

Impact of Remote Teaching on Japanese Medical University Students' Sleeping Habits : a Longitudinal Study

Reiko Hori (✉ rhor@aichi-med-u.ac.jp)

Aichi Medical University School of Medicine

Eiji Shibata

Yokkaichi Nursing and Medical Care University

Iwao Okajima

Aichi Medical University School of Medicine

Masahiro Matsunaga

Aichi Medical University School of Medicine

Tomohiro Umemura

Aichi Medical University School of Medicine

Akihiko Narisada

Aichi Medical University School of Medicine

Kohta Suzuki

Aichi Medical University School of Medicine

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Abstract

Background: The coronavirus disease 2019 (COVID-19) pandemic has changed our daily life. Owing to the imposed restrictions, many educational facilities have introduced remote teaching. This study aims to understand the impact of remote teaching on Japanese university students' sleeping habits.

Methods: The participants were medical university students. We used data from an ongoing longitudinal sleeping habits survey. For 684 participants who enrolled in the university during 2018–2020, multilevel analyses of sleep duration during weekdays and weekends across 3 years were conducted, adjusting for gender, grade, place of stay, sleep problems and lifestyle habits.

Results: Among the participants, 356 male (mean \pm standard deviation: 22 ± 3 , 18–37 years old) and 288 female (22 ± 3 , 18–32 years old) students in 2018, 365 male (24 ± 3 , 18–36 years old) and 284 female (22 ± 2 , 18–33 years old) students in 2019, and 226 male (20 ± 3 , 18–36 years old) and 167 female (21 ± 2 , 18–34 years old) students in 2020 answered the questionnaire. The mean sleep duration during weekdays (in minutes) was 407.6 ± 60.3 in 2018, 406.9 ± 63.0 in 2019, and 417.3 ± 80.9 in 2020. The mean sleep duration during weekends (in minutes) was 494.5 ± 82.5 in 2018, 488.3 ± 87.9 in 2019, and 462.3 ± 96.4 in 2020. The analysis showed that sleep duration during weekdays was associated with the place of stay and survey year. Moreover, students reported significantly longer sleep duration during weekdays in 2020 than 2019, but no significant difference in sleep duration between 2018 and 2019. Sleep duration during weekends was found to be associated with the survey year, gender and always doing something before going to bed. Sleep duration during weekends was shorter in 2020 than 2019 and longer in male students and students who always do something before going to bed. Ten students were reported to have a delayed sleep phase in 2020.

Conclusions: Students' sleep duration increased during weekdays and decreased during weekends in 2020. This difference could be explained by the COVID-19 pandemic and the introduction of remote teaching.

Background

The coronavirus disease 2019 (COVID-19) pandemic has affected various aspects of our daily life. In Japan, the so-called "urban lockdown" with a penalty was not imposed; however, certain directives, such as avoiding unnecessary outings and working remotely from home, were encouraged [1]. Students were also requested to avoid going to school and engage in self-directed learning at first, with a subsequent transition to remote classes or practical assignments in a step-by-step manner.

Sleeping habits, including sleep duration, sleep loss, and sleep quality are known to be related to students' academic achievement [2-5], psychological health [6-8], physical health [7, 9, 10], and health-related quality of life [11]. Using the Pittsburgh Sleep Quality Index, a recent meta-analysis [12] reported that the pooled prevalence of poor sleep quality was 52.7% among medical students. However, to our knowledge, there has been no report regarding sleeping habits in Japanese medical students. We have

met young people with school absenteeism and some sleep-wake problems in clinical practice and at a university site. Therefore, we conducted a pilot study on sleeping habits for our university students anonymously. It showed some differences in sleep duration based on gender, grade, and living place, and some students had various sleep-wake problems [13]. We have been conducting an annual survey to collect data on university students' sleeping habits since 2018 to understand their everyday lives further and analyze their current sleep patterns.

Some reports [14-17] on sleeping habits during the COVID-19 pandemic have been published. A worldwide internet-based Global Chrono Corona Survey that queried sleep-wake times before and during COVID-19 social restriction reported that the individual sleep duration during weekdays increased and sleep duration during work-free days decreased [14]. Moreover, it reported the individual mid-point of sleep delayed in social restriction. However, not all participants answered at these two time points of the survey—that is, before and during the COVID-19 pandemic. Another online survey on sleep, conducted among the general public in Switzerland, Austria, and Germany, showed that the difference between mid-sleep on free days and workdays and the difference in sleep duration between free days and workdays were reduced. Further, sleep duration was increased during the lockdown [15]. A study on sleep in 139 university students in the U.S., taking the same classes remotely during the stay-at-home phase of the pandemic, reported an increase in the average sleep duration for both weekdays and weekends during the stay-at-home phase compared to before the pandemic [16]. An observational study on 207 nursing students in Spain, monitored in February and April 2020, showed that they spent more time in bed [17]. Although these studies differ in terms of the surveillance, participants, countries, and measurement methods, they were conducted in countries with strict lockdowns and compared data across few months. Contrarily, in Japan, the state of emergency for COVID-19 was declared on April 7 and lifted on May 25; subsequently, the regulations were eased in stages. However, the general public was directed to work or study remotely in July 2020, and since then, many universities have been conducting remote lectures in conformity with the request. Given this context, we assessed the students' sleep duration and phase during weekdays and weekends from 2018 to 2020. This study aims to determine whether medical students' sleeping habits have changed during the COVID-19 pandemic.

Methods

Participants

The study participants were all medical students at a medical university in Japan. In 2018 and 2019, a beneficial sleeping habits survey questionnaire was distributed to each participant and collected during their annual physical examination in April. The physical examination was conducted based on the School Health and Safety Act in Japan [18]. The participants were informed of this study's purpose and methods, and were asked to consent to participation by ticking a box in the survey. The consent of the participants who missed ticking the box in the questionnaire was confirmed later by email. In 2020, the survey was conducted online in July because the students could not visit the university campus amid the COVID-19 pandemic.

Usually, the students from the first to the fourth year attend around five or six classes a day, starting at 8:50 in the morning. Conversely, the fifth- and sixth-year students participate in clinical practice in the university hospital or community-based hospitals from the morning as per each hospital's schedule. In July 2020, a quarter of the students in the first grade went to school in rotation, and the remaining first-year students and the second- and third-year students were instructed to take remote classes. The students reported living at their homes or their parents' homes. The schedule for the remote classes was the same as usual. As the fifth- and sixth-year students could not go to community-based hospitals, they attended clinical practice at the university hospital, thereby reducing the time and sharing the opportunity.

Measures

A few second-year students created the questionnaire used in this study as part of a practical assignment for their curriculum in 2016—it was adapted from a questionnaire developed by Shirakawa [19]. The questions were designed to collect information about sleeping habits and living situations, including the following: the hours at which one goes to bed and wakes up during weekdays and weekends; the time spent lying awake in bed before falling asleep and after waking up; how comfortable one feels with the sleep duration; frequency of naps; a self-assessment of one's sleeping depth; one's ease in waking up from bed; what one does before going to bed; the time spent watching TV or using a mobile phone; how one gets up; how often one wakes up early in the morning; arousal frequency during sleep; frequency of going to the bathroom during sleep time; whether there is a need to use hypnotics or minor tranquilizers for sleeping; how frequently sleep paralysis occurs; how frequently one dreams, snores, experiences sleep apnea; whether one performs any extracurricular activity, has a part-time job; whether one lives alone or with family; and whether one smokes or drinks. The Aichi Medical University Hospital Ethics Board approved this study's design (approval number: 2018-M005, 2020-M015).

Statistical Analysis

Data were analyzed for 644 students in 2018, 649 students in 2019, and 392 students in 2020. Among them, 199 observations for weekdays and 181 for weekends, were treated as missing data. They were as follows: (A) the bedtime or wake-up time was absent (12 observations for weekdays and 21 for weekends in 2018; 12 observations for weekdays and 18 for weekends in 2019), (B) the sleep duration was less than 240 minutes (7 observations for weekdays and 6 for weekends in 2018; 5 observations for weekdays and 4 for weekends in 2019; 6 observations for weekdays and 4 for weekends in 2020), or (C) it was more than 900 minutes, and their bedtime and wakeup time were (C-1) between 6:00 to 10:00 and 23:00 to 4:00 (30 observations for weekdays and 16 for weekends in 2018; 45 observations for weekdays and 26 for weekends in 2019; 2 observations for weekdays and 2 for weekends in 2020), (C-2) between 10:00 to 15:00 and 5:00 to 12:00 (2 observations for weekends in 2018; 66 observations for weekdays and 39 for weekends in 2019; 9 observations for weekdays and 9 for weekends in 2020), (C-3) between 22:00 to 4:00 and 18:00 to 0:00 (1 observation for weekdays and 23 for weekends in 2018; 2 observations for weekdays and 18 for weekends in 2019; 1 observation for weekdays in 2020), or other three data (between 8:30 and 8:15 on weekdays in 2020, between 22:00 and 14:00 on weekends in 2019,

and between 7:45 and 6:45 on weekends in 2020), respectively. These data were considered bedtime and wake-up time transposed, mixed up 12-hour and 24-hour notations, or some sort of mistake. For the multilevel analyses, 684 participants were included, who enrolled in the university during 2018-2020. Among the responses collected, 173 observations for weekdays and 161 for weekends were treated as missing data. Such observations included the following: (A) the bedtime or wake-up time was absent (12 observations for weekdays and 21 for weekends in 2018; 6 observations for weekdays and 12 for weekends in 2019); (B) the sleep duration was less than 240 minutes (7 observations for weekdays and 6 for weekends in 2018; 3 observations for weekdays and 2 for weekends in 2019; 3 observations for weekdays and 3 for weekends in 2020); or (C) it was more than 900 minutes, and their bedtime and wakeup time were (C-1) between 6:00 to 10:00 and 23:00 to 4:00 (30 observations for weekdays and 16 for weekends in 2018; 40 observations for weekdays and 24 for weekends in 2019; 2 observations for weekdays and 2 for weekends in 2020); (C-2) between 10:00 to 15:00 and 5:00 to 12:00 (2 observations for weekends in 2018; 60 observations for weekdays and 29 for weekends in 2019; 8 observations for weekdays and 7 for weekends in 2020); or (C-3) between 22:00 to 4:00 and 18:00 to 0:00 (1 observation for weekdays and 23 for weekends in 2018; 1 observations for weekdays and 14 for weekends in 2019).

All analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA). The mean sleep duration during weekdays and weekends was compared using a paired t-test. Multilevel analyses were performed to determine whether there was any difference among each sleep duration data for weekdays and weekends across the 3 years, using the SAS PROC MIXED procedure. We did not exclude participants for whom bedtime or wake-up data were missing, as SAS PROC MIXED automatically handles missing data using restricted maximum likelihood.

We used the following model to explore the differences in the slopes for each interval of 3 years.

$$\text{Sleep duration}_{iy} = \beta_1 + \beta_2 \times \text{Gender}_i + \beta_3 \times \text{Grade}_{iy} + \beta_4 \times \text{Place of stay}_{iy} + \beta_5 \times \text{Smoking}_{iy} + \beta_6 \times \text{Drinking}_{iy} + \beta_7 \times \text{Extracurricular activities}_{iy} + \beta_8 \times \text{Part-time job}_{iy} + \beta_9 \times \text{Doing something always before going to bed}_{iy} + \beta_{10} \times \text{Taking any hypnotics or minor tranquilizer}_{iy} + \beta_{11} \times \text{Apnea}_{iy} + \beta_{12} \times \text{Arousal during sleep}_{iy} + e_{iy}$$

where i represents the individual, y represents year, β_1-12 represents parameters, and e is the error term.

The level of statistical significance was set at 5% ($p < 0.05$).

Results

Among the 707 participants in 2018, 356 male (22 ± 3 , 18–37 years old) and 288 female (22 ± 3 , 18–32 years old) students answered the questionnaire and had their data analyzed (response rate was 91.1%). Among 709 participants in 2019, 365 male (24 ± 3 , 18–36 years old) and 284 female (22 ± 2 , 18–33 years old) students responded (response rate was 91.5%) and had their data analyzed, except for one student who disagreed. Among 718 students in 2020, 226 male (20 ± 3 , 18–37 years old) and 167 female (21 ± 2 , 18–34 years old) students responded and had their data analyzed (response rate was 54.6%).

Table 1. Mean sleep duration during weekdays and weekends

Year		Mean sleep duration during weekdays (min.)	Mean sleep duration during weekends (min.)	P-value
2018	Total	407.6 ± 60.3	494.5 ± 82.6	<0.0001
	Men	413.4 ± 63.1	485.8 ± 83.4	<0.0001
	Women	400.1 ± 55.7	505.5 ± 80.1	<0.0001
2019	Total	406.9 ± 63.0	488.3 ± 87.9	<0.0001
	Men	408.7 ± 59.2	481.1 ± 85.3	<0.0001
	Women	404.6 ± 67.8	497.8 ± 90.7	<0.0001
2020	Total	417.3 ± 80.9	462.3 ± 96.4	<0.0001
	Men	418.8 ± 86.0	456.6 ± 102.7	<0.0001
	Women	415.2 ± 74.0	470.1 ± 87.0	<0.0001

The mean sleep duration (in minutes) during weekdays was 407.6 ± 60.3 in 2018, 406.9 ± 63.0 in 2019, and 417.3 ± 80.9 in 2020 (Table 1). Based on the explanatory variables regarding basal characteristics, behaviors, sleep-wake problems, the multilevel analysis of sleep duration during weekdays through the 3 years, whose model used 1184 data among 1536 data, revealed that sleep duration was related to the grade, place of stay, and survey year (Table 2). Moreover, sleep duration during weekdays in 2020 was significantly longer than in 2019, but there was no significant difference between 2018 and 2019. It was longer among those living alone than in those staying at their family home.

The mean sleep duration (in minutes) during weekends was 494.5 ± 82.6 in 2018, 488.3 ± 87.9 in 2019, and 462.3 ± 96.4 in 2020 (Table 1). The multilevel analysis of sleep duration during weekends through the 3 years, whose model used 1181 data among 1536 data, showed that sleep duration during weekends was related to gender, the grade, doing something always before going to bed and survey year (Table 3). Sleep duration during weekends in 2020 was shorter than in 2019, although there was no significant difference between 2018 and 2019. Additionally, sleep duration during weekends was shorter in male students than in female students, and longer among students who consistently do something before going to bed.

A total of 10 students went to sleep between 3:00 and 6:00 and got up after 9:00 during weekdays in 2020, compared to two in 2018 and three in 2019. Conversely, 35 students in 2018, 31 students in 2019, and 44 students in 2020 went to sleep between 3:00 and 6:00 and woke up after 9:00 only during weekends.

Table 2. Multilevel analysis of sleep duration during weekdays in 2018–2020

	Estimate	SE	95% confidence limits		P-value
			Lower	Upper	
Men	2.1	4.4	-6.6	10.7	0.64
Women	reference				
2018	-0.9	3.7	-8.1	6.3	0.80
2019	reference				
2020	18.4	5.0	8.6	28.2	0.0003
Family home	reference				
Lodgings	23.3	4.4	14.6	32.1	<.0001
First year	reference				
Second year	14.4	7.7	-0.7	29.4	0.06
Third year	11.6	8.0	-4.1	27.3	0.15
Fourth year	21.2	8.3	4.9	37.5	0.1
Fifth year	14.3	8.3	-2.0	30.5	0.08
Sixth year	20.2	8.3	4.0	36.4	0.01
Doing something always before going to bed					
Yes	-0.08	5.6	-11.3	11.1	0.98
no	reference				
Taking hypnotics or minor tranquilizer					
Yes	-10.9	12.6	-38.1	16.4	0.41
no	reference				
Sleep apnea					
Yes	1.6	5.0	-8.4	11.6	0.75

no	reference				
Arousal during sleep					
Yes	9.1	5.8	-2.5	20.7	0.12
no	reference				
Extracurricular activities					
Yes	-1.8	4.6	-10.8	7.3	0.70
No	reference				
Part-time job					
Yes	0	4.3	-8.6	8.5	0.99
No	reference				
Smoking					
Yes	10.2	11.7	-17.6	38.0	0.41
No	reference				
Drinking					
Yes	0.2	4.2	-8.1	8.5	0.97
No	reference				

Table 3. Multilevel analysis of sleep duration during weekends in 2018–2020

	Estimate	SE	95% confidence limits		P-value
			Lower	Upper	
Men	-24.4	6.4	-37.1	-11.8	0.0002
Women	reference				
2018	0.3	5.3	-10.1	10.8	0.95
2019	reference				
2020	-25.1	7.2	-39.2	-11.0	0.0005
Family home	reference				
Lodgings	5.0	6.4	-7.9	18.0	0.44
First year	reference				
Second year	24.2	11.3	2.0	46.4	0.03
Third year	26.8	11.8	3.6	50.0	0.02
Fourth year	24.7	12.3	0.7	48.8	0.04
Fifth year	3.9	12.3	-20.2	28.2	0.75
Sixth year	-0.8	12.2	-24.8	23.2	0.95
Doing something always before going to bed					
Yes	17.8	8.1	1.6	34.0	0.03
no	reference				
Taking hypnotics or minor tranquilizer					
Yes	-9.9	18.2	-49.5	29.7	0.60
no	reference				
Sleep apnea					
Yes	-3.5	7.3	-18.1	11.0	0.63

no	reference					
Arousal during sleep						
Yes	13.0	8.3	-3.6	29.5	0.12	
no	reference					
Extracurricular activities						
Yes	-10.8	6.7	-24.1	2.4	0.11	
No	reference					
Part-time job						
Yes	2.2	6.3	-10.4	14.8	0.73	
No	reference					
Smoking						
Yes	0.3	16.4	-38.6	39.2	0.98	
No	reference					
Drinking						
Yes	7.3	6.1	-4.9	19.4	0.24	
No	reference					

Discussion

The annual study on students' health and sleeping habits from 2018 to 2020 showed that their sleep duration during weekdays increased. Contrastingly, sleep duration during weekends decreased, in the context of the COVID-19 pandemic in 2020. It also showed that 10 students went to bed early in the morning and woke up late in 2020.

The students' sleep duration during weekdays was shorter than during weekends for each year. This was consistent with the 2015 NHK Japanese Time Use Survey [20], which showed that the mean sleep duration was 7 hours and 15 minutes during weekdays; 7 hours and 42 minutes on Saturday; and 8 hours and 3 minutes on Sunday. It also showed that the mean sleep duration during weekdays was 7 hours and

27 minutes for men in their 20s and 7 hours and 18 minutes for women in their 20s; 7 hours and 43 minutes for men in their 20s and 8 hours and 6 minutes for women in their 20s on Saturday; and 8 hours and 25 minutes for men in their 20s and 8 hours 27 minutes for women in their 20s on Sunday. Although the participants of this study may have slept shorter duration than responders of the NHK survey in their 20s did, the difference in gender may denote the same tendency.

Although the sleep duration on weekdays and weekends did not differ between 2018 and 2019, in 2020, the sleep duration increased during weekdays and decreased during weekends. It means the gap between the sleep duration during weekdays and weekends decreased, which is one of indices of sleep deprivation. Furthermore, in 2020, 10 out of 393 students' sleep phase was delayed, while two out of 644 students in 2018 and three out of 649 students in 2019 had a delayed sleep phase. We posited that the introduction of remote classes during the COVID-19 pandemic resulted in these changes. Remote classes save the commute time of students, allowing them to sleep longer and overcome sleep deprivation. However, these classes may have caused a delay in the sleep phase of some students. Instead of having a fixed time, they could also take the classes whenever they choose to. Some studies on adolescents reported a later bedtime on weekend nights compared to school nights [21]. Thus, several students may have slept later on weekdays without a tight schedule similar to weekends.

Furthermore, students who always do something before going to bed slept longer during weekends, but not during weekdays. A total of 95% of them used a smartphone or watched TV before going to bed. As the students must go to school during weekdays, they may get up even if they do not have enough sleep. It might be why they sleep longer during weekends to compensate for the sleep debt accumulated on weekdays [22].

The students' sleep duration on weekdays was not associated with gender but to living alone. Given the fact that students living alone tend to live closer to the university, indicating that they need less time to commute to school, it was expected, to some extent, that they would be able to sleep longer than the participants living with their families. Previous studies among adult workers reported that long commute times were associated with self-reports of short sleep duration [23] and actigraphy-measured short sleep duration and regularity [24]. Thus, future studies should conduct in-depth analyses of the relationship between commute time to university and students living with family. Although there were some differences in students' sleep duration in different grades, the trends were not the same during weekdays and weekends. Students' curricula by grade may affect these differences, and further studies are necessary.

This study has some limitations. First, our sample was limited to participants recruited from a single medical university. Second, as we could not conduct a written survey in 2020, an online survey was conducted a couple of months later than planned, and the response rate decreased. Meanwhile, the participants answered the questionnaires in their private spaces in 2020, while they did so in public spaces in 2018 and 2019. Third, our data were based on subjective answers, and many responses cannot be believed to be true. Participants may have been reluctant to answer truthfully in the questionnaire

because they had to write their names on them, and they were not anonymized. We could not collect objective data using an actigraph or portable electroencephalogram for a large group of students. Although there were many erroneous answers and the collection rate decreased in 2020, the number of students with a delayed sleep phase increased. Furthermore, as responders were generally considered stiffer and more proper than non-responders, this result might be undervalued. Although it would benefit to overcome sleep deprivation in many students, delayed sleep phase have a negative influence on students' life and health[25]. Despite the above limitations, the participants' sleeping habits are expected to have been examined longitudinally through this annual survey.

Conclusions

Students' sleep duration was longer during weekdays and shortened during weekends in 2020. This difference could result from remote teaching during the COVID-19 pandemic, which also might have sleep-wake phase delayed in some students. Although it is unknown whether these changes are reversible, students should be more supported in terms of sleep duration and sleep-wake cycle. Furthermore, a follow-up review should be conducted in the next few years to examine these aspects.

Abbreviations

COVID-19: Coronavirus disease

Declarations

Ethics approval and consent to participate:

This study was approved by the Aichi Medical University Hospital Ethics Board (approval number: 2018-M005, 2020-M015).

Consent for publication:

Not applicable.

Availability of data and material:

It is not possible to share the raw research data publicly since data privacy could be compromised. However, the raw data are available with the corresponding author. Any researcher interested in gaining access to the raw data can send their request to the corresponding author at the contact information mentioned in the manuscript. All data generated or analyzed during this study are included in this published article.

Competing interests:

The authors declare they have no competing interests.

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Authors' information:

Contributions

All authors contributed to the generation of the paper. RH conceived and designed this study, collected and analyzed the data, and drafted the manuscript. KS contributed to designing, implementing the study, and critically prepared, provided counsel for analyses, and agreed on the submitted paper's final format. ES participated in the study design and data collection. IO, MM, TU, and AN participated in data collection and interpreted the data. All the authors read and accepted the final draft of the manuscript.

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