Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Research Paper

A cross-sectional study of the psychological impact of the COVID-19 pandemic on undergraduate and graduate students in Japan

Tetsuro Noda [a,*], Hiromu Nagaura [b], Toshihiko Tsutsumi [c], Yoshinobu Fujita [b], Yusuke Asao [a], Ayane Matsuda [d], Atsuhiro Satsuma [e], Manami Nakanishi [c], Reika Ohnishi [b], Miku Takemori [f]

[a] Hyogo University of Teacher Education, Japan
[b] Kobe University of Health and Welfare, Japan
[c] Osaka University of Human Sciences, Japan
[d] Hyogo Prefecture Himeji Child Consultation Center, Japan
[e] Sekizen Hospital, Japan
[f] Child Day Service Chao, Japan

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ABSTRACT

Background: Due to the COVID-19 pandemic, a state of emergency was declared in Japan and university classes were suspended, causing concern about the deterioration of the mental health of isolated students. This study aimed to understand students' mental health status during the COVID-19 pandemic and suggest measures to prevent depressive anxiety among them.
Method: Undergraduate and graduate students at one national and two private universities in the Kansai region were surveyed. The Kessler Psychological Distress Scale-6 was used to assess the students' mental health. Questions were included to assess students' awareness of COVID-19 and changes in lifestyle habits, including drinking, smoking, gaming, and other addictive habits. The University of Tokyo Health Sociology's version of the Sense of Coherence Scale was used to assess the ability to cope with stressors.
Results: More than 50% of undergraduate and graduate students felt more than mild depressive anxiety and approximately 11% felt severe depressive anxiety, indicating that anxiety about the future worsened the levels of depressive anxiety. Life with reversed day and night schedules was associated with the worsening of depressive anxiety levels, but a high sense of coherence was associated with decreased levels of depressive anxiety.
Conclusion: COVID-19 pandemic triggered isolation which led to worsening the mental health of undergraduate and graduate students. Psychological support for lifestyle and a sense of coherence is necessary to prevent mental health deterioration among isolated students.
Limitations: As we were unable to contact all students, the sample bias may affect interpretation of the data

1. Introduction

The novel coronavirus disease 2019 (COVID-19) was first reported in Wuhan, China, in early December 2019 and has since spread rapidly around the world, resulting in numerous cases of infections and deaths (World Health Organization, 2021). In Japan, the first infected person was confirmed among returnees from Wuhan on January 16, 2020. Initially, the increase in the number of infected individuals was small.

Following the World Health Organization's formal declaration of the novel coronavirus outbreak as a Public Health Emergency of International Concern (PHEIC) on January 30, 2020, the Japanese government declared COVID-19 as an infectious disease under the Infectious Disease Control Law on February 1. On February 13, the first COVID-19-related death in Japan was reported. On February 27, the Japanese Prime Minister called for the temporary closure of all schools. By mid-March, the number of infected individuals began to rise rapidly, and on April 7, a state of emergency was declared in seven prefectures, including Tokyo and Osaka. On April 16, a nationwide state of emergency was declared, and the population was requested to refrain from going out unnecessarily. The university was closed and students were forced to stay home. Additionally, at the beginning, online classes were sometimes impossible due to inadequate equipment and lack of training for

* Corresponding author.
E-mail address: tetsuro10@me.com (T. Noda).

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instructors regarding how to conduct online lectures. On May 25, the state of emergency was lifted as the infection began to come under control; however, due to fear of group infection outbreaks, today, most university campuses remain closed and continue to offer online classes.

Globally, students have been particularly vulnerable in terms of the risk to their mental health during the COVID-19 pandemic (Ochink et al., 2021). The campus closures in Japan have left students not only unable to enjoy campus life but also forced them into isolation with little to no contact with others and compelled them to wear masks and maintain social distance. Pandemic-related isolation is said to cause various psychological reactions, including traumatic stress symptoms, depressive anxiety, confusion, anger, insomnia, and suicide (Brooks et al., 2020). In Italy, during the lockdown, students were reported to have experienced more psychological distress than workers (Marelli et al., 2020). Risk factors associated with the worsening of students' mental health during the COVID-19 pandemic include being female, participation in distance education, exposure to mass media, low levels of social support, previous mental health problems, financial problems, delays in academic activities, and living in a city (Cao et al., 2020; Ma et al., 2020; Ochnik et al., 2021; Giusti et al., 2021). Smoking and consuming alcohol have also been associated with increased risk (Nomura et al., 2021). Given the expectation that the pandemic will continue to impact university education, it is imperative to proceed with research from various perspectives to prevent the further deterioration of students' mental health.

Although the suicide rate in Japan has been decreasing, a marked increase has been observed since July 2020, especially among females, children, and adolescents. Some researchers suspect that this increase may be due to the influence of the COVID-19 pandemic (Tanaka and Okamoto, 2021). As of 2015, suicide was the leading cause of death among young people between the ages of 15 and 34 in Japan in the only G7 member with this rate of suicide (Ministry of Health, Labor and Welfare, 2020). A cross-sectional survey of Akita University students at the end of the state of emergency on May 20, 2020, reported that indicative depressive symptoms and suicide-related ideation were found in 11.5% and 6.7% of students, respectively (Nomura et al., 2021). Thus, the impact of the COVID-19 pandemic on student mental health is expected to be serious.

This study aimed to understand the psychological states of students after the declaration of a state of emergency due to the COVID-19 pandemic and examine the relationship between the psychological impact and lifestyle changes, including awareness of COVID-19 and addictive habits such as alcohol consumption, smoking cigarettes, gaming, gambling, and social networking. Although in Japan, gaming disorder has become a serious issue among the younger population, we focused on gaming disorder. We also focused on the sense of coherence (SOC) in relation to students during the pandemic, as SOC is considered to be the ability to cope with everyday life stressors and foster resilience (Antonovsky, 1987; McGee et al., 2018). For the purpose of this study, we will treat SOC as the ability to cope with COVID-19 as a stressor. We conducted this study with the aim of examining measures that could prevent the worsening of student mental health during the COVID-19 pandemic.

2. Method

2.1. Participants and procedure

To investigate the mental health status of students during and after the state of emergency, changes in lifestyle, etc., this study was conducted from May 1 to 15, 2020 (Time 1, during the state of emergency) and from July 1 to 15, 2020 (Time 2, about one month after the end of the state of emergency).

Undergraduate and graduate students at one private and one national university in Hyogo prefecture and one private university in Osaka prefecture (A-, B-, and C-university, respectively) participated in this survey. Students at A-university were recruited from the Department of School Education, students from B University were recruited from the Department of Social Welfare and Health Sports Communication, and students from C-university were recruited from the Department of Health Psychology on university's online system. Every participants completed an online structured questionnaire to assess their mental health status. Students were asked to complete the questionnaire anonymously. Of the 2182 students that received the survey, 1073 students responded during Time 1 (collection rate = 49.2%), and of the 2282 students that received the survey during Time 2843 students responded (collection rate = 36.9%). The total number of participants for both time periods was 1916.

2.2. Questionnaires

Students were asked about their gender, age, year of study, and type of residence as demographic information, and were asked to answer questions about their awareness of COVID-19, such as "I feel COVID-19 is scary," "I feel stressed about changes in my daily life for preventing the spread of COVID-19," and "I am worried about my future due to COVID-19." A five-point Likert scale (1 = *strongly agree*, 2 = *agree*, 3= *undecided*, 4 = *disagree*, and 5 = *strongly disagree*) was used to evaluate their lifestyle in the past 30 days. Statements included, "I am leading a day-and-night reversed life" and "I try to keep a balanced diet." Participants were also asked about their alcohol intake, smoking frequency, as well as hours spent gaming, gambling (for example, pachinko and slots), social networking, and watching videos (e.g., YouTube). Participants rated these statements based on if their habits had changed in comparison to before the state of emergency (*no habit, decreased, unchanged*, or *increased*). To screen for a gaming disorder, the Internet Gaming Disorder Scale Japanese (IGDSJ) (Sumi et al., 2018), which was developed based on the symptoms of Internet gaming disorder listed in the DSM-5 (American Psychiatry Association, 2013), was used. The scale included 9 items, to which participants answered yes or no. Reliability, as depicted by Cronbach's alpha as a measure of internal consistensy, was 0.74. The University of Tokyo Health Sociology version of a three-item sense of coherence scale (SOC-3-UTHS) (Togari et al., 2007) was used to measure SOC. SOC-3-UTHS was created based on Antonovsky's definition of the subordinate concept of SOC. It utilizes a seven-point scale to investigate three items: comprehensibility, manageability, and meaningfulness. Reliability, as depicted by Cronbach's alpha, was 0.77. The Japanese version of the Kessler Psychological Distress Six-Item Scale (K6; Kessler et al., 2003), which was designed to screen depressive anxiety symptoms over the preceding 30 days, was used to assess the students' mental health status. Participants responded to various statements using a five-point scale (0 = *not at all* to 4 = *daily*). The total score ranged from 0 to 24 points (0−4 = no symptoms, 5−9 = mild symptoms, 10−12 = moderate symptoms, 13−24 = severe symptoms). The reliability, as depicted by Cronbach's alpha, was 0.85.

2.3. Ethical considerations

The ethics committee of Kobe University of Health and Welfare approved this study. Before obtaining consent, all participants were informed of the purpose of this study and that the survey was anonymous, their university names and individual information would not be identified, and that participation was voluntary.

2.4. Statistical analysis

Data were analyzed using SPSS version 27.0. Descriptive statistics were calculated for each variable. Data are expressed as mean (standard deviation), median (interquartile range), or number (percentage). A chi-square test was used to evaluate the demographic characteristics of participants at Time 1 and Time 2. For univariate analysis, a parametric test (*t*-test) was used to assess the difference in mean age at Time 1 and

Table 1
Relationship between demographic characteristics and depressive anxiety level at Time 1 and Time 2.

	Time 1						Time 2					
Demographic Characteristics	*n* 1073 (100.0)	K6 Score Median(IQR)	Univariate Statistics *P*	Multivariate OR	95% CI	*p*	*n* 843(100.0)	K6 Score Median(IQR)	Univariate Statistics *P*	Multivariate OR	95% CI	*p*
Age (years)												
Mean (SD)	24.2(9.99)			1.01	(0.98–1.05)	.46	24.6 (10.10)			1.03	(1.00–1.07)	<0.05
Gender												
Male	458(42.7)	4.0(1.0.8.0)	15.92, df=2 $p < 0.01$	Reference			353(41.9)	5.0(2.0–9.0)	3.51,df=2, $p = 0.173$	Reference		
Female	611(56.9)	5.0(2.0–9.0)	Male vs Female, $p <$ 0.01	1.31	(0.88–1.93)	.18	482(57.2)	5.0(2.8–9.0)		1.46	(1.06–1.99)	<0.05
N/A	4(0.4)	11.0 (3.3–21.0)		1.84	(0.22–15.6)	.58	8(0.9)	8.5 (4.3–13.0)		0.22	(0.03–1.96)	.18
University												
A	691(64.4)	4.0(2.0–8.0)	15.14, df=2, p<0.01	Refernce			531(63.0)	5.0(2.0–8.0)	19.8, df=2, $p <$ 0.001	Reference		
B	255(23.8)	5.0(2.0–9.0)	A vs C, $p < 0.01$	1.54	(0.83–2.86)	.17	128(15.2)	6.0 (3.0–10.0)	AvsB, $p < 0.05$	1.3	(0.86–1.96)	.21
C	127(11.8)	6.0(3.0–11.0)		1.99	(1.16–3.40)	<0.05	184(21.8)	6.0 (3.0–11.0)	AvsC, $p < 0.001$	1.63	(0.96–2.76)	.07
Grade												
①1st year	320(30.2)	3.0(1.0–7.0)	29.87, df=5, p<0.001	Refernce			254(30.1)	4.0(1.0–8.0)	24.7, df=5, $p <$ 0.001	Reference		
②2nd year	144(13.6)	5.0(2.0–8.0)	①vs④, $p < 0.001$	1.65	(0.98–2.78)	.06	146(17.3)	6.0 (3.0–10.3)	①vs②③④, $p < 0.05$	1.47	(0.91–2.38)	.12
③3rd year	159(15.0)	5.0(2.0–9.0)	④vs⑥, $p <$. 01	2.82	(1.47–5.40)	<0.05	105(12.5)	7.0 (3.0–10.0)	②vs⑤, $p < 0.05$	1.6	(0.96–2.66)	.07
④4th year	114(10.8)	6.0(3.0–11.0)		2.92	(1.38–6.20)	<0.05	70(8.3)	7.0 (3.0–10.0)		1.99	(1.12–3.54)	<0.05
⑤Graduate without working experience	124(11.7)	5.0(2.0–8.0)		2.50	(0.90–6.92)	.08	171(20.3)	4.0(2.0–8.0)		1.94	(1.07–3.53)	<0.05
⑥Graduate with working experience	197(18.6)	4.0(2.0–8.0)		4.10	(1.98–8.41)	<0.001	97(11.5)	6.0(3.0–9.0)		1.33	(0.55–3.22)	.53
Place of residence												
Parent's House	752(70.1)	4.0(2.0–8.0)	0.66, df=3, $p = 0.88$	Refernce			544(64.5)	5.0 (2.0–10.0)	4.5, df=3, $p = 0.21$	Reference		
Dormitory	122(11.4)	5.0(2.0–7.3)		0.91	(0.55–1.50)	.70	145(17.2)	5.0(2.0–8.0)		1.12	(0.70–1.79)	.63
Alone	145(13.5)	5.0(2.0–8.5)		0.75	(0.45–1.25)	.27	116(13.8)	6.0(3.0–9.0)		0.97	(0.62–1.51)	.88
Others	54(5.0)	4.0(1.0–8.0)		0.91	(0.36–2.27)	.84	38(4.5)	3.0(1.0–7.0)		0.62	(0.31–1.25)	.19

Notes.: ns = Bonferroni correction shows no significance defarence.
IQR = interquartile range.
There were missing 15 cases in the grade at Time 1; age data was missing 8 cases at Times 1 and 2 cases at Time 2.

Time 2 because equal variance could be assumed by the Leven test. The points of K6, SOC-3-UTHS, and IGDSJ were not normally distributed according to the Kolmogorov-Smirnov test. Therefore, a nonparametric test (Kruskal-Wallis test) was used to assess the relationship between demographic characteristics, awareness of COVID-19, changes in lifestyle, and depressive anxiety levels. The relationship between SOC, gaming disorder, and depressive anxiety level was also assessed using the Kruskal-Wallis test. A Bonferroni correction was performed when there was a significant difference. To explore the factors significantly associated with the level of depressive anxiety, two dummy variables (K6 score of less than five = 0 and K6 score of five or more = 1) were used as dependent variables, and students' awareness of COVID-19, demographic characteristics, lifestyle changes, and SOC3-UTHS and IGDSJ scores were used as independent variables. Since it was confirmed that there was no collinearity in the independent variables, multivariate logistic regression analyses were conducted. The Hosmer-Lemeshow test showed $p = 0.905$ at Time 1 and $p = 0.434$ at Time 2. The percentage of correct classification was 71.5% at Time 1 and 75.7% at Time 2.

To account for missing data, multiple imputation analyses with five imputations were performed. Statistical significance was set at a two-sided *p-value* of less than 0.05.

3. Result

3.1. Demographic characteristics

In all, 57.0% of the participants were female students and 0.63% answered that they were neither male nor female, or did not want to answer. The mean age was 24.2 ($SD = 9.99$) years at Time 1 and 24.6 ($SD = 10.10$) years at Time 2, exhibiting no significant difference between them, $t(1904) = 0.884$, $p = 0.377$. Significant differences were noted depending upon the university, year of study, grade, and residential status between Times 1 and 2, χ^2 (2, $N = 1916$) 46.6, $p < 0.001$; χ^2 (5, $N = 1906$) 47.0, $p < 0.001$; and χ^2 (3, $N = 1916$) 14.0, $p < 0.01$, respectively.

3.2. Relationship between demographic characteristics and depressive anxiety level at times 1 and 2 (Table 1)

The following is what was revealed by univariate analysis.

The median K6 of females was significantly higher than that of males at Time 1. The median of K6 was higher in the year of study; first-year students ranked the lowest for the median of K6 at both Times 1 and 2, while the fourth-year students ranked the highest. There was a significant difference in the median of K6 between universities at Times 1 and 2.

The following is what was revealed by multivariate logistic analysis.

The odds ratio (OR) for age was 1.03, 95% CI [1.00, 1.07], at Time 2. The higher the age, the higher was the level of depressive anxiety. The OR of females was 1.46, 95% CI [1.06, 1.99], at Time 2. Regarding the year of study, the ORs of the fourth-year students were 2.92 at Time 1, 95% CI [1.38, 6.20], and 1.99 at Time 2,95% CI [1.12,3.54], and that at Time 1, the OR of graduate students with working experience was the highest at 4.10, 95% CI [1.98, 8.41]. Between universities, university-C had an OR of 1.99 at Time 1, 95% CI [1.16, 3.40].

3.3. Relationship between awareness of COVID-19, changes in lifestyle, and depressive anxiety level at times 1 and 2 (Table 2)

Students who answered that they *agree* or *strongly agree* with the statements "I feel afraid of COVID-19," "I feel stressed about changes for preventing the spread of COVID-19 in my daily life," and "I feel anxious about my future because of COVID-19″ accounted for 77.9%, 62.6%, and 49.3% of participants at Time 1, and 71.7%, 59.4%, and 44.0% of participants at Time 2, respectively. Univariate analysis revealed a significant difference at Times 1 and 2, with the frequency of *strongly agree* responses being the highest. In addition, the ORs of those who answered that they *strongly agree* with the statements "I feel stressed about changes for preventing the spread of COVID-19 in my daily life" and "I feel anxious about my future due to COVID-19″ were higher at Times 1 and 2. In particular, the OR of the former response at Time 1 was extremely high at 28.30, 95% CI [9.91, 80.78].

Regarding lifestyle change, 28.9% and 27.6% of students answered *agree* and *strongly agree* for day/night reversal at Times 1 and 2, respectively, both of which were found to be significantly different in the univariate analysis, with the median of strongly agree being the highest. Multivariate logistic analysis showed that the number of participants who answered *disagree* had an OR of 1.88, 95% CI [1.16, 3.05], at Time 1, and *strongly agree* had the highest OR of 2.03, 95% CI [1.11,3.73], at Time 2.

Regarding the statement that participants were "eating a nutritionally balanced diet," students who answered *disagree* or *strongly disagree* were considered to not eat a nutritionally balanced diet and accounted for 31.1% and 34.5% of the participants at Times 1 and 2, respectively. Univariate analysis revealed significant differences between the two, with the median for *strongly disagree* being lower at 3.0 (1.0–7.0) and 4.0 (1.0–8.0), respectively. In all, 65% of the students reported having no drinking habits at Times 1 or 2. Regarding alcohol intake, 9% of the students answered that their intake *decreased* or *increased* at Time 1, while at Time 2, 9.5% answered *decreased* and 6.9% answered *increased*. The multivariate logistic analysis showed an OR of 0.40, 95% CI [0.24, 0.66], for *unchanged* at Time 1.

Regarding smoking, approximately 92% of the students reported that they had *no habit* at Times 1 and 2, with increases and decreases being observed in the range of 1%–3%. No significant difference was observed in the median K6 score, with an OR of decrease in the frequency of smoking being 14.40, 95% CI [1.84, 111.7], at Time 1.

In terms of game-playing habits, 35.5% and 42.0% of participants reported having *no habit* at Times 1 and 2, respectively. For gaming hours, 40.5% and 29.1% of participants reported that the number of hours spent gaming *increased* at Times 1 and 2, respectively. Regarding the medians of K6 (interquartile range), the median K6 score for participants that reported hours spent gaming *decreased* was highest at 5.5 (2.3–11.8) and 7.0 (4.0–10.0) at Times 1 and 2, respectively. Multivariate logistic analysis revealed that the OR of *decreased* was 2.80, 95% CI [1.44, 5.46], at Time 1.

"Have Gambling Habit" represented 6.4% and 4.6% of participants at Times 1 and 2, respectively, but there was no factor affecting the level of depressive anxiety.

"Have Social Networking Habit" represented about 94% of participants at both Times 1 and 2. The increase was 59.2% at Time 1 and 54% at Time 2. The multivariate logistic analysis revealed that the OR of decrease in the frequency of using social media was 2.92, 95% CI [1.17,7.27], at Time 2.

Regarding video viewing, habituation was observed in more than 90% of the students at Times 1 and 2. Video viewing hours increased by 75.1% and 69.2% at Times 1 and 2, respectively, but there was no change in habits that could affect the level of depressive anxiety.

3.4. Relationship between IGDSJ and SOC3-UTHS scores and depressive anxiety level at times 1 and 2 (Table 3)

A score of more than five on the IGDSJ indicates the possibility of a gaming disorder, which was obtained by 30 out of 1073 (2.8%) participants at Time 1 and by 25 out of 843 (3.0%) participants at Time 2. Univariate analysis revealed that the higher the score, the worse the depressive anxiety level. Multivariate logistic analysis revealed that the OR for IGDSJ score was 1.33, 95% CI [1.12, 1.57], at Time 1 and 1.15, 95% CI [1.00, 1.31], at Time 2.

Regarding the SOC3-UTHS, univariate analysis revealed that the higher the score, the lower the depressive anxiety level, with an OR for SOC3-UTHS score of 0.85, 95% CI [0.80,0.90)], at Time 1 and an OR of

Table 2
Relationship between awareness of COVID-19 or changes in lifestyle and depressive anxiety level at Time 1 and Time 2.

		Time 1						Time2					
Awareness of COVID-19 or changes in lifestyle		*n*	K6Score	Univariate	Multivariate			*n*	K6Score	Univariate	Multivariate		
		1073 (100.0)	Median (IQR)	Statistics *P*	OR	95%CI	*p*	843 (100.0)	Median (IQR)	Statistics *P*	OR(95%CI)		*p*
I feel afraid of COVID-19	①Strongly Disagree	43(4.0)	2.0 (0.0–6.0)	24.2,df=4, $p<0.001$	Reference			35(4.2)	4.0 (0.0–12.0)	19.3, df=4, $p<0.01$	Reference		
	②Disagree	74(6.9)	3.0 (1.0–7.0)	①vs⑤, $p<0.001$	1.67	0.55–5.09	.37	98(11.6)	4.0 (1.0–7.3)	②④vs⑤, $p<0.01$	1.46	(0.54–3.99)	.46
	③Neutral	120 (11.2)	4.0 (1.0–7.8)	②④vs⑤, $p<0.05$	1.86	0.62–5.56	.27	106 (12.6)	5.0 (3.0–10.0)		1.45	(0.58–3.64)	.43
	④Agree	581 (54.1)	4.0 (2.0–8.0)		1.71	0.60–4.84	.08	465 (55.2)	5.0 (2.0–8.5)		1.71	(0.72–4.07)	.22
	⑤Strongly Agree	255 (23.8)	6.0 (3.0–10.0)		2.64	0.86–8.11	<0.001	139 (16.5)	7.0 (4.0–11.0)		2.39	(0.97–5.88)	.06
I feel stressed about changes in my daily life to prevent the spread of COVID-19	①Strongly Disagree	71(6.6)	1.0 (0.0–5.0)	206.5, df=4, $p<0.001$	Reference			53(6.3)	1.0 (0.0–3.5)	139.5, df=4, $p<0.001$	Reference		
	②Disagree	123 (11.5)	2.0 (0.0–5.0)	①②vs④⑤, $p<0.001$	3.60	1.30–9.98	<0.05	110 (13.0)	3.0 (0.0–7.0)	①vs③,$p<0.05$	0.57	(0.27–1.22)	.15
	③Neutral	208 (19.4)	3.0 (1.0–5.0)	③vs④⑤, $p<0.001$	4.60	1.73–12.22	<0.01	179 (21.2)	4.0 (1.0–8.0)	①vs④⑤, $p<0.001$	0.84	(0.43–1.66)	.62
	④Agree	459 (42.8)	5.0 (2.0–8.0)	④vs⑤, $p<0.001$	10.76	4.12–28.1	<0.001	361 (42.8)	6(3.0–9.0)	②③vs④⑤, $p<0.001$	1.44	(0.75–2.76)	.27
	⑤Strongly Agree	212 (19.8)	9.0 (5.0–14.0)		28.30	9.91–80.78	<0.001	140 (16.6)	9(5.0–14.0)	④vs⑤, $p<0.001$	4.2	(2.01–8.71)	<0.001
I feel anxious about my future due to COVID-19	①Strongly Disagree	98(9.1)	2.0 (0.0–4.0)	159.6, df=4, $p<0.001$	Reference			100 (11.9)	2.5 (0.0–6.0)	117.3, df=4, $p<0.001$	Reference		
	②Disagree	170 (15.8)	3.0 (1.0–6.0)	①vs③④⑤, $p<0.001$	0.80	0.41–1.55	.51	170 (20.2)	3.0 (1.0–7.0)	①vs③,$p<0.01$	1.64	(0.83–3.24)	.15
	③Neutral	276 (25.7)	4.0 (1.0–7.0)	②vs④⑤, $p<0.001$	0.98	0.51–1.88	.95	202 (24.0)	5.0 (3.0–8.0)	①vs④⑤, $p<0.001$	2.16	(1.13–4.14)	<0.05
	④Agree	358 (33.4)	5.0 (3.0–7.0)	④vs⑤, $p<0.001$	1.46	0.76–2.82	.26	273 (32.4)	6.0 (4.0–10.0)	②③vs④⑤, $p<0.001$	2.88	(1.52–5.45)	<0.01
	⑤Strongly Agree	171 (15.9)	8.0 (5.0–13.0)		2.79	1.13–6.91	<0.05	98(11.6)	10.0 (5.0–14.0)	⑤vs⑥, $p<0.001$	5.26	(2.55–10.84)	<0.001
Day/night reversal	①Strongly Disagree	387 (36.1)	3.0 (1.0–6.0)	52.7, df=4, $p<0.001$	Reference			317 (37.6)	4.0 (1.0–7.0)	51.2, df=4, $p<0.001$	Reference		
	②Disagree	195 (18.2)	4.0 (2.0–8.0)	①vs②③, $p<0.05$	1.88	1,16–3.05	<0.05	162 (19.2)	6.0 (3.0–10.0)	①vs②④, $p<0.01$	1.55	(1.02–2.36)	<0.05
	③Neutral	181 (16.9)	5.0 (2.0–9.0)	①vs④⑤, $p<0,001$	1.55	0.91–2.66	.11	131 (15.5)	6.0–10.0)	①vs③⑤, $p<0.001$	1.78	(1.15–2.77)	<0.05
	④Agree	211 (19.7)	5.0 (2.0–10.0)	②vs⑤,$p<0.05$	1.03	0.62–1.72	.91	159 (18.9)	5.0 (2.0–10.0)	④vs⑤,$p<0.01$	1.72	(1.11–2.67)	<0.05
	⑤Strongly Agree	99(9.2)	7.0 (3.5–12.0)		2.11	0.96–4.64	.06	74(8.8)	8.0 (5.0–13.0)	②vs⑤,$p<0.05$	2.03	(1.11–3.73)	<0.05
Eating a nutritionally balanced diet	①Strongly Disagree	109 (10.2)	6.0 (3.0–12.0)	31.9, df=4, $p<0.001$	Reference			101 (12.0)	6.0 (3.0–12.0)	23.7, df=4, $p<0.001$	Reference		
	②Disagree	224 (20.9)	5.0 (2.0–8.0)	①vs④⑤, $p<0.001$	1.47	0.78–2.80	.24	190 (22.5)	6.0 (3.0–10.0)	①②vs④⑤, $p<0.05$	1.05	(0.59–1.89)	.86
	③Neutral	221 (20.6)	5.0 (2.0–9.0)	①vs②,$p<0.05$	1.30	0.68–2.48	.43	205 (24.3)	6.0 (3.0–10.0)		1.05	(0.58–1.92)	.86
	④Agree	365 (34.0)	4.0 (2.0–7.0)	③vs⑤,$p<0.01$	1.02	0.53–1.96	.96	246 (29.2)	4.0 (2.0–8.0)		1.11	(0.62–1.99)	.73
	⑤Strongly Agree	154 (14.4)	3.0 (1.0–7.0)		1.16	0.54–2.45	.71	101 (12.0)	4.0 (1.0–8.0)		0.83	(0.42–1.64)	.60
Alcohol intake	①No Habit				Reference						Reference		

(*continued on next page*)

Table 2 (*continued*)

		Time 1						Time2					
		679 (63.0)	4.0 (2.0–8.0)	8.49, df=3, $p<0.05$				557 (66.1)	5.0 (2.0–9.0)	4.16, df=3, $p=0.244$			
	②Decreased	96(8.9)	5.0 (2.0–9.0)		0.66	0.35–1.24	.19	80(9.5)	6.0 (3.0–8.0)		0.73	(0.42–1.26)	.26
	③Unchanged	200 (18.6)	5.0 (2.0–9.0)	ns	0.40	0.24–0.66	<0.001	148 (17.6)	4.0 (2.0–8.0)	ns	1.30	(0.85–1.99)	.23
	④Increased	98(9.1)	5.0(2.75–10.0)		0.84	0.38–1.84	.67	58(6.9)	5.5 (3.0–11.3)		0.84	(0.48–1.47)	.53
Smoking amount	①No Habit	983 (91.6)	4.0 (2.0–8.0)	6.82,df=3, $p=0.08$	Reference			780 (92.5)	5.0 (2.0–9.0)	4.4, df=3, $p=0.221$	Reference		
	②Decreased	21(2.0)	6.0(3.0–13.0)		14.40	1.84–111.67	<0.05	10(1.2)	7.0 (5.3–8.5)		1.25	(0.40–3.94)	.70
	③Unchanged	39(3.6)	5.0 (0.0–9.0)	ns	0.96	0.34–2.74	.94	24(2.8)	4.0 (2.3–6.0)	ns	1.03	(0.44–2.39)	.94
	④Increased	30(2.8)	6.0 (2.8–9.3)		1.80	0.66–5.12	.25	29(3.4)	6.0 (3.0–13.0)		1.43	(0.54–3.82)	.47
Gaming hours	①No Habit	381 (35.5)	4.0 (2.0–8.0)	11.0,df=3, $p<0.05$	Reference			354 (42.0)	5.0 (2.0–8.5)	12.1, df=3, $p<0.01$	Reference		
	②Decreased	52(4.8)	5.5(2.3–11.8)		2.80	1.44–5.46	<0.01	84(10.0)	7.0 (4.0–10.0)	② vs ①③, $p<0.05$	1.70	(0.82–3.47)	.15
	③Unchanged	205 (19.1)	4.0 (1.0–8.0)	ns	1.20	0.72–1.98	.49	160 (19.0)	5(2.0–8.8)		1.08	(0.71–1.66)	.72
	④Increased	435 (40.5)	5.0 (2.0–9.0)		0.75	0.46–1.21	.24	245 (29.1)	6.0 (3.0–9.5)		1.02	(0.71–1.48)	.90
Gambling hours	①No Habit	1004 (93.6)	4.0 (2.0–8.0)	10.5, df=3, $p<0.05$	Reference			804 (95.4)	5.0 (2.0–9.0)	3.9, df=3, $p=0.273$	Reference		
	②Decreased	35(3.3)	7.0(3.0–10.0)		4.79	(0.81–28.12	.08	12(1.4)	8.5 (5.3–12.0)		2.12	(0.88–5.12)	.10
	③Unchanged	23(2.1)	6.0 (0.0–13.0)	ns	0.52	(0.15–1.74)	.29	17(2.0)	4.0 (1.5–8.0)	ns	1.25	(0.41–3.84)	.69
	④Increased	11(1.0)	8.0(4.0–12.0)		0.47	(0.08–2.74)	.40	10(1.2)	6.5 (1.5–10.5)		1.89	(0.31–11.43)	.49
SNS hours	①No Habit	66(6.2)	3.0 (1.0–6.3)	10.9, df=3, $p<0.05$	Reference			45(5.3)	4.0 (1.5–8.5)	8.9, df=3, $p<0.05$	Reference		
	②Decreased	51(4.8)	5.0 (2.0–9.0)		1.47	0.50–4.30	.48	47(5.6)	6.0 (4.0–10.0)		2.92	(1.17–7.27)	<0.05
	③Unchanged	321 (29.9)	2.0 (4.0–7.0)	ns	1.40	0.61–3.19	.44	296 (35.1)	5.0 (1.3–9.0)	ns	1.52	(0.77–2.99)	.23
	④Increased	635 (59.2)	5.0 (2.0–8.0)		2.12	0.92–5.11	.08	455 (54.0)	6.0 (3.0–9.0)		1.72	(0.87–3.38)	.12
Video viewing hours	①No Habit	61(5.7)	5.0 (2.0–10.0)	10.2, df=3, $p<0.05$	Reference			58(6.9)	4.0 (2.0–6.5)	8.9, df=4, $p=0.06$	Reference		
	②Decreased	19(1.8)	9.0(3.0–11.0)		3.10	0.97–9.95	.06	31(3.7)	7.0 (4.0–11.0)		1.13	(0.30–4.34)	.86
	③Unchanged	187 (17.4)	3.0 (1.0–7.0)	ns	1.48	0.69–3.17	.31	171 (20.30)	5.0 (2.0–10.0)	ns	0.76	(0.37–1.55)	.45
	④Increased	806 (75.1)	5.0 (2.0–8.0)		1.52	0.75–3.09	.24	583 (69.2)	5(2.0–9.0)		0.84	(0.43–1.62)	.60

Notes. ns = Bonferroni correction shows no significant difference.
IQR = interquartile range.

Table 3
Relationship between IGDSJ and SOC3-UTHS scores and depressive anxiety level at Time 1 and Time 2.

	Depressive anxiety level				Univariate[a]	Multivariate[b]
	None	Mild	Moderate	Severe	Statisics *P*	OR(95%CI)
IGDSJ	Median(interquartile)					
Time 1	0(0–0)	0(0–1)	0(0–1)	1(0–2)	60.51, df=3, $p < 0.001$	1.33(1.12–1.57)
Time 2	0(0–0)	0(0–1)	0(0–1)	0(0–2)	50.41, df=3,$p < 0.001$	1.15(1.00–1.31)
SOC3-UTHS						
Time 1	13(11–15)	12(10–14)	12(9.25–13)	11(8–13)	54.64,df=3,$p < 0.001$	0.85(0.80–0.90)
Time 2	13(11–15)	12(10–14)	11(9–13)	10(7–13)	74.97, df=3, $p < 0.001$	0.89(0.85–0.94)

Notes.
[a] Kruscal-Wallis test.
[b] Multivariable logistic regression analysis.

0.89, 95% CI [0.85, 0.94], at Time 2.

4. Discussion

Using the K6 screening test, this study aimed to determine the level of depressive anxiety in students who had been forced to lead a secluded life and take online lectures since the declaration of a state of emergency due to the COVID-19 pandemic. This study also aimed to explore the lifestyle factors that may affect depressive anxiety in these individuals

As some studies have shown (Ochnik et al., 2021; Nomura et al., 2021; Giusti et al., 2021), this study also suggests that females have worse mental health than males.

The depressive anxiety levels of the students did not decrease during the period from Time 1 to Time 2. According to the National Health Survey, about 65% of Japanese people in their twenties were normal in the K6 screening test (Ministry of Health, Labor and Welfare, 2019), suggesting that the students' depressive anxiety levels in our study were higher than usual. A survey of Spanish university students during the pandemic using the 12-item General Health Questionnaire reported that 17.8% were none, with women being in a worse condition than men (Marques et al., 2020). A study of Changzhi Medical College students using the seven-item Generalized Anxiety Disorder Scale found that about 75% of students were not and that living with parents was a protective factor against anxiety (Cao et al., 2020). However, in this study, there was no evident relationship between the place of residence of the students and their depressive anxiety levels. Both studies concluded that COVID-19 had an impact on students' mental health.

There was a significant difference in the median of K6 scores among the included universities. This may be related to the fact that most of the students from B- and C-universities were majoring in health sciences and thus were more likely to suffer from mental health problems due to the COVID-19 pandemic (Reverté-Villarroya et al., 2021).

More than 70% of the students felt a strong sense of fear of COVID-19, likely due to the influence of the excessively sensational media reports. However, multivariate logistic analysis did not identify these reports as factors that would worsen the level of depressive anxiety. Feeling stressed about daily lifestyle changes in relation to the prevention of the spread of COVID-19 and feeling anxious about one's future due to the influence of COVID-19 were identified as factors contributing to the worsening of depressive anxiety levels. The median K6 score was lowest for first-year students and highest for fourth-year students. At Time 1, most graduate students with working experience were studying while working, so it was thought that the declaration of the state of emergency must have affected their work as well, resulting in a higher OR. At Time 2, the OR was highest among the fourth-year students, indicating that the recession caused by the COVID-19 pandemic had an impact on fourth-year students preparing to enter the workforce.

Pišot et al. (2020) reported that factors such as sleep time, unhealthy diet, alcohol intake, smoking, and the use of TV and digital devices were prominent during the COVID-19 pandemic but did not clarify how they might impact mental health.

In this study, day/night inversion was observed in approximately 30% of the participants at Times 1 and 2, and the median value of K6 for participants who reported they *strongly agree* was the highest in the univariate analysis. Multivariate logistic analysis revealed an OR of 1.88 for participants who reported they *disagree* at Time 1 and an OR greater than 1 for participants who reported they *strongly disagree* for every item at Time 2, suggesting that day/night inversion, regardless of the degree, was associated with worsening depressive anxiety levels. Participants who reported that they were not trying to eat a nutritionally balanced diet accounted for more than 30% of participants at Times 1 and 2, with the median K6 score for this group being significantly higher.

In Europe, the United States, and Australia, studies have shown that depression, anxiety, and stress are associated with increased alcohol intake during the COVID-19 pandemic (Grossman et al., 2020; Tran et al., 2020; Weerakoon et al., 2020; Jacob et al., 2021). However, in this study, similar proportions of increased and decreased alcohol intake were observed, indicating that alcohol intake was not a factor in increasing depressive anxiety levels. Multivariate logistic analysis revealed that a decrease in smoking frequency at Time 1 was associated with increased levels of depressive anxiety. It may be that the depression anxiety level increased because it became more difficult to smoke due to the stay-at-home order during a state of emergency.

Gaming habits were reported by more than 60% of participants, but there was no evident relationship between the increase in gaming hours and the worsening of depressive anxiety levels. Games that can be played with others online may act as a communication tool and reduce students' sense of isolation. The reason why decreased gaming hours were associated with worsened depressive anxiety levels may be that the game could not be played because the participant was experiencing a high level of depressive anxiety.

By contrast, IGDSJ scores were reported to be a factor that significantly increased ORs at Times 1 and 2. Approximately 3% of the participants were suspected of having a gaming disorder in the present study, similar to the estimated 5% of university students with gaming disorder reported by Sumi et al. (2018). The estimated prevalence of gaming disorder among the general Japanese young population was 5.1% (Higuchi et al., 2021); therefore, we think it is necessary to promote the appropriate use of games.

Regarding video viewing and gambling hours, there was no change in habits associated with depressive anxiety levels. Regarding social networking time, most students were identified as having increased the number of hours spent using social media. At Time 2, the reason why decreased social networking time was associated with increased depressive anxiety levels may be that participants were not able to use social networking sites because they were experiencing a high level of depressive anxiety.

There are concerns that smoking, gaming, and social networking may become addictive, but the results suggest that among those who habitually game, smoke, and are active on social media, an appropriate usage is effective in reducing depressive anxiety levels.

Regarding SOC and the COVID-19 pandemic, a study by Ruiz-Frutos et al. (2020) found that a low SOC was associated with poor mental health among non-health workers after the decleration of a state of

emergency and stay-at-home orders. Another study by Jung et al. (2020) observed that low SOC in women was associated with poor coping. In the current study, it was clarified that females had higher levels of depression anxiety than males, and the stress of daily life to prevent COVID-19 infection and anxiety about the future due to COVID-19 worsened the level of depression anxiety in participants. Drinking, smoking, playing games, and using social networks did not necessarily exacerbate the level of depression anxiety, and higher levels of SOC resulted in lower levels of depressive anxiety. Based on this knowledge, we need to provide support to prevent the worsening of students' mental health.

5. Limitations

The collection rate at Times 1 and 2 were 49.2% and 36.9%, respectively, indicating that the study sample may be biased. There was a significant difference in the demographic characteristics of the participants between Times 1 and 2, which may have affected the data. As the data used in this study were obtained only from students at three universities in the Kansai region, they may not necessarily be representative of all Japanese students. Since the questionnaires were self-administered, the respondent's language ability and how well they understood the questionnaire could have affected the results. Additionally, centralization tendency was likely to occur.

Despite these limitations, these data contribute to our knowledge of the mental health of students during the COVID-19 pandemic.

6. Conclusions

More than 50% of undergraduate and graduate students felt more than mild depressive anxiety, and about 11% felt severe depressive anxiety at the time a state of emergency was declared and one month after it was lifted. Although most students felt afraid of COVID-19, their depressive anxiety levels were related to the stress of daily life in which they were forced to actively prevent the spread of COVID-19 infection and their anxiety about the future. Many students lived a day/night-reversed life with nutritional imbalances, which was associated with worsened levels of depressive anxiety. The frequency of drinking and smoking was found to increase and decrease to the same extent, but a decrease in smoking was associated with depressive anxiety.

Gaming hours, social networking time, and video viewing hours exhibited large increases, but the decrease in gaming hours influenced the increase in depressive anxiety levels. Thus, moderate use may reduce depressive anxiety among those who are already habituated to smoking, gaming, and social networking. However, the higher the IGDSJ scores, the worse the levels of depressive anxiety, indicating the need to emphasize the prevention of gaming disorders.

Moreover, SOC was associated with lower levels of depressive anxiety, indicating that lifestyle advice and psychological support focusing on SOC are required to prevent students' mental health from deteriorating.

Since the student's mental health was found to deteriorate even after the state of emergency was rescinded, it is feared that as the COVID-19 pandemic continues, students' mental health will continue to worsen. It is necessary to provide guidance on healthy lifestyle habits, addictive behaviors, and support for increasing SOC to prevent the further deterioration of students' mental health.

CRediT authorship contribution statement

Tetsuro Noda: Conceptualization, Data curation, Formal analysis, Project administration, Writing – original draft, Writing – review & editing. **Hiromu Nagaura:** Conceptualization, Data curation, Formal analysis, Writing – review & editing. **Toshihiko Tsutsumi:** Conceptualization, Data curation, Formal analysis, Writing – review & editing. **Yoshinobu Fujita:** Conceptualization, Data curation, Writing – review & editing. **Yusuke Asao:** Conceptualization, Data curation, Writing – review & editing. **Ayane Matsuda:** Conceptualization, Data curation, Project administration, Writing – review & editing. **Atsuhiro Satsuma:** Conceptualization, Data curation, Writing – review & editing. **Manami Nakanishi:** Conceptualization, Data curation, Writing – review & editing. **Reika Ohnishi:** Conceptualization, Data curation, Writing – review & editing. **Miku Takemori:** Conceptualization, Data curation, Writing – review & editing.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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