

The Impact of Electronic Devices and Distance Learning on Sleep Quality among Medical Science Students during the COVID-19 Pandemic in Indonesia

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ABSTRACT

Background: The COVID-19 pandemic has forced many universities to implement online learning. While this shift has brought positive aspects, excessive gadget and social networking use has led to poor sleep quality among healthcare students. This study aims to analyze the impact of electronic devices and high-intensity social media usage on the sleep quality of multidisciplinary healthcare students during the pandemic. **Methods:** This cross-sectional study used online surveys to assess the impact of electronic devices and distance learning on sleep quality. Inclusion criteria involved healthcare students enrolled at the university, while exclusion criteria involved students with certain preexisting medical conditions or habits. The study utilized validated instruments to measure relevant data and descriptive and bivariate statistical analyses were used to analyze the data. **Results:** The results showed that most students used electronic devices for more than 6 hours, with most using smartphones and laptops. Only 40.3% of students used blue light filters, and poor sleep quality was reported by 63.3% of students. There was a significant relationship between poor sleep quality and device usage exceeding 2 gadgets, but no significant relationship between sleep quality and high-intensity social media use or device usage exceeding 6 hours. **Conclusion:** Excessive electronic device usage and increased social media usage were identified as contributing factors to impaired sleep quality among multidisciplinary healthcare students who underwent online learning during the COVID pandemic. These findings highlight the need for interventions and policies to promote healthy device usage and sleep habits among students during distance learning.

Keywords: blue light filters; COVID-19; electronic; sleep quality; smartphones; laptops

INTRODUCTION

Since the outbreak of Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV2), Indonesia has experienced significant impacts in various fields, including health, economy, education, and society. To reduce the number of Coronavirus Disease 2019 (COVID-19) cases, the government has advised limiting physical contact and social activities. In response, the education sector has adapted by implementing health protocols, such as the use of telemedicine as a means of learning.(1)

The pandemic-induced shift to online learning has brought about both positive and negative impacts. On one hand, it has provided learners with greater flexibility in terms of timing and location, simpler learning tools, lower costs, and reduced risk of COVID-19 transmission.(2)

On the other hand, it has also raised concerns about excessive gadgets and social networking use, resulting in poor sleep quality among a significant proportion of students.(3)

According to previous research conducted in Indonesia prior to the COVID-19 pandemic, medical students had a prevalence rate of sleep disorders of approximately 46%, with reported inadequate sleeping time.(4,5) The use of computers and smartphones for entertainment, communication, and internet browsing at night, particularly before sleep, can lead to longer sleep onset times and worsen insomnia symptoms.(6) Emens et al., hypothesized that the impaired quality of sleep is likely due to exposure to light inhibiting the release of melatonin hormone in the pineal gland, which is responsible for regulating the sleep-wake cycle.(7)

The impaired sleep quality experienced by students can have profound impacts on their current and future well-being. These impacts can be categorized into three main areas, impaired academic performance, negative psychological outcomes, and increased risk of chronic diseases.(8–10)

The prolonged use of electronic devices exceeding 6 hours, the use of multiple electronic media, the absence of blue light filters, and the high-intensity usage of social media have been found to have a negative impact on the quality of sleep among students.(11,12) Considering the above-mentioned external factors and their potential impact on sleep quality, it is essential to focus on improving the educational performance and overall well-being of students, especially during this time and in the future. This study aims to analyze the aforementioned factors and their effect on sleep quality among multidisciplinary healthcare students undergoing distance learning during the COVID pandemic.

METHODS

This study utilized an analytical observational design and cross-sectional study design for assessing the effect of electronic devices and distance learning on sleep quality. By using online surveys, the study author obtained relevant information from students attending Udayana University. The university on which the study is based offers an Interprofessional Healthcare Program that includes six study programs: clinical medicine, nursing, dentistry, physiotherapy, public health, and psychology. The program aims to provide a collaborative learning environment for students from different healthcare professions, with the goal of improving patient outcomes through enhanced teamwork and communication among healthcare providers. At Udayana University Faculty of Medicine, the learning process has also been required to adapt in response to the COVID-19 pandemic. To comply with health guidelines, traditional face-to-face classes have been replaced with a network-based system. The university has provided facilities, such as the Online Academic Service for E-learning (OASE), as well as other social networking platforms, to support virtual education. These platforms facilitate virtual face-to-face education, small group discussions, lectures, student projects, and exams. Students are expected to use electronic devices to engage in distance medical education. Relevant information regarding electronic device usage and sleep quality was measured using a customized survey item and the translated version of the Social Networking Time Use Scale (SONTUS) and The Pittsburgh Sleep Quality Index (PSQI).(13,14) The SONTUS and PSQI are both validated instruments that provide reliable and relevant data for our study, making them ideal for our research purposes. The survey was distributed using Google Form™ via social media, WhatsApp, and email in May 2021. Informed consent for participating in this study was obtained through an online survey.

The inclusion criteria for our study is multidisciplinary healthcare students enrolled in Udayana University.

Using purposive sampling, we aim to collect the data from all multidisciplinary healthcare students enrolled in the university. Students who met the following criteria will be excluded from this study, students who have been previously diagnosed with depression, and anxiety, with antidepressant or antipsychotic medication prescription by a psychiatrist, students with a smoking habit with more than 10 cigarettes per day, alcohol consumption of more than 3 glasses per day, and consuming excessive caffeinated products, patients who refused to participate or unable to sign the inform consent.

Descriptive statistical analysis was performed to characterize the study participants demographic. The data were tested for normality using the Kolmogorov-Smirnov test, as the number of respondents exceeded 50. A p-value less than 0.05 is considered statistically significant.

In this study, we used a nominal scale to categorize the duration of electronic device usage such as smartphones, laptops, and tablets for distance learning. The variable for the number of gadgets used is defined as the active usage of gadgets or electronic devices. Data is collected through a survey and is categorized as either more than 2 or less than 2. Blue light filter usage refers to respondents who activate the blue light filter mode on their electronic devices. All variables are measured on a nominal scale, with "yes" indicating the use of electronic devices for more than 6 hours, active use of more than 2 devices, and blue light filter, and "no" indicating otherwise. Using the SONTUS questionnaire, we categorized a score higher than 14 as high-intensity social networking media usage.

Bivariate statistical analysis was used to determine differences in sleep quality scores based on several characteristics, including duration of gadget usage for distance learning for more than 6 hours, usage of more than 2 gadgets, blue light filter usage, and high intensity of social networking usage. The bivariate analysis employed Chi-squared and Fisher's statistical tests to compare independent variables with two different categories. The statistical test used was logistic regression. The entire data analysis process was facilitated by the statistical software The Statistical Package for the Social Sciences version 20 (SPSS V20).

RESULTS

In this study, all 619 students enrolled in the multidisciplinary healthcare program at Udayana University were given the link for participating in the survey. Of these, 573 students returned their questionnaires, resulting in a response rate of 92.5%. The study analyzed the basic characteristics of the research subjects, including their age, gender, and program of study using descriptive analysis. Table 1 presents the demographic characteristics of the research subjects, revealing a predominance of female respondents at a ratio of 3:1 to male study participants. The median age of the students was 20 years.

The normality test using the Kolmogorov-Smirnov formula showed a p-value of <0.05, indicating a non-normal age distribution. Six programs were included in the study, with the highest proportion of students

being from clinical medicine (39.4%), public health (22.6%), nursing (9.8%), physiotherapy (11.5%), pharmacology (9.6%), and dentistry department (7.4%).

TABLE 1: Demographic characteristics.

Item	N (% , p-value)
Gender	
Male	134 (25.6%)
Female	389 (74.4%)
Age group	
18-20 years old	405 (77.5%)
21-23 years old	118 (22.5%)
Department	
Clinical medicine	206 (39.4%)
Nursing	118 (22.6%)
Dentistry	51 (9.8%)
Physiotherapy	60 (11.5%)
Public health	38 (7.3%)
Psychology	50 (9.6%)
Electronic device usage habit	
Usage duration <6h	10 (1.9%)
Usage duration >6h	513 (98.1%)
Number of gadgets ≤2	438 (83.7%)
Number of gadgets >2	85 (16.3%)
Blue light filter - yes	211 (40.3%)
Blue light filter - no	312 (59.7%)
Social media use - low	10 (1.9%)
Social media use - high	513 (98.1%)

Table 1 describes the pattern of device usage duration > 6 hours among multidisciplinary healthcare students. Of the 513 students who used electronic devices for more than 6 hours, 98.1% spent a significant amount of time browsing the internet. The majority of students used ≤ 2 gadgets, with the most common combination of smartphones and laptops. The number of students using more than 2 gadgets was 85 (16.3%). The study also looked at the use of blue light filters on gadgets, with only 40.3% of respondents using filters. Interestingly, the pattern of blue light filter usage was lower among students who used multiple gadgets, and the use of filters on gadgets other than mobile phones was not investigated.

We can observe a high-intensity pattern of social media use among multidisciplinary healthcare students as measured by the SONTUS questionnaire. The results show that almost all students (98.1%) use social media extensively. The SONTUS questionnaire comprises five components measuring social media use, namely: (1) during relaxation and leisure time, (2) during academic periods, (3) during public space usage, (4) periods of stress, and (5) motivation for usage.

Table 2 displays the sleep quality characteristics of multidisciplinary healthcare students measured using the PQSI survey. The majority of multidisciplinary healthcare students (63.3%) have poor sleep quality, with a ratio of students with good sleep quality to impaired sleep quality of 1:1.72.

TABLE 2: Gadget use and sleep quality.

Electronic device usage habit	Sleep quality n (%)		P-value (<0.05)
	Poor	Good	
Usage duration <6h	6 (60)	4 (40)	0.533
Usage duration >6h	325 (63.8)	188 (36.6)	
Number of gadgets ≤2	285 (65.1)	153 (34.9)	0.037
Number of gadgets >2	46 (54.1)	39 (45)	
Blue light filter - yes	128 (60.7)	83 (39.3)	0.176
Blue light filter - no	203 (65.1)	109 (34.9)	
Social media use - low	7 (70)	3 (30)	0.467
Social media use - high	324 (63.2)	189 (36.8)	

Table 2 analyzes the sleep quality scores of multidisciplinary healthcare students in relation to gadget use. The distribution of data for device usage exceeding 6 hours was found to be abnormal ($p < 0.001$) and was normalized using the \log^{10} function. Since there were fewer than 5 non-users of devices in a column, Fisher's formula could not be used for bivariate analysis. The significance level was set at $p < 0.05$, and the analysis showed a non-significant relationship between poor sleep quality and device usage exceeding 6 hours. 325 multidisciplinary healthcare students (63.4%) who experienced sleep disturbances had device usage exceeding 6 hours.

The chi-squared formula was used to analyze the difference in sleep quality based on the number of electronic device usage exceeding 2, with a significance level set at $p < 0.05$. The analysis showed a significant relationship between poor sleep quality and device usage exceeding 2 gadgets, with 54.1% of multidisciplinary healthcare students experiencing sleep disturbances due to device usage exceeding 2 gadgets.

The study found no significant relationship between sleep quality and high-intensity social media use. Furthermore, both users and non-users of blue light filters have poor sleep quality among multidisciplinary healthcare students.

DISCUSSION

During the Covid-19 pandemic, there has been a transformation in the learning system, resulting in an increase in the use of electronic devices for educational, entertainment, informational, and communication purposes.(15) In our study, we have observed a significant increase in the use of electronic devices and the number of gadgets used per day that emit light among multidisciplinary healthcare students, such as personal computers, smartphones, laptops, and tablets, for more than 6 hours. This trend is consistent with the findings of other studies, including Ayran et al., which reported that a majority of students use electronic devices to access the internet for more than 6 hours per day, including before going to bed.(16)

Prolonged use of electronic devices is associated with impaired sleep quality. The level of the hormone melatonin circulating in the body underlies the phenomenon at hand. The pineal gland secretes melatonin to regulate the sleep-wake circadian cycle. Even low-intensity light of 200-300 lux can suppress melatonin secretion. Smartphones emit light with the same spectrum as blue light, which falls between 400-460nm and can be almost entirely absorbed by melanopsin in the retina, effectively transmitting almost all impulses. In young people, the retina's function is still optimal, enabling cone and rod receptors to function maximally. Low-intensity light exposure to blue light can increase melatonin suppression at night after a 2-hour exposure.(17) Lavender et al.'s research revealed that respondents who used electronic devices that emit light, such as television, laptops, computers, and smartphones,

interacted with more than one device at a time, prolonging light exposure and causing distractions when trying to sleep.(18) This finding is in line with Hysing et al., research on the teenage population in Norway, which found that the more gadgets used during sleep time and the more multitasking occurred among teenagers, resulting in longer sleep onset and shorter sleep duration compared to those who used only one gadget.(19) The purpose of gadget use is not solely to fill leisure time on social media, and in our case, electronic devices are used for distance learning.(20)

Based on our survey, the global PSQI score indicates that the majority of students, at 54.3%, have poor sleep quality. The component of PSQI that plays the most significant role in the high total PSQI score is the low duration of sleep among students, which is less than six hours per day, or 39%. Even prior to COVID, these findings are consistent with the research conducted by Agustini et al. and Aryadi et al., which showed that students tend to have poor sleep quality due to inadequate sleep hours.(23, 24) We did not conduct prior research to evaluate the baseline of electronic device usage and sleep quality prior to the pandemic for comparison purpose, but we expect that the overall usage of electronic device has risen during COVID, when most teachings shifted to online platforms and social media exposure increased. Kolhar et al. stated that social media use among students could delay their sleep time and reduce their sleep duration. (20) This phenomenon can be explained by a hypothesized theory that exposure to light from electronic devices inhibits melatonin production, preventing it from reaching its peak level at night. (25)

Philips et al. investigated the correlation between sleep patterns and academic performance among students, the study concluded that students with irregular sleep patterns tend to have lower academic grades. (26) This finding is particularly important as some students may be at risk of experiencing a decline in their academic performance during the ongoing pandemic.

As for the limitations of our study, there are several points to consider. Firstly, due to the circumstances and social distancing policies, we were unable to conduct an interviewer-administered survey and had to rely solely on a self-administered survey. Therefore, we could only rely on the information provided by the respondents without being able to confirm the truthfulness or validity of their answers. Nonetheless, since the survey questions did not contain sensitive information, we believe that the respondents provided their answers as accurately as possible. Secondly, there were other potential confounding factors that could affect sleep quality, such as COVID-related depression, anxiety, and other psychological disorders. We initially included survey questions to assess these issues, but we decided not to include them in our study as evaluating psychological disorders such as depression and anxiety would require a more rigorous assessment. Despite this limitation, we believe that our study and

large sample size provides valuable insights into the relationship between external factors and sleep quality during the pandemic.

Our study further establishes that there is a significant association between excessive electronic device usage and impaired sleep quality among multidisciplinary healthcare students who underwent online learning during the COVID pandemic. External factors such as prolonged use of electronic devices for more than 6 hours and increased social media usage were identified as contributing factors to this difference.

CONCLUSION

Excessive electronic device usage and increased social media usage were identified as contributing factors to impaired sleep quality among multidisciplinary healthcare students who underwent online learning during the COVID pandemic. These findings highlight the need for interventions and policies to promote healthy device usage and sleep habits among students during distance learning.

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