

ORIGINAL ARTICLE

A 2-year longitudinal study of the association between unhealthy lifestyle factors and the development of depressive symptoms in university students

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Abstract

Aim: The aim of this study was to investigate the association between unhealthy lifestyle factors and the development of depressive symptoms with adjustment for socio-demographic characteristics in university students using health checkup data.

Methods: Among information obtained from university student health checkups conducted in 2017 and 2019, we analyzed both the clinical data and responses to questionnaires. The subjects used for analysis were 3190 individuals (2382 men and 808 women, mean age 19.0 years) who had been free of depressive symptoms in the 2017 survey and were available for a 2-year follow-up. The Patient Health Questionnaire (PHQ-2) was used as a self-rating scale for depressive symptoms. Multivariable logistic regression analysis was conducted to investigate the association between lifestyle factors (such as body mass index, self-rated health, whether breakfast was taken, degree of exercise, satisfaction with sleep, smoking, and alcohol drinking) in the 2017 survey and any development of depressive symptoms revealed in the 2019 survey, adjusting for sociodemographic variables and other lifestyle factors.

Results: Multivariable logistic analysis showed that poor satisfaction with sleep (odds ratio [OR], 4.09; 95% confidence interval [CI], 1.96–8.53; $p < 0.01$) and female gender (OR, 2.16; 95% CI, 1.01–4.60; $p = 0.05$) were significantly associated with the development of depressive symptoms 2 years later.

Conclusion: This study has revealed an association between poor satisfaction with sleep and the development of depressive symptoms. We believe that these findings may be useful for the prevention and treatment of depressive symptoms in university students.

KEYWORDS

depressive symptoms, lifestyle factors, satisfaction with sleep, university students, women

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INTRODUCTION

Most mental disorders begin during adolescence/young adulthood (ages 12–24 years), with three-quarters of lifetime mental disorders occurring by age 25.¹ Depression is a common mental disorder, and highly prevalent among university students; a meta-analysis of previous studies reported a prevalence of depressive symptoms of about one-third in this population.² Depression is an important problem in adolescence because it reduces the quality of life and is associated with suicide risk.³

It is widely known that genetic and temperament-related factors and stressful life events, such as academic stress, traumatic experiences, poor economic status, and low self-confidence, are associated with depression.⁴ In addition, previous studies have indicated that healthy lifestyle habits are undoubtedly essential for maintenance of good mental health.⁵ Several lifestyle-related factors are known to be associated with depression or anxiety among university students, such as smoking, frequent alcohol use, poor sleep quality, irregular eating habits, and perceived health status.^{2,6} These modifiable risk factors are considered to be useful targets for the treatment and prevention of depression.⁷

However, previous studies of the association between unhealthy lifestyle factors and depression among university students have had some limitations. Although adolescence is a time of much stress due to physical and mental growth and environmental changes, only a limited number of studies have prospectively examined the relationship between unhealthy lifestyle factors and the development of depression,² while also considering the temporal relationship. Furthermore, although unhealthy lifestyle factors influence each other, few studies have adjusted for the confounding effects of various unhealthy lifestyle factors.^{8,9}

In the present study, we analyzed data from an annual health checkup of students at a large Japanese university to investigate the association between unhealthy lifestyle factors and the development of depressive symptoms. Our aim was to examine this association in a longitudinal survey. We hypothesized that individual unhealthy lifestyle factors would have different associations with the development of depressive symptoms.

METHODS

Study participants and data collection

Kyoto University Occupational Welfare Division carries out an annual health checkup for all students every April, as we have reported previously in detail.^{6,10} This checkup consists of anthropometric measures, including height and weight, as well as blood pressure, urinalysis, and a self-administrated web-based questionnaire that addresses lifestyle, physical and mental health status, medical history, and current health status. The questionnaire includes the first two items of the nine-item Patient Health Questionnaire (PHQ-9),¹¹ known as the PHQ-2,¹² as well as items about sleep satisfaction and

self-rated health (SRH). Data for this longitudinal study were obtained in 2017 and 2019.

We used the data from the 2017 health checkup for a baseline survey, and those from the 2019 health checkup for a follow-up survey. A total of 7411 students received health checkups in the baseline year. We excluded participants who had not received regular health checkups ($n = 219$), who were 30 years of age or older ($n = 536$), who had not enrolled after 2018 ($n = 8$), and who did not respond to the PHQ-2 ($n = 7$). For the baseline survey, we selected data from 6641 subjects. Next, subjects with PHQ-2 scores of 3 or more ($n = 250$) were excluded, leaving 6391 students with PHQ-2 scores of less than 3. Among them, we excluded those who had graduated or were untraceable ($n = 3159$), and 3232 samples were included in the longitudinal analysis. Among them, we excluded individuals who had not undergone regular health checkups ($n = 42$) and had not responded to the PHQ-2 ($n = 0$) during the follow-up survey. Finally, for the longitudinal analysis, we included data from a total of 3190 subjects (Figure 1).

Outcome, exposure, and confounding variables

Depressive symptoms

Depressive symptoms were assessed using the first two items of the PHQ-9,¹¹ known as the PHQ-2.¹² These two items query the frequency of symptoms of depressed mood (feeling down, melancholy, or hopelessness) and loss of pleasure (little interest or enjoyment in things) and are scored on a scale comprising 0 (*not at all*), 1 (*a few days*), 2 (*more than half of all days*), and 3 (*almost daily*). Thus, the total PHQ-2 score ranges from 0 to 6. We set a cutoff score of 3 by dichotomizing this variable into two categories, as recommended previously.¹³ The PHQ-2 has shown good reliability and validity for assessment of major depression in primary care patients.¹² Depressive symptoms were considered to have developed when participants with PHQ-2 scores of less than 3 in the baseline survey were found to have PHQ-2 scores of 3 or more in the follow-up survey. Cronbach's α coefficient for the PHQ-2 in the follow-up survey was 0.830, which indicated good internal consistency.

Unhealthy lifestyle factors

Self-rated health was assessed by asking the question "How would you rate your health in general?" Possible answers were *very good*, *good*, *fair*, *bad* or *very bad*.¹⁴ This variable was further dichotomized into two categories: *poor* (including *bad* and *very bad*) and *good* (including *fair*, *good* and *very good*) self-rated health, with reference to the previous study.⁶

Sleep satisfaction was categorized as *very satisfied*, *satisfied*, *dissatisfied*, or *very dissatisfied*. Responses of *somewhat dissatisfied/very dissatisfied* were defined as *poor satisfaction with sleep*, with reference to the previous study.⁶

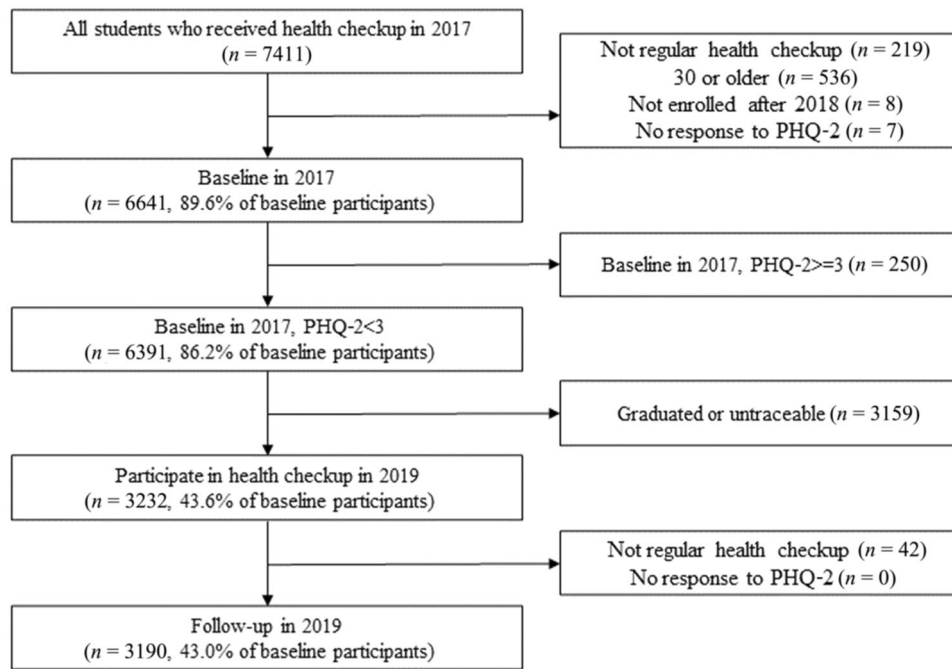


FIGURE 1 Flowchart of participants selection.

Breakfast was categorized as *daily*, *sometimes*, or *never*. The answer *never* was treated as *skipping breakfast*.

Exercise was categorized as *daily*, *sometimes*, or *seldom*. *Seldom* was defined as *no exercise*, with reference to the previous study.⁶

Alcohol drinking was categorized as *never*, *sometimes—averaging 1 or less a day (7 or less a week)*, *averaging 1 or more a day (7 or more a week)*, and *have had repeated problems caused by alcohol at home, school, work, etc.* All categories except for *never* were defined as *drinking*.

Smoking was categorized as *no*, *about 10 cigarettes/day*, *about 20 cigarettes/day*, *about 30 or more cigarettes/day*, and *more than 30 cigarettes/day*. All categories except for *no* were defined as *smoking*.

Height and weight were measured as part of the health checkup. We calculated body mass index (BMI) as weight in kilograms divided by height in meters squared (kg/m^2) and categorized it into three groups: *underweight* (<18.5), *normal weight* ($18.5\text{--}24.9$), and *obese* (≥ 25), with reference to the previous study.⁶

Sociodemographic characteristics

We collected data for the following variables: sex (male, female), age (quantitative variable), nationality (Japanese or foreign), faculty (arts, science, medicine), and admission year (2017, 2016, 2015, before 2014).

Statistical analyses

Descriptive statistics were calculated for all variables.

Associations between unhealthy lifestyle factors and the development of depressive symptoms were analyzed using crude and multivariable logistic regression. We conducted a series of logistic regression analyses to examine the association between unhealthy lifestyle factors at the baseline and the development of depressive symptoms at follow-up, adjusting for sociodemographic variables and other lifestyle factors. Baseline covariates included sex, age, nationality, faculty, admission year, BMI, SRH, breakfast, exercise, satisfaction with sleep, smoking, and alcohol drinking. Results were expressed as OR and 95% CI. All analyses were performed using SPSS 27.0 for Windows.

RESULTS

The baseline characteristics of the participants are shown in Table 1. The subjects used for statistical analysis were 3190 individuals (2382 men and 808 women, mean age 19.0 years) who had been free of depressive symptoms in the 2017 survey and were available for the 2-year follow-up.

The results of multivariable logistic regression analyses for the development of depressive symptoms in subjects who had shown no depressive symptoms in 2017 are shown in Table 2. The prevalence of development of depressive symptoms was 1.2% among the subjects as a whole ($n = 3190$): 1.0% in men and 1.9% in women. The final logistic regression model (Nagelkerke R Square 0.087) showed that poor satisfaction with sleep (OR, 4.09; 95% CI, 1.96–8.53; $p < 0.01$) and female gender (OR, 2.16; 95% CI, 1.01–4.60; $p = 0.05$) were significantly associated with the development of depressive symptoms 2 years later.

TABLE 1 Baseline characteristics of the study participants.

Population characteristics	All participants	
	n	%
Total number of participants	3190	
Age mean (SD)	19.0	1.2
Sex		
Women	808	25.3
Men	2382	74.7
Nationality		
Foreign	42	1.3
Japanese	3148	98.7
Faculty		
Arts	1220	38.2
Science	1334	41.8
Medicine	636	19.9
Admission year		
2017	1978	62.0
2016	810	25.4
2015	199	6.2
Before 2014	203	6.4
BMI		
<18.5	520	16.3
18.5–24.9	2373	74.4
≥25	249	7.8
SRH		
Poor	91	2.9
Fair	3099	97.1
Skipping breakfast		
Yes	769	24.1
No	2421	75.9
Lack of exercise		
Yes	985	30.9
No	2205	69.1
Satisfaction with sleep		
Poor	560	17.6
Fair	2630	82.4
Smoking		
Yes	19	0.6
No	3171	99.4
Alcohol drinking		
Yes	575	18.0
No	2615	82.0

Abbreviations: BMI, body mass index; SD, standard deviation; SRH, self-rated health.

Additional analyses

Characteristics at the baseline in 2017 for the PHQ-2 < 3 group ($n = 6391$) who received a health checkup in 2019 and for those who were not followed up are shown in Table S1. The Student's unpaired *t*-test was employed for the analysis of continuous variables, while the chi-square test was utilized for categorical variables. The mean age was significantly lower for subjects who participated in 2019 than for those who did not. The percentages of subjects who developed depressive symptoms according to faculty, admission year, BMI, skipping breakfast, satisfaction with sleep, smoking, and alcohol drinking differed significantly between the two groups.

DISCUSSION

In the present study, we investigated the association between unhealthy lifestyle factors and the development of depressive symptoms 2 years later among Japanese university students. The results showed that poor satisfaction with sleep and female gender were significantly associated with the development of depressive symptoms. As sleep habits can be modifiable, they are a potentially valuable target for the treatment and prevention of depression.

In the present study, poor satisfaction with sleep was significantly associated with the development of depressive symptoms after 2 years. Significant associations between poor satisfaction with sleep and the onset of depression have also been reported in several prospective studies across different countries. In a French cohort study, poor sleep quality was significantly associated with incident depressive symptoms over a 4-year follow-up period.¹⁵ In a cohort study of older US women, poor satisfaction with sleep was a risk factor for the development of depressive symptoms 6 years later.¹⁶ In another cohort study of US women, subjective poor sleep quality was associated with a higher likelihood of worsening depressive symptoms.¹⁷ The present results are consistent with these previous studies. However, the measures of sleep satisfaction used in those studies differed. To establish the validity of sleep assessment during regular health checkups, further research should be conducted on the association between poor sleep satisfaction and the development of depressive symptoms using validated and reliable rating scales, such as the Pittsburgh Sleep Quality Index¹⁸ or RU-SATED,^{19,20} or by conducting objective sleep assessment studies using wearable devices.²¹ In addition, previous studies have employed various methods for improvement of adolescent sleep health, including individual psychotherapy,²¹ school-based programs,²² and digital interventions,^{23,24} which have demonstrated positive effects. Continued innovation in these areas is warranted.

In the present study, female gender was significantly associated with the development of depressive symptoms 2 years later. Depression has been consistently reported to be more common in women, with a lifetime prevalence about twice as high as that in men, and three times as high in early teens.²⁵ The causes of this gender difference in the prevalence of depression need to be examined from

TABLE 2 Results of multivariable logistic regression analysis of the development of depressive symptoms in subjects without depressive symptoms in 2017 ($n = 3190$).

	Percentage of subjects who developed depressive symptoms		Crude			Adjusted				
	n	%	OR	95% CI	p-value	AOR	95% CI	p-value		
Sex										
Women	15	1.9	1.94	1.01	3.74	0.05	2.16	1.01	4.60	0.05
Men	23	1.0	1.00				1.00			
Age										
			1.10	0.86	1.40	0.46	0.94	0.56	1.58	0.81
Nationality										
Foreign	0	0.0	0.00	0.00		1.00	0.00	0.00		1.00
Japanese	38	1.2	1.00				1.00			
Faculty										
						0.36				0.53
Arts	12	1.0	0.56	0.25	1.29		0.66	0.27	1.63	
Science	15	1.1	0.65	0.30	1.41		1.00	0.40	2.50	
Medicine	11	1.7	1.00				1.00			
Admission year										
						0.23				0.59
2017	18	0.9	1.00				1.00			
2016	14	1.7	1.92	0.95	3.87		1.53	0.58	4.03	
2015	2	1.0	1.11	0.25	4.80		0.71	0.07	7.66	
Before 2014	4	2.0	2.19	0.73	6.53		2.98	0.33	26.97	
BMI										
						0.41				0.39
<18.5	5	1.0	0.88	0.33	2.29		0.81	0.31	2.16	
18.5–24.9	26	1.1	1.00				1.00			
≥25	5	2.0	1.85	0.70	4.86		1.89	0.68	5.21	
SRH										
Poor	4	4.4	4.14	1.44	11.94	0.01	2.60	0.77	8.74	0.12
Fair	34	1.1	1.00				1.00			
Skipping breakfast										
Yes	12	1.6	1.46	0.73	2.91	0.28	1.02	0.45	2.35	0.96
No	26	1.1	1.00				1.00			
Lack of exercise										
Yes	13	1.3	1.17	0.59	2.29	0.65	0.76	0.36	1.60	0.47
No	25	1.1	1.00				1.00			
Poor satisfaction with sleep										
Yes	17	3.0	3.89	2.04	7.42	0.00	4.09	1.96	8.53	<0.01
No	21	0.8	1.00				1.00			
Smoking										
Yes	0	0.0	0.00	0.00		1.00	0.00	0.00		1.00
No	38	1.2	1.00				1.00			

(Continues)

TABLE 2 (Continued)

	Percentage of subjects who developed depressive symptoms		Crude			Adjusted				
	n	%	OR	95% CI	p-value	AOR	95% CI	p-value		
Alcohol drinking										
Yes	5	0.9	0.69	0.27	1.77	0.43	0.37	0.11	1.24	0.11
No	33	1.3%	1.00				1.00			

Note: A series of logistic regression analyses to examine the association between unhealthy lifestyle factors at the baseline and the development of depressive symptoms at follow-up. Adjusted for sex, age group, nationality, faculty, admission year, BMI, SRH, skipping breakfast, lack of exercise, poor satisfaction with sleep, smoking, and alcohol drinking.

Abbreviations: AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; OR, odds ratio; SRH, self-rated health.

multiple perspectives, including sociological factors (poverty, vulnerability to violence, inequality, etc.), psychological factors, and biological factors (hormones, etc.), in addition to the unhealthy lifestyle factors investigated in this survey.

In this study, crude analyses showed that poor SRH was significantly associated with the development of depressive symptoms 2 years later. However, these associations lost significance in the adjusted model, indicating that other covariates may impact the relationship between SRH and the development of depressive symptoms. The association between SRH and depressive symptoms has been investigated in several cross-sectional and prospective studies. In a cross-sectional study of university students in France and Japan, poor SRH was associated with higher PHQ-2 scores (more depressive symptoms).⁶ In a longitudinal study of Finnish subjects aged 18–79 years, the association between poor SRH and depression was significant at 2 years. A study examining the association between poor SRH and depressive symptoms assessed using the Hospital Anxiety and Depression Scale found that SRH was associated with a two- to threefold increase in the likelihood of developing depressive symptoms 3 years later.²⁶ An Australian study of older adults reported that SRH, assessed on a scale of 0–100, was a risk factor for the development of depressive symptoms 2 years later.²⁷ Though the results of the present study differed from those of previous ones, it appears that the association between SRH and depressive symptoms among university students may be partly a direct one.

Some of the lifestyle habits suggested to be associated with depressive symptoms in previous studies, such as alcohol drinking, smoking, skipping breakfast, obesity, and lack of exercise,^{2,5,6,28} did not show significant associations in the crude or multivariate models employed in the present study. This may have been due to the characteristics of the subjects. Although it has been pointed out that alcohol drinking, smoking, obesity, and lack of exercise are associated with depressive symptoms,^{2,5,6,28} the young age of the present study's subjects and the small number of drinkers and smokers may have had an influence. In addition, because many of the subjects were young, healthy, and in good physical condition, any effects of obesity and lack of exercise may have been difficult to detect. Further studies are warranted to examine the complex interactions

between unhealthy lifestyle habits, which showed no significant relationships in the present study, and the development of depressive symptoms.

The present study had several limitations. First, it used two main diagnostic symptoms to define depressive symptoms. As any previous history of depressive symptoms and other mental disorders was not evaluated, a further study using clinically diagnosed symptoms of depression would be required. Second, the validity and reliability of the questionnaire used for assessing lifestyle factors had not been evaluated. Therefore, to confirm the present findings, a different questionnaire or a more objective method will be necessary. Third, the study was conducted at a single university, albeit a large one, which may have introduced sampling bias in the attributes of the participants. To increase generalizability, further multicenter studies will be required. Fourth, in the present study, some participants were not included in the 2-year follow-up, and differed in background factors, such as age, and frequency of drinking and smoking, compared with those included in the follow-up. This may have caused additional sampling bias. Fifth, participants with a history of previous depressive symptoms, or who experienced depressive symptoms between the two surveys but had recovered by the time of the follow-up survey, may not have been recognized in this study. Sixth, questions on sociodemographic factors, such as separation from friends, staying in school, and the death of a parent, were not included in the questionnaire. These factors may have an influence on depressive symptoms. Questionnaires used in future studies of unhealthy lifestyle factors and depression will need to include items on the above points for improvement of validity.

CONCLUSION

In conclusion, the present study of Japanese university students has demonstrated that poor satisfaction with sleep is associated with the development of depressive symptoms 2 years later. Our results suggest that promotion of a healthy lifestyle focusing on improved sleep may be important for the treatment and prevention of depressive symptoms among university students.

AUTHOR CONTRIBUTIONS

All authors contributed to and have approved the final manuscript. Ryuji Furihata, Mami Ishida, Yukako Nakagami, Maya Yanase, Teruhisa Uwatoko, Satoe Okabayashi, Kosuke Kiyohara and Takashi Kawamura contributed to study design, data collection, data interpretation, and preparation of the manuscript. Ryuji Furihata performed the statistical data analyses.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

N/A.

ETHICS APPROVAL STATEMENT

The study was approved by the Institutional Review Board of the Kyoto University Ethics Committee (R1732-1).

PATIENT CONSENT STATEMENT

All analyses and procedures were anonymized. As de-identified clinical data were employed in accordance with Japanese ethical guidelines, the need for individual informed consent was waived.

CLINICAL TRIAL REGISTRATION

N/A.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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