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REGULAR ARTICLE

Cross-sectional observation of the relationship of depressive symptoms with lifestyles and parents' status among Japanese junior high school students

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Abstract
Objectives Students' depressive symptoms might be related to their own risk factors and to their parents' status. The objective of this cross-sectional study was to examine the relationship of depressive symptoms with lifestyle variables and parents' psychological and socio-demographic status among Japanese junior high school students.
Methods Of 477 students and their parents, 409 (85.7 %) students and 314 (65.8 %) parents participated in the study. Students answered self-reported questionnaire on depressive symptoms, their heights and weights, subjective stress, body dissatisfaction, lifestyles including sleep duration and extracurricular physical activity in school and other physical activity outside the school, and nutritional intake. Parents responded to questionnaire on depressive symptoms and socio-demographic status.
Results The prevalence of depressive symptoms was 24.9 %. Students with depressive symptoms were more likely to have stress. Students in shorter and longer sleep duration groups were more likely to have depressive symptoms. The students with depressive symptoms had smaller amount of energy intake than did those without depressive symptoms. Multiple logistic regression analysis revealed significant relationships between students' depressive symptoms and some independent variables. Sex, subjective stress, "almost-never"-categorized extracurricular physical activity in school and other physical activity outside the school, and having a parent with depressive symptoms were significantly associated with students' depressive symptoms.
Conclusion Reducing mental stress and taking care of lifestyles, especially, "almost-everyday"-categorized extracurricular physical activity in school and other physical activity outside the school, may have benefits for students' mental health, and having a parent with depressive symptoms may be associated with students' depressive symptoms.

Keywords Adolescents · Depressive symptoms · Mental health · Lifestyle · Stress · Parent status

Introduction

Depressive disorders have become a leading cause of burden in the Global Burden of Disease (GBD) 1990 and 2000 studies [1]. The World Health Organization [2] reported that depression was ranked the third on the list of leading causes of disease burden, accounting for 4 % or more of all disability-adjusted life years, and that depression was estimated to be ranked the first on this list by 2030. The prevalence of major depression disorder (MDD) in adolescents was reported to be 3–6 % [3], and 20 % of adolescents were estimated to have suffered from a depressive episode by the age of 18 years [4], with the large majority experiencing a second depressive episode

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within 5 years [5], in spite of a reported possibility of racial/ethnic differences in depression [6, 7]. In addition, more than half of depressed adolescents were reported to continue to experience MDD into adulthood [8]. Moreover, 25 % of females and 10 % of males were estimated to be subclinically depressed [9]. Previous studies showed that adolescents with subclinical depression were at elevated risk for later developing MDD [10], substance abuse, higher levels of neuroticism, academic underachievement, unemployment and early parenthood [11, 12]. Therefore, the depression in childhood should be detected early and carefully treated in order to prevent it from continuing into adulthood.

Recently, research on depression in children and adolescents and their risk factors has advanced dramatically. It was recognized that major depression in parents significantly contributes to major depression in their adolescents [13, 14], and that low socio-economic status (SES) in childhood is associated with a higher lifetime risk of depression later in life [15]. On the contrary, higher SES in childhood was reported to affect the onset of depression [16]. Other factors such as exposure to acute stressful events and chronic adversity, e.g., history of abuse and bullying [17], poor body image [18–21], "almost never"-categorized extracurricular physical activity in school and other physical activity outside the school [22–28], and sleep duration [29, 30], were reported to affect depressive symptoms in adolescents. Moreover, an association between depressive symptoms and low levels of eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and dietary B vitamins, particularly folate and vitamin B-6 has been suggested in Japanese adolescents [31, 32]. However, only few studies have been focused on the relationships between depressive symptoms in adolescents and those possible risk factors in Japan.

The present study aimed at examining the relationship of depressive symptoms with their life styles and parents' psychological and socio-demographic status among Japanese junior high school students.

Materials and methods

Subjects

In 2013, a cross-sectional study was conducted in the national university-affiliated junior high school in Matsumoto city in Nagano prefecture. Of the 477 students and their parents, 409 (85.7 %) students and 314 (65.8 %) parents participated in the present study. We handed out the questionnaire to all the students and parents through the teachers, together with a briefing note on the survey, informing them of the objective and method of the survey, publication of the results and option to refuse participating, and obtained informed consent by their returning the questionnaire. This study and protocol including the procedure of informed consent from the participants were also approved by the Ethics Review Committee of Shinshu University School of Medicine.

Procedures

Students and their parents were requested to respond to self-administered questionnaires which had been handed out to them in advance through teachers. Students responded to their own questionnaire while they were in school. Parents were asked to respond to the questionnaire at home.

Student's depressive symptoms were assessed with the Japanese version of the Children's Depression Inventory (CDI) developed by Kovacs [33]. Adolescents self-reported their heights and weights. Body mass index (BMI) was calculated as body weight (kg) divided by the square of body height (m). The lifestyle questionnaire included information on subjective stress, body dissatisfaction, sleep duration, and extracurricular physical activity in school and other physical activity outside the school [34]. Nutritional intake during the preceding month was assessed with a brief self-administered diet history questionnaire for Japanese adolescents (BDHQ15y) known as the Food Frequency Questionnaire [35]. The values of the dietary intake were energy-adjusted using the density method (i.e., percentage of energy provided by energy-providing nutrients and amount per 1000 kcal of energy provided by other nutrients) [36].

Parents' depressive symptoms were assessed with the Japanese version of Kessler's K6 scale [37, 38]. The K6 scale consisted of six-item self-report questionnaire, asking how frequently respondents experienced symptoms of psychological distress during the past 30 days. The response options ranged from 0 = none of the time to 4 as = all of the time (the range of the scale score was 0–24). In the present study, the parent participants were classified into two groups: those with and without depressive symptoms (a total K6 score of 5 or more and a total K6 score of 0–4, respectively) according to the recommended cut-off point [39]. The internal consistency reliability of K6 as well as its sensitivity and specificity were acceptable at the present cut-off point of 4/5, as suggested by Sakurai et al. [40]. Parents' educational levels and living arrangements were collected using the self-reported questionnaire.

Statistical analysis

In the analysis of depressive symptoms in the students, the results were divided into two main groups employing

the summed score of 16 as a cut-off point: "with depressive symptoms" (≧16) and "without depressive symptoms" (<16). Boys' and girls' data were pooled together for the present analysis, since there was no significant gender difference in the present study. In the analysis of nutritional intake, we excluded 39 students who reported extremely low or high energy intake, i.e., 'less than half the estimated energy requirement for the lowest or more than 1.5 times the estimated requirement for the highest physical activity category according to the Dietary Reference Intakes for Japanese [41]; 1000–1225 or 3750–4650 kcal/day [31, 32]. In addition, two students with missing data of body weight and BMI were excluded in the analysis. Univariate associations between depressive symptoms and variables regarding the students' characteristics (sleep duration on weekday and physical activity), and parents' status (educational levels, living arrangements, and depressive symptoms) were assessed with the Chi-square test for categorical variables and with the t test and Mann–Whitney *U* test for continuous variables. Multiple logistic regression analysis was carried out to evaluate the odds ratio with a 95 % confidence interval for associations between the presence of a potential risk factor for or protective factor against depression and the variables for which significant relationships were observed in the univariate analysis. Covariates included in the adjusted multivariate model (Model 1) were sex and age, while the covariates in Model 2 were sex, age, living arrangements, stress, sleep duration, extracurricular physical activity in school and other physical activity outside the school, and parents' variables (sex, educational levels, depressive symptoms). All analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 22.0 by IBM (SPSS Inc, Chicago, Illinois, USA).

Results

A total of 409 students and 314 parents agreed to participate in the present study. There was no gender difference in the rates of response to the questionnaire for students or parents. Data were available for 241 matched parent–child pairs after excluding 95 students and 73 parents due to incomplete data. Characteristics of the participants are shown in Table 1. The mean age of the students was 13.6 years. The mean total CDI score was 12.4, and 60 students (24.9 %) were categorized as "with depressive symptoms". Of the 241 parents, 23 (9.5 %) were males and 218 were females (90.5 %). The mean age of the parents was 45.3 years. The mean total K6 score was 4.2, and 86 parents (35.7 %) were categorized as "with depressive symptoms".

Table 1 Characteristics of the participants in the present study

Characteristics	$n = 241$
Students	
CDI total score	12.4 ± 5.9
<16	181 (75.1)
16≦	60 (24.9)
Sex	
Male	95 (39.4)
Female	146 (60.6)
Age	13.6 ± 0.9
Grade	
1st	69 (28.6)
2nd	99 (41.1)
3rd	73 (30.3)
BMI (missing data $n = 24$)	18.2 ± 2.0
<18.5	133 (55.2)
18.5≦, <25.0	83 (34.4)
25.0≦	1 (0.4)
Living with both parents	
Yes	226 (93.8)
No	15 (6.2)
Parents	
Sex	
Male	23 (9.5)
Female	218 (90.5)
Age (missing data $n = 16$)	45.3 ± 3.8
BMI (missing data $n = 10$)	20.7 ± 4.5
<18.5	25 (10.4)
18.5≦, <25.0	187 (77.6)
25.0≦	19 (7.9)
Educational levels	
High school	37 (15.4)
Junior college, vocational training or technical school	115 (47.7)
University	89 (36.9)
K6 score	4.2 ± 4.3
<5	155 (64.3)
5≦	86 (35.7)

Data are represented as *n* (%) or mean ± standard deviation

Table 2 presents the characteristics of the participants. Sex, age, grade, BMI, and living arrangements were not significantly related to depressive symptoms. Students with depressive symptoms were more likely to have stress. Students in the shorter and longer sleep duration groups were more likely to have depressive symptoms compared with those in the moderate sleep group. In addition, the frequency of extracurricular physical activity in school and other physical activity outside the school was significantly related to the presence of depressive symptoms. With

Table 2 Comparisons of the characteristics and lifestyle variables between students without depressive symptoms and those with depressive symptoms

	Students without depressive symptoms ($n = 181$; 75.1 %)[a]	Students with depressive symptoms ($n = 60$; 24.9 %)[b]	p*
Students' variables			
CDI total score	9.7 ± 3.3	20.4 ± 4.6	<0.01
Sex			
Boys	69 (72.6)	26 (27.4)	0.47
Girls	112 (76.7)	34 (23.3)	
Age	13.7 ± 0.9	13.5 ± 0.9	0.23
Grade			
1st	51 (73.9)	18 (26.1)	0.96
2nd	75 (75.8)	24 (24.2)	
3rd	55 (75.3)	18 (24.7)	
BMI (missing data $n = 24$)	18.2 ± 2.0	18.1 ± 2.1	0.88
<18.5	96 (72.2)	37 (27.8)	0.41
18.5≦, < 25.0	66 (79.5)	17 (20.5)	
25.0≦	1 (100.0)	0 (0.0)	
Living with both parents			
Yes	170 (75.2)	56 (24.8)	1.00
No	11 (73.3)	4 (26.7)	
Stress			
Yes	92 (64.3)	51 (35.7)	<0.01
No	89 (90.8)	9 (9.2)	
Sleep duration on weekday			
8 h≦	24 (63.2)	14 (36.8)	0.01
7≦, <8	73 (84.9)	13 (15.1)	
6≦, <7	59 (76.6)	18 (23.4)	
<6 h	25 (62.5)	15 (37.5)	
Physical activity			
Almost everyday	88 (79.3)	23 (20.7)	0.01
1–2 days a week	38 (49.1)	10 (20.8)	
1–3 days a month	34 (79.1)	9 (20.9)	
Almost never	21 (53.8)	18 (46.2)	
Parents' variables			
Sex			
Male	16 (69.6)	7 (30.4)	0.61
Female	165 (75.7)	53 (24.3)	
Educational levels			
High school	23 (62.2)	14 (37.8)	0.11
Junior college, vocational training	93 (80.9)	22 (19.1)	
Or technical school	65 (73.0)	24 (27.0)	
University			
Parents' K6 score			
<5	124 (80.0)	31 (20.0)	0.02
5≦	57 (66.3)	29 (33.7)	

Data are represented as n (%) or mean ± standard deviation

* p values are shown for χ^2 test for categorical variables and for independent t test for continuous variables

[a] Students with a CDI score of <16

[b] Students with a CDI score of ≧16

Table 3 Comparisons of nutritional intake between students with and without depressive symptoms

	All	Students without depressive symptoms (n = 155; 77.2 %)[a]	Students with depressive symptoms (n = 45; 22.8 %)[b]	p[c]
Body weight (kg)	45.5 ± 7.6	45.3 ± 7.5	45.7 ± 7.3	0.83
BMI (kg/m^2)	18.2 ± 2.1	18.2 ± 2.1	18.2 ± 2.2	0.93
Energy (kcal/day)	2330 ± 732	2390 ± 743	2123 ± 662	0.01
Riboflavin (mg/day/1000 kcal)	0.82 ± 0.21	0.81 ± 0.20	0.86 ± 0.25	0.32
VitamineB6 (mg/day/1000 kcal)	0.63 ± 0.15	0.63 ± 0.14	0.63 ± 0.18	0.93
VitamineB12 (μg/day/1000 kcal)	4.10 ± 2.15	3.97 ± 1.95	4.57 ± 2.71	0.39
Folate (μg/day/1000 kcal)	179 ± 69	179 ± 64	180 ± 85	0.50
n-3 fatty acids (g/day/1000 kcal)	1.1 ± 0.3	1.1 ± 0.3	1.1 ± 0.4	0.78

Data for 41 students were excluded for the present analysis, since they did not report body weight or BMI, and since they reported incorrect responses to the energy-related items of the diet history questionnaire for Japanese adolescents

Data are represented as mean ± standard deviation

[a] Students without a CDI score of <16

[b] Students with a CDI score of ≧16

[c] p values are shown for Mann–Whitney U test

regard to parents' characteristics, only parents' depressive status was significantly related to students' depressive symptoms.

The nutritional intakes of the students are shown in Table 3. There was no significant difference in body weight or BMI between the students with depressive symptoms and those without depressive symptoms. Students with depressive symptoms had a significantly smaller amount of total energy than did students without depressive symptoms. Except for the total energy, there was no significant difference in any of the nutrients between the two groups.

Table 4 shows the relationships between depressive symptoms in students and various risk factors. In the crude model, subjective stress, "almost never"-categorized extracurricular physical activity in school and other physical activity outside the school, and parents' depressive symptoms positively contributed to depressive symptoms in students. Sleep duration on weekdays between 7 and 8 h negatively contributed to students' depressive symptoms compared with longer than 8 h in the crude model. The results in Model 1 with adjusting for sex and grade, were similar to those in the crude model. In Model 2 with fully adjusted confounders, subjective stress, "almost never"-categorized extracurricular physical activity in school and other physical activity outside the school, and parents with depressive symptoms positively contributed to depressive symptoms in students. Sleep duration between 7 and 8 h on weekdays did not contribute to students' depressive symptoms compared with longer than 8 h after adjustments. However, a u-shaped dose–response trend was observed between sleep duration and depressive symptoms in these analyses.

Discussion

In the present study, we analyzed the relationships of junior high school students' depressive symptoms with their subjective stress, socio-demographic status, and parents' depressive symptoms in consideration of possible confounding factors such as their lifestyles. The prevalence of depressive symptoms in this study was found to be 24.9 %. This rate was similar to the rates reported in other studies, 22.5 % for boys and 31.2 % for girls [31] and 28 % [42] in Japanese adolescents, although those reported rates were assessed with other methods using the Center for Epidemiologic Studies Depression scale [43] and the Birleson Depression Self-Rating Scale [44] for Children, respectively.

The positive association between depressive symptoms in students and stress found in the present study was consistent with that reported in previous studies [45–48]. This positive association might be explained with reference to studies showing that stress negatively contributed to the brain reward function [49, 50], and that stressful experiences decreased the levels of brain-derived neurotrophic factor (BDNF) which play an important role in mood regulation and show antidepressant-like behavior [51].

The negative association between depressive symptoms in students and the frequency of extracurricular physical activity in school and other physical activity outside the school found in this study was consistent with the findings of previous cross-sectional and prospective studies in adolescents [22, 24, 25, 28]. This inverse relationship might be explained in terms of both biological and psychosocial mechanisms. In biological mechanisms, physical

Table 4 Contributions of various risk factors to students' depressive symptoms by the multiple logistic regression analysis

N		Crude OR (95 % CI)	*p* for trend	Model 1[a] OR (95 % CI)	*p* for trend	Model 2[b] OR (95 % CI)	*p* for trend
Students' variables							
Sex							
Boys	95	1 (reference)				1 (reference)	
Girls	146	0.81 (0.45–1.46)				0.44 (0.20–0.95)	
Grade							
1st	69	1 (reference)	0.85			1 (reference)	0.11
2nd	99	0.91 (0.45–1.84)				1.27 (0.53–3.04)	
3rd	73	0.93 (0.44–1.98)				0.55 (0.19–1.58)	
Stress							
No	98	1 (reference)		1 (reference)		1 (reference)	
Yes	143	5.48 (2.55–11.8)		6.11 (2.79–13.4)		7.27 (3.05–17.4)	
Physical activity							
Almost every day	111	1 (reference)	0.01	1 (reference)	<0.01	1 (reference)	0.02
1–2 days a week	48	1.01 (0.44–2.32)		1.22 (0.50–2.97)		1.04 (0.38–2.86)	
1–3 days a month	43	1.01 (0.43–2.41)		1.29 (0.50–3.33)		1.43 (0.49–4.21)	
Almost never	39	3.28 (1.51–7.15)		4.31 (1.80–10.3)		4.15 (1.46–11.8)	
Sleep duration on weekday							
8 h≦	38	1 (reference)	0.51	1 (reference)	0.38	1 (reference)	0.49
7≦, <8	86	0.31 (0.13–0.74)		0.32 (0.13–0.77)		0.39 (0.13–1.16)	
6≦, <7	77	0.52 (0.23–1.22)		0.56 (0.23–1.34)		0.83 (0.28–2.46)	
<6 h	40	1.03 (0.41–2.58)		1.27 (0.45–3.55)		1.51 (0.43–5.29)	
Parents' variables							
Sex							
Male	23	1 (reference)		1 (reference)		1 (reference)	
Female	218	0.52 (0.29–1.88)		0.75 (0.29–1.92)		0.48 (0.15–1.53)	
Educational levels							
High school	37	1 (reference)	0.53	1 (reference)	0.53	1 (reference)	0.78
Junior college, vocational training or technical school	115	0.39 (0.17–0.87)		0.39 (0.17–0.89)		0.44 (0.15–1.33)	
University	89	0.61 (0.27–1.37)		0.61 (0.27–1.38)		0.63 (0.23–1.69)	
Parents' K6 score							
<5	155	1 (reference)		1 (reference)		1 (reference)	
5≦	86	2.03 (1.12–3.69)		2.04 (1.12–3.71)		2.48 (1.21–5.06)	

Depressive symptoms were defined as having a children's depression inventory score of ≧16 for the students

[a] Adjusted for sex, grade

[b] Adjusted for sex, grade, stress, physical activity, sleep duration on weekday, and parents' variables

activity may prevent or help treat depression through increasing functional activity of monoamines related to mood, attenuating hippocampal atrophy through increased BDNF, increasing neurogenesis in the dentate gyrus of the hippocampus, or through mediation of neuroimmunological reactivity [52]. In terms of psychosocial effects, physical activity decreased emotional strain and feelings of loneliness, and increased self-esteem [53]. Moreover, perceptions of enjoyment while participating in physical activity and team sports were inversely related to depressive symptoms [54]. However, a recent study suggested that light to moderate intensity of physical activity serves as a protective factor of depression, whereas physical activity of high intensity is a risk factor for general mental health problems and hostility [55]. Further studies will be needed to look into the relationship between intensity of physical activity and depressive symptoms in adolescents.

The present univariate and logistic regression analyses revealed that a U or J-shaped dose–response trend holds

true between sleep duration and depressive symptoms among the students. The nationwide survey by the National Institute for Educational Policy Research [56] revealed that 40 % Japanese junior high school students sleep longer than 8 h, 36.4 % for 7–8 h, 18.0 % for 6–7 h, and 5.2 % for less than 6 h. Comparison in sleep duration between the students in the present study and in the nationwide survey suggests that the students of the National university-affiliated junior high school are short sleepers than those surveyed at the national levels, resulting presumably from their need to study late at night. The present result, however, is essentially consistent with the findings reported by Sivertsen et al. [57] who showed that depressed adolescents exhibited significantly shorter sleep duration, and by Lovato and Gradisar [29] who showed that adolescent with depression experienced significantly more wakefulness in bed and more subjective sleep disturbance. It was also reported that adolescents with sleep durations of $\leq$5 and $\geq$10 h had a significantly higher risk for depression and suicidal ideation compared with those with a sleep duration of 8 h [58, 59]. Since hormonal, neural and psychological mechanisms resulting from genetic and environmental factors were reported to contribute the association of sleep with emotional and behavioral difficulties in adolescents [60], it is suggested that those mechanisms are genetically and environmentally involved in the excessive and insufficient sleep duration.

It was found in the present study that the students with depressive symptoms had a significantly lower amount of total energy than did those without depressive symptoms. This finding is consistent with the findings reported by Murakami et al. [31] and Oddy et al. [61], both of whom showed that adolescents with depressive symptoms tended to consume lesser amount of energy intake than those without depressive symptoms. In the present study, however, there was no significant difference in any other nutrients between the students with depressive symptoms and those without depressive symptoms. Murakami et al. [31, 32] reported that higher intakes of folate and vitamin B-6 were associated with a lower prevalence of depressive symptoms in early adolescents, and that higher intakes of fish, EPA and DHA were significantly associated with depressive symptoms only in early male adolescents. In contrast, nutritional intakes such as B vitamins and n-3 fatty acids were reported not to be related to depressive symptoms in adolescents in western countries [61]. Further studies will be needed to investigate the association between depressive symptoms and nutritional intake.

It was found in the present study that parents' depression status was significantly associated with depressive symptoms in the adolescents. This finding was corroborated by the previous studies. Rice et al. [13] reported that children with parental depression had a three- to four-times-greater risk of their depression compared to the children without parental depression. On the other hand, Tully et al. [14] demonstrated that having one parent with major depression or having a mother with major depression was associated with significantly greater risks for major depression and disruptive behavior disorders in both adopted and non-adopted adolescents. As suggested by Lovejoy et al. [62], maternal depression is considered to be a risk factor for parenting difficulties. Furthermore, lower SES was reported to be inversely associated with depression [15]. Ochi et al. [16] reported that in Japan, childhood SES is more likely to be positively associated with the lifetime onset of mental disorders, regardless of family history of mental disorders.

Strength and limitations

A major strength of this study is that since detailed information including the students' lifestyle and parents' depression status was obtained from the data for matched parent–child pairs, the contributions of those factors to students' depressive symptoms could be evaluated after controlling for possible confounders. However, this study has several limitations. First, the most notable limitation in the present study is its limited power to detect significance for some of the complex associations resulting from limited samples. However, even with this sample size we found significant relationships of depressive symptoms in students with stress in students and their parents' depressive status. Second, we could not determine causal relationships between students' depressive symptoms and other variables, since this study was cross-sectional. Third, the junior high school enrolled in the present study was national university-affiliated, and there might be differences in social factors such as parents' educational levels and SES between the parents in this school and those in public junior high schools. These differences might have caused a selection bias, making it difficult to generalize our data. Fourth, we were not able to obtain any response from absent students, and the valid response rate was not very high (50.5 %). Poor mental health status may be more common among frequently or long-absent students, and it is possible that the students with poor mental health might have refused to respond to a questionnaire about depressive symptoms. The prevalence of depressive symptoms based on the matched parent-student pair case was 24.9 % in the present study. For the unmatched parent-student case, however, the prevalence of depressive symptoms was estimated to be 43.0 % (as 34/79 $\times$ 100), since 320 students responded properly to the questions about CDI among 409 student participants and 79 students did not match with parents among 320 students, and since 34 students were categorized with "with depressive

symptoms" according to their CDI scores. Therefore, the prevalence of depressive symptoms seems to be underestimated on the basis of the matched parent-student pair case in comparison to the unmatched case.

Conclusion

Subjective stress, the frequency of extracurricular physical activity in school and other physical activity outside the school, and parents' depressive status were significantly related to students' depressive symptoms. These findings suggest that reducing mental stress and considering appropriate lifestyles, especially, physical activity in adolescents may have benefits for mental health. It was also noteworthy in this study that having a parent with depressive symptoms was significantly associated with students' depressive symptoms.

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