Assessment of Life Factors Affecting the Occurrence of Depressive Episodes in Adolescents: a Secondary Analysis Using the Korea Youth Risk Behavior Survey

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Abstract

Background Adolescence is a period that witnesses many changes in lifestyle, such as in social activity and school life, and it is vulnerable to the depressive disorder. Therefore, we intended to evaluate the factors affecting the onset of depressive episodes.

Methods We conducted a secondary analysis using the 2019 Korean Youth Risk Behavior Web-based survey data, including a total of 57,303 subjects from the first year of middle school to the third year of high school and selected among 400 schools. Factors including dietary habits, physical activity, study time, internet use time and other health risk behaviors were included in the analysis. Logistic regression analysis was performed to evaluate the risk of occurrence of depressive episodes.

Results Physical activity, internet use for more than three hours on weekdays, and a study time of more than two hours on weekends were assessed as risk factors of depressive episodes. On the other hand, internet use on weekends and having breakfast regularly were suggested as a protective way to reduce risk in Korean students.

Conclusion We identified the factors influencing the depressive episode of adolescents. We suggest that activities appropriate to the culture and lifestyle of adolescents should be recommended in order to reduce the occurrence of depressive episodes.

Background

Adolescence is a period of rapid physical development, which requires adapting to a new environment [1]. In adolescence, environmental changes happen in school activities and interpersonal relationships as well as individual changes in after-school activity, eating habits, and physical activities. These changes are related to high risk of mental disorders such as depressive disorder, anxiety disorder, and substance use disorder [2–4]; in particular, the prevalence of major depressive disorder among adolescents appears to be increasing, with one US-based study showing an increase from 8.69% in 2005 to 12.66 in 2015 [5]. The onset of major depressive episodes during adolescence can affect not only daily life in adolescence but also one's quality of life in adulthood; thus, risk factors assessment, early detection, and intervention are important [6].

Studies on various factors influencing the prevalence of depressive disorder in adolescents have been actively conducted [2, 3, 7–12]. Eating habits is one of the factors associated with mental health in adolescence. Adolescents with irregular eating habits, including skipping meals, reported more severe depression symptoms and high perceived anxiety [2, 4, 8]; in addition, food insecurity is associated with poor mental health, which leads to lower academic achievement [13]. However, the number of teenagers who skip breakfast in many countries is still increasing, and it is recognized as a social problem. Physical activity is evaluated as an improving factor in the mental health of adolescents. Physical activity guidelines for Americans recommend that adolescents aged 6–17 years do at least 60 minutes of moderate-to-vigorous exercise per day [14].

Internet use in adolescents is also known to have an effect on their mental health [9, 10]. Unlike in the past, adolescents and young adults now rely on the internet for many aspects of their daily life, including school activities, interpersonal relationships, information acquisition, and leisure activities. Despite the convenience of the internet, the excessive use of social networking services (SNS) and online game addiction among teenagers have been evaluated as negative factors affecting their mental health. Although it is still difficult to definitively define the recommended internet use time for adolescents, it is generally advised that this be limited to two hours a day [15, 16]. However, some argue that this recommendation is virtually impossible [17], with another study reporting that a four-hour internet use per day does not have a negative effect on mental health [18]. Family environments, such as immigrant and multicultural families, can also affect the mental health of adolescents. Adolescents from multicultural families or immigrant families may have higher depressive and anxiety symptoms and are known to be at risk for mental illness [11, 12, 19]. In addition, academic performance, socioeconomic status, gender, smoking, alcohol, and other characteristics of daily life are related to the mental health of adolescents [7, 13]. Smoking, alcohol, and poor academic performance have been correlated with depressive disorder and anxiety disorder in adolescents, and those with such unhealthy lifestyle are at high risk of developing substance use disorder [20].

Previous studies have been conducted on individual factors that affect the mental health of adolescents, but comprehensive studies covering all variables of health risk behavior, family structure, physical activity, and internet use time are lacking. Through this study, we intend to identify the factors associated with the onset of major depressive disorder in adolescence and to present standards for adolescents' healthy lifestyle.

Methods

Participants

This study performed a secondary data analysis based on the 15th 2019 Korean Youth Risk Behavior Web-based survey (2019, KYRBS) data. KYRBS is conducted by the Korean Disease Control and Prevention Agency (KDCA) annually to evaluate the physical and mental health status of Korean middle and high school students [21]. KYRBS adopted a multi-stage cluster sampling design to obtain a representative sample of Korean adolescents, dividing 17 provinces nationwide into 44 regions according to the size of the city and selecting middle school (grades 7–9) and high school (grades 10–12) students among 400 schools. KYRBS is an anonymous self-response online survey, and the selected students participated using a computer in their school's computer room under the supervision of trained teachers. Students could decide whether to participate after receiving a detailed explanation of the survey's purpose and process from the trained teacher, and written informed consent was obtained from the participants. Information on the detailed research design and research methods of KYRBS can be found in a previous paper [21]. In the 2019 KYRBS, a total of 60,100 people from 800 schools (400 middle schools and 400 high schools) were selected as subjects, of which 57,303 (95.3%) who agreed to participate in the survey were included. Since KYRBS is based on an online survey system, there were no

non-response items in the original data, but logical errors and outliers were treated as missing values. In this study, the data file for the SPSS program provided by KDCA was used for analyses.

Assessment

Demographics

We analyzed the individual demographic data including gender, age, size of the city, school type, grade, educational background, perceived academic performance, perceived household economic status, type of residence, and parents' nationality. The size of the city was divided into big, small to medium, and small in consideration of geographical accessibility, number of schools and population, and living environment. Perceived academic performance and perceived household economic status were classified into five categories: upper, upper middle, middle, lower middle, and lower. The type of residence was evaluated as (1) living in a parent's house, (2) living in a relative's house, (3) lodging or living alone, (4) living in a dormitory, and (5) living in a childcare facility. Information on the family—including parental nationality—was obtained when the subjects agreed to answer the question. In this study, we classified nationalities as either Korean or other nationalities.

Health risk behavior and health status

The frequency of breakfast during the week, the number of days of physical activity for more than 60 minutes a day during the week, and the weekday/weekend sitting time for studying and using internet were evaluated. As for the question on physical activity, we assessed the number of weekdays in which their heart rate was higher than usual or they did 60 minutes or more of breathtaking physical activity, regardless of the type of physical activity. The participants were asked to report the average weekday/weekend sitting time autonomously. Considering that the subjects spent around six hours at school, weekday sitting time for studying was classified as < 240 min, 240–359 min, 360–479 min, 480 – 599, min, 600–719 min, $\geq$ 720 min, and weekend sitting time for studying was divided into none, 1–119 min, 120–239 min, 240–359 min, 360–479 min, and $\geq$ 480 min. Internet use time was classified into none, 1–60 min, 61–120 min, 121–180 min, $\geq$ 180 min. The subjective perception of their own health status was answered with five responses: "very healthy," "healthy," "so so," "unhealthy," and "very unhealthy." In addition, the subjective perception of body shape was evaluated as follows: "very skinny," "skinny," "so so," "obese," and "very obese." Health risk behaviors such as smoking, alcohol use, habitual drug/substance use, and sexual experience were also evaluated. Participants also answered whether they had received hospital treatment for violent incidents within one year; this was classified as "yes" or "no" for the regression analysis.

Mental status

The perceived stress level and subjective experience of depressive episodes are included in this study. The former was classified into five responses: "very much," "a lot," "a little," "not much," and "not at all,"

and the latter was evaluated by answering the question “Did you ever feel sad or desperate strong enough to stop your daily life for 2 weeks in the last 12 months?”

Statistical analyses

In this study, students who provided insufficient answers were excluded; in the end, a total of 46,206 subjects were included in the analysis. All statistical analyses were performed using the SPSS 25.0 software (IBM corp, Armonk, NY, 2019), and *p*-values of less than 0.05 were considered statistically significant. The variables, including demographics, health risk behaviors, health risk behaviors, weekend sleep time, and physical/mental status, were compared by grade groups using a one-way analysis of variance (ANOVA) and chi-square test. ANOVA, chi-square test, and logistic regression were used to compare the incidence of depressive episodes and other individual variables between groups according to weekday sleep time. Logistic regression analyses including all variables were performed to confirm the relationship between individual variables and depressive episodes. Binary regression analysis with the depressive episode as the dependent variable was performed, followed by regression analysis between statistically significant variables and the depressive episode to evaluate the effect of weekday and weekend sleep time on depressive episodes. The results of logistic regression have been reported as unadjusted and adjusted odds ratios with 95% confidence intervals.

Ethics statement

KYRBS has been conducted by Ministry of Education, Ministry of Health and Welfare, and KDCA as national approved statistical data [21]. The raw data used in this study were approved for use through the KDCA website, and the provided raw data were collected with a unique number that cannot be identified without the subject’s personal information, ensuring the subject’s anonymity. The protocol of this study for secondary analysis was approved by the Institutional Review Board of the Korea University Medical Center, Ansan Hospital, Gyeonggi-do, Korea (No. 2020AS0309).

Results

Sociodemographic characteristics

In each grade group, more boys participated than girls, but this was not statistically significant. The ratio of co-ed school was the highest in middle and high school, and the ratio of co-ed school decreased in high school compared to middle school. The ratio of adolescents from multicultural families was less than 3%, and grade 7 students reported the highest number. Compared with high school students, middle school students perceived that their academic achievement and family economy were relatively higher. In contrast, as the grade went up, the number of students who perceived their health status and body shape negatively increased. The percentage of high school students who perceived themselves as being (very) unhealthy or (very) obese was higher than that of middle school students. More than 50% of the subjects tried to control their weight, and these efforts were in the order of weight loss, weight maintenance, and weight gain. The percentage of adolescents who were physically active for more than 60 minutes a day

tended to decrease, and sitting time for studying tended to increase as they grew up. The duration of sitting time for studying increased with grade, and this tendency was clearer when entering high school (grade 9: 425.80 ± 237.63 and grade 10: 520.05 ± 263.81). Perceived stress (more than “a lot”) also tended to increase as age increased, and the ratio of students who experienced depressive episodes within one year was the highest in the third year of high school (Table 1). The number of students who experienced drinking and smoking increased with age, and the drinking experience of the third grade of high school was 58.7% (more than half). The ratio of sexual experience was 1.2% in the first year of middle school and gradually increased according to the grade; it was reported as being 9.9% among students in the third year of high school (Additional file 1, supplement 1). The major findings are presented in Table 1, and information on all variables included in this study is presented in Additional file 1, supplement 1.

Table 1
Sociodemographic characteristics

Variables	Grade 7 (<i>n</i> : 7975)	Grade 8 (<i>n</i> : 7723)	Grade 9 (<i>n</i> : 8014)	Grade 10 (<i>n</i> : 7498)	Grade 11 (<i>n</i> : 7242)	Grade 12 (<i>n</i> : 7754)	<i>p</i> - value
Age, years	12.50 ± 0.51	13.52 ± 0.52	14.51 ± 0.52	15.51 ± 0.52	16.50 ± 0.52	17.47 ± 0.52	
Gender, Female	3879 (48.6)	3803 (49.2)	3865 (48.2)	3619 (48.3)	3544 (48.9)	3723 (48.0)	0.637
School type							< 0.01
Coed school	5878 (73.7)	5664 (73.3)	5900 (73.6)	4377 (58.4)	4204 (48.1)	4491 (57.9)	
Boys school							
Girls school	1079 (13.5)	1074 (13.9)	1095 (13.7)	1532 (20.4)	1498 (20.7)	1604 (20.7)	
	1018 (12.8)	985 (12.8)	1019 (12.7)	1589 (21.2)	154 (21.3)	1659 (21.4)	
Multicultural family							< 0.01
Yes	170 (2.8)	130 (2.4)	103 (1.9)	62 (1.3)	58 (1.3)	57 (1.3)	
No	5803 (97.2)	5213 (97.6)	5213 (98.1)	4617 (98.7)	4256 (98.7)	4371 (98.7)	
Perceived academic performance	1468 (18.4)	1183 (15.3)	1323 (16.5)	737 (9.8)	702 (9.7)	829 (10.7)	< 0.01
Upper					1665 (23.0)		
Upper middle	2493 (31.3)	2068 (26.8)	2083 (26.0)	1753 (23.4)		1857 (23.9)	
Middle	2509 (31.5)	2238 (29.0)	2093 (26.1)	2343 (31.2)	2379 (32.9)	2521 (32.5)	
Lower middle					1773 (24.5)		
Lower	1143 (14.3)	1616 (20.9)	1768 (22.1)	1861 (24.8)		1844 (23.8)	
	362 (4.5)	618 (8.0)	747 (9.3)	804 (10.7)	723 (10.0)	703 (9.1)	

Each number is presented as mean ± standard deviation or sample size (ratio by group). Dietary behaviors^a: Number of days of having breakfast of the week, Physical activity^b, days: Number of days of physical activity for at least 60 minutes per day of the week, WD^c: weekday, WK^d: weekend

Variables	Grade 7 (<i>n</i> : 7975)	Grade 8 (<i>n</i> : 7723)	Grade 9 (<i>n</i> : 8014)	Grade 10 (<i>n</i> : 7498)	Grade 11 (<i>n</i> : 7242)	Grade 12 (<i>n</i> : 7754)	<i>p</i> -value
Perceived economic status							< 0.01
Upper	1303 (16.3)	965 (12.5)	874 (10.9)	652 (8.7)	597 (8.2)	578 (7.5)	
Upper middle	2635 (33.0)	2350 (30.4)	2344 (29.2)	2071 (27.6)	1894 (26.2)	1946 (25.1)	
Middle					3615 (49.9)	3952 (51.0)	
Lower middle	3425 (42.9)	3638 (47.1)	392 (48.8)	3761 (50.2)	933 (12.9)	1055 (13.6)	
Lower	542 (6.8)	661 (8.6)	751 (9.4)	842 (11.2)	203 (2.8)		
	70 (0.9)	109 (1.4)	133 (1.7)	172 (2.3)		223 (2.9)	
Dietary behavior ^a , days	5.28 (± 2.74)	5.04 (± 2.75)	4.95 (± 2.77)	5.02 (± 2.68)	4.83 (± 2.68)	5.01 (± 2.70)	< 0.01
Perceived health status							< 0.01
Very healthy	2438 (30.6)	2134 (27.6)	2292 (28.6)	1932 (25.8)	1714 (23.7)	1860 (24.0)	
Healthy	3736 (46.8)	3544 (45.9)	3527 (44.0)	3401 (45.4)	3151 (43.5)	3200 (41.3)	
So so							
Unhealthy	1528 (19.2)	1667 (21.6)	1715 (21.4)	1604 (21.4)	1753 (24.2)	1933 (24.9)	
Very unhealthy	263 (3.3)	358 (4.6)	455 (5.7)	532 (7.1)	575 (7.9)	712 (9.2)	
	10 (0.1)	20 (0.3)	25 (0.3)	29 (0.4)	49 (0.7)	49 (0.6)	

Each number is presented as mean ± standard deviation or sample size (ratio by group). Dietary behaviors^a: Number of days of having breakfast of the week, Physical activity^b, days: Number of days of physical activity for at least 60 minutes per day of the week, WD^c: weekday, WK^d: weekend

Variables	Grade 7 (<i>n</i> : 7975)	Grade 8 (<i>n</i> : 7723)	Grade 9 (<i>n</i> : 8014)	Grade 10 (<i>n</i> : 7498)	Grade 11 (<i>n</i> : 7242)	Grade 12 (<i>n</i> : 7754)	<i>p</i> - value
Body perception							< 0.01
Very skinny	332 (4.2)	336 (4.4)	359 (4.5)	341 (4.5)	293 (4.0)	285 (3.7)	
Skinny					1465 (20.2)	1480 (19.1)	
So so	1802 (22.6)	1756 (22.7)	1770 (22.1)	1582 (21.1)			
Obese	2944 (37.5)	2898 (37.5)	2965 (37.0)	2680 (35.7)	2572 (35.5)	2727 (35.2)	
Very obese	2395 (30.0)	2309 (29.9)	2465 (30.8)	2399 (32.0)	2682 (34.6)	2682 (34.6)	
	452 (5.7)	424 (5.5)	455 (5.7)	496 (6.6)	514 (7.1)	580 (7.5)	
Physical activity ^b , days	3.32 ± 2.21	3.26 ± 2.16	3.20 ± 2.19	2.83 ± 2.02	2.84 ± 2.01	2.69 ± 2.00	< 0.01
Time for studying (WD ^c), min	376.68 ± 242.87	415.80 ± 242.87	425.80 ± 237.63	520.05 ± 263.81	516.83 ± 251.16	550.70 ± 252.37	< 0.01
Time for studying (WK ^d), min	148.56 ± 155.73	186.37 ± 178.95	191.13 ± 187.34	266.74 ± 225.93	276.76 ± 232.376	339.08 ± 266.73	< 0.01
Time for Internet use (WD ^c), min	111.75 ± 112.57	122.82 ± 122.45	117.96 ± 120.20	104.29 ± 109.48	103.07 ± 110.23	97.73 ± 105.12	< 0.01
Time for Internet use (WK ^d), min	186.55 ± 163.00	208.39 ± 174.33	202.43 ± 176.93	189.43 ± 161.08	174.93 ± 161.61	163.74 ± 152.89	< 0.01

Each number is presented as mean ± standard deviation or sample size (ratio by group). Dietary behaviors^a: Number of days of having breakfast of the week, Physical activity^b, days: Number of days of physical activity for at least 60 minutes per day of the week, WD^c: weekday, WK^d: weekend

Variables	Grade 7 (n: 7975)	Grade 8 (n: 7723)	Grade 9 (n: 8014)	Grade 10 (n: 7498)	Grade 11 (n: 7242)	Grade 12 (n: 7754)	p-value
Perceived stress status							< 0.01
Very much	643 (8.1)	754 (9.8)	820 (10.2)	822 (11.0)	874 (12.1)	976 (12.6)	
A lot	2021 (25.3)	2156 (27.9)	2143 (26.7)	2166 (28.9)	2175 (30.0)	2264 (29.2)	
A little							
Not much	3276 (41.1)	3204 (41.5)	3407 (42.5)	3203 (42.7)	2991 (41.3)	3223 (41.6)	
Not at all	1625 (20.4)	1307 (16.9)	1353 (16.9)	1044 (13.9)	989 (13.7)	1057 (13.6)	
	410 (5.1)	302 (3.9)	291 (3.6)	263 (3.5)	213 (2.9)	234 (3.0)	
Depressive episode, yes	1752 (22.0)	2075 (26.9)	2228 (27.8)	1993 (26.6)	2024 (27.9)	2294 (29.6)	< 0.01
Each number is presented as mean ± standard deviation or sample size (ratio by group). Dietary behaviors ^a : Number of days of having breakfast of the week, Physical activity ^b , days: Number of days of physical activity for at least 60 minutes per day of the week, WD ^c : weekday, WK ^d : weekend							

Logistic regression analyses investigating predictors of depressive episode

We identified the individual variables that influence the depressive episode through logistic regression analysis to confirm the association between individual variables and the presence of depressive episodes. The risk of depressive episodes was high in the order of girls' school, coeducational, and boys' school, and girls had a higher risk than boys. The higher the grade, the higher the risk of developing depressive episodes, and those with low academic achievement had a higher risk of depression than those with high academic achievement. Having a multicultural family was not significant as a factor influencing depression, but adolescents who did not live with their parents had a higher risk than those living with parents. Negative perceptions of own health status and body shape and efforts to control weight were also found to increase the risk of onset of depressive episodes. Students who had breakfast more than five days a week had a lower risk of depressive episodes, and students having breakfast for only one day had a higher risk of depressive episodes than students who had none. Physical activity once a week was evaluated as a factor that increased the risk of developing depression, but physical activity for more than two days was not statistically significant. The risk was higher in the group spending more than 12 hours of study time on weekdays (odds ratio [OR] 1.178), and the group with less than four hours of study time on weekends had a lower risk of depressive episodes (1–119 minutes: OR 0.876 and 120–239 minutes: 0.928, respectively). An internet use time of up to one hour on weekdays and three hours on

weekends was associated with a low risk of developing depressive episodes; however, if this was over three hours on weekdays, the risk of depressive episodes increased. Alcohol drinking, smoking, drug/substance use, sexual behavior, and hospital treatment for violent events within one year were identified as factors that increase the risk of developing depressive episodes. Then, we performed the logistic regression analysis with the variables that showed statistically significant results as independent variables except multicultural family and city type. After controlling for each variable, the perceived health status, perceived academic performance, time for studying/internet use, physical activity, and other health risk behaviors showed significant results. As physical activity increased, the risk of depressive episodes was higher (adjusted odds ratio [aOR] 1.212–1.625), and the study time on weekends was evaluated as increasing the risk of depressive episodes. Internet use on weekends was evaluated as a factor in reducing the onset of depressive episodes. The main findings of the regression analysis including physical activity, study time, and internet use time are presented in Table 2, and all findings are presented in Additional file 1, supplement 2.

Table 2
Logistic regression analyses of factors associated with depressive episode

Variables	Unadjusted Model				Adjusted Model*			
	OR	95% CI for OR		p-value	OR	95% CI for OR		p-value
Gender								
Boys	1							
Girls	1.879	1.802	1.959	< 0.001	1.998	1.881	2.122	< 0.001
School grade								
Middle 1st grade	1				1			
Middle 2nd grade	1.305	1.213	1.404	< 0.001	1.123	1.038	1.215	< 0.01
Middle 3rd grade	1.368	1.273	1.470	< 0.001	1.098	1.015	1.188	< 0.05
High 1st grade	1.286	1.195	1.384	< 0.001	0.924	0.849	1.006	0.067
High 2nd grade	1.378	1.280	1.483	< 0.001	0.867	0.795	0.945	< 0.01
High 3rd grade	1.492	1.389	1.604	< 0.001	0.886	0.812	0.966	< 0.01
Perceived health status								
Very healthy	1				1			
Healthy	1.429	1.352	1.511	< 0.001	1.377	1.297	1.463	< 0.001
So so	2.326	2.189	2.473	< 0.001	2.115	1.975	2.264	< 0.001
Unhealthy	3.897	3.577	4.247	< 0.001	3.406	3.095	3.748	< 0.001
Very unhealthy	6.393	4.740	8.623	< 0.001	6.198	4.474	8.585	< 0.001

*Adjusted Model for all variables shown in Table 3, except multicultural family and city type. Dietary behaviors^a: Number of days of having breakfast of the week, Physical activity^b, days: Number of days of physical activity for at least 60 minutes per day of the week, WD^c: weekday, WK^d: weekend

Variables	Unadjusted Model				Adjusted Model*			
	OR	95% CI for OR		p-value	OR	95% CI for OR		p-value
Dietary behavior ^a								
none	1				1			
1 day	1.145	1.049	1.248	< 0.01	1.086	0.989	1.193	0.086
2 days	1.020	0.939	1.107	0.645	0.992	0.908	1.085	0.866
3 days	1.007	0.925	1.095	0.880	0.970	0.886	1.063	0.514
4 days	0.983	0.898	1.076	0.711	0.975	0.884	1.075	0.608
5 days	0.904	0.837	0.977	< 0.05	0.948	0.872	1.031	0.213
6 days	0.820	0.751	0.894	< 0.001	0.895	0.815	0.983	< 0.05
7 days	0.671	0.632	0.712	< 0.001	0.793	0.742	0.847	< 0.001
Physical activity ^b								
None	1				1			
1 day	1.136	1.067	1.209	< 0.001	1.212	1.133	1.297	< 0.001
2 days	1.007	0.945	1.073	0.836	1.181	1.102	1.265	< 0.001
3 days	1.014	0.948	1.085	0.682	1.297	1.203	1.398	< 0.001
4 days	0.943	0.864	1.030	0.193	1.292	1.173	1.425	< 0.001
5 days	0.951	0.869	1.040	0.271	1.328	1.201	1.467	< 0.001
6 days	0.985	0.856	1.134	0.837	1.446	1.241	1.685	< 0.001
7 days	1.054	0.965	1.151	0.244	1.625	1.469	1.797	< 0.001
								< 0.001
								< 0.001

*Adjusted Model for all variables shown in Table 3, except multicultural family and city type. Dietary behaviors^a: Number of days of having breakfast of the week, Physical activity^b, days: Number of days of physical activity for at least 60 minutes per day of the week, WD^c: weekday, WK^d: weekend

Variables	Unadjusted Model				Adjusted Model*			
	OR	95% CI for OR		p-value	OR	95% CI for OR		p-value
Time for studying (WD ^c)								
360–479 min	1				1			
< 240 min	0.990	0.920	1.065	0.777	1.149	1.062	1.243	< 0.01
240–359 min	1.079	0.986	1.182	0.100	1.194	1.083	1.316	< 0.001
480–599 min	1.022	0.949	1.101	0.565	1.015	0.937	1.099	0.715
600–719 min	1.077	0.999	1.161	0.052	1.062	0.978	1.154	0.153
> 720 min	1.178	1.095	1.268	< 0.001	1.125	1.033	1.226	< 0.01
Time for studying (WK ^d)								
None	1				1			
1–119 min	0.876	0.812	0.944	< 0.001	1.014	0.934	1.100	0.743
120–239 min	0.928	0.864	0.996	< 0.05	1.102	1.018	1.193	< 0.05
240–359 min	0.991	0.919	1.070	0.824	1.217	1.116	1.327	< 0.001
360–479 min	0.985	0.901	1.077	0.744	1.267	1.144	1.404	< 0.001
> 480 min	1.121	1.039	1.210	< 0.01	1.518	1.380	1.670	< 0.001
Time for internet use (WD ^c)								
None	1				1			
1–60 min	0.885	0.834	0.940	< 0.001	1.025	0.949	1.107	0.531
61–120 min	0.954	0.897	1.014	0.134	1.057	0.974	1.147	0.184
121–180 min	1.057	0.987	1.132	0.115	1.042	0.950	1.144	0.381
> 180 min	1.344	1.259	1.434	< 0.001	1.174	1.068	1.292	< 0.05

*Adjusted Model for all variables shown in Table 3, except multicultural family and city type. Dietary behaviors^a: Number of days of having breakfast of the week, Physical activity^b, days: Number of days of physical activity for at least 60 minutes per day of the week, WD^c: weekday, WK^d: weekend

Variables	Unadjusted Model				Adjusted Model*			
	OR	95% CI for OR		p-value	OR	95% CI for OR		p-value
Time for internet use (WK ^d)	1				1			
None	0.799	0.739	0.865	< 0.001	0.866	0.788	0.952	< 0.01
1–60 min	0.818	0.761	0.879	< 0.001	0.895	0.819	0.979	< 0.05
61–120 min	0.817	0.762	0.877	< 0.001	0.894	0.817	0.979	< 0.05
121–180 min	1.000	0.947	1.057	< 0.001	0.929	0.854	1.010	< 0.01
> 180 min				0.993				
*Adjusted Model for all variables shown in Table 3, except multicultural family and city type. Dietary behaviors ^a : Number of days of having breakfast of the week, Physical activity ^b , days: Number of days of physical activity for at least 60 minutes per day of the week, WD ^c : weekday, WK ^d : weekend								

Discussion

In this study, we identified factors related to depressive episodes in adolescents. Similar to the results of previous studies [3, 19, 22–26], gender, age, academic achievement, family economic state, type of living, physical activity, health status, perception of body shape, and study time were related to presence of depressive episodes. Smoking, alcohol, violence victim experiences, and teenage sexual experiences, known as risk factors for adolescent depressive disorder, were also identified as factors that increase the risk of depressive episodes in this study, and risk of violence victim experience was the highest among them (aOR: 1.516–2.149). Being a multicultural family did not show statistically significant results, and the perception that subjective family economic status was middle lowered the risk of depressive episodes.

Physical health is highly related to mental health, and physically ill patients are at high risk of developing depressive disorder [23, 27]. Moreover, in adolescence, individuals' perception of their own body shape affects self-esteem and mental health [23]. The negative perception of one's body shape is also a risk factor of developing mental disorders such as depressive disorder [28]. In this study, adolescents who thought that they were (very) obese or very skinny were at high risk of depressive episodes in an univariable analysis; however, in a multivariate analysis, the perception that one's body was (very) skinny was evaluated as a risk factor. The efforts to control their weight were also evaluated as a risk factor. We judged that adolescents' efforts to maintain their socially preferred skinny body would have served as a stress factor. Academic achievements were also evaluated as a risk factor for the occurrence of depressive episodes in adolescents in connection with the social environment. In Korea, academic achievement is critical for students, and college entrance is a major stress factor, especially among high

school students. In an univariable regression analysis, the third grade of high school was evaluated as the high-risk factor of depressive episodes, but in a multivariable regression analysis, the risk of depressive episodes tended to decrease as the grade increased. In the same analysis, students with lower academic achievement had a higher risk of depressive episodes than those with higher academic achievement. Taken together, we interpreted that the risk of onset of depressive episodes increases due to stress caused by college entrance exams as the grade also increases. Echoing previous studies, regular breakfast was also associated with depression episodes. In this study, we found that adolescents who had breakfast for more than six days had a significantly lower risk of depressive episodes.

We identified several results that differ from those of previous studies. The literature has reported that regular physical activity is associated with low levels of depression and anxiety [2, 3]. However, in Korean adolescents, we presented opposite results. In an univariable regression, adolescents who exercised one day per week had a higher risk of depressive episodes than adolescents who did not exercise at all (OR: 1.136). In a multivariable logistic regression adjusting other variables, the risk of depressive episode increased along with the number of days of physical activity (aOR: 1.181–1.625). Adolescents doing daily physical activity had the highest risk of depressive episodes; in addition, the length of sitting time for studying or internet use also showed significant results. Adolescents who had a shorter time for studying than the average school activity time on weekdays had a higher risk of developing depressive episodes. In a multivariate regression, adolescents who study less than four hours or more than 12 hours on weekends had a higher risk of developing depressive episodes. The high risk of students with short study hours may be related to school refusal. Students with school refusal have a high risk of depressive disorder and anxiety disorder, and adolescents with depressive disorder have been reported to be associated with a decline in school function and academic achievement [29–31]. Excessive study time is also a stress factor for adolescents, and this lifestyle makes it difficult for them to get enough rest. Adolescents who spend more than two hours of study time per day on weekends were at high risk of developing depressive episodes. The appropriate study time (6–12 hours including school activity on weekdays, and less than two hours on weekends) shown in the results can be suggested as a recommended time for studying not to increase the risk of depressive episodes.

Internet use on weekend was found to lower the risk of depressive episodes, which we believe is related to the leisure culture of Korean youth. The internet penetration rate in Korea is very high, and teenagers can easily access it through smartphones and PCs. In an existing study conducted in South Korea, adolescents reported using the internet for pleasure, stress relief, and socializing with friends [32]. In addition, the numbers of students returning home late due to private academic activities have been increasing; for this reason, there are limitations in physical activity such as outdoor activities and meeting friends in person. Considering this situation, we judged that Korean youths prefer indoor activities such as internet games rather than physical activities to relieve stress. Based on these results, we suggest that the effects and adverse effects of internet use must be reevaluated according to cultural characteristics. Existing studies have been conducted mainly on the problem of internet use [9, 10, 33, 34]. Although internet game addiction, excessive use of SNS, obesity due to reduced physical activity, and decline in basic physical strength can be problematic, it is not wise to judge internet use itself negatively. Leisure

activities using the internet, including internet games, movies, and social activities, are gradually increasing, and information acquisition through the internet is common these days. Adequate internet use can reduce tension and improve mood in the same way as physical activity. Excessive internet use poses a high risk of developing depressive episodes, but a use limited to less than three hours on weekends under supervision of a caregiver does not have negative effects on adolescents' mental health.

This study has strengths in that we comprehensively evaluated factors related to the risk of developing depressive disorder among adolescents. By presenting findings that show significant differences from the existing results, we were able to suggest the necessity of establishing the new standard of healthy lifestyle according to youth culture. Depending on the adolescents' living environment, appropriate study time and internet use may be more beneficial to mental health than physical activity; nevertheless, there are some limitations in this study. First, in the question about physical activity, we did not evaluate the type of physical activity, students' spontaneity, and preference for physical activity. For this reason, students who engage in physical activity during physical education class or work part-time regardless of their will were included in the results. We have suggested the possibility that unwanted physical activity can negatively affect mental health, but in order to more clearly define the causality, future studies must confirm the effect of spontaneity of physical activity on depressive episode. Second, this study was conducted on adolescents in South Korea, and caution is needed when interpreting the results. As mentioned above, because risk factors related to Korean youth and students' interests are different, it is difficult to generalize the recommended time to use the Internet and study for all students. Thus, our recommendation will have to be applied flexibly depending on an individual's characteristics and on the culture of the youth group. Third, there is a possibility that individual biases were included by evaluating subjective perceptions instead of objective measures for variables. However, previous studies have shown that subjective perceptions influence emotional states in adolescents [35, 36]. In this context, adolescents' subjective evaluation of their social economic status influenced their emotional status. Fourth, we were unable to record internet use time on weekends. As a study also shows that using the internet for more than seven hours a day is related to depressive symptoms [10], further research is needed. Fifth, although students reported the subjective perception of depressive episodes, the severity of depressive episodes was not evaluated.

Conclusion

We identified risk factors and protective factors associated with the onset of depressive episodes among Korean adolescents. Internet use of more than three hours on weekdays and inappropriate study time (less than six hours on weekdays and more than two hours on weekends) posed a high risk of depressive episodes, and internet use on weekends and having breakfast more than six days per week were suggested as ways to reduce such risk. Unlike previous studies conducted in other countries, physical activity was a risk factor for depressive episodes among Korean adolescents. We argue that this reflects Korean adolescents' way of managing stress as well as their youth culture and lifestyles. Risk factors such as academic achievement and family economic power are highly related to social awareness, which

needs to be changed. To prevent the onset of depressive episodes in adolescents, it is necessary to understand their cultures and lifestyle and set an appropriate strategy for improving their mental health.

Declarations

Ethics approval and consent to participate

KYRBS has been conducted by Ministry of Education, Ministry of Health and Welfare, and KDCA as national approved statistical data. The protocol of this study for secondary analysis was approved by the Institutional Review Board of the Korea University Medical Center, Ansan Hospital, Gyeonggi-do, Korea (No. 2020AS0309).

Consent for publication

Not applicable

Availability of data and materials

The datasets generated and/or analysed during the current study are on the Korea Disease Control Agency website, [<http://www.kdca.go.kr/yhs/home.jsp>]

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JL: Conceptualization, Methodology, Data curation, Formal Analysis, and Writing original draft. CH: Conceptualization, Methodology, Writing—Review & Editing. YK: Conceptualization, Methodology, Writing—Review & Editing. ML: Formal analysis, Writing—Review & Editing. HY: Conceptualization, Methodology, Formal analysis, Writing—Review & Editing, Supervision.

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