



# Mental Health Problems among University Students under the Prolonged COVID-19 Pandemic in Japan: A Repeated Cross-Sectional Survey

Moe Seto,<sup>1</sup> Hitomi Usukura,<sup>2,3</sup> Yasuto Kunii,<sup>4</sup> Yumiko Hamaie,<sup>4</sup>  
Eiichi N. Kodama,<sup>5,6</sup> Yuko Makino,<sup>6</sup> Yoshitaka Kinouchi,<sup>7</sup> Chihiro Ito,<sup>7</sup>  
Tadayoshi Ikeda<sup>7</sup> and Hiroaki Tomita<sup>1,2,4</sup>

<sup>1</sup>Department of Psychiatry, Tohoku University Hospital, Sendai, Miyagi, Japan

<sup>2</sup>Department of Psychiatry, Tohoku University Graduate School of Medicine, Sendai, Miyagi, Japan

<sup>3</sup>Department of Psychology and Behavioral Sciences, Faculty of Human Sciences, Tohoku Gakuin University, Sendai, Miyagi, Japan

<sup>4</sup>Department of Disaster Psychiatry, International Research Institute of Disaster Science, Tohoku University, Sendai, Miyagi, Japan

<sup>5</sup>Department of Infectious Diseases, International Research Institute of Disaster Science, Tohoku University, Sendai, Miyagi, Japan

<sup>6</sup>Department of Infectious Diseases, Tohoku University Graduate School of Medicine, Sendai, Miyagi, Japan

<sup>7</sup>Institute for Excellence in Higher Education, Tohoku University, Sendai, Miyagi, Japan

Numerous studies have investigated the impact of the coronavirus disease 2019 (COVID-19) pandemic on mental health among university students within a year of its onset, but few have examined the impact of a prolonged pandemic on university life. This study aimed to evaluate the impact of the COVID-19 pandemic on the mental health of students in a large university community. Online questionnaire surveys were conducted on students from March 24 to April 14 (first survey,  $n = 3,357$ ) and December 2-23, 2021 (second survey,  $n = 2,604$ ). The questionnaires included items on demographic data, living conditions, and mental health status as measured using the Patient Health Questionnaire-9 for depressive symptoms and the Generalized Anxiety Disorder-7 scale for anxiety symptoms. The results showed that, compared with undergraduate students, graduate students, except those in Medicine, Dentistry, and Pharmaceutical Science courses, had more anxiety symptoms. Furthermore, among undergraduate students, depressive and anxiety symptoms were significantly higher in fourth- than in first-year students. Logistic regression analyses of data from both surveys revealed the seven risk factors associated with depressive or anxiety symptoms that affected the mental health of university students throughout the COVID-19 pandemic: 1) female or nonbinary gender, 2) graduate student, 3) quarantine experience due to COVID-19, 4) isolation from friends and acquaintances, 5) disorganized pattern of daily life, 6) worse financial situation, and 7) no availability of consultations regarding health, life, and finances. These findings suggest that mental health measures for university students need to be designed specific to each course.

**Keywords:** anxiety symptoms; COVID-19 pandemic; depressive symptoms; university students

Tohoku J. Exp. Med., 2023 May, 260 (1), 1-11.

doi: 10.1620/tjem.2023.J012

## Introduction

Japan frequently experiences natural disasters such as earthquakes, and based on findings and knowledge of disaster mental health, the need for post-disaster mental health

and psychosocial support has been widely recognized, leading to the provision of multi-layered support (Seto et al. 2019; Kunii et al. 2022a, b). However, no adequate support system for mental health under a pandemic has been established.

Received October 10, 2022; revised and accepted February 10, 2023; J-STAGE Advance online publication February 23, 2023

Correspondence: Hiroaki Tomita, M.D., Ph.D., Department of Psychiatry, Tohoku University Graduate School of Medicine, 1-1 Seiryomachi, Aoba-ku, Sendai, Miyagi 980-8574, Japan.

e-mail: htomita@med.tohoku.ac.jp

©2023 Tohoku University Medical Press. This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC-BY-NC-ND 4.0). Anyone may download, reuse, copy, reprint, or distribute the article without modifications or adaptations for non-profit purposes if they cite the original authors and source properly. <https://creativecommons.org/licenses/by-nc-nd/4.0/>

Women, younger people, unemployed people, and those with chronic/mental illness have experienced more distress during the COVID-19 pandemic (Xiong et al. 2020). Similarly, it has been pointed out that college students have also been at increased risk for mental health disorders during the pandemic (Xiong et al. 2020; Zhai and Du 2020). School life was abruptly interrupted in March 2020 because schools and events were frequently closed or canceled under a state of emergency declaration issued by the Japanese government in response to COVID-19. In universities, online classes became commonplace, and the number of opportunities for interpersonal exchange on campuses decreased significantly. Under situations where interpersonal interaction is reduced, peer support is difficult to obtain, leading to concerns about mental health problems. Previous studies have found that university students experienced mental health problems such as depression, anxiety, insomnia, and increased distress during the acute phase of the pandemic (Chen et al. 2020; Elmer et al. 2020; Ma et al. 2020; Son et al. 2020; Wang et al. 2020b; Wathélet et al. 2020). In the early phase of the pandemic in Japan, Nomura et al. (2021) conducted a mental health survey of 2,712 university students and pointed out that smoking, drinking alcohol, being female, and using social network services put students at higher risk of depression. Another study conducted on 473 Japanese medical students found that students who had concerns about online classes were at higher risk of anxiety and depression (Nishimura et al. 2021).

Although many cross-sectional studies have investigated mental health among university students, few studies have examined the impact of a prolonged pandemic on university life. There have consistently been changes in infec-

tion status and social situations related to the pandemic, and behavioral restrictions have accordingly become more or less restrictive. Nevertheless, maintaining countermeasures against infection has continuously been urged to some extent throughout the pandemic. Therefore, the present study aimed to assess the mental health situation of undergraduate and graduate students in a large university community under the prolonged COVID-19 pandemic.

## Methods

We conducted two surveys, once per academic year. Data were collected using an online questionnaire accessible via the Internet from March 24 to April 14 (first survey; early in the fourth wave of the COVID-19 pandemic in Japan) and from December 2 to 23 (second survey, between the fifth and sixth waves), 2021 (Ministry of Health, Labour and Welfare of Japan 2022). To ensure that the infection status and restrictions would be sufficiently different, we conducted the second survey in December because it was 9 months after the first survey and before the school holiday. A timeline of the data collection is shown in Fig. 1. Both surveys were conducted anonymously.

### Participants

Information about the survey was announced via an on-campus e-mail system and the Student Affairs Information System for all students enrolled at Tohoku University. Participation in the surveys was voluntary, and all students were guaranteed that the content of their responses and whether they had responded would remain anonymous and have no impact on evaluations of their academic performance. Completing the questionnaire was considered to indicate consent. The study protocol was

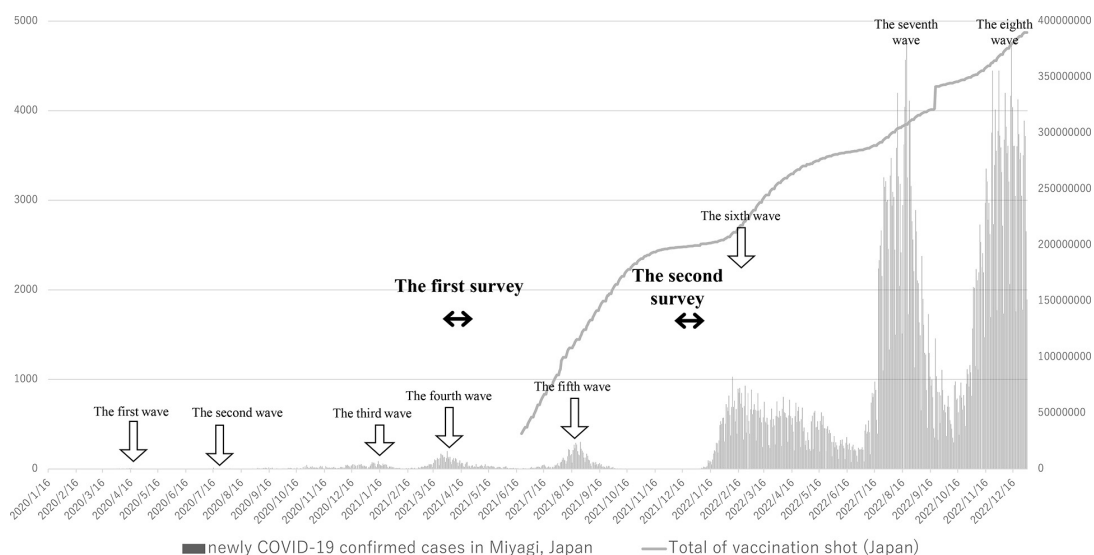


Fig. 1. Timeline of the data collection and number of newly confirmed COVID-19 cases in Miyagi Prefecture, Japan.

The figure summarizes the timeline of the data collection and the number of newly confirmed COVID-19 cases (daily) in Miyagi Prefecture, where Tohoku University is located. The figure also shows the cumulative number of COVID-19 vaccinations in Japan, which was compiled by the Digital Agency of Japan (<https://info.vrs.digital.go.jp/>; accessed January 10, 2023).

approved by the Ethics Committee of the Tohoku University Graduate School of Medicine (2020-1-1032, 2021-1-714). In the first survey, 3,799 students participated, 3,357 of whom completed all questionnaire sections. In the second survey, 2,817 students participated, 2,604 of whom completed all questionnaire sections (Fig. 2).

### Questionnaire

The questionnaires were composed of items on demographic data, living conditions, and mental health status. Demographic data consisted of questions about gender, undergraduate or graduate course (detailed information about the program, such as whether it was for a master's, doctoral, or professional degree was included in only the second survey), year of study (included only in the second survey), domestic or international student, and experience of being affected by COVID-19 or being a close contact of someone with COVID-19. Items on living conditions consisted of questions about living with a family or not, average number of days per week spent meeting and talking with friends and acquaintances, average number of days per week meeting and talking with friends and acquaintances prior to the COVID-19 pandemic (included only in the first survey), changes in the frequency of meeting and talking with friends and acquaintances after the start of the COVID-19 pandemic (included only in the second survey), changes in patterns of daily life after the start of the COVID-19 pandemic, changes in one's financial situation in regard to student life after the start of the COVID-19 pandemic, and availability of consultations regarding

health, life, and finances. Mental health conditions were measured using the Patient Health Questionnaire-9 (PHQ-9), which is composed of nine items on the frequency of depressive symptoms experienced within the last 2 weeks, and Generalized Anxiety Disorder-7 (GAD-7) scale, which is composed of seven items on the frequency of anxiety symptoms experienced within the last 2 weeks (Spitzer et al. 1999, 2006; Muramatsu 2014; Muramatsu et al. 2018).

### Statistical analysis

The Shapiro-Wilk test was used to evaluate the distribution, and then the Mann-Whitney  $U$  test was performed to compare the median scores on the PHQ-9 and GAD-7 scale between the first and second surveys. To compare the percentage of severity levels regarding depression and anxiety, PHQ-9 scores were classified into the following five groups representing levels of depressive symptoms according to criteria widely used in previous studies (Kroenke et al. 2001; Muramatsu 2014; Muramatsu et al. 2018): 0-4 (minimal or none), 5-9 (mild), 10-14 (moderate), 15-19 (moderate-severe), and 20-27 (severe). GAD-7 scores were classified into the following four groups representing levels of general anxiety symptoms according to criteria widely used in previous studies (Spitzer et al. 2006; Muramatsu 2014): 0-4 (minimal or none), 5-9 (mild), 10-14 (moderate), and 15-21 (severe). Using these severity classifications, chi-squared tests with adjusted standardized residuals were performed to compare the proportions of students with depressive symptoms and anxiety between the first and second surveys. Logistic regression analyses were conducted

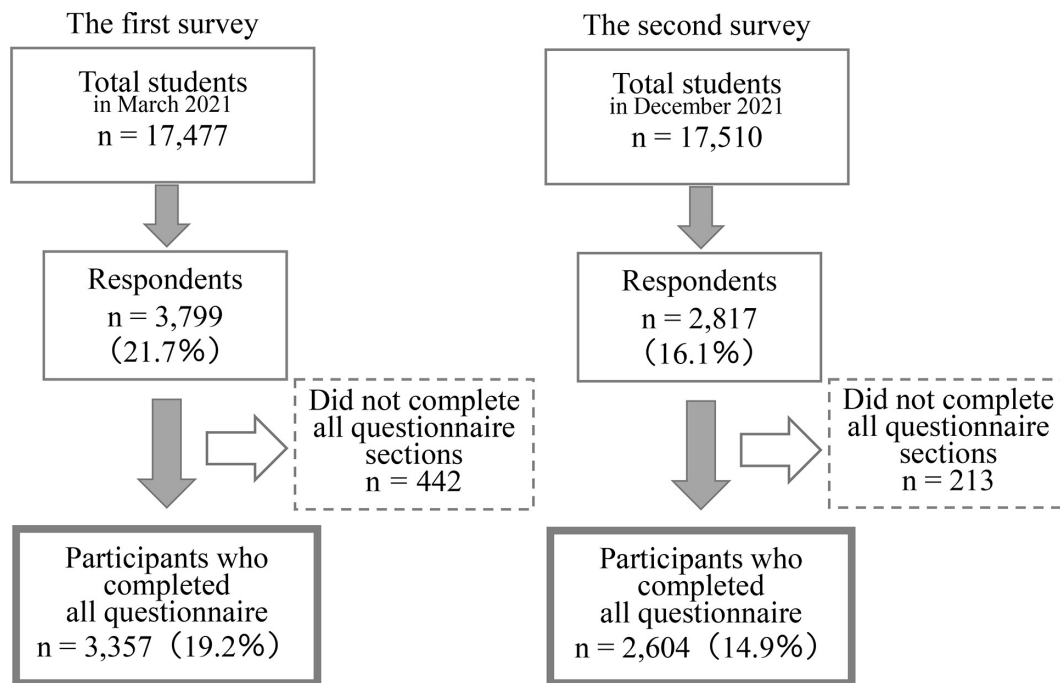


Fig. 2. Flowchart of participant selection in the first and second surveys.

The participants were recruited from among all students at Tohoku University. In the first survey, 3,799 students participated, 3,357 of whom completed all questionnaire sections. In the second survey, 2,817 students participated, 2,604 of whom completed all questionnaire sections.

Table 1. Educational programs and courses at Tohoku University.

	Undergraduate program (four-year course)	Undergraduate programs (six-year course)	Master's program	Doctoral program (three-year course)	Doctoral program (four-year course)	Professional degree
Faculty/Graduate School of Arts and Letters	✓		✓	✓		
Faculty/Graduate School of Education	✓		✓	✓		
School/Graduate School of Law	✓		✓	✓		
Faculty of Economics/Graduate School of Economics and Management	✓		✓	✓		
Faculty/Graduate School of Science	✓		✓	✓		
School/Graduate School of Engineering	✓		✓	✓		
Faculty of Agriculture/Graduate School of Agricultural Science	✓		✓	✓		
School/Graduate School of Medicine	✓	✓	✓	✓	✓	
School/Graduate School of Dentistry		✓	✓		✓	
Faculty/Graduate School of Pharmaceutical Sciences	✓	✓	✓	✓	✓	
Graduate School of International Cultural Studies			✓	✓		
Graduate School of Information Sciences			✓	✓		
Graduate School of Life Sciences			✓	✓		
Graduate School of Environmental Studies			✓	✓		
Graduate School of Biomedical Engineering			✓	✓		
Graduate School of Educational Informatics				✓		
Law School						✓
Graduate School of Publicpolicy						✓
Accounting School						✓

Table 1 provides an outline of 19 courses and educational programs at Tohoku University.

to evaluate associations between mental health conditions and demographic data or living conditions. All independent variables were used in the analyses using the forced-entry method. In the second survey, detailed data about the students' educational programs were collected (Table 1): 1) undergraduate program, 2) master's program, 3) doctoral program, or 4) professional degree program. Using these classifications, analyses of variance were conducted to compare the depressive and anxiety symptom scores by grade for each program. However, because detailed course information (i.e., a 4- or 6-year program) was not collected for the Medicine and Pharmaceutical Sciences students, and some grade responses were insufficient from Dentistry students, mental health outcomes were compared among grades for each educational program except the above three.

All statistical analyses were carried out using SPSS Statistics 27 (IBM, Armonk, NY, USA), and all statistical tests were two-sided with a significance level of  $p < 0.05$ .

## Results

### Characteristics

The response rates in the first and second surveys were 21.0% and 16.5% and 13.2% and 17.5% for undergraduate and graduate students, respectively. Table 2 shows the number of participants by each program and gender.

### Prevalence of depressive and anxiety symptoms

The median PHQ-9 scores in the first and second surveys were 5.00 [interquartile range (IQR) = 2.00-10.00] and

5.00 (IQR = 2.00-10.00), respectively, with no significant difference observed between the two groups ( $p = 0.820$ ). Furthermore, no significant difference was seen in the proportions of students with depressive symptoms (PHQ-9 score  $\geq 10$ ), as shown in Fig. 3 [ $\chi^2(4) = 6.95, p = 0.138$ ].

The median GAD-7 scale scores in the first and second surveys were 2.00 (IQR = 0.00-6.00) and 3.00 (IQR = 1.00-7.00), respectively, and anxiety symptom scores were significantly higher in the second than in the first survey ( $p < 0.001$ ). The proportions of students with anxiety symptoms (GAD-7 score  $\geq 10$ ) were 13.1% and 14.2% in the first and second surveys, respectively, as shown in Fig. 4. The proportions of participants in the four subgroups differed significantly in regard to the severity of anxiety symptoms between the first and second surveys [ $\chi^2(3) = 18.344, p < 0.001$ ]. Residual analysis revealed that more students had mild anxiety in the second (24.1%) than in the first survey (20.1%), and that fewer students had minimal or no anxiety in the second (61.7%) than in the first survey (66.8%) (adjusted standardized residual for mild anxiety = 3.65,  $p < 0.0001$ , adjusted standardized residual for minimal or no anxiety = 4.09,  $p = 0.0003$ ).

### Risk factors for depression and anxiety under the pandemic

We conducted logistic regression analysis to evaluate factors related to the students' depressive and anxiety symptoms at various time points during the COVID-19 pandemic, as shown in Tables 3 and 4. The analysis revealed that the following factors were significantly associated with

Table 2. Characteristics of participants (educational program and gender).

	The first survey			The second survey		
	Total students	Participants	Response rate	Total students	Participants	Response rate
Undergraduate program	10,466	2,203	21.0%	10,629	1,400	13.2%
(Male)		(1,396)			(876)	
(Female)		(789)			(499)	
(Other)		(18)			(25)	
Graduate school	7,011	1,154	16.5%	6,881	1,203	17.5%
(Male)		(737)			(780)	
(Female)		(412)			(414)	
(Other)		(5)			(8)	

Table 2 shows the participants' characteristics and response rates by educational program and gender. The number of total students was based on Tohoku University data at the time of each survey.

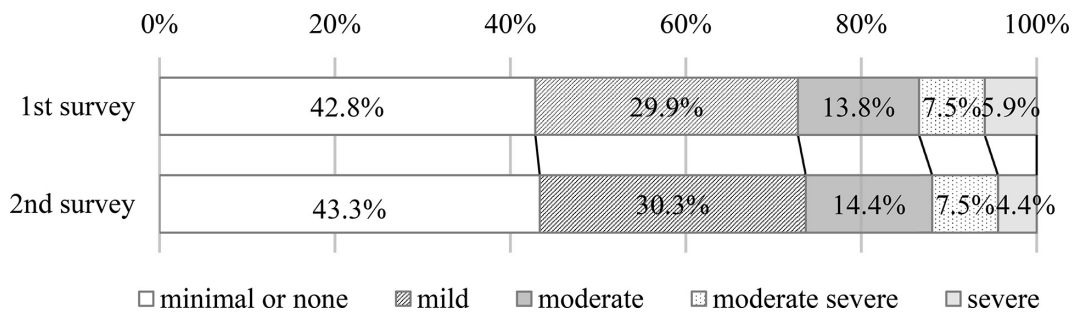


Fig. 3. Percentage of students with depressive symptoms.

Patient Health Questionnaire-9 (PHQ-9) scores were classified into the following five groups representing levels of depressive symptoms: 0-4 (minimal or none), 5-9 (mild), 10-14 (moderate), 15-19 (moderate-severe), and 20-27 (severe). The figure also shows the percentage of participants per level of depressive symptoms.

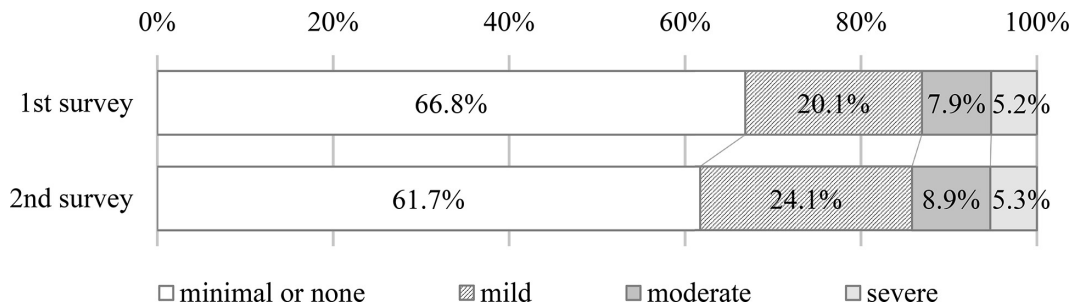


Fig. 4. Percentage of students with anxiety symptoms.

Generalized Anxiety Disorder-7 (GAD-7) scores were classified into the following four groups representing levels of general anxiety symptoms: 0-4 (minimal or none), 5-9 (mild), 10-14 (moderate), and 15-21 (severe). The figure also shows the percentage of participants per level of anxiety symptoms.

depressive or anxiety symptoms: 1) female or nonbinary gender, 2) graduate student, 3) quarantine experience due to COVID-19, 4) isolation from friends and acquaintances, 5) disorganized pattern of daily life, 6) worse financial situation, and 7) no availability of consultations regarding health, life, and finances.

Female and nonbinary students were associated with an increased risk of depressive and anxiety symptoms compared with male students in the first and second surveys. Graduate students were associated with an increased risk of anxiety symptoms compared with undergraduate students. Students who had been affected by COVID-19 or consid-

ered a close contact of someone with COVID-19 were at higher risk of anxiety symptoms in only the second survey.

In the first survey, students who did not meet and talk with friends and acquaintances at all were associated with a higher risk of depressive symptoms than were those who met and talked with friends and acquaintances 5-7 days per week. In the second survey, students who met and talked with friends and acquaintances 0, 1, 3, and 4 days per week were at higher risk of depressive and anxiety symptoms than were those who met and talked with friends and acquaintances 5-7 days per week. Irregular and disorganized patterns of daily life after the start of the COVID-19

Table 3. Factors associated with depressive and anxiety symptoms in the first survey according to logistic regression analysis.

	The first survey (March 24 - April 14, 2021) n = 3,357							
	n	%	PHQ-9			GAD-7		
			OR	(95%CI)	p value	OR	(95%CI)	p value
Gender								
Male	2,133	63.54	1	(reference)		1	(reference)	
Female	1,201	35.78	<b>1.24</b>	<b>(1.03-1.49)</b>	<b>0.022*</b>	1.21	(0.96-1.53)	0.108
Other	23	0.685	<b>5.48</b>	<b>(2.20-13.67)</b>	<b>&lt; 0.001**</b>	2.31	(0.78-6.85)	0.132
Course								
Undergraduate program	2,203	65.62	1	(reference)		1	(reference)	
Graduate school	1,154	34.38	1.21	(0.98-1.49)	0.072	<b>1.85</b>	<b>(1.43-2.39)</b>	<b>&lt; 0.001**</b>
International student								
Domestic students	2,895	86.24	1	(reference)		1	(reference)	
International students	462	13.76	0.82	(0.62-1.09)	0.171	1.09	(0.78-1.51)	0.621
COVID-19 impact								
Never be affected by the COVID-19 or considered a close contact of the COVID-19	3,055	91	1	(reference)		1	(reference)	
Experience of being affected by the COVID-19 or considered a close contact of the COVID-19	302	8.996	1.10	(0.81-1.49)	0.552	0.90	(0.61-1.34)	0.616
Living with family or not								
Live with family at home	696	20.73	1	(reference)		1	(reference)	
Not live with family	2,661	79.27	1.21	(0.96-1.51)	0.100	0.84	(0.63-1.11)	0.219
Average days per week to meet and talk with friends and acquaintances								
5-7 days	578	17.22	1	(reference)		1	(reference)	
3-4 days	608	18.11	1.07	(0.78-1.46)	0.692	1.19	(0.79-1.79)	0.399
2 days	634	18.89	1.14	(0.83-1.56)	0.421	0.91	(0.60-1.38)	0.671
1 day	752	22.4	1.28	(0.94-1.74)	0.121	1.17	(0.78-1.73)	0.449
0 days	785	23.38	<b>1.84</b>	<b>(1.34-2.51)</b>	<b>&lt; 0.001**</b>	1.34	(0.90-1.99)	0.153
Average days per week to meet and talk with friends and acquaintances prior to the COVID-19 epidemic								
5-7 days	2,003	59.67	1	(reference)		1	(reference)	
3-4 days	762	22.7	1.11	(0.89-1.40)	0.349	1.00	(0.75-1.35)	0.983
2 days	226	6.732	0.98	(0.68-1.43)	0.926	1.11	(0.69-1.80)	0.672
1 day	177	5.273	1.32	(0.88-1.98)	0.177	1.42	(0.85-2.38)	0.182
0 days	189	5.63	<b>1.61</b>	<b>(1.09-2.38)</b>	<b>0.018*</b>	1.23	(0.74-2.06)	0.419
Change in the pattern of daily life after the COVID-19 epidemic								
Become more regular	110	3.277	1	(reference)		1	(reference)	
Become somewhat more regular	281	8.371	1.70	(0.88-3.27)	0.115	1.20	(0.54-2.69)	0.652
No change	873	26.01	1.36	(0.74-2.50)	0.329	0.92	(0.43-1.95)	0.825
Become somewhat irregular and disorganized	1,320	39.32	<b>1.86</b>	<b>(1.02-3.40)</b>	<b>0.043*</b>	1.08	(0.52-2.25)	0.830
Become irregular and disorganized	773	23.03	<b>6.26</b>	<b>(3.41-11.47)</b>	<b>&lt; 0.001**</b>	<b>2.80</b>	<b>(1.35-5.80)</b>	<b>0.006*</b>
Change in the financial situation regarding student life after the COVID-19 epidemic								
No change	2,053	61.16	1	(reference)		1	(reference)	
Improved	144	4.29	0.95	(0.60-1.49)	0.813	0.72	(0.37-1.39)	0.325
Slightly worsened	938	27.94	1.20	(0.99-1.47)	0.068	1.18	(0.92-1.53)	0.202
Significantly worsened	222	6.613	<b>2.29</b>	<b>(1.63-3.21)</b>	<b>&lt; 0.001**</b>	<b>1.74</b>	<b>(1.19-2.53)</b>	<b>&lt; 0.001**</b>
Availability of consult about health, life, and finances								
Don't have any issues needed to consult	1,366	40.69	1	(reference)		1	(reference)	
Able to consult about issues needed to do so	1,366	40.69	<b>1.39</b>	<b>(1.13-1.70)</b>	<b>0.001**</b>	<b>1.92</b>	<b>(1.41-2.63)</b>	<b>&lt; 0.001**</b>
Not able to consult about issues needed to do so	1,366	40.69	<b>6.89</b>	<b>(5.39-8.81)</b>	<b>&lt; 0.001**</b>	<b>10.22</b>	<b>(7.46-14.01)</b>	<b>&lt; 0.001**</b>

Table 3 summarizes the demographics of participating university students and the results of logistic regression analysis regarding factors associated with the mental health conditions of university students in the first survey. PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder-7 scale; OR, odds ratio; CI, confidence interval. \* $p < 0.05$ , \*\* $p < 0.01$ .

Table 4. Factors associated with depressive and anxiety symptoms in the second survey according to logistic regression analysis.

	The second survey (December 2-23, 2021) n = 2,603							
	n	%	PHQ-9			GAD-7		
			OR	(95%CI)	p value	OR	(95%CI)	p value
<b>Gender</b>								
Male	1,657	63.66	1	(reference)		1	(reference)	
Female	913	35.07	<b>1.34</b>	<b>(1.08-1.66)</b>	<b>0.007*</b>	<b>1.37</b>	<b>(1.06-1.78)</b>	<b>0.017*</b>
Other	33	1.268	<b>3.77</b>	<b>(1.72-8.28)</b>	<b>&lt; 0.001**</b>	<b>3.09</b>	<b>(1.28-7.44)</b>	<b>0.012*</b>
<b>Course</b>								
Undergraduate program	1,400	53.78	1	(reference)		1	(reference)	
Graduate school	1,203	46.22	1.22	(0.97-1.53)	0.095	<b>1.45</b>	<b>(1.1-1.92)</b>	<b>0.009*</b>
<b>International student</b>								
Domestic students	2,104	80.83	1	(reference)		1	(reference)	
International students	499	19.17	<b>0.71</b>	<b>(0.53-0.96)</b>	<b>0.024*</b>	1.18	(0.84-1.65)	0.336
<b>COVID-19 impact</b>								
Never be affected by the COVID-19 or considered a close contact of the COVID-19	2,257	86.71	1	(reference)		1	(reference)	
Experience of being affected by the COVID-19 or considered a close contact of the COVID-19	346	13.29	1.18	(0.88-1.57)	0.272	<b>1.44</b>	<b>(1.03-2.01)</b>	<b>0.033*</b>
<b>Living with family or not</b>								
Live with family at home	514	19.75	1	(reference)		1	(reference)	
Not live with family	2,089	80.25	0.99	(0.76-1.27)	0.908	0.78	(0.58-1.06)	0.111
<b>Average days per week to meet and talk with friends and acquaintances</b>								
5-7 days	1,087	41.76	1	(reference)		1	(reference)	
3-4 days	677	26.01	<b>1.6</b>	<b>(1.24-2.07)</b>	<b>&lt; 0.001**</b>	<b>1.66</b>	<b>(1.19-2.32)</b>	<b>&lt; 0.003**</b>
2 days	335	12.87	1.24	(0.89-1.72)	0.202	1.36	(0.91-2.06)	0.137
1 day	261	10.03	<b>1.94</b>	<b>(1.38-2.74)</b>	<b>&lt; 0.001**</b>	<b>2.42</b>	<b>(1.62-3.6)</b>	<b>&lt; 0.001**</b>
0 days	243	9.335	<b>2.16</b>	<b>(1.52-3.08)</b>	<b>&lt; 0.001**</b>	<b>2.91</b>	<b>(1.94-4.35)</b>	<b>&lt; 0.001**</b>
<b>Change in frequency to meet and talk with friends and acquaintances after the COVID-19 epidemic</b>								
No change	709	27.24	1	(reference)		1	(reference)	
Increase	55	2.113	0.6	(0.26-1.39)	0.234	0.42	(0.12-1.47)	0.176
Decrease	1,839	70.65	1.01	(0.79-1.29)	0.934	0.91	(0.67-1.23)	0.529
<b>Change in the pattern of daily life after the COVID-19 epidemic</b>								
Become more regular	77	2.958	1	(reference)		1	(reference)	
Become somewhat more regular	198	7.607	0.96	(0.49-1.9)	0.913	1.73	(0.71-4.2)	0.22
No change	943	36.23	0.65	(0.36-1.19)	0.162	1.07	(0.48-2.43)	0.86
Become somewhat irregular and disorganized	909	34.92	1.03	(0.57-1.88)	0.918	1.11	(0.49-2.5)	0.80
Become irregular and disorganized	476	18.29	<b>2.86</b>	<b>(1.55-5.26)</b>	<b>&lt; 0.001**</b>	<b>2.7</b>	<b>(1.2-6.1)</b>	<b>0.02*</b>
<b>Current financial situation regarding student life during the COVID-19 epidemic</b>								
Have enough money	815	31.31	1	(reference)		1	(reference)	
Don't have enough money, but don't have significant difficulties	1,434	55.09	1.16	(0.92-1.46)	0.218	1.11	(0.83-1.48)	0.480
Don't have enough money, and finding life difficult	280	10.76	<b>1.43</b>	<b>(1.01-2.02)</b>	<b>0.044*</b>	1.19	(0.79-1.81)	0.400
Really don't have enough money, and finding life very difficult	74	2.843	<b>4.19</b>	<b>(2.26-7.79)</b>	<b>&lt; 0.001**</b>	<b>4.39</b>	<b>(2.42-7.97)</b>	<b>&lt; 0.001**</b>
<b>Availability of consult about health, life, and finances</b>								
Don't have any issues needed to consult	1,047	40.22	1	(reference)		1	(reference)	
Able to consult about issues needed to do so	1,150	44.18	<b>1.43</b>	<b>(1.13-1.8)</b>	<b>0.003**</b>	<b>1.73</b>	<b>(1.25-2.39)</b>	<b>0.001**</b>
Not able to consult about issues needed to do so	406	15.6	<b>7.9</b>	<b>(5.94-10.51)</b>	<b>&lt; 0.001**</b>	<b>7.44</b>	<b>(5.29-10.46)</b>	<b>&lt; 0.001**</b>

Table 4 summarizes the demographics of participating university students and the results of logistic regression analysis regarding factors associated with the mental health conditions of university students in the second survey. PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder-7 scale; OR, odds ratio; CI, confidence interval. \* $p < 0.05$ , \*\* $p < 0.01$ .

pandemic were associated with an increased risk of depressive and anxiety symptoms in both surveys. Students with a worse economic condition or difficult economic condition were at a higher risk of depressive and anxiety symptoms than were those whose economic conditions had not been affected by the COVID-19 pandemic or who had sufficient financial resources. Students who could not access consultations regarding health, life, and finances were associated with an increased risk of depressive and anxiety symptoms than were those who could.

#### *Differences in depressive and anxiety symptoms by grade for each course under the pandemic*

Based on the results of analysis of variance (ANOVA) using data from the second survey (except Medicine, Dentistry, and Pharmaceutical Sciences), no significant differences in depressive symptoms were found among the students from the four programs [ $F(3, 2227) = 0.759, p = 0.517$ ]. Regarding anxiety symptoms, significant differences were observed among the programs [ $F(3, 2227) = 12.462, p < 0.001$ ], and the results of Bonferroni post-hoc analysis showed that master's and doctoral students had more anxiety symptoms than did undergraduate students (Table 5).

ANOVA was also used to compare depressive and anxiety symptoms among the grades for each program using data from the second survey, as shown in Table 6. Among the undergraduate students, the PHQ-9 scores for depressive symptoms and the GAD-7 scale scores for anxiety symptoms were significantly higher in fourth- than in first-year students [ $F(4, 1172) = 4.873, p < 0.001$  vs.  $F(4, 1172) = 3.655, p = 0.006$ , respectively]. Among the master's students, the GAD-7 scale scores for anxiety symptoms were significantly higher in second- than in first-year students [ $F(2, 659) = 5.585, p = 0.004$ ]. Among students in a doctoral program, the GAD-7 scale scores for anxiety symptoms were significantly higher in students who had studied longer than 3 years than in first-year doctoral students [ $F(3, 365) = 2.680, p = 0.047$ ].

## Discussion

To our knowledge, this is the first study to investigate the impact of the prolonged COVID-19 pandemic on students in a large university community. Surveys conducted in 2021 from March 24 to April 14 (first survey) and from December 2 to 23 (second survey) revealed differences in situations in regard to infections between the first and second surveys (Fig. 1). We found that the proportion of students with depressive or anxiety symptoms had not decreased, despite the decline in COVID-19 infections between the first and second surveys. These findings suggest that risk factors for mental health problems remained influential even years after the onset of the pandemic.

#### *Changes in mental health status among university students under the pandemic*

The proportions of students with depressive symptoms and anxiety symptoms were 27.2% and 26.3%, and 13.1% and 14.2% in the first and second surveys, respectively. These proportions were higher than those of the general population in Japan reported in a previous study (17.3% with depressive symptoms and 10.9% with anxiety symptoms) (Ueda et al. 2020). During the pandemic, elementary, junior high, and high schools quickly resumed face-to-face classes, whereas universities shifted to online classes. Although remote work has become widespread among working people, university students have restrictions in terms of not only face-to-face classes, but also extracurricular activities and part-time work; these restrictions have greatly affected their campus life. These changes in the environment surrounding university students may also have affected their mental health.

It is noteworthy that the proportion of students who had mild anxiety symptoms in the second survey increased compared with the first survey, despite the decline in COVID-19 infections. This might have been due to the prolonged impact of the pandemic on daily life or other factors unrelated to the pandemic, such as end-of-year exami-

Table 5. Differences in depressive and anxiety symptoms among the educational programs in the second survey (except Medicine, Dentistry, Pharmaceutical Sciences).

	(n = 2,231)							
	n	%	PHQ-9			GAD-7		
			Mean	SD	p value	Mean	SD	p value
Undergraduate program	1,177	52.8%	6.8	5.8	0.517	4.0	4.4	< 0.001**
Master's program	662	29.7%	6.9	6.1		4.9	5.1	Undergraduate < Master's, Doctoral
Doctoral program	369	16.5%	7.3	6.2		5.6	5.3	
Professional degree	23	1.0%	7.2	4.2		4.7	4.2	

Table 5 shows the numbers of participants in each of the six programs at Tohoku University and the percentage of participants in each program among the total number of respondents. Table 5 also shows the mean scores and standard deviations (SDs) for the Patient Health Questionnaire-9 (PHQ-9) and Generalized Anxiety Disorder-7 (GAD-7) for students in each program. The results of analysis of variance and a Bonferroni post-hoc test comparing PHQ-9 and GAD-7 scores among the six programs are shown. PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder-7 scale; SD, standard deviation. \*\* $p < 0.01$ .



Table 6. Differences in depressive and anxiety symptoms by grade for each educational program in the second survey (except Medicine, Dentistry, Pharmaceutical Sciences).

				PHQ-9			GAD-7		
		n	%	Mean	SD	p value	Mean	SD	p value
Undergraduate program, n = 1,177	1st grade	381	32.4%	6.0	5.0	0.001**	3.5	4.0	0.006**
	2nd grade	247	21.0%	7.1	5.8	1st < 4th	3.7	4.2	1st < 4th
	3rd grade	249	21.2%	6.5	5.7		4.2	4.7	
	4th grade	296	25.1%	7.8	6.4		4.6	4.8	
	5th grade and above	4	0.3%	11.0	10.2		7.8	8.1	
Master's program, n = 662	1st grade	327	49.4%	6.5	5.9	0.166	4.2	4.8	0.004**
	2nd grade	327	49.4%	7.4	6.2		5.5	5.4	1st < 2nd
	3rd grade and above	8	1.2%	7.0	4.9		6.9	4.2	
Doctoral program, n = 369	1st grade	126	34.1%	7.3	6.4	0.100	5.2	5.1	0.047*
	2nd grade	113	30.6%	6.8	5.6		5.4	5.0	1st < 4th and above
	3rd grade	103	27.9%	7.2	6.2		5.5	5.1	
	4th grade and above	27	7.3%	10.1	7.1		8.3	7.2	
Professional degree, n = 23	1st grade	10	43.5%	6.8	4.0	0.753	5.3	4.3	0.661
	2nd grade	9	39.1%	7.6	4.6		4.7	4.3	
	3rd grade	4	17.4%	6.3	3.0		3.0	1.4	

Table 6 shows the numbers of participants per grade in each program at Tohoku University and the percentage of participants in each grade among the total number of students in each program. Table 6 also shows the mean scores and standard deviations (SDs) for the Patient Health Questionnaire-9 (PHQ-9) and Generalized Anxiety Disorder-7 (GAD-7) scale for each grade. The results of analysis of variance and a Bonferroni post-hoc test comparing PHQ-9 and GAD-7 scores by grade are shown. PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder-7 scale; SD, standard deviation. \* $p < 0.05$ , \*\* $p < 0.01$ .

nations and graduation-related deadlines (e.g., master's or doctoral thesis) around the time of the second survey. The first survey was mainly conducted during the spring holiday at the end of the school year, when students had nearly completed their examinations to graduate or move on to the next grade, and thus had less anxiety compared with during the semester.

Regarding the characteristics of mental health conditions specific to each educational program, the anxiety levels of graduate students were higher than those of undergraduate students in both the first and second surveys. A meta-analysis of student mental health data published from January 1, 2020 to January 1, 2021 revealed that undergraduates had severer depressive and anxiety symptoms than did graduate students (Deng et al. 2021), which was contrary to the results of the present study. While the meta-analysis data were collected in the early phase (within several months) of the pandemic, the present survey was conducted in March 2021 and December 2021 (15 months and 2 years after the onset of the COVID-19 pandemic, respectively). This difference suggests that prolonged lifestyle changes due to the pandemic may have caused a severer impact on the mental health conditions of graduate students compared with undergraduate students. Wang et al. (2020b) reported that graduate students had better mental health conditions than undergraduate students based on a survey conducted in the early phase of the pandemic, and

speculated that graduate students maintained their mental health by concentrating on research. Our results from surveys conducted in the chronic phase of the pandemic suggested that, as the pandemic continued, long-term restrictions in students' daily campus lives may have hindered research activities, thereby leading to more stress and anxiety among graduate students.

The final-year undergraduate, master's, and doctoral students in each program (except Medicine, Dentistry, and Pharmaceutical Sciences) showed more anxiety symptoms than first-year students. Previous studies conducted in the early stages of the pandemic hypothesized that first-year students in each course may have experienced severe stress because of adjustments to their new environment in the midst of the COVID-19 pandemic, which distracted the necessary networking process (Wang et al. 2020a). Surprisingly, the present survey found that first-year students showed relatively fair mental health conditions regardless of the pandemic, whereas final-year students in each course showed severer mental health conditions. First-year students may have an advantage in adapting to a pandemic situation because they must adjust to a new life, regardless of whether there is an ongoing pandemic. On the other hand, final-year students need to prepare for graduation while facing unfamiliar and unexpected situations due to the pandemic. Our results highlight the necessity of mental health care and support for the final-year students in

each course in the chronic phase of a pandemic.

#### *Factors associated with depressive or anxiety symptoms among students during the COVID-19 pandemic*

The present study revealed that the following factors were associated with depressive or anxiety symptoms throughout the period between the first and second surveys during the COVID-19 pandemic: 1) female or nonbinary gender, 2) graduate student, 3) quarantine experience due to COVID-19, 4) isolation from friends and acquaintances, 5) disorganized pattern of daily life, 6) worse financial situation, and 7) no availability of consultations regarding health, life, and finances. The involvement of these factors with the mental health conditions of university students under the COVID-19 pandemic is mostly consistent with findings from studies conducted in the early stage of pandemic in Japan, China, and Western countries (Chen et al. 2020; Elmer et al. 2020; Wathélet et al. 2020). The present study indicated that these factors remained major risk factors for mental health problems among university students, even under the prolonged pandemic. Therefore, these factors should be considered when devising mental health measures under a pandemic.

For example, regarding worse financial situations and isolation, Tohoku University facilitated systems to hire students as peer supporters or teaching assistants with the aim of enriching educational systems while providing financial support. Tohoku University also established scholarships to support students with financial difficulties or utilized outcome data from the survey to call on charities for students supports. It is important to provide occasions where students can receive support or consult professionals regarding their life, health, or finances, especially under situations such as the COVID-19 pandemic.

In conclusion, the results of the present study suggest that mental health problems among university students may have persisted at a similar level between the early phase and 2 years after the onset of the COVID-19 pandemic. Students identifying as female or nonbinary gender, graduate students, and final-year students in each educational program were identified as high-risk populations in regard to mental health problems. In consideration of the factors affecting the mental health of university students under a pandemic, it is necessary to maintain interactions between students, encourage them to maintain a routine lifestyle, and to provide consultation services and financial support. In summary, it may be beneficial to provide students with comprehensive psychosocial support as well as support designed for the characteristics of each course to help prevent mental health problems during a pandemic.

#### *Limitations*

The present study had several limitations. First, it was not possible to compare data regarding mental health status among students before and after the start of the COVID-19 pandemic because of a lack of information before the start

of the pandemic. In addition, future research needs to be conducted after the end of the pandemic to compare the results with the present data and help estimate the influence of the pandemic on mental health among students. When preparing a support system for pandemics or disaster settings, regular mental health surveys in ordinary settings are needed to grasp the overall mental health status of university students. Second, as the present surveys were conducted anonymously with the intention of increasing the response rate, it was not possible to link participants in the first and second surveys to analyze longitudinal changes within individuals. Third, the response rates of the first and second surveys were low (14.9% and 19.9% of all university students, respectively). Students may have been overwhelmed with questionnaires sent via the university's official mailing system. The responders to these surveys may have been biased toward students who were cooperative with administrators or had an interest in health and life conditions during the pandemic. Fourth, differences were found in situations regarding infections and campus schedules between the first and second surveys, and these may have influenced the students' mental health conditions in complex ways. Although it would have been ideal to match the prevailing infection conditions among communities between the surveys, the situation was continuously changing, with ongoing differences in the number of infections and social conditions related to the pandemic. It is technically difficult to set the timing of the survey to the peak of a wave of infections because the timing of such peaks is hard to predict. However, countermeasures against COVID-19 continue to be required, and the level of social activities has yet to return to previous levels; therefore, it is meaningful to continue to monitor the mental health situation among university students regularly under the condition of a prolonged pandemic.

#### **Acknowledgments**

This study was supported by a grant from the Mitsubishi Foundation (grant No. 202012006). We thank all of the survey participants and the university faculty members for their support and cooperation.

#### **Conflict of Interest**

The authors declare no conflict of interest.

#### **References**

- Chen, R.N., Liang, S.W., Peng, Y., Li, X.G., Chen, J.B., Tang, S.Y. & Zhao, J.B. (2020) Mental health status and change in living rhythms among college students in China during the COVID-19 pandemic: a large-scale survey. *J. Psychosom. Res.*, **137**, 110219.
- Deng, J., Zhou, F., Hou, W., Silver, Z., Wong, C.Y., Chang, O., Drakos, A., Zuo, Q.K. & Huang, E. (2021) The prevalence of depressive symptoms, anxiety symptoms and sleep disturbance in higher education students during the COVID-19 pandemic: a systematic review and meta-analysis. *Psychiatry Res.*, **301**, 113863.
- Elmer, T., Mephram, K. & Stadtfeld, C. (2020) Students under

- lockdown: comparisons of students' social networks and mental health before and during the COVID-19 crisis in Switzerland. *PLoS One*, **15**, e0236337.
- Kroenke, K., Spitzer, R.L. & Williams, J.B. (2001) The PHQ-9: validity of a brief depression severity measure. *J. Gen. Intern. Med.*, **16**, 606-613.
- Kunii, Y., Usukura, H., Otsuka, K., Maeda, M., Yabe, H., Takahashi, S., Tachikawa, H. & Tomita, H. (2022a) Lessons learned from psychosocial support and mental health surveys during the 10 years since the Great East Japan Earthquake: establishing evidence-based disaster psychiatry. *Psychiatry Clin. Neurosci.*, **76**, 212-221.
- Kunii, Y., Usukura, H., Utsumi, Y., Seto, M., Hamaie, Y., Sugawara, Y., Nakaya, N., Kuriyama, S., Hozawa, A., Tsuji, I. & Tomita, H. (2022b) Review of mental health consequences of the Great East Japan Earthquake through long-term epidemiological studies: The Shichigahama Health Promotion Project. *Tohoku J. Exp. Med.*, **257**, 85-95.
- Ma, Z., Zhao, J., Li, Y., Chen, D., Wang, T., Zhang, Z., Chen, Z., Yu, Q., Jiang, J., Fan, F. & Liu, X. (2020) Mental health problems and correlates among 746 217 college students during the coronavirus disease 2019 outbreak in China. *Epidemiol. Psychiatr. Sci.*, **29**, e181.
- Ministry of Health, Labour and Welfare of Japan (2022) COVID-19 trends: Trend in the number of newly confirmed cases (daily). <https://covid19.mhlw.go.jp/> [Accessed: August 14, 2022].
- Muramatsu, K. (2014) An up-to-date letter in the Japanese version of PHQ, PHQ-9, PHQ-15. *Graduate School of Niigata Seiryō University Clinical Psychology Research*, **7**, 35-39 (in Japanese).
- Muramatsu, K., Miyaoka, H., Kamijima, K., Muramatsu, Y., Tanaka, Y., Hosaka, M., Miwa, Y., Fuse, K., Yoshimine, F., Mashima, I., Shimizu, N., Ito, H. & Shimizu, E. (2018) Performance of the Japanese version of the Patient Health Questionnaire-9 (J-PHQ-9) for depression in primary care. *Gen. Hosp. Psychiatry*, **52**, 64-69.
- Nishimura, Y., Ochi, K., Tokumasu, K., Obika, M., Hagiya, H., Kataoka, H. & Otsuka, F. (2021) Impact of the COVID-19 pandemic on the psychological distress of medical students in Japan: cross-sectional survey study. *J. Med. Internet Res.*, **23**, e25232.
- Nomura, K., Minamizono, S., Maeda, E., Kim, R., Iwata, T., Hirayama, J., Ono, K., Fushimi, M., Goto, T., Mishima, K. & Yamamoto, F. (2021) Cross-sectional survey of depressive symptoms and suicide-related ideation at a Japanese national university during the COVID-19 stay-home order. *Environ. Health Prev. Med.*, **26**, 30.
- Seto, M., Nemoto, H., Kobayashi, N., Kikuchi, S., Honda, N., Kim, Y., Kelman, I. & Tomita, H. (2019) Post-disaster mental health and psychosocial support in the areas affected by the Great East Japan Earthquake: a qualitative study. *BMC Psychiatry*, **19**, 261.
- Son, C., Hegde, S., Smith, A., Wang, X. & Sasangohar, F. (2020) Effects of COVID-19 on college students' mental health in the United States: interview survey study. *J. Med. Internet Res.*, **22**, e21279.
- Spitzer, R.L., Kroenke, K. & Williams, J.B.; the Patient Health Questionnaire Primary Care Study Group (1999) Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. *JAMA*, **282**, 1737-1744.
- Spitzer, R.L., Kroenke, K., Williams, J.B. & Lowe, B. (2006) A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch. Intern. Med.*, **166**, 1092-1097.
- Ueda, M., Stickley, A., Sueki, H. & Matsubayashi, T. (2020) Mental health status of the general population in Japan during the COVID-19 pandemic. *Psychiatry Clin. Neurosci.*, **74**, 505-506.
- Wang, X., Hegde, S., Son, C., Keller, B., Smith, A. & Sasangohar, F. (2020a) Investigating mental health of US college students during the COVID-19 pandemic: cross-sectional survey study. *J. Med. Internet Res.*, **22**, e22817.
- Wang, Z.H., Yang, H.L., Yang, Y.Q., Liu, D., Li, Z.H., Zhang, X.R., Zhang, Y.J., Shen, D., Chen, P.L., Song, W.Q., Wang, X.M., Wu, X.B., Yang, X.F. & Mao, C. (2020b) Prevalence of anxiety and depression symptom, and the demands for psychological knowledge and interventions in college students during COVID-19 epidemic: a large cross-sectional study. *J. Affect. Disord.*, **275**, 188-193.
- Wathelet, M., Duhem, S., Vaiva, G., Baubet, T., Habran, E., Veerapa, E., Debien, C., Molenda, S., Horn, M., Grandgenevre, P., Notredame, C.E. & D'Hondt, F. (2020) Factors associated with mental health disorders among university students in France confined during the COVID-19 pandemic. *JAMA Netw. Open*, **3**, e2025591.
- Xiong, J., Lipsitz, O., Nasri, F., Lui, L.M.W., Gill, H., Phan, L., Chen-Li, D., Iacobucci, M., Ho, R., Majeed, A. & McIntyre, R.S. (2020) Impact of COVID-19 pandemic on mental health in the general population: a systematic review. *J. Affect. Disord.*, **277**, 55-64.
- Zhai, Y. & Du, X. (2020) Addressing collegiate mental health amid COVID-19 pandemic. *Psychiatry Res.*, **288**, 113003.