



Association between morningness-eveningness, sleep duration, weekend catch-up sleep and depression among Korean high-school students

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Abstract

The present study aimed to examine the association between morningness-eveningness preferences, sleep duration, weekend catch-up sleep duration and depression among Korean high-school students. A total of 8,655 high-school students participated from 15 districts in South Korea and completed an online self-report questionnaire. The following sleep characteristics were assessed: weekday and weekend sleep duration, weekend catch-up sleep duration, morningness-eveningness preference, perceived sufficiency of sleep, self-reported snoring and sleep apnea, daytime sleepiness, and sleep environment. Age, gender, body mass index, number of private classes, proneness to internet addiction, and depressive mood were also evaluated. A logistic regression analysis was conducted to compute odds ratios for the association between depression and sleep characteristics, after controlling for relevant covariates. Eveningness preference was a significant predictor of depressive mood (adjusted OR, 1.71; 95% CI, 1.47–1.99). Weekend CUS durations that were ≥ 2 hr and enrollment in numerous private classes were associated with a lower risk for depression (0.68, 0.55–0.85; 0.76, 0.60–0.95; respectively). Female gender, underweight and obese body weight, short weekday sleep durations, excessive daytime sleepiness, perceived excessiveness and insufficiency of sleep, self-reported snoring and sleep apnea, proneness to internet addiction and a non-optimal sleep environment were associated with an increased risk for depression. Eveningness preference and insufficient weekday sleep duration were associated with an increased risk for depression. Weekend CUS duration ≥ 2 hr reduced the risk for depression. Diverse aspects, including sleeping habits and sleep-related environmental factors, should be considered to reduce depressive symptoms in late adolescents.

KEYWORDS

adolescents, depression, morningness-eveningness preference, sleep

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1 | INTRODUCTION

The adolescent periods are essential developmental stages for both physical and psychological maturation. Adolescents tend to present shorter sleep duration during the night and delayed sleep phase compared to childhood. With these changes in circadian rhythms, environmental and psychosocial factors, such as early school start times and competing academic and social demands (Crowley et al., 2014; Gregory & Sadeh, 2012), may result in a higher prevalence of insufficient sleep in adolescents (Paruthi et al., 2016; Wheaton, Jones, Cooper, & Croft, 2018). Adolescents are vulnerable to psychological and physical health problems, such as depressive mood and sleep disturbances (Williams, Holmbeck, & Greenley, 2002).

Morningness (advanced sleep period) and eveningness (delayed sleep period) types are based on circadian rhythms and chronobiology (Negri, Dorn, Pabst, & Susman, 2011; Young & Kay, 2001). Individuals with eveningness preference have substantially more irregular sleep-wake schedules than their counterparts with morningness preference. Adolescents experience an age-related increase in eveningness preference, which indicates that adolescents go to bed and awaken at a later time than children. The behavioural trait of eveningness is associated with increased susceptibility to depression in adults (Antypa, Vogelzang, Meesters, Schoevers, & Penninx, 2016; Merikanto et al., 2013). The studies with adolescents also revealed a significant relationship between eveningness preference and depression (Chiu, Yang, & Kuo, 2017; Fares et al., 2015; Haraden, Mullin, & Hankin, 2017). Eveningness preference is associated with increased risk of diabetes, psychological, neurological, respiratory and gastrointestinal/abdominal disorders, and all-cause mortality (Knutson & von Schantz, 2018).

Insufficient sleep duration in adolescents has been associated with a greater risk for depression (Berger, Wahlstrom, & Widome, 2019). A recent study of adolescents aged 13–19 years has provided evidence for an association between short sleep and depression (Yeo et al., 2019). In a large Japanese cross-sectional study, long sleep duration during school nights might be associated with the lowest risk of depression (Ojio, Nishida, Shimodera, Togo, & Sasaki, 2016). Thus, a sufficient sleep time during weekdays is important to prevent depression in adolescents.

Weekend catch-up sleep (CUS) was calculated as weekend sleep duration minus weekday sleep duration (Kim et al., 2012). Weekend CUS is a compensatory phenomenon for weekday sleep deficit. Several studies of adults showed that weekend CUS behaviour was associated with lower risk of hypertension and better health-related quality of life (Hwangbo, Kim, Chu, Yun, & Yang, 2013; Oh, Kim,

Kong, Oh, & Moon, 2019). In a study of 936 school children (aged 10 or 11 years), weekend CUS showed a lowering effect on being overweight (Kim et al., 2012). The presence of weekend CUS may have a positive effect on human health.

However, there is a lack of studies that examined the association between adolescent depression and sleep-related integrated factors, such as sleep traits during weekdays and weekends, and environmental situations. We aimed to investigate the relationship between morningness-eveningness preferences, sleep duration, weekend CUS duration and depression in Korean high-school students.

2 | METHODS

2.1 | Study participants

This nationwide cross-sectional study on the effect of sleep health status on daily functioning in Korean adolescents was conducted by the Sleep Center at the Samsung Medical Center and Korea Centers for Disease Control and Prevention between July 1 and 31, 2011. High-school students were sampled from 15 districts (metropolises/provinces) in Korea. The nationwide selection of schools and data collection from students was supported by the Ministry of Education, Science and Technology. A total of 75 high schools (grades 10–12) were randomly sampled. Each school had approximately 30 students in each class, and two classes were randomly selected from each grade of every school to represent the overall population of the respective grade.

A total of 12,666 Korean high-school students in the 10th to 12th grades had initially enrolled in this study. We excluded 4,017 students who went to various special-purpose high schools. A further 84 students were excluded because their average, weekday or weekend sleep durations were either extremely long or short (Figure 1). The final sample ($N = 8,565$) consisted of 4,104 (47.9%) female and 4,461 (52.1%) male general high-school students. The average age of the students was 16.77 ± 0.85 years.

Written informed consent was obtained from all participants and the institutional review board of Samsung Seoul Hospital approved the protocol and design of the study.

2.2 | Demographics and sleep habits

In the present study, data were collected by means of an online survey. Students who participated in the survey were asked to complete

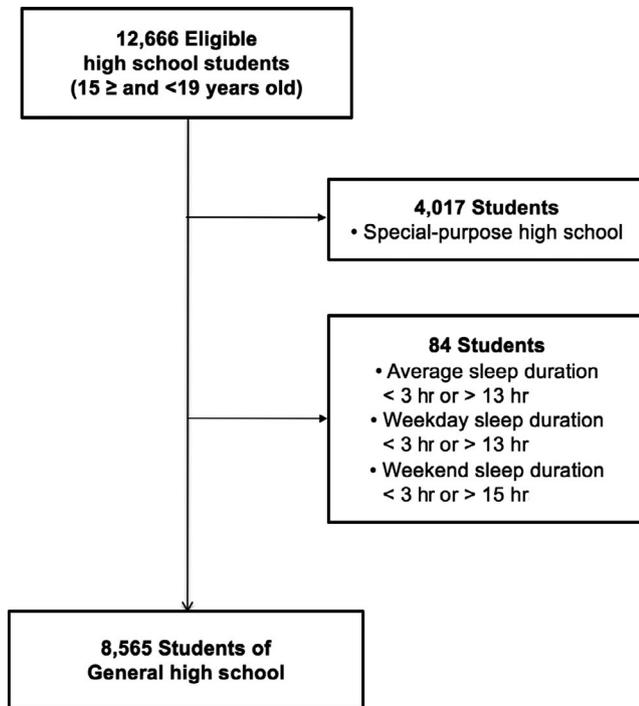


FIGURE 1 Study flow diagram. Out of 12,666 participants in Korean high schools, 8,565 students were included in this study

a questionnaire in the computer room of their school. All the students from each class completed the questionnaire at the same time. Their demographic characteristics, namely, age, gender, school grade and body mass index (BMI), and the number of private educational classes that they attended (i.e., excluding regular school classes), were also measured. BMI values were transformed into age- and gender-adjusted z-scores based on the 2017 Korean National Growth Charts for children and adolescents (Kim et al., 2018). The resultant scores were used to classify students into the following categories: underweight (i.e., BMI that is below the normal limit: <5th percentile), normal (BMI that is within the normal limit: 5th \leq BMI < 85th percentile), overweight (BMI that is higher than the normal limit: 85th \leq BMI < 95th percentile) and obese (BMI \geq 95th percentile). The questions that were used to assess sleep habits (e.g., sleep duration and bedtimes and wake times on weekdays and weekends) were as follows: (a) "What is your average sleep duration on a typical week night and weekend night?" (b) "On average, when do you usually go to bed on week nights and weekend nights?" (c) "At what time do you usually wake up on weekdays and weekends?" Weekend CUS duration was calculated by subtracting the weekday sleep duration from the weekend sleep duration. Subjective perceptions of the sufficiency of sleep durations were assessed using the following question: "Do you consider your average sleep duration to be adequate?" The possible answers to this question were "inadequate," "adequate" or "much." The quality of the sleep environment was also evaluated.

The Korean version of the Epworth Sleepiness Scale (ESS) was used to assess daytime sleepiness (Cho et al., 2011). The last item of the eight situations that were depicted in the original ESS was only relevant to respondents who drove cars (i.e.,

"When I stop driving my car for a few minutes as a result of heavy traffic"). However, it was modified to describe a situation that involved a passenger because those who are younger than the age of 20 years are not allowed to drive in Korea. An ESS score that was ≥ 11 was indicative of the experience of excessive daytime sleepiness.

Perceived snoring and sleep apnea were assessed using the following two questions: "How often did you snore loudly while sleeping during the past 30 days?" "How often have you experienced breath-holding, breathing pauses, and an inability to breathe when you were sleeping during the past 30 days?" Detailed information about these assessments have been published elsewhere (Seo, Kim, Yang, & Hong, 2017; Yang et al., 2017).

2.3 | Morningness-eveningness preference

Morningness and eveningness preferences were assessed using the Morningness-Eveningness Questionnaire (MEQ) for children (Carskadon, Vieira, & Acebo, 1993). Morningness-eveningness is a construct developed to estimate phase tendencies from self-descriptions. The child morningness-eveningness score consists of responses to 10 questions about preferred timing of specific activities (e.g., bedtime and wake time, test taking). Total scale scores ranged from 10 to 42, and lower scores were indicative of an eveningness preference. To facilitate the interpretation of our findings, additional analyses were conducted with the scores divided into tertiles: eveningness preference (11 \leq MEQ scores < 23), intermediate (23 \leq MEQ scores < 27) and morningness preference (27 \leq MEQ scores < 41).

2.4 | Depression

The Korean version of the Beck Depression Inventory (BDI), which is the most commonly used self-report measure of depression, was used to assess depressive symptoms (Hahn et al., 1986). Students were required to indicate how they were feeling at the time of taking the test by responding to each of 21 items on a rating scale that ranged from 0 to 3. Total scores that ranged from 0 to 9 were indicative of minimal depressive symptoms. On the other hand, total scores that ranged from 10 to 15, 16 to 23 and 24 to 62 were indicative of mild, moderate and severe depression, respectively (Beck & Steer, 1987). In this study, BDI scores that were ≥ 16 (i.e., the cut-off score) were indicative of depressive mood.

2.5 | Ancillary factors that are related to sleep

The number of private after-school classes that students attended was measured. Risk of internet addiction was assessed using the Internet Addiction Proneness Scale for Youth (Kim, Jung, Lee, Kim, & Cho, 2008).

2.6 | Statistical analysis

We used Pearson's chi-squared (χ^2) test to analyse categorical variables and the *t*-test and one-way analysis of variance (ANOVA) to analyse continuous variables. Furthermore, Bonferroni correction for post-hoc multiple comparisons was applied to examine mean differences between groups that were created using tertiles for MEQ scores. A multiple logistic regression analysis was conducted to compute adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for depressive mood, after controlling for relevant covariates. Logistic regression was performed with MEQ as both tertile categorical variable and a continuous variable. The data were analysed using Stata® (version 14.0, StataCorp.). The results of two-tailed tests with *p*-values that were <.05 were considered to be statistically significant.

3 | RESULTS

The number of participants who had a depressive mood ($BDI \geq 16$) was 1,794 (20.9%). Women were more likely to report a depressive mood ($p < .001$) than men. The proportion of students with short (<5 hr) weekday and weekend CUS durations was higher among those with a depressive mood. Students with a depressive mood were more likely to snore or have sleep apnea than their counterparts who reported lower levels of depressive mood ($p < .001$). Students with a depressive mood obtained significantly lower MEQ scores ($p < .001$). The characteristics of the two groups are presented in detail in Table 1.

Classification of students into different groups based on tertiles for MEQ scores revealed that 2,717 (32%) students had eveningness preference (i.e., 3rd tertile; $11 \leq MEQ < 23$) (Table 2). Students with eveningness preference reported shorter weekday sleep durations, longer weekend sleep durations and increased weekend CUS durations than the other two groups (all $ps < .001$). Self-reported snoring ($p < .001$) and sleep apnea ($p < .001$) were more prevalent among those with eveningness preference than among the other groups. Further, 26% of the students met the criteria for excessive daytime sleepiness ($ESS \geq 11$), and this was significantly higher than what was observed in the other groups ($p < .001$).

Table 3 summarizes the results of multivariate logistic regression analysis that was conducted to estimate the risk of depressive mood among high-school students. Eveningness preference was a significant predictor of depressive mood (adjusted OR = 1.71, 95% CI = 1.47–1.99). The OR for depressive mood was higher among female than among male adolescents (adjusted OR = 2.24, 95% CI = 1.99–2.53). The OR for depressive mood was higher among students who were underweight (adjusted OR = 1.27, 95% CI = 1.02–1.57) and obese (adjusted OR = 1.41, 95% CI = 1.13–1.75) than among their counterparts who were of normal weight. Short weekday sleep durations were associated with a higher OR for depressive mood (adjusted OR = 0.86, 95% CI = 0.81–0.91). On the other hand, weekend CUS durations that were longer than 2 hr were associated with a lower

OR for depressive mood (adjusted OR = 0.68, 95% CI = 0.55–0.85). Self-reported snoring (adjusted OR = 1.27, 95% CI = 1.11–1.46) and sleep apnea (OR = 2.10, 95% CI = 1.75–2.52) were associated with higher ORs for depressive mood. Enrollment in private after-school classes was associated with a significantly lower OR for depressive mood. Proneness to internet addiction was associated with a higher OR for depressive mood (adjusted OR = 1.06, 95% CI = 1.05–1.06). A non-optimal sleep environment was a significant predictor of depressive mood (adjusted OR = 1.86, 95% CI = 1.56–2.21).

4 | DISCUSSION

The results of the present nationwide cross-sectional study revealed that sleep-related and environmental factors contributed to depressive mood among Korean high-school students. Eveningness preference was significantly associated with depressive mood among high-school students. Insufficient weekday sleep durations were associated with an increased risk of depressive mood. Furthermore, weekend CUS durations that were longer than 2 hr were associated with a lower risk of depressive mood. Self-reported snoring and sleep apnea were associated with an increased risk of depressive mood among adolescents. This is a study of a large sample size from a nationwide Korean survey to demonstrate that eveningness preference is associated with an increased risk of depressive mood. Furthermore, weekend CUS durations that are ≥ 2 hr are associated with lower rates of depressive mood among Korean high-school students.

Morningness and eveningness preferences change throughout a person's lifespan. Eveningness preference dominates during adolescence, but a stronger morningness preference takes precedence during adulthood (Carskadon et al., 1993). Eveningness preference has been linked to negative physical and mental health outcomes (Alvaro, Roberts, & Harris, 2014). Several studies have found that eveningness preference is associated with depression. A study that was conducted among 360 children and adolescents (8–16 years old) revealed that a strong eveningness preference increases the risk of the emergence of depressive symptoms (Haraden et al., 2017). Another study that was conducted among 2,139 children and adolescents (7–13 years old) found that eveningness preference was independently associated with self-reported depression, after poor sleep quality was controlled for (Chiu et al., 2017). In our study of 8,565 adolescents (15–18 years old), eveningness preference was associated with a 1.7-fold increase in the risk of depressive mood, after all other covariates were controlled for.

The cumulative rate of major depression can rise from 5% during early adolescence to a figure that is as high as 20% by the end of adolescence (Hankin et al., 1998). Short sleep durations increase the risk of major depression, which in turn increases the risk of shorter sleep durations (Ojio et al., 2016; Roberts & Duong, 2014). Another study demonstrated that adolescents with sleep disturbances revealed higher level of depression (Roberts & Duong, 2014). Our results have found that short weekday sleep

TABLE 1 Characteristics of subgroups by Beck Depression Inventory scores

	BDI < 16	BDI ≥ 16	p value
Subjects	6,771 (79.1)	1,794 (20.9)	
Gender			<.001
Women	3,042 (44.9)	1,062 (59.2)	
Men	3,729 (55.1)	732 (40.8)	
Age, years	16.77 ± 0.86	16.78 ± 0.85	.79
BMI, kg/m ²	21.14 ± 3.00	21.25 ± 3.27	.19
Category			.001
Underweight	458 (6.8)	149 (8.3)	
Normal	5,436 (80.3)	1,364 (76.0)	
Overweight	447 (6.6)	131 (7.3)	
Obesity	430 (6.3)	150 (8.4)	
Sleep duration			
Weekday, hr			<.001
<5	725 (10.7)	334 (18.6)	
5 to <6	2,295 (33.9)	652 (36.4)	
6 to <7	2,625 (38.8)	556 (31.0)	
7 to <8	880 (13.0)	183 (10.2)	
≥8	246 (3.6)	69 (3.8)	
Weekend, hr			.001
<5	70 (1.0)	31 (1.7)	
5 to <6	218 (3.2)	86 (4.8)	
6 to <7	676 (10.0)	196 (11.0)	
7 to <8	1,216 (18.0)	294 (16.4)	
≥8	4,591 (67.8)	1,187 (66.1)	
Weekend catch-up sleep, hr	2.69 ± 1.81	3.02 ± 2.08	<.001
Category			.036
0	546 (8.1)	145 (8.1)	
0< or 2>	1534 (22.6)	356 (19.8)	
≥2	4,691 (69.3)	1,293 (72.1)	
Perceived sufficiency of sleep			<.001
Adequate	2054 (30.3)	257 (14.3)	
Much	331 (4.9)	104 (5.8)	
Inadequate	4,386 (64.8)	1,433 (79.9)	
Snore			<.001
Yes	1,328 (19.6)	539 (30.0)	
No	5,443 (80.4)	1,255 (70.0)	
Witnessed sleep apnea			<.001
Yes	416 (6.1)	297 (16.6)	
No	6,355 (93.9)	1,497 (83.4)	
ESS scores	6.69 ± 3.50	8.74 ± 4.22	<.001
Excessive daytime sleepiness			<.001

(Continues)

TABLE 1 (Continued)

	BDI < 16	BDI ≥ 16	p value
ESS <11	5,874 (86.8)	1,230 (68.6)	
ESS ≥11	897 (13.2)	564 (31.4)	
Private class, numbers			.07
0	3,300 (48.7)	904 (50.4)	
1	1913 (28.3)	529 (29.5)	
2	1,062 (15.7)	241 (13.4)	
≥3	496 (7.3)	120 (6.7)	
Internet addiction, mean ± SD	27.61 ± 7.16	32.168 ± 10.20	<.001
Tertile			<.001
20–23	2,379 (35.1)	383 (21.3)	
24–29	2,300 (34.0)	473 (26.4)	
30–80	2092 (30.9)	938 (52.3)	
Sleep environment			<.001
Optimal	6,261 (92.5)	1516 (84.5)	
Non-optimal	510 (7.5)	278 (15.5)	
MEQ scores	24.95 ± 4.20	22.85 ± 4.57	<.001

Data are n (%) or mean ± standard deviation (SD) values.

Abbreviations: BDI, Beck Depression Inventory; BMI, body mass index; ESS, Epworth Sleepiness Scale; MEQ, Morningness-Eveningness Questionnaire.

durations were associated with an increased risk of depression in late adolescents. In addition, the perceived excessiveness and insufficiency of sleep were associated with an increased risk of depression.

Sleep debt leads to unfavourable health conditions and consequences (Medic, Wille, & Hemels, 2017). Weekend CUS is a compensatory behaviour that people engage in to cope with weekday sleep debt. Weekend CUS has been found to reduce the risk for obesity and prevalence of hypertension (Hwangbo et al., 2013; Im et al., 2017; Kim et al., 2012). A recent study that was conducted among 4,871 adults found that weekend CUS duration is associated with better health-related quality of life (Oh et al., 2019). The risk for anxiety and depression was higher among those who did not engage in weekend CUS than among those who did. However, the association between weekend CUS and depression among adolescents has not been adequately examined. To the best of our knowledge, our data are the first to show that weekend CUS durations that are ≥2 hr play a protective role against depression among high-school students.

Adolescence is a high-risk period for depression, especially for young girls (Rohde, Beevers, Stice, & O'Neil, 2009). Rohde et al. (2009) reported the risk for depression was higher among female than among male high-school students. Our data demonstrated that female adolescents had a 2.2-fold higher risk for depression compared to male adolescents. With regard to the relationship between depression and body weight, the risk for depression has been found

TABLE 2 Characteristics of the study population across MEQ tertile

	MEQ tertile			p value	Significant pairwise comparisons
	27 ≤ MEQ ≤ 41 (A)	23 ≤ MEQ < 27 (B)	11 ≤ MEQ < 23 (C)		
Subjects	2,836 (33.1)	3,012 (35.2)	2,717 (31.7)		
Gender				<.001	
Women	1,219 (43.0)	1,469 (48.8)	1,416 (52.1)		
Men	1617 (57.0)	1543 (51.2)	1,301 (47.9)		
Age, years	16.78 ± 0.86	16.77 ± 0.86	16.77 ± 0.84	.733	
BMI, kg/m ²	21.25 ± 3.02	21.15 ± 3.06	21.08 ± 3.11	.105	
Category				.566	
Underweight	190 (6.7)	207 (6.9)	210 (7.8)		
Normal	2,258 (79.6)	2,385 (79.2)	2,157 (79.4)		
Overweight	186 (6.6)	217 (7.2)	175 (6.4)		
Obesity	202 (7.1)	203 (6.7)	175 (6.4)		
Sleep duration					
Weekday, hr	5.93 ± 1.03	5.77 ± 0.99	5.58 ± 1.10	<.001	A-B*, A-C*, B-C*
Weekend, hr	8.09 ± 1.74	8.54 ± 1.85	8.89 ± 2.10	<.001	A-B*, A-C*, B-C*
Weekend catch-up sleep, hr	2.18 ± 1.60	2.79 ± 1.77	3.34 ± 2.06	<.001	A-B*, A-C*, B-C*
Perceived sufficiency of sleep				<.001	
Adequate	1,218 (43.0)	759 (25.2)	334 (12.3)		
Much	202 (7.1)	138 (4.6)	95 (3.5)		
Inadequate	1,416 (49.9)	2,115 (70.2)	2,288 (84.2)		
Snore				<.001	
Yes	521 (18.4)	647 (21.5)	699 (25.7)		
No	2,315 (81.6)	2,365 (78.5)	2018 (74.3)		
Witnessed sleep apnea				<.001	
Yes	167 (5.9)	259 (8.6)	287 (10.6)		
No	2,669 (94.1)	2,753 (91.4)	2,430 (89.4)		
ESS scores	6.02 ± 3.43	6.99 ± 3.50	8.42 ± 4.00	<.001	A-B*, A-C*, B-C*
Excessive daytime sleepiness				<.001	
ESS ≥11	297 (10.5)	451 (15.0)	713 (26.2)		
ESS <11	2,539 (89.5)	2,561 (85.0)	2004 (73.8)		
BDI scores	7.46 ± 7.23	9.51 ± 7.45	12.16 ± 8.79	<.001	A-B*, A-C*, B-C*
Depression, BDI ≥11				<.001	
Private class, numbers				<.001	
0	1511 (53.3)	1,474 (48.9)	1,219 (44.8)		
1	743 (26.2)	857 (28.5)	842 (31.0)		
2	414 (14.6)	455 (15.1)	434 (16.0)		
≥3	168 (5.9)	226 (7.5)	222 (8.2)		
Internet addiction, mean ± SD	26.86 ± 7.02	28.54 ± 7.77	30.37 ± 9.09	<.001	A-B*, A-C*, B-C*
Tertile				<.001	
20–23	1,176 (41.5)	921 (30.6)	665 (24.5)		
24–29	899 (31.7)	1,018 (33.8)	856 (31.5)		
30–80	761 (26.8)	1,073 (35.6)	1,196 (44.0)		

(Continues)

TABLE 2 (Continued)

	MEQ tertile			p value	Significant pairwise comparisons
	27 ≤ MEQ ≤ 41 (A)	23 ≤ MEQ < 27 (B)	11 ≤ MEQ < 23 (C)		
Sleep environment				<.001	
Optimal	2,612 (92.1)	2,757 (91.5)	2,408 (88.6)		
Non-optimal	224 (7.9)	255 (8.5)	309 (11.4)		

Data are n (%) or mean ± standard deviation (SD) values.

Abbreviations: BDI, Beck Depression Inventory; BMI, body mass index; ESS, Epworth Sleepiness Scale; MEQ, Morningness-Eveningness Questionnaire.

*p < .001.

TABLE 3 Multivariate logistic regression model for the presence of depressive mood

	OR (95% CI)	p value
MEQ		
27 ≤ MEQ < 41 (reference)	1	
23 ≤ MEQ < 27	1.15 (0.99–1.34)	.068
11 ≤ MEQ < 23	1.71 (1.47–1.99)	<.001
Age	1.00 (0.93–1.07)	.901
Women	2.24 (1.99–2.53)	<.001
BMI		
Normal (reference)	1	
Underweight	1.27 (1.02–1.57)	.03
Overweight	1.19 (0.95–1.48)	.131
Obesity	1.41 (1.13–1.75)	.002
Weekday sleep duration	0.86 (0.81–0.91)	<.001
Weekend catch-up sleep, hr		
0 (reference)	1	
Between 0 and 2	0.84 (0.66–1.06)	.142
≥2	0.68 (0.55–0.85)	.001
Perceived sufficiency of sleep		
Much	2.15 (1.63–2.84)	<.001
Inadequate	1.71 (1.46–2.01)	<.001
Snore	1.27 (1.11–1.46)	<.001
Witnessed sleep apnea	2.10 (1.75–2.52)	<.001
ESS scores	1.08 (1.07–1.10)	<.001
Private class, numbers		
0 (reference)	1	
1	0.93 (0.81–1.06)	.268
2	0.76 (0.64–0.90)	.002
≥3	0.76 (0.60–0.95)	.019
Internet addiction	1.06 (1.05–1.06)	<.001
Non-optimal sleep environment	1.86 (1.56–2.21)	<.001

Abbreviations: BMI, body mass index; CI, confidence interval; ESS, Epworth Sleepiness Scale; MEQ, Morningness-Eveningness Questionnaire; OR, odds ratio.

to be higher among Korean adults who are underweight and obese than among their counterparts who are of normal weight (Hong & Hur, 2017). In our study of late adolescents, we found similar results of a U-shaped relationship between body weight and the prevalence of depressive mood; in other words, risk for depression was higher among students who were underweight and obese.

Asian parents invest substantial amounts of resources in their children's private education in general (Cai & Wu, 2019). High-income parents tend to provide their children with more educational opportunities, but low-income parents tend to be unable to support their children's educational needs. The number of positive and negative social events is more strongly related to well-being among subjects with greater depressive symptoms compared to those with fewer depressive symptoms (Steger & Kashdan, 2009). In our study, high-school students who received private tutoring were at a lower risk for depression. Amidst the highly competitive educational environment in Korean, fewer opportunities for private tutoring can lead to educational isolation, which in turn can lead to depression among Korean adolescents.

Obstructive sleep apnea (OSA) is one of the most prevalent sleep disorders, characterized by recurrent episodes of complete or partial obstruction of the upper airway during sleep. Patients with OSA are comorbid, with not only physical health problems but also various mental health problems. Almost half of adults with OSA experience psychological difficulties, including depression and anxiety (Guilleminault, Eldridge, Tilkian, Simmons, & Dement, 1977; Reynolds et al., 1984). Although many earlier researchers investigated the association between OSA and attention-deficit hyperactivity disorder or aggression, fewer studies have focused on the relationship between adolescent OSA and depression (Gozal, 1998; Marcus et al., 2012, 2013). In the present study, late adolescents with self-reported sleep apnea had a 2.1-fold increased risk for depression compared with their counterparts without sleep apnea.

A major strength of the present study is that it used a large nationally representative sample of 8,565 Korean high-school students. All the participants belonged to a specific age group, namely, late adolescence (i.e., 15–19 years old). However, the present study also has several limitations. First, our study relied solely on self-report measures, which can lead to common method bias; we did not use objective measures of sleep status. Second,

it is difficult to elucidate causal relationships between sleep-related variables and depression because a cross-sectional research design was used in this study. Finally, our study did not examine the socioeconomic status of the participants. However, other factors that are related to socioeconomic status, such as the number of private classes that they attended and internet addiction, were examined.

5 | CONCLUSIONS

An eveningness preference, female gender, underweight and obese body weight statuses, short weekday sleep durations, excessive daytime sleepiness, perceived excessiveness and insufficiency of sleep, self-reported snoring and sleep apnea, proneness to internet addiction and non-optimal sleep environments were found to be associated with an increased risk for depression in Korean late adolescents. In contrast, weekend CUS durations that were ≥ 2 hr were associated with a lower risk for depression and appeared to act as a protective factor. Additionally, enrollment in numerous private classes was associated with a lower risk for depression. Therefore, diverse aspects, including sleep habits and sleep-related environmental factors, should be considered in order to reduce depressive symptoms in late adolescents.

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CONFLICT OF INTEREST

No conflicts of interest declared.

AUTHOR CONTRIBUTIONS

All the authors have made substantial contributions to the conception and design of the study, and acquisition, analysis and interpretation of the data. JHK, DK, JSS, YH, HRL, DLK, KIY and SBH have made substantial contributions to the conception and design of study, the interpretation of data, and writing the manuscript. DLK, JHK, DK, JSS, KIY and SBH have contributed to the acquisition and interpretation of data. YH has contributed substantially to the processing, analysis and interpretation of data.

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