HOKKAIDO UNIVERSITY

Instructions for use

Impact of the COVID-19 pandemic on the physical and psychological health of female college students in Japan

Abstract

The spread of COVID-19 has dramatically changed our lives. This study aimed to examine the lifestyles of female college students, focusing on physical activity, sleep status, and anxiety status during the pandemic (a state of emergency) in Japan. 184 female college students completed two questionnaires, anthropometric measurements, and daily activity log and diet record: 115 and 69 participants before and during the pandemic, respectively. Findings showed a significant decrease in physical activity: physical activity levels fell from "normal" to "low" and the daily step counts decreased by half, from 8671 to 4640. In addition, the results from the questionnaires revealed that half of the participants were at risk of having sleep disturbances, and their cycles became more nocturnal, which may have caused higher anxiety states and lower sleep quality during the pandemic. In addition, anxiety states worsened, with 100% of the participants experiencing high anxiety during the pandemic. Monitoring lifestyle disturbances during the pandemic is needed for the development of interventions to improve health among young women.

Keywords anxiety, college students, COVID-19, female, physical activity, sleep disturbances

Key Points

Restrictions associated with the spread of COVID-19 had an impact on the amount of physical activity of female college students in Japan, equivalent to those associated with restrictions on blockades.

The sleep quality of female college students under mobility restrictions was poor and the sleep cycle shifted to a nocturnal pattern.

Female college students were in a higher state of anxiety than before mobility restriction, and the anxiety factors were those associated with the change of college life.

1. Introduction

The spread of coronavirus disease 2019 (COVID-19) has dramatically changed our lives (World Health Organization, 2020). In many countries, decreases in the amount of physical activity, quality of sleep, and changes in eating habits have been observed because of restrictions on going out, and there are concerns about the health effects resulting from these changes (Blume et al., 2020; Herle et al., 2021; Hu & Huang, 2020). Previous research on infectious diseases faced to date, such as severe acute respiratory syndrome, has also shown that the psychological impact of contagion and isolation is not limited to the fear of contracting the virus (Barbisch et al., 2015). In addition to anxiety and a sense of helplessness about the progression of an unknown disease, numerous restrictions, isolation, prejudice, and loss of social roles have resulted in intolerable psychological and social changes (Thakur & Jain, 2020: Swami et al., 2021). To

reduce the psychological burden of the epidemic, researchers have cited the need for data collection and research to address and plan for mental health and psychosocial support (IASC, 2015).

In Japan, one of the countries that have been massively affected by the pandemic, the Sports Agency raised a serious concern about the occurrence of "secondary health effects" of the COVID-19 pandemic, such as weight gain due to lack of exercise and the development and worsening of lifestyle-related diseases (Japan Sports Agency, 2021). In Japan, a state of emergency was declared on April 7, 2020, which required the restriction of unnecessary outings (Cabinet Secretariat, 2020). Later, owing to a decrease in the number of people with infections, it was lifted nationwide on May 25, 2020. However, the restrictions have had a long-term impact on people's lives due to changes to daily routines (e.g., eating, exercise, and sleep patterns) and college students are not an exception. At universities, in-person classes had to be stopped because of heightened concerns about the high risk of infection; as of June, of the same year, the rate of in-person classes was less than 10% (Ministry of Education, 2020). Therefore, college students have lost the opportunity to commute to school over a long period of time, and it is possible that the physical activity of college students has decreased, which may result in other adverse health outcomes.

In this regard, the risk of weight gain due to low levels of physical activity during restrictions has been mentioned as a "secondary health effect of COVID-19." (Japan Sports Agency, 2021). However, this is only a general concern and may also impact other aspects of health in young women. For example, the energy intake of young women in Japan has been declining since 1950, and malnutrition is a growing problem (Ministry of Health, Labour and Welfare, 2020a). This may be exacerbated by low energy intake to avoid weight gain coupled with less opportunities for physical activity under restrictive conditions. The increase in thinning among young women associated with low nutrition is one of the serious health issues in Japan; 21.7% of women in their 20s are underweight and this is further associated with bone loss, the risk of low-birth-weight births, and other long-term health problems in young women (Ministry of Health, Labour and Welfare, 2020a). As such, it is important to capture trends in physical activity and dietary intake among young women during emergencies.

Previous studies have reported greater perceived stress among women than men during restrained conditions and a higher prevalence of post-traumatic stress syndrome during emergencies (Almeida et al., 2020; Blume et al., 2020; Xiong et al., 2020). It has also been reported that the impact on their educational engagement and anxiety about the future may lead to disturbances in sleep quality and habits, with a stronger mental health impact on students (Christian et al., 2020), which is particularly problematic in women (Marelli et al., 2021). These

findings also suggest that female college students may be more vulnerable to the effects of restrictions and that it is necessary to identify lifestyle changes and anxiety states and develop strategies to reduce the negative health effects of restrictions. However, the absence of research on female college students is an impediment of a better understanding of adverse physical-health-related outcomes and experiences among this population in the face of the pandemic. To contribute to addressing this gap, this study aimed to examine particularly the changes to lifestyles of female college students in Japan during preventive restrictions against infection.

2. Methods

2.1 Participants

A total of 184 female students from a university in Japan were recruited using purposive sampling. All participants were nursing majors, who agreed to take part in this study: before the pandemic, participants were recruited face to face, while online during the pandemic. The pre-pandemic group comprised 115 participants without restriction experience and an average age of 19.5 years. The pandemic group comprised 69 participants with a restricted experience and an average age of 19.2 years.

Data collection

We conducted two questionnaire surveys, obtained anthropometric measurements, and assessed the daily activity log and diet records of the participants. The data were collected

between May 2018 and May 2021. Before the pandemic, a series of surveys were administered

face to face, while data collection was made online during the pandemic. Japan declared a state

of emergency on April 7, 2020. In this study, we defined a pandemic as the period when the first

state of emergency is declared. As such, we created two categories that are pre-pandemic and

pandemic groups, which are shown in the Participants section above

2.2 Demographic data

We developed a questionnaire to collect data on the demographic characteristics and

psychological status of the participants and information about COVID-19. The duration of the

questionnaire was approximately 15 minutes. Demographic data included age, weight, height,

residential status, and part-time employment.

2.3 Physical activity

Total energy intake (TEI) (kcal/day) was estimated using the factorial method based on

records of the participants' activities of daily living every 15 min for three consecutive days

(Bouchard et al., 1983; Eisenmann et al., 2003; Morio et al., 1997). Basal metabolic rate (BMR)

(kcal/day) was calculated as the basal metabolic reference value (kcal/kg body weight/day) $\times$

basal body weight (kg), based on the basal metabolic reference value for Japanese individuals

(Ministry of Health, Labour and Welfare, 2020b). Physical activity level (PAL) was defined as

total energy expenditure (TEE) divided by the BMR (Black et al., 1996). According to the Dietary

Intake Standards for Japanese (2020), PAL is classified as "low (I)," "normal (II)," or "high (III)." Those with "low (I)" PAL are expected to be sedentary and static for most of their lives. Those with "normal (II)" classification are ones whose work is mainly sedentary but may also include moving around in the workplace, working, serving customers in a standing position, walking to work, shopping, housework, and light sports. The "high (III)" category is defined as those who work in jobs that require a lot of movement and standing, or have an active leisure-time exercise routine, such as sports. In this study, terms belonging to both groups were identified based on this index. We also identified the categories to which individuals belonged and compared the proportions between the groups. The number of steps was measured using a simple and objective method for measuring the amount of physical activity. The number of steps taken (steps/day) over a three-day period was determined using pedometer applications (Pedometer++, Pedometer and Walk Logger) (Fong et al., 2016).

2.4 Food intake

All participants recorded the content and quantity of food they consumed for three consecutive days and calculated the TEI (kcal/day), intake of various nutrients (carbohydrate, protein, and fat) (kcal/day), and percentage of TEI (%/E) (Ministry of Health, Labour and Welfare, 2020b). The estimated energy requirement (EER) was calculated as BMR × PAL (Ministry of Health, Labour and Welfare, 2020b; Brooks et al., 2004; National Academies Press, 2005). We

compared the EER with the TEI (%/E) before and during the pandemic. The Ministry of Health, Labor, and Welfare of Japan has set the target intake for each macronutrient as a percentage of TEI (%E). The standard values for each macronutrient are 50–65% for carbohydrates, 13–20% for protein, and 20–30% for fat. In this study, we compared the percentages of each macronutrient in the TEI (%/E) of the during the pandemic group (Ministry of Health, Labour and Welfare, 2020b).

2.5 Sleep questionnaires

The Pittsburgh Sleep Quality Index Japanese version (PSQIJ) is a self-administered questionnaire used to assess subjective sleep quality in the previous month (Buysse et al., 1989). The self-rated items of the PSQIJ generate seven component scores (range of subscale scores: 0–3): sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication, and daytime dysfunction. The sum of these seven component scores yields one global score for subjective sleep quality (ranging from 0–21), with higher scores representing poorer subjective sleep quality (Doi et al., 2000; Doi et al., 1998). Only the during the pandemic group was asked to select "wake-up time" and "sleep time" as "later than usual," "same as usual," or "earlier than usual" compared with the time before the first emergency declaration in April 2020.

2.6 Anxiety questionnaires

All participants completed the Japanese version of the State-Trait Anxiety Inventory (STAI) (Spielberger et al., 1970). The STAI divides anxiety states into state anxiety (A-state, state anxiety) and trait anxiety (A-trait, trait anxiety). It measures two anxiety states by separating anxiety levels caused by short-term fluctuations in tension levels from anxiety levels as a long-term personality trait. Scores ranged from 20 to 80, with higher scores indicating greater anxiety. Respondents measuring trait and state anxiety were asked to rate their anxiety on a scale from 1 (not at all) to 4 (mostly), with a higher score indicating greater anxiety. Shimizu et al. translated the STAI into Japanese and tested its reliability (Shimizu & Imae, 1981). Iwamoto et al. reported that the validity and reliability of the STAI were good and that the A-state scale was particularly appropriate as an indicator of the psychological impact of primary stressors (Iwamoto M et al., 1989). In the Japanese version of the STAI, a score of 42 or more for state anxiety and 45 or more for trait anxiety are defined as high anxiety that can be clinically problematic in women. During the restrictions, participants were asked to select a cause for concern from "Impact on the health of myself and others in the community," "Impact on college life," "Impact on the economy and job search," "Impact on academic work," and "others." For those who chose "other," a separate free text response was obtained.

2.7 Data analysis

Statistical analyses were performed using the SAS JMP version 16.1. All data were tested for normality using the Kolmogorov-Smirnov test. The Mann-Whitney U test and Student's t-test was used to compare the characteristics between the before the pandemic and during the pandemic groups. We set the level of significance at $p < 0.05$.

2.8 Ethical considerations

The study protocol and methods were reviewed and approved by the Ethics Review Committee of the Faculty of Health Sciences, Hokkaido University (No. 18-18, 18-104, 19-115, 20-73). All research participants were required to fill out an informed consent form after being briefed on the study.

3. Results

3.1 Demographic data

The demographic and selection characteristics of the participants are presented in Table 1. The mean age was approximately 19 years; the body mass index (BMI) determination of the majority was normal, and more than half of the participants lived with their parents. When comparing both groups, there were no differences in age, anthropometric data, or percentage of those living with their parents. The results of the BMI assessment showed that the largest proportion of participants in both groups were classified as "normal." There were no significant differences in the percentages of BMI judgments.

3.2 Physical activity

Table 2 shows the results of the comparison of items related to physical activity in both groups. For energy consumption (kcal/day), the physical activity level and number of steps taken (steps/day) of the during the pandemic group showed significantly lower values. Table 3 shows the results of the classification according to the Dietary Intake Standards for the Japanese 2020 edition, published by the Ministry of Health, Labor, and Welfare (Ministry of Health, Labour and Welfare. 2020b). The physical activity level of the during the pandemic group was classified as I (low), while the physical activity level of the before the pandemic group was classified as II (normal), indicating a decrease in the level of physical activity. Table 3 shows the results of the individual classification based on the values of PALs. The ratio of those classified as I (low) in the during the pandemic group was twice as high as those in the before the pandemic group, and those classified as having III (high) PAL decreased by less than half.

3.3 Food intake

Table 2 shows the results of the comparison of items related to the diets of both groups. In the during the pandemic group, the mean values of TEI (%/E) and carbohydrate intake per day were significantly lower than in the before the pandemic group. The EER was 2014.1±381.6 kcal/day in the before the pandemic group and 1810.2±251.4 kcal/day in the sub-expansion group. A comparison was made between the EERs and actual energy intake in each of the two groups.

In the before the pandemic group, the actual energy intake was significantly lower than the EER.

In the during the pandemic group, there was no significant difference between the EERs and

energy intake (Data not shown).

3.4 Sleep questionnaires

Table 4 shows the comparison of PSQIJ scores between the two groups. Approximately

half of the patients in both groups exceeded the cut-off value of the PSQIJ and were judged to

have a suspected sleep disorder. There was no significant difference in the PSQIJ scores between

the two groups. In the during the pandemic group, 59.4% reported a later waking time and 34.8%

reported a later falling asleep time (Table 5).

3.5 Anxiety questionnaires

Table 6 shows the results of the comparison between the anxiety states of the two groups.

The STAI subscales of state anxiety and trait anxiety showed significantly higher values for the

during the pandemic group on both scales (Table 4). All the participants (100%) of the during the

pandemic group exceeded the cut-off value for state anxiety and were in a high anxiety state

(Table 7). In addition, for trait anxiety, 78.0% of the participants in the during the pandemic group

had high anxiety. There was no correlation between trait and state anxiety in the during the

pandemic group ($p > 0.05$, Data not shown). The most frequently selected anxiety factor was "the

effect on my own health and the health of those around me," followed by "the impact on college

life," "the impact on finances and employment," and "the impact on studies and further education

(Figure 1)." The other most frequently cited factor was "the reaction of those around me when I

am infected."

4. Discussion

The mean number of steps taken by the participants was 4640 (steps/day), which

reflected a significant decrease of 53.5% compared to the pre-restriction. The Ministry of Health,

Labour, and Welfare has set a goal of 8500 steps/day for women (Ministry of Health, Labor and

Welfare, 2020c). The mean steps in the pre-restriction reached the goal; however, the restriction

was much less than half of the target (Table 2). The decrease in PALs from II to I predicted a

reduction in walking time by half. During the restriction, the participants took most of their

lectures online and were restricted from part-time employment and leisure activities such as clubs

and other activities.

A reduction in steps was observed in the areas where the spread of the disease occurred,

and our results are similar to the rate of reduction (25–54%) observed in areas that were restricted

by strict house arrest (Dunton et al., 2020; Pépin et al., 2020). In 2019, before the spread of

COVID-19, the average number of steps walked by women aged 20–29 years in the country was

6641 (Ministry of Health, Labor and Welfare, 2020c). The number of steps taken in this study

before the restriction was higher than the national average, suggesting that the amount of physical

activity before the restriction was good. Social distancing measures, including the lockdown of

college, may have caused a significant decrease in physical activity. The partial restrictions

imposed in our country may have had the same effect on college students as in areas under a

blockade with strict house arrest, exacerbating their low PALs.

In this study, the BMI of participants were approximately 20 in both groups, with

approximately 80% classified as "normal." There was no significant change in BMI during the

restriction period, but a significant decrease in energy intake was observed. The decrease in

energy intake may have been due to reduced appetite and fewer opportunities to eat out because

of reduced physical activity. The Sports Authority identified weight gain due to reduced physical

activity as a "secondary health effect of COVID-19." (Japan Sports Agency, 2021). In young

women, the health consequences of low nutrition may be of greater concern than the increased

risk of lifestyle-related diseases due to weight gain.

The energy intake of young women has continued to decline since 1950, and restrictions

may have contributed to the low nutritional status of young women (Ministry of Health, Labor

and Welfare. 2020a). Low nutrition can lead to increased fatigue and decreased muscle mass

(National Institutes of Health Osteoporosis and Related Bone Diseases National Resource Center,

2018). During menopause, women experience a decrease in estrogen production, which leads to

a loss of muscle mass, strength, bone density, and an increased risk of falls and fractures

(Komukai et al., 2003). To prevent these factors from compromising the quality of life, it is necessary to achieve peak bone mass at a young age. Bone formation requires moderate physical activity and an adequate diet (National Institutes of Health Osteoporosis and Related Bone Diseases National Resource Center, 2018). This is exactly the age at which bone formation is most effective, and any reduction in physical activity and energy intake due to restrictions may reduce women's health in the long term.

In this study, the mean PSQIJ general score for both groups were above the cut-off value of 5.5, indicating that approximately half of the participants in each group were suspected of having a sleep disorder. There was no significant difference in the mean PSQIJ general score or rate of suspected sleep disorders between the two groups. This suggests that sleep quality was not compromised by the restrictions. The results also support the recent finding of poor sleep quality among college students (Table 4) (Becker et al., 2018; Choueiry et al., 2016 Yue et al., 2021).

In contrast, our study found that individuals' sleep rhythms were delayed (Table 5). In the survey, 59.4% of the participants in the during the pandemic group recognized a delay in their waking time and 34.8% in their bedtime, which could be attributed to the fact that online classes eliminated the need to spend time commuting to school and getting ready. The nocturnal pattern of life during the spread of COVID-19, especially among young people, has been observed in China, where the infection is more severe, and the United States (Dai et al.,2021; Lee et al., 2020;

Marelli et al., 2021; Wright et al., 2020;). It has been reported that those with a nocturnal sleep cycle have more physical and mental subjective symptoms, chronic sleep deprivation, and a marked tendency to carry over fatigue to the next day, which may have long-term effects on their health (Concepcion et al., 2014; Randler, 2011).

All participants during the pandemic showed a high level of state anxiety, and a worsening compared to before the pandemic group (Table 6,7). Additionally, "Impact on college life" was the second most frequently cited anxiety factor after 'impact on health of myself and others' (Figure 8). State anxiety is caused by short-term fluctuations in tension levels and is influenced by external stress. Similar deterioration of the anxiety state has been reported in China, the USA, European countries, and other countries under restricted conditions but there is no report that all participants fell into a high anxiety state as in this study (Huang & Zhao, 2020; Husky et al., 2020; Liu et al., 2020). In this study, specific factors of the anxiety state were not identified. For this reason, more research is needed to identify the factors of anxiety among female university students during the pandemic and to develop social supports.

This study had some limitations that need to be addressed. In this study, we conducted a survey of a limited and relatively small group of female university students living in a city using purposeful sampling. In addition, because this was a cross-sectional study comparing and examining different participants before and during the spread of COVID-19 infections, it is

insufficient to consider the effects of physical activity and dietary intake levels before the COVID-19 epidemic. However, the pre-and post-expansion groups in this study were very homogenous, which may be useful for capturing changes in lifestyle patterns. In addition, the data on physical activity and dietary intake in this study were calculated from data obtained from self-administered questionnaires. Therefore, the data may not be objective, and it cannot be denied that recall bias may have influenced the results. This study assessed the physical activity, food intake, sleep, and anxiety of university students under very limited conditions, such as emerging infectious diseases and the declaration of a state of emergency in spring.

5. Conclusions

Restrictions associated with the spread of COVID-19 had a significant impact on the physical activity, sleep patterns and psychological well-being of female college students, equivalent to those associated with restrictions on blockades. Overall, our findings demonstrated that lifestyle habits identified during restrictions not only worsened young females' current health, but also increased their risk of poor quality of life. Health monitoring and development of interventions targeting female college students are needed to address lifestyle-related issues during the pandemic.

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Table 1. Comparative results of socio-demographic data before and dring the pandemic

	Before (N=115)		During (N=69)		p-value*
	Mean	SD	Mean	SD	
Age (years)	19.5	1.0	19.2	0.4	0.058
Height (cm)	158.7	5.5	158.9	5.5	0.731
Weight (kg)	52.0	7.1	50.8	5.7	0.150
BMI (kg/m^2)	20.7	2.5	20.0	2.0	0.061
BMI classification (n, %)[†]					0.845
Underweight		20(17.0)		10 (14.0)	
Normal		92 (79.0)		57 (83.0)	
Overweight/obese		3 (3.0)		2 (2.0)	
Live with parents (n, %)					0.876
Yes		69 (60.0)		43 (62.3)	
No		46 (40.0)		26 (37.7)	

*Student's t-test

† BMI classification: <18.5 kg/m^2 = underweight; 18.5 to 24.9 kg/m^2 = normal; >25.0 kg/m^2 = overweight/obese.

Table2. Comparative results of physical activity, food intake and sleep status before and during the pandemic

	Before (N=115)		During (N=69)		*p-value**
	Mean	SD	Mean	SD	
TEI （kcal/day）	1784.8	446.6	1692.9	1230.9	<0.001
EER （kcal/day）	2014.1	381.6	1810.2	251.4	<0.001
Carbohydrate （g/day）	296.9	71.2	204.6	75.9	<0.01
Carbohydrate （%E ）	52.1	10.1	50.5	10.3	0.287
Protein （g/day）	71.0	25.8	70.2	38.1	0.869
Protein （%E）	16.0	4.6	17.1	5.6	0.169
Fat （g/day）	62.6	23.7	57.4	22.8	0.190
Fat （%E）	31.2	7.8	32.5	9.3	0.312
TEE	2283.3	530.8	1726.9	505.4	<0.001
PAL	1.76	0.4	1.52	0.4	<0.001
Steps (steps/day)	8671	3945.8	4640	3512.4	<0.001

*Student's t-test

Table 3. Results based on physical activity levels

	Before (N=115) n (%)	During (N=69) n (%)	p-value **
PAL classification (%)†			<0.001
Low (1)	40 (34.8%)	44 (63.8%)	
Normal (2)	40 (34.8%)	19 (27.5%)	
High (3)	35 (30.4%)	6 (8.7%)	

† Low(1). PAL score> 1.60, Normal(2). $1.60 \leq$ PAL score < 1.90, High(3). $1.90 \leq$ PAL score

** Mann–Whitney U test

Table 4. Comparative results of PSQI-J before and during pandemic

	Before (N=115)		During (N=69)		p-value
	Mean	SD	Mean	SD	
PSQI general score	5.7	2.7	5.8	3.7	0.936 *
PSQI-J classification[†](%)					0.763 **
Normal		61 (53.1)		35 (50.7)	
Low sleep quality		54 (46.9)		34 (49.3)	

†Poor sleep quality was defined as individuals who scored > 5.5 points.

* Student's t-test , ** Mann–Whitney U test

Table5. Changes in waking and sleeping times in a during pandemic group

		(%)
Wake up time[†]	Early	3.4
	No change	27.6
	Late	69
Bedtime[‡]	Early	5.8
	No change	55.1
	Late	39.1

† Current wake up time compared to before April 2020, when the restrictions started

‡ Current bed time compared to before April 2020, when the restrictions started

Table 6. Comparative results of STAI pre- and during COVID-19

	Before (N=58)		During (N=69)		p-value*
	Mean	SD	Mean	SD	
STAI					
A-state [†]	36 .0	5.6	48.4	2.8	<0.001
A-trait [‡]	49.6	5.8	47.8	4.6	<0.05

† A-state: Anxiety levels caused by short-term fluctuations in tension

‡ A-trait: anxiety felt over a long period of time, unaffected by situational factors

*Student's t-test

Table 7. .STAI state and trait scores according to before and during the pandemic

	Before (N=58) N (%)	During (N=69) N (%)	p-value **
A-State[†]			<0.001
High	14 (24.1)	69 (100.0)	
Normal	44 (75.9)	0 (0)	
A-Trait[‡]			0.167
High	47 (81.0)	54 (78.0)	
Normal	11 (19.0)	15 (22.0)	

†High anxiety was defined as individuals who scored $\geq$ 42 points

‡High anxiety was defined as individuals who scored $\geq$ 45 points

** Mann–Whitney U test

Figure 1. Anxiety perceived under the restrictions