2).

Figure 1 shows the crude and adjusted prevalence rates for the presence of poorest sleep quality according to the mental health clusters of university students. For those in Cluster 3 with the best mental health, only 2.3% were in the group with poor sleep quality. In Cluster 1 with the greatest psychological distress, more than half of the sample (60%) was in the group with the poor sleep quality. Even after adjustments, the prevalence rates were significantly different (47.1%, 19.0% and 3.2%) for the clusters with high, intermediate and low psychological distress, respectively.

### Discussion

In the present study, we explored data on sleep quality (poor quality) and its association with

**Table 1.** Description of the characteristics and lifestyle of university students. Rio Grande-RS, Brazil (n=944), 2019.

Characteristics	Sample		Characteristics	Sample	
	n	%		n	%
Sex			Food insecurity		
Male	338	35.8	No	729	77.5
Female	605	64.2	Yes	212	22.5
Age group (years)			Social support (quartile)		
18-20	271	28.7	1 (major)	196	22.3
21-24	388	41.2	2	225	25.6
25 or more	284	30.1	3	237	26.9
Income (quartile)			4 (minor)	222	25.2
1 (richest)	199	25.1	Physical Activity (min/week)		
2	217	27.3	0	318	39.0
3	201	25.3	1 to 149	242	29.7
4 (poorest)	177	22.3	150 or more	255	31.3
Year of the course			Smoking		
1º	317	33.7	No	767	81.5
2º	201	21.4	Yes	174	18.5
3º	256	27.2	Alcohol consumption		
4 onwards	167	17.7	<6 days/month	691	73.8
Satisfaction with the course			≥6 days/month	245	26.2
No	444	47.1	Drug use (last month)		
Yes	498	52.9	No	768	81.7
Concern about violence in the neighbourhood			Yes	172	18.3
Little	290	30.7	Nutritional status		
Mean	326	34.6	Eutrophic	559	59.9
Very	327	34.7	Overweight	260	27.9
Discrimination at university			Obese	114	12.2
No	681	73.9	Mental Health (clusters of psychological distress)		
Yes	240	26.1	Great	194	23.1
			Intermediate	336	40.1
			Low	308	36.8

it continues

Source: Authors.

sociodemographic, behavioural and academic characteristics. We found that being female, having low income, being dissatisfied with the course, being highly concerned about violence in the neighbourhood, suffering discrimination, being food insecure, having low social support, smoking, and suffering psychological distress were significantly associated with the poorest sleep quality.

The median MSQ of the students was 32.5 points (IQR=25.5-40), and the last quartile reached 45 points (IQR=42-48). In the study by Falavigna *et al.*<sup>26</sup> using the MSQ in a study of Brazilian university students, the median score was 26 (IQR=21.0-32.0). A study with older adults resulted in a median of 21 points on the MSQ<sup>33</sup>, and another study with adults and elderly people

from rural areas reported a mean score of 29.4 (95%CI 28.7-30.1)<sup>34</sup>. Our findings were superior and highlight the relevance of studying sleep health in this specific population. The presence of these problems deserves attention because they have a direct impact on health conditions, promoting changes that affect individuals' physical performance and mental health. It is worth noting that few sleep studies in university populations use the MSQ, which somehow impairs the comparison of results.

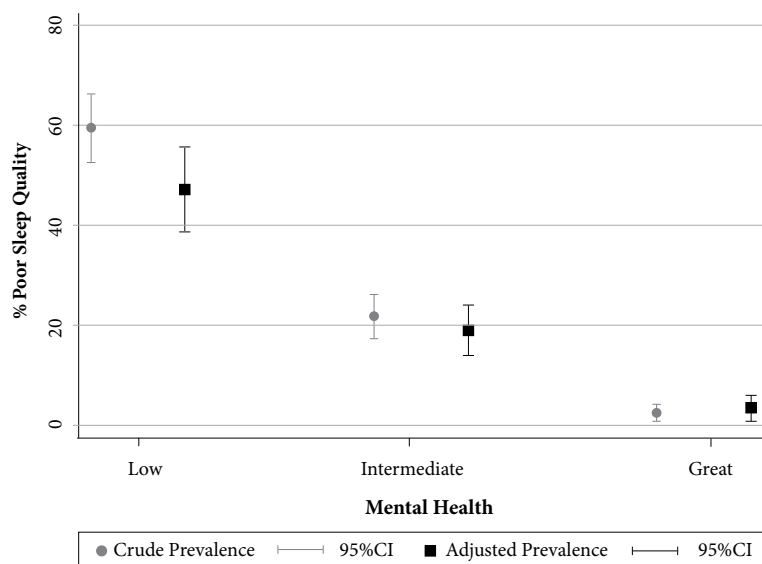
However, national studies<sup>17,18,26</sup> and international studies<sup>16,25</sup> have shown that sleep problems among university students are prevalent and vary according to the different instruments used

**Table 2.** Crude and adjusted analysis of the poorest sleep quality, according to demographic, anthropometric and behavioural characteristics of university students. Rio Grande-RS, Brazil (n=944), 2019.

Characteristics	PQS %	Gross Analysis RP (95%CI)	p-value	Adjusted	p-value
				Analysis* RP (95%CI)	
Sex					
Male	15.4	1.00		1.00	
Female	27.4	1.78 (1.35-2.36)		1.81 (1.33-2.45)	
Age group (years)					
18-20	21.0	1.00	0.622		
21-24	24.2	1.15 (0.86-1.54)			
25 or more	23.6	1.12 (0.82-1.53)			
Income (quartile)					
1 (poorest)	31.2	1.00		1.00	0.014
2	22.1	0.71 (0.51-0.98)		0.70 (0.50-0.96)	
3	22.4	0.72 (0.52-1.00)		0.72 (0.52-1.00)	
4 (richest)	16.9	0.54 (0.37-0.80)		0.56 (0.38-0.83)	
Year of the course					
1°	23.0	1.00	0.926		
2°	21.4	0.93 (0.67-1.30)			
3°	23.8	1.03 (0.77-1.39)			
4° onwards	23.9	1.04 (0.74-1.46)			
Satisfaction with the course					
No	27.0	1.00	0.005	1.00	0.439
Yes	19.3	0.71 (0.56-0.90)		0.90 (0.70-1.17)	
Concern about violence in the neighbourhood					
Little	13.4	1.00	p<0.001	1.00	p<0.001
Mean	24.2	1.80 (1.27-2.56)		1.98 (1.32-2.98)	
Very	30.6	2.27 (1.63-3.18)		2.21 (1.48-3.28)	
Discrimination at university					
No	19.2	1.00	p<0.001	1.00	0.009
Yes	33.3	1.73 (1.37-2.19)		1.42 (1.08-1.86)	
Food insecurity					
No	19.8	1.00	p<0.001	1.00	0.007
Yes	33.9	1.71 (1.35-2.17)		1.45 (1.11-1.89)	
Social support (quartile)					
1 (minor)	36.5	1.00	p<0.001	1.00	p<0.001
2	21.8	0.60 (0.44-0.81)		0.57 (0.41-0.79)	
3	16.5	0.45 (0.32-0.63)		0.42 (0.30-0.61)	
4 (major)	17.8	0.49 (0.35-0.69)		0.51 (0.36-0.73)	
Physical Activity (min/week)					
0	27.0	1.00	0.009	0.376	0.376
1 to 149	19.8	0.73 (0.54-1.00)		0.89 (0.65-1.21)	
150 or more	16.8	0.62 (0.45-0.86)		0.81 (0.59-1.10)	
Smoking					
No	21.6	1.00	0.040	1.00	0.022
Yes	28.7	1.33 (1.01-1.74)		1.42 (1.05-1.92)	
Alcohol consumption					
<6 days/month	22.1	1.00	0.308		
≥6 days/month	25.3	1.14 (0.88-1.47)			
Drug Use					
No	22.5	1.00	0.482		
Yes	25.0	1.11 (0.83-1.48)			
Nutritional status					
Eutrophic	19.9	1.00	0.001	1.00	0.479
Overweight	24.2	1.22 (0.93-1.60)		1.03 (0.74-1.42)	
Obese	35.1	1.77 (1.31-2.39)		1.22 (0.88-1.68)	

PQS= Poor sleep quality. \*1st level: sex and income; 2nd level: satisfaction with the course, concern about violence in the neighbourhood, discrimination at the university, food insecurity, social support; 3rd level: physical activity, smoking, nutritional status and mental health.

Source: Authors.



**Figure 1.** Mental health of university students with poor sleep quality. Rio Grande-RS, 2019 (n=838).

Source: Authors.

and the means of data collection. In Brazil, there are few studies of the undergraduate population<sup>17,20,35</sup>, the most part of these studies included other regions of country than South and studied other health outcomes. Even with impaired comparability, the common finding of the current study and other studies<sup>17,20,35</sup> is that the sleep of university students seems to be poorer than that of the general population.

A 2019 American College Health Association report, studying 98 colleges and universities in the United States (n=67,972), conducted the National Health Assessment of University Students (ACHANCHA-II), which listed some factors such as: “traumatic or very difficult to deal with” in the last 12 months. Sleep difficulties, including latency time, sleep duration, insomnia and daytime sleepiness affected 35.2% of university students and ranked third among difficulties faced by students in the past 12 months. Only academic (51.2%) and financial (36.9%) problems were ranked higher. When evaluates the factors that negatively affected academic performance, 22.4% of the students cited sleep difficulties, only stress (34.2%) and anxiety (27.8%) affect their academic activities more<sup>36</sup>.

An American study, conducted between 2015 and 2017 in six universities with 7,696 students,

found sleep dissatisfaction among 62% of the participants. Women were more likely to have unsatisfactory sleep (64%) than men (57%)<sup>16</sup>. A study in Japan conducted with university women found that poor sleep quality was associated with inappropriate health behaviours, such as high levels of stress and excessive use of smartphones<sup>37</sup>. In the same vein, Brazilian studies show poor sleep quality among university students<sup>17,18,38</sup>. According to a systematic review and meta-analysis including only Brazilian studies, poor-quality sleep affected more than half (51.5%) of medical students<sup>38</sup>. Another study conducted in Brazil showed that over a 10-year period, there was an 8.2 percentage point increase in self-reported sleep dissatisfaction among high school students aged 15 to 19 years (from 26.3% to 34.5%)<sup>39</sup>.

Regarding sex, the present study, as well as other studies<sup>16-18</sup>, showed a higher prevalence of sleep problems among female students. Women were approximately twice as likely to have poorer sleep quality than men in this sample. A Brazilian study showed an overall prevalence of 30% of students reported poor sleep, and men had a 16% lower risk of poor sleep quality<sup>17</sup>. Plausible explanations as to why women suffer more sleep difficulties may be related to psychological conditions, since they present symptoms of anxiety

and depression more frequently than men. Hormonal changes present during menstrual cycles, pregnancy and menopause are also factors that can affect sleep<sup>40,41</sup>.

People's living conditions also influence lifestyle and perception of health status and sleep quality<sup>42</sup>. Similar to other studies<sup>35,43</sup>, we found poor sleep quality among students with lower purchasing power. Peltz *et al.*<sup>43</sup> showed that students with high levels of financial stress and whose families had low socioeconomic status were at greater risk of suffering poor sleep quality than those who worked and had higher incomes. Income appears to play an important role in sleep quality. Grandner *et al.*<sup>44</sup> showed that as income decreases, sleep complaints increase.

On the other hand, a Brazilian population-based study did not find this association, although it showed results of poor sleep among individuals who did not work. Sleep disorders in unemployed individuals may be related to numerous factors, such as poorer emotional health, dissatisfaction with life and even the presence of financial insecurity<sup>41</sup>. In Brazil, low-income individuals have fewer opportunities to enrol in higher education. Inclusion and student assistance policies are strategies to support academic success<sup>45</sup> and reduce social inequities among students in Brazil, and these policies may also affect their health status, including improvements in sleep.

Regarding fear of neighbourhood violence and discrimination, our study presented results similar to those discussed in the literature. Social disorders in the neighbourhood, such as crime and theft, generate insecurity and dissatisfaction in individuals and favour the perception that the environment in which they live represents a constant threat. The high load of stress that this perception causes can trigger an increase in the levels of adrenaline and cortisol<sup>46</sup>, which can interfere with sleep. In addition, a longitudinal study showed that discrimination perceived by students was related to an increase in sleep problems<sup>47</sup>. Becerra *et al.*<sup>24</sup> also found that suffering any level of discrimination was related to poor sleep health among university students, including feelings of tiredness, fatigue and daytime sleepiness. Experiences of discrimination are sometimes associated with substance use<sup>47</sup> and may increase feelings of loneliness and stress, that may contribute to reduced sleep quality<sup>48</sup>.

Individual factors such as food insecurity, social support, smoking and psychological distress were also associated with poor sleep quality. The

presence of financial limitations during college can make students more vulnerable to food insecurity due to reduced purchasing power due to the costs with the course itself, housing and food<sup>49</sup>. A literature review found that experiencing or being at risk of food insecurity is correlated with having fewer days of sufficient sleep (in hours) per week and greater odds of reporting poor sleep quality<sup>50</sup>.

The lack of social support can be harmful, especially for university students, who go through times of stress, problems of adjustment and pressures to succeed in college. Evidence suggests that social support has a protective effect on mental health<sup>51</sup> and that higher levels of social support predict better sleep quality<sup>52</sup>. Social support, in the academic sphere, is capable of acting as a potential stimulator, providing support for students to satisfactorily perform their academic activities<sup>53</sup>.

The association between tobacco use and poor sleep quality was maintained in the final model. Smokers had poorer sleep quality; previous studies showed similar results<sup>17,35</sup>. Nicotine, present in cigarettes, acts by stimulating the central nervous system and thus interferes with sleep, increasing the latency time<sup>54</sup>. Although evidence shows that young adults are more likely to abuse alcohol and drugs<sup>23</sup> and that this abuse negatively affects sleep quality, our study did not show this association with the outcome. This may be due to the divergent effects of alcohol and drugs on sleep, depending on the amount and frequency.

Regarding psychological distress, students in this group had poorer sleep quality, which corroborates other studies<sup>16,55,56</sup>. Elevated levels of cortisol reduce serotonin receptors, a hormone essential for sleep, and this decrease is present in depressive conditions<sup>57</sup>. On the other hand, changes in sleep patterns can also cause hormonal changes, producing depressive symptoms<sup>57</sup>. Previous studies have reported a high prevalence of sleep and mental health problems<sup>16,55,56</sup> among university students, including depression, stress<sup>58</sup> and anxiety<sup>16</sup>. Mental health reflects other aspects of university student development, such as academic performance and physical health<sup>58</sup>. Interventions focused on improving both sleep quality and mental health can mitigate these problems in affected student populations.

Some limitations must be considered. The cross-sectional design does not allow us to establish temporal relationships, and caution is required in the interpretation of the findings, especially due to the bidirectional relationship that



behavioural variables such as nutritional status, smoking and mental distress may have with the outcome. Another limitation is that the data were collected at a single university, which does not allow the results to be easily extrapolated to the entire population of university students. It is important to note that we did not collect information on other factors that may affect sleep quality, such as use of sleeping pills, diagnosis of mental disorders and occupations with shift work, which are known to affect sleep quality.

The present study also has strengths. First, we emphasize that this is one of the few studies that seeks to jointly evaluate behavioural factors, environmental perceptions (such as concern about violence in the neighbourhood and social support) and some academic aspects (discrimination at university, satisfaction with course and year of education) and their effects on the sleep quality of university students. Although studies

on sleep often include samples of university students, studies exploring the effects of academic variables on these students are sparse, especially in LMICs such as Brazil. Our data may be useful for future studies, given the current context of the COVID-19 pandemic. Comparing the factors associated with the sleep of prepandemic university students with those during the pandemic may provide a real understanding of the impact generated by COVID-19 on student sleep, as well as its associated factors.

Based on our findings, we consider that preventive actions within the academic scope are needed for the sleep health of this population. The formation of groups with psychosocial approaches can be of great value. Working on students' ability to deal with and manage life's adversities, especially tensions caused by the responsibilities that academic life requires, can contribute to minimizing sleep problems.

## Collaborations

FV Maciel conceived the study and wrote the manuscript. AT Wendt performed data analysis and critically reviewed the manuscript. LM Demenech worked on research coordination, wrote the methods and reviewed the final version of the manuscript. SC Dumith worked on research coordination and reviewed the final version of the manuscript.

## Funding

The first author would like to thank the Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul (FAPERGS) from which she received a scholarship during her doctorate. SC Dumith is a Research Productivity Scholar from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPQ).

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Article submitted 28/03/2022

Approved 30/09/2022

Final version submitted 02/10/2022

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Chief editors: Romeu Gomes, Antônio Augusto Moura da Silva