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Sleep quality and sleep hygiene in Slovenian university students during the COVID-19 pandemic

Kakovost in higiena spanja pri slovenskih študentih med pandemijo bolezni covida-19

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Abstract

Background: The COVID-19 pandemic has profoundly impacted global physical and mental health. This study sought to 1) assess Slovenian university students' sleep habits during the initial COVID-19 epidemic and lockdown and 2) evaluate sleep hygiene's role as a potential predictor of sleep quality during this period.

Methods: The prospective cross-sectional study was conducted during the first five weeks of the officially declared epidemic in Slovenia. A total of 541 participants (80% female; mean age 22.1, *SD* = 2.1) responsded to questions on sleep quality, changes in sleep patterns, sleep hygiene, and mental health.

Results: A majority of university students (82.6%) reported either increased or unchanged sleep durations during the pandemic compared to the period before the pandemic. Conversely, 48.6% indicated less consistent sleep schedules, and 37.2% noted a decline in sleep quality. Regression analysis revealed that even after accounting for potentially sleep-affecting variables (demographics, physical and mental health status, stress, anxiety, and depression indicators), sleep hygiene remained a significant predictor of sleep quality.

Conclusions: Our findings confirm the previously observed shifts in sleep patterns during the pandemic and highlight the pivotal role of sleep hygiene in maintaining sleep quality during such public health crises. Notably, this research also pioneers the investigation of sleep habits among Slovenian students, filling a notable gap in the literature, as no prior studies have addressed this demographic either before or during the pandemic.

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Izvleček

Izhodišča: Pandemija covida-19 je močno vplivala na telesno in duševno zdravje ljudi po vsem svetu. V tej raziskavi smo želeli oceniti spalne navade slovenskih študentov med pandemijo bolezni covida-19 ter ovrednotiti vlogo higiene spanja kot možnega napovednega dejavnika za kakovost spanja v tem obdobju.

Metoda: Ta prospektivna presečna študija je bila izvedena v prvih 5 tednih uradno razglašene epidemije v Sloveniji. Skupaj 541 udeležencev (80 % žensk; povprečna starost 22,1 leta, standardni odklon = 2,1) je odgovarjalo na vprašanja o kakovosti spanja, spremembah vzorcev spanja, higieni spanja in duševnem zdravju.

Rezultati: Večina študentov (82,6 %) je poročala o podaljšanju ali nespremenjenem trajanju spanja med pandemijo v primerjavi z obdobjem pred pandemijo. Nasprotno pa je 48,6 % udeležencev navedlo manj dosledne ritme budnosti in spanja. 37,2 % jih je opazilo poslabšanje kakovosti spanja med pandemijo v primerjavi z obdobjem pred njo. Regresijska analiza je pokazala, da je higiena spanja pomemben napovedni dejavnik kakovosti spanja tudi ob upoštevanju možnih spremenljivk za vpliv na kakovost spanja (demografski podatki, telesno in duševno zdravstveno stanje, stres, kazalniki tesnobe in depresije).

Zaključki: Naši rezultati potrjujejo že prej opažene in tudi v mednarodnih raziskavah poročane spremembe vzorcev spanja med pandemijo. Hkrati poudarjajo ključno vlogo higiene spanja pri vzdrževanju kakovosti spanja med javnozdravstvenimi krizami. Ob tem je pomembno poudariti, da je ta raziskava prva, ki preučuje spalne navade slovenskih študentov, s čimer zapolnjuje pomembno vrzel v strokovni literaturi. Dosedanje študije spalnih vzorcev v tej demografskih skupini v Sloveniji doslej sploh še niso obravnavale.

1 Introduction

The Coronavirus 2019 (COVID-19) had a marked impact on individuals' physical and mental well-being globally. Studies show individuals were more susceptible to various mental health problems, including heightened anxiety and depression (e.g., 1-5), psychological stress, and post-traumatic stress disorder (PTSD) (4,6). Less favourable psychological functioning during the COVID-19 pandemic was also described in the Slovenian population (7-11), with young adults being particularly vulnerable to heightened levels of anxiety and perceived stress (8). Given the established link between mental health and sleep disturbances (12), the potential sleep-related challenges during the pandemic might have been exacerbated by significant alterations in daily life and routines, such as decreased sunlight exposure, remote work/study, and social isolation (13).

Multiple studies have corroborated that the COVID-19 pandemic posed a risk for diminished sleep quality, emergence of sleep challenges (e.g., 6,14-19), and increased consumption of hypnotics (14). Nonetheless, different facets of sleep may have been variably impacted. For instance, a few studies noted an unanticipated surge in sleep duration in contrast to population-based data gathered before the pandemic (20,21). Additionally, research has indicated that the impact of the COVID-19 pandemic on sleep might have differed among individuals (22).

University students are known to be at high risk for developing sleep problems due to specific challenges of early adulthood (i.e., changes in living arrangements, social life, biological developments, and financial situations) (23,24). The COVID-19 pandemic introduced additional stressors (9,25) and altered health behaviours, including suboptimal dietary habits and decreased physical activity (26), possibly further exacerbating sleep issues among this vulnerable population.

Sleep hygiene is a set of behaviours and environmental conditions promoting healthy sleep and is the most widely accessible approach toward sleep improvement (27). It is believed to affect both sleep quality and quantity positively. Alcohol consumption, intake of caffeine, energy drinks, and stimulants, as well as regular use of technology like phones or computers prior to sleep (27-29), are prevalent behaviours that conflict with good sleep hygiene. Environmental factors have been linked to poor sleep quality, while psychological issues, including depression, anxiety, and stress, have been correlated with sleep disorders, notably insomnia (30). It was suggested that sleep hygiene recommendations should be included in the WHO COVID-19 technical guidance for the general public and healthcare workers (31). Still, only a few studies have delved into the impact of sleep hygiene on sleep quality amidst

the COVID-19 pandemic. These studies suggest that focusing on sleep hygiene interventions could help alleviate its adverse effects on sleep patterns (32).

The objective of our study was to examine the sleep quality experienced by Slovenian university students during the COVID-19 pandemic. We were also keen on investigating the potential role of sleep hygiene in predicting sleep quality during this period for this susceptible group. It is worth noting that, based on our research, no prior publications have shed light on the sleep patterns of university students in Slovenia neither during nor before the pandemic.

2 Methods

2.1 Study design and data collection

This prospective cross-sectional study was conducted during the officially declared epidemic in Slovenia from 16th March to 31st May 2020, five weeks into the first national lockdown. During this period, the government closed all sales and service facilities, except for food and pharmacy stores, halted public transportation, banned public gatherings, and universities officially transitioned from in-person teaching to remote learning. University students were invited to participate in our online-based study through social media platforms, university newsletters, and email. Informed consent was obtained from each participant before starting the study. The survey took approximately 10 minutes to complete. To ensure anonymity, no personal data that could identify participants was collected. Participants could withdraw from the survey at any time without giving any justification and without any consequences to their academic status. The study complied with the Declaration of Helsinki and was approved by the by the Republic of Slovenia National Medical Ethics Committee (reference number: 0120-279/2020/3).

2.2 Subjects

The sample consisted of 541 participants. The majority (80%) were females, and most were undergraduate university students (63.5%). On average, participants were 22.1 years old (*SD* = 2.1). During the study, 79.7% of university students cohabited with their parents, 12.8% with their partners, 3.2% with roommates, and 2% lived alone. In terms of medical background, the majority of participants did not report any chronic somatic (92.4%) or mental (93.7%) illnesses or a diagnosis of a sleep disorder (99.1%). The demographic and medical characteristics of the sample are displayed in Table 1.

Table 1: Demographic and medical characteristics of the sample.

Characteristics	n (%)
Baseline demographic characteristics (N=541)	
Age (years) (*M* ± *SD* (range))	22.1±2.1 (19-29)
Gender	
• Male	107 (19.8)
• Female	433 (80)
• Other	1 (0.2)
Educational level	
• Undergraduate	390 (72.2)
• Graduate	150 (27.7)
Cohabitation conditions during epidemic	
• Parents	431 (79.7)
• Partner	69 (12.8)
• Flat mates	17 (3.1)
• Alone	11 (2.0)
• Other	13 (2.4)
Medical background	
Diagnosis of chronic somatic illness	
• Yes	41 (7.6)
• No	500 (92.4)
Diagnosis of mental illness	
• Yes	34 (6.3)
• No	507 (93.7)
Diagnosis of sleep disorder	
• Yes	5 (0.9)
• No	536 (99.1)

Legend: *M* and *SD* represent mean and standard deviation, respectively.

2.3 Measures

Sleep quality. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI; Buysse et al. 1989) (6). The PSQI is a self-rated questionnaire that assesses sleep quality and disturbances. Nineteen individual items generate seven 'component' scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The answers are scored on a 0 to 3 scale, where 3 reflects the negative extreme on the Likert scale. In the present study, the sleep disturbances scale was not included; therefore, the final score for global sleep quality consisted of six scales. A similar approach, using the same six scales, has been applied in several other studies on sleep quality during the pandemic (34). The present study's reliability coefficient was satisfactory (Cronbach α = .76).

Additionally, participants rated their perceived change in sleep (quality, regularity, duration, and nap duration) on a self-developed 3-point scale (0 – decreased or worsened, 1 – did not change, 2 – increased or improved) during the COVID-19 pandemic compared to the period before the pandemic.

Sleep hygiene. Sleep hygiene was measured using the Sleep Hygiene Index (SHI; Mastin et al. 2006) (35), a 13-item self-administered scale designed to assess the presence and frequency of behaviors that compromise sleep hygiene. Participants rated the items on a 5-point Likert scale. A higher total score indicates less optimal sleep hygiene status. The Cronbach alpha coefficient for the current sample was α = .72.

Depression, anxiety, and stress. The Depression, Anxiety, and Stress Scale (DASS-21; Lovibond & Lovibond 1995) (36) was used to assess depression, general anxiety, and stress. Respondents rated a 21-item self-report scale on a 4-point Likert scale, ranging from 0 to 3, with higher scores indicating greater symptom severity. A total score was obtained by summing the scores of the aforementioned scales. The reliability coefficients for depression (Cronbach α = .89), anxiety (Cronbach α = .80), stress (Cronbach α = .91), and total score (Cronbach α = .94) indicate good reliability for the current sample.

2.4 Statistical analysis

Descriptive statistics and frequency analyses were first conducted to examine the perceived change in sleep among students during the COVID-19 epidemic in Slovenia. Next, we analysed the relationship between the variables using Pearson's correlation coefficient. A multiple regression was then employed to determine whether sleep hygiene could predict sleep quality after accounting for demographic and mental health variables. Multiple regression was performed in four steps; in the first three steps, we added control variables (demographic and mental health variables), and lastly, we added sleep hygiene. All analyses were performed using IBM SPSS version 26.

3 Results

3.1 Self-reported changes in sleep

First, we investigated self-reported changes in the amount of sleep at night, quality of sleep, sleep regularity (i.e., sleep-wake patterns or sleep rhythm), and the number of daily naps during the COVID-19 pandemic compared to the period before. The results are presented in Figure 1.

The results depicted in Figure 1 indicate that 82.6% of participants reported sleeping for the same duration or longer during the pandemic than they did before its onset. Only 17.4% indicated they slept less during the night, as illustrated in Figure 1A. On average, participants claimed to have slept 7.5 hours per night (*SD* = 1.34) over the past month (during the pandemic). Among those who said they slept more during the pandemic, the average sleep duration was 8.05 hours (*SD* = 1.10). Participants who believed their sleep duration remained consistent reported an average of 7.48 hours (*SD* = 1.22), while those who felt they were sleeping less reported an average of 6.23 hours (*SD* = 1.28). For individuals who claimed to sleep more, the average increase was 100.11 minutes (*SD* = 56.52). Conversely, those who said they slept less experienced an average reduction of 109.89 minutes (*SD* = 54.55).

The majority of participants (62.7%) reported no changes in their daytime napping habits. Specifically, 17.6% stated they napped more frequently, whereas 19.8% claimed they napped less, as shown in Figure 1B.

Regarding sleep quality, as illustrated in Figure 1C, 62.8% of participants felt their sleep quality remained the same or improved, while 37.2% noticed a decline. Figure 1D presents a different trend concerning changes in sleep rhythm: almost half (48.6%) of the participants felt their sleep-wake patterns became less regular. Based on these findings, we were interested in exploring further sleep hygiene's role in predicting sleep quality.

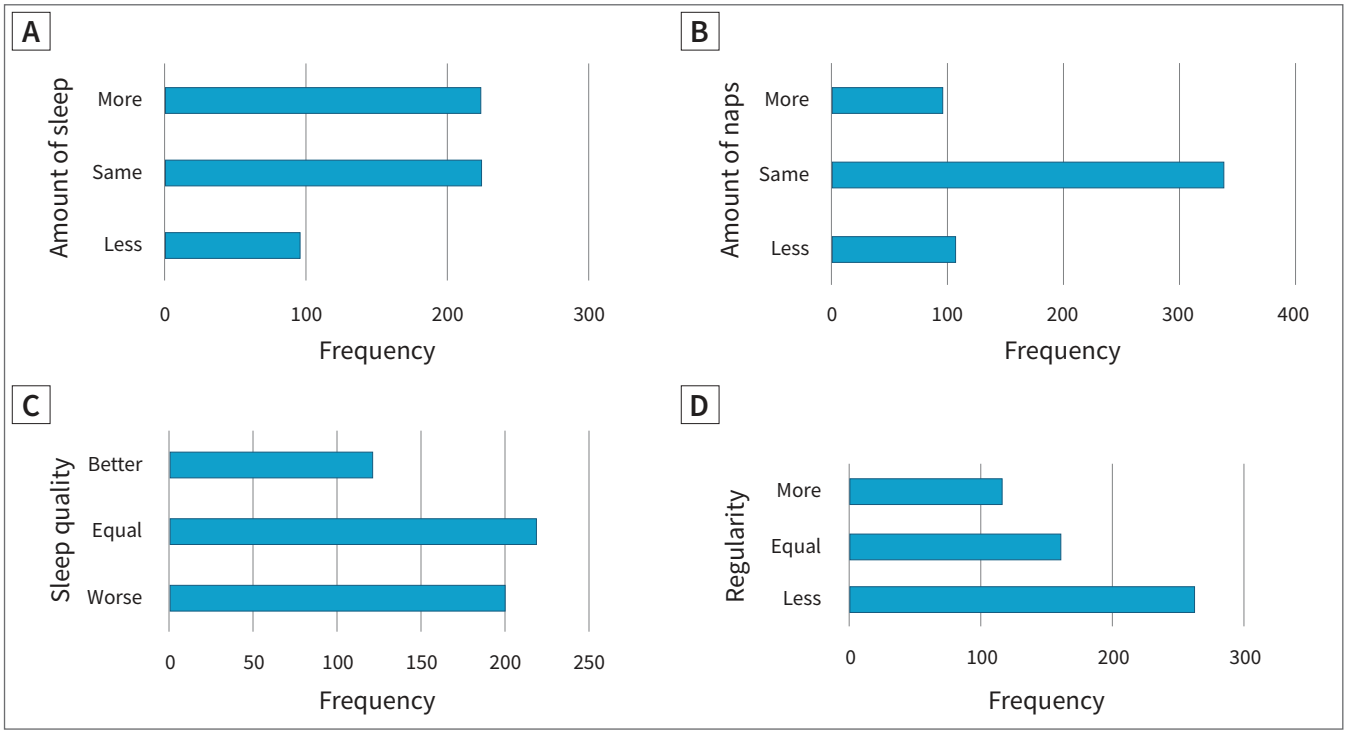

Figure 1: Self-reported changes in the amount of sleep at night, quality of sleep, sleep regularity and the number of daily naps during the COVID-19 pandemic compared to the period before.
Top: Self-reported changes in the amount of sleep (A) and amount of naps during a day (B); bottom: self-reported changes in quality of sleep (C) and regularity, i.e., changes in sleep-wake patterns (D). Absolute frequencies of answers are presented.

3.2 The relation between sleep hygiene and sleep quality

We aimed to explore the relationship between sleep hygiene and sleep quality among university students during the pandemic. Because sleep quality can also be influenced by demographic factors, the presence or absence of physical illness or mental disorder, and overall mental health, we incorporated these variables into our regression model (refer to Table 3). Table 2 presents the descriptive statistics (means and standard deviations) and the correlations among the variables incorporated in the regression model.

To assess the predictive value of sleep hygiene on sleep quality, accounting for control variables, we conducted a hierarchical linear regression using the enter method. In the initial step, we incorporated demographic variables, namely gender and age. Subsequently, variables indicating the presence or absence of physical, mental, or sleep disorders were added in the second step, followed by the introduction of mental health measures from the DASS-21 questionnaire (encompassing depression, anxiety, and stress) in the third step. Finally, sleep hygiene was introduced in the fourth and last step. The outcomes are delineated in Table 3.

The regression analysis results showed that gender and age were not significantly related to sleep quality. Additionally, the model was not significant. The variables added in step two explained a significant (8%) proportion of variance. The presence of a mental or sleep disorder was significantly related to sleep quality, whereas physical illness did not affect sleep quality. Mental health indicators (depression, anxiety, and stress) were added in step three and explained an additional 22% of the variance. All three variables included in step three were significant predictors of sleep quality. Lastly, including sleep hygiene in the model resulted in a significant model, which explained an additional 6%. The final model explained 37% of the variance in sleep quality.

4 Discussion

During the COVID-19 pandemic, our cross-sectional study sought to analyse the sleep patterns of university students in Slovenia and address sleep hygiene's role in predicting sleep quality in this public health crisis.

Table 2: Descriptive statistics and correlations between study variables.

	N	*M*	*SD*	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Gender[a]	540	0.80	0.40	-								
2. Age	541	22.08	2.10	.012	-							
3. Physical illness[b]	541	0.08	0.26	.055	-.007	-						
4. Mental disorder[b]	541	0.06	0.24	.049	.023	.041	-					
5. Sleep disorder[b]	541	0.01	0.10	.000	-.031	-.028	.214**	-				
6. Depression	541	6.21	4.89	.013	-.029	.014	.162**	.118**	-			
7. Anxiety	541	3.93	3.79	.097*	-.055	.044	.172**	.104*	.621**	-		
8. Stress	541	8.13	5.10	.142**	-.011	.026	.170**	.119**	.714**	.725**	-	
9. Sleep hygiene	541	31.22	6.67	.010	-.042	.059	.162**	.055	.476**	.441**	.495**	-
10. Sleep quality	541	5.12	3.26	.058	-.016	.047	.210**	.222**	.448**	.448**	.489**	.489**

Legend: [a] Gender: male = 0, female = 1 (other answers (n = 1) were excluded from further analysis); [b] Diagnosis: 0 = no, 1 = yes. *M* and *SD* represent mean and standard deviation, respectively.
* $p < .05$
** $p < .01$.

Our findings revealed that a majority of students either increased their sleep duration or maintained it during the first pandemic wave. Notably, on average, individuals who reported either an increase or no change in their sleep length slept over the seven-hour nightly recommendation for young adults' optimum health (37). Surprisingly, other global research (e.g., 15,21,38,39) also noted a similar unexpected increase in sleep duration after the pandemic onset. These patterns suggest that global COVID-19 strategies unintentionally provided an environment conducive to more sleep, addressing the typical sleep deprivation seen among university students. The observed extended sleep could be linked to earlier studies, which show that university students often face significant sleep deprivation (e.g., 23,24). This observation aligns with the young adults' reduced sleep durations in the past years (40). However, this hypothesis requires more research for validation.

Despite observing a positive increase in sleep duration, the COVID-19 pandemic appears to have significantly influenced students' sleep patterns and overall sleep quality. In our study, almost half of the participants reported less regular sleeping schedules during the pandemic, which could potentially be attributed to a lack of structured daily routines because of social isolation (e.g., 13), increased indoor activities with decreased outdoor activities, extended screen usage (13,15,41) and limited exposure to natural daylight (15) – factors which can negatively impact the circadian rhythm. Changes in living situations, such as staying with parents during the lockdown (most of the respondents cohabitated with their parents at the time of the study), could also have altered university students' sleep habits.

Interestingly, over one-third of the students reported a decrease in subjective sleep quality, which aligns with prior studies suggesting COVID-19 as a potential risk factor for reduced sleep quality and emerging sleep disorders (e.g., 2,6,11,15,19,41). Historically, sleep quality has been known to be impacted during major crises (42), such as the SARS outbreak in 2003 (43), the Persian Gulf War (44), and post-natural disasters (45). Hence, the increased sleep duration we noted does not negate the possibility of more students facing sleep disturbances.

As self-reported poor sleep quality and disruptions in circadian rhythm, rather than just reduced sleep duration, have been linked to several health risks (46), including a weakened immune response that could heighten the susceptibility to infections and reduce vaccine efficacy (e.g., 47), we were further interested in

Table 3: Multiple regression analysis predicting sleep quality.

	Model 1		Model 2		Model 3		Model 4	
	B	β	B	β	B	β	B	β
Step 1								
Gender[a]	0.473	.058	0.386	.047	0.012	.001	0.123	.015
Age	-0.027	-.017	-0.025	-.016	0.001	.001	0.013	.009
R^2		.004						
Step 2								
Physical illness[b]			0.514	.042	0.394	.032	0.233	.019
Mental disorder[b]			2.335	.172**	1.231	.091*	0.990	.073*
Sleep disorder[b]			6.297	.185**	4.802	.141**	5.059	.149**
ΔR^2				.079				
Step 3								
Depression					0.102	.154*	0.060	.034
Anxiety					0.128	.149*	0.099	.045*
Stress					0.152	.237**	0.101	.038*
ΔR^2						.221		
Step 4								
Sleep hygiene							0.146	.298**
ΔR^2								.063
R^2	.004		.083**		.304**		.367**	
F for change in R^2	0.978		15.429**		56.231**		52.485**	

Legend: [a] Gender: male = 0, female = 1 (other answers (n = 1) were excluded from further analysis); [b] Diagnosis: 0 = no, 1 = yes. B = Unstandardized Coefficients; β = Standardized coefficients.
* $p < .05$
** $p < .01$.

the role of healthy sleep habits in predicting sleep quality. Our regression analysis indicates that, even after accounting for various potential influencers on sleep (like demographics, health conditions, and mental health status), sleep hygiene remains a strong predictor of perceived sleep quality among university students. Besides that, mental health (diagnosis of mental disorder and stress, anxiety, and depression symptoms) and sleep disturbances diagnosis also predict sleep quality, aligning with past research findings (e.g., 48,49).

Consistent with previous research, our study strengthens the notion that sleep hygiene is strongly associated with sleep quality (50,51). These findings are further supported by an Italian study that investigated the impact of the pandemic on sleep and mental health in young adults, revealing a significant association between insomnia severity and poor sleep hygiene practices, as well as dysfunctional beliefs about sleep, self-reported mental disorders, anxiety, and depression, among a large sample of 1989 participants (52). In recent literature, a comprehensive meta-analysis highlighted the efficacy of sleep hygiene recommendations in ameliorating sleep disturbances in patients diagnosed with insomnia. Significant improvements were noted from pre-treatment to post-treatment evaluations. However, in comparison to cognitive behavioural therapy for insomnia (CBT-I) and mindfulness-based therapy, sleep hygiene was found to be

slightly less effective (53). Lin and Chung's study in 2022 (54) further postulated that sleep hygiene could potentially serve as a foundational mechanism elucidating the disparities in sleep quality among individuals differentiated by trait self-control and chronotype. Consequently, fostering adaptive sleep hygiene practices might bolster the capacity of individuals to establish and maintain efficient, regular sleep patterns. A recent longitudinal study by Zagaria et al. (32) reinforced this premise by revealing a strong correlation between suboptimal sleep hygiene during the COVID-19 pandemic and an accentuated escalation in sleep disturbances, even after adjusting for potential confounders including demographics, pandemic-specific information, and psychological stressors. Furthermore, it is imperative to acknowledge that sleep hygiene education is currently the most common practice among non-pharmacological interventions for sleep disturbances (55,56).

Given its cost-effectiveness and accessibility, sleep hygiene represents a promising strategy to pre-emptively address and potentially mitigate sleep disruptions, even amidst public health crises like the COVID-19 pandemic. In addition to being easy to apply, readily available, and relatively inexpensive, sleep hygiene interventions/education can also be widely disseminated to individuals not likely to seek medical treatment for their sleep problems, as it does not require the direct involvement of a clinician. Thus, it could serve as a first-line intervention in a stepped-care model for those who want to improve their sleep (57).

To enhance sleep quality among students in Slovenia, universities could implement sleep hygiene education through (mandatory) workshops, online modules, and integration into orientation programs. By providing practical tips on consistent sleep schedules, creating a restful environment, and managing screen time, students could adopt healthier sleep habits. This step could ensure that all students have access to essential information, setting the stage for more intensive interventions if needed. Additionally, fostering open discussions about sleep and encouraging proactive sleep health could help universities create a supportive environment that prioritizes student well-being. Collaborations with health services and student organizations could lead to comprehensive sleep hygiene campaigns, including educational materials, guest lectures, and peer support groups. Such an approach could help normalize the conversation about sleep health, making it a fundamental part of student life and well-being. The stepped-care model has been shown to be especially efficient in young adults (58).

To sum up, our study sheds light on student sleep patterns during the initial wave of COVID-19 in Slovenia, emphasizing the potential role of sleep hygiene in managing sleep quality amidst this public health crisis. It is also the first study exploring Slovenian students' sleep on a larger sample of participants from different Slovenian universities.

However, we acknowledge several limitations in our study. The cross-sectional design of our study prevents us from establishing causal relationships between variables. More longitudinal studies are essential to gain a deeper understanding of the dynamics of sleep related to the pandemic and to evaluate the long-term and residual effects of this health crisis on sleep. Furthermore, our study focused exclusively on university students, which limits the generalizability of our findings to a broader population. Additionally, our sample was not representative; our survey, conducted on a voluntary basis, resulted in 80 % female and 20 % male respondents. This gender imbalance further restricts the applicability of our findings to a broader (student) population in Slovenia. While we did not aim for a representative sample, the insights gained still highlight relevant trends in university student sleep patterns during the COVID-19 pandemic. Our study also relied on online self-reported surveys without incorporating clinical or instrumental assessments, which could have offered more objective insights. Despite these limitations, our findings provide valuable initial insights and underscore the need for further study. Our results align with other pandemic studies, suggesting sleep hygiene might be a crucial intervention to boost sleep quality during and post-pandemic.

5 Conclusions

Our study illuminated the evolving sleep patterns of Slovenian university students during the COVID-19 pandemic's initial wave, underscoring an unexpected increase in sleep duration amidst an overall decline in sleep quality. These findings resonate with global patterns, suggesting that pandemic-related strategies inadvertently fostered conditions favourable for extended sleep. Despite this, a significant proportion experienced reduced sleep quality, aligning with previous findings about sleep disturbances during major crises. Sleep hygiene emerged as a robust predictor of perceived sleep quality, emphasizing its potential as a preventive measure. Future longitudinal research must delve deeper into these findings and explore the

broader implications of sleep hygiene interventions during public health emergencies and beyond.

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Conflict of interest

Ours is not an industry-supported study. None of the authors have potential conflicts of interest to be disclosed. All the authors have seen and approved the manuscript. Parts of this work were published in the Master thesis of one of the authors (Vesna Vrečko Pizzulin) at the University of Maribor.

Author contributions

All authors developed the study concept, contributed to the study design, data collection, and data analysis, interpreted the data, drafted the manuscript, and approved the final version.

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