

Impact of Sleep Duration on Emotional Status in Adolescents

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Abstract

Background: Chronic sleep deficiency adversely affects emotional and physical health. This study was to identify the current nocturnal sleep duration in South Korean adolescents and to analyze the association of emotional status such as subjective happiness, depression and suicidal attempts with the nocturnal sleep duration.

Methods: We calculated sleep duration in a representative sample of South Korean middle- and high-school students according to grade, sex, and survey year using raw data from the Korea Youth Risk Behavior Web-Based Survey from 2007-2011. Students were then categorized by nocturnal sleep duration into sleep groups with 1 hour interval. Emotional status was assessed according to sleep duration. Total sample size was 291,813 which represent 15 million students.

Results: Mean sleep duration for 2007-2011 was 6.32 ± 0.01 hours. Over the 90% of adolescents slept less than 8 hours. Sleep duration was dramatically decreased as students became senior grade. The longer sleep duration adolescents had, the more feeling of happiness they had regardless of grade. Vice versa, the lesser sleep duration students had, the more feeling of stress, depression, suicidal ideation and attempts they had. For example, less than 5 hours sleepers chose very unhappy 2.19 (95%CI 1.87-2.57) times more, extremely stressed 5.10 (4.33-6.02), depressions 1.94 (1.86-2.03), suicidal ideation 1.95 (1.85-2.06) and suicidal attempt 1.39 (1.24-1.55) than adolescents with 8-9 hour sleep duration.

Conclusions: Sleep deficiency is associated with increasing stress, depression, suicidal ideation and attempts. Appropriate nocturnal sleep duration is critical for emotional health in adolescents.

Keywords: Child/Adolescent; Stress; Sleep disorder; Epidemiology; Depression

Introduction

Sleep is essential for sustaining a vibrant and healthy life, and is a key contributor to emotional stability and learning abilities such as memory, judgment, and insight [1,2]. Especially in adolescents, chronic sleep deficiency adversely affects emotional and physical health [3-5]. Despite these negative effects, adolescents often do not get sufficient sleep due to the competing demands of studying, social activities, the internet, and social networking [6-8]. When given sufficient time, adolescents generally sleep nine hours per day; however, it is usually impossible for them to sleep so long, except for on the weekend or when on vacation [9,10]. Although the optimal sleep duration in adolescents is still being debated, there is widespread agreement that, worldwide, adolescents are not getting enough sleep [11-16]. This situation is extreme in South Korea, where high school students reportedly average 4.9 to 6.5 hours of sleep duration per day [17-19]. This severe lack of sleep would be expected to cause abnormal mood and behavior in Korean adolescents.

One troubling behavior that may be related to sleep deprivation in this population is suicide. The suicide rate in South Korea has increased rapidly since the late 1990s, and now stands at 33.5 completed suicides per 100,000 persons, the highest among the Organization for Economic Cooperation and Development (OECD) countries [20]. The suicide rate among 15-19-year-old adolescents has also increased, increasing from 6.3 in 2000, to 8.0 in 2008 and 8.9 per 100,000 in 2011 [21,22]. The public health authorities have tried to lower the suicide rate, but it continues to climb. Sleep deprivation can provoke emotional instability, depression, and stress, and it may be associated with suicide [15,23-25]. Despite this, public health policy and interventions protecting adolescents from the emotional harm stemming from chronic sleep deficiency have yet to be implemented in South Korea [26]. Therefore, the present study aimed to verify the importance of

sufficient sleep on the emotional health of Korean adolescents using data from a nationwide questionnaire.

Materials and Methods

Subjects and data collection

This study was based on data obtained from an online survey, the Korea Youth Risk Behavior Web-Based Survey (KYRBWS), from 2007-2011. The KYRBWS has been implemented by the Korea Centers for Disease Control and Prevention (KCDC) yearly since 2005. The survey covered 14 topics: smoking, drinking, obesity and weight control, physical activity, diet, injury prevention, drug use, sexual behavior, mental health, oral hygiene, personal hygiene, allergies, health equity, and Internet addiction. The portion of the KYRBWS on health behavior was done via the Internet as an anonymous self-report questionnaire. From 2007-2011, students were chosen to be representative of the South Korean school-age population, using proportional and systemic sampling methods in a two-stage cluster method: the primary extraction selected 800 schools (400 middle and 400 high schools) and the secondary extraction identified specific classrooms with a sampling interval matched to the population

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ratio. After these sampling procedures, individual students randomly selected from the classrooms were anonymously invited to participate in the KYRBWS [27]. Students who were absent or students with special needs or literacy disabilities were excluded from the survey. Using these results, we analyzed items pertaining to sleep, mood, suicidal ideation and attempts from 2007 to 2011. From an original sample of 373,883 students in 16 geographical areas over the country, we analyzed data from 291,813 (78.05%) without writing errors with computed sleep time.

Study design

We calculated sleep duration according to grade, sex, and survey year using raw data from the KYRBWS from 2007-2011 [27]. Sleep duration was calculated with bedtime and wake time in items of KYRBWS. Sleep durations given as over 15 hours or under 3 hours per day were eliminated, as they were assumed to be recording errors or outliers. Students were then categorized by nocturnal sleep duration into sleep groups: less than 5 hours, 5-6 hours, 6-7 hours, 7-8 hours, 8-9 hours, and over 9 hours. Emotional state of adolescents was investigated according to their sleep duration. The 8-9 hours sleep group was selected as the reference group [10].

Emotional status was assessed via subjective feelings of stress, happiness, depression, and suicidal ideation and attempts. Stress was evaluated with “How stressed do you usually feel?” to which students could answer “extremely stressed,” “very stressed,” “stressed,” “occasionally stressed,” or “rarely stressed.” Happiness was evaluated with “How happy do you usually feel?” to which students could answer “very unhappy,” “unhappy,” “moderately happy,” “happy,” or “very happy.” Moreover, three continuous questions-whether over the past two weeks students had felt frustrated or sad to the point that they cannot function in daily life, had had suicidal ideation, or had attempted suicide during last 12 months-were analyzed.

Statistical analysis

The weights of each case were calculated by KCDC; cases were not weighted by year because similar cases were enrolled for the entire study period (2007-2011). All of the statistical procedures followed a complex sample analysis. We first compare the estimated means and ratios of each group; then, to determine the relationships between feelings of happiness or stress, suicidal ideation, suicide attempts, and sleep group, we used chi-square tests and logistic regressions in a complex sample analysis. SPSS version 20.0 (IBM, New York, USA) was used for all statistical analyses.

Results

Demographics

Between zero and four schools were dropped every year from the KYRBWS; the participation rate ranged from 94.8% in 2007 to 97.7% in 2010 (Supplementary table) [27]. Among the total 373,883 participants, 291,813 (78.05%) students were enrolled. (151,134 males [51.8%]; 140,679 females [48.2%]) Distributions between grade 7-12 (16.1%-17.1%) and between survey years were also approximately even. (55,040 [18.9%] in 2007 and 64,410 [22.1%] in 2011) The estimated populations of students based on the sample were shown in Table 1.

Sleep duration

Mean sleep duration for 2007-2011 was shown in Table 1. Overall mean sleep duration in South Korean adolescents was 6.32 ± 0.01 hour. Sleep duration was dramatically decreased as the students became

senior grade, and significantly different from each grade. In general, no statistical differences were observed by year with a few exceptions (Figure 1 and Table 2).

Distributions of sleep groups

Divided by computed sleep duration, the distribution of the subjects was shown in Table 1. The most common sleep group was 6-7 hour sleep group (25.9%) followed by 5-6 hour group (24.0%), 7-8 hour group (20.8%), less than 5 hour group (20.2%), 8-9 hour group (7.5%) and over 9 hour group (1.6%). Therefore 90.9% of all students slept less than 8 hours. Looking specifically at students in 7th grade, 4.5% of students slept less than 5 hours, 10.1% slept 5-6 hour, 24.3% slept 6-7 hour, 38.0% slept 7-8 hour, 18.9% slept 8-9 hour, and 4.3% slept

Grade		Estimated population size (percent)		sleep duration
		Estimated population size	(percent)	
7 th		2 448 201 ± 31 617	(16.0)	7.30 (7.29-7.32)
8 th		2 498 531 ± 30 976	(16.3)	7.03 (7.01-7.05)
9 th		2 611 328 ± 31 641	(17.1)	6.68 (6.66-6.69)
10 th		2 666 042 ± 27 446	(17.4)	5.91 (5.89-5.93)
11 th		2 580 698 ± 27 276	(16.9)	5.75 (5.73-5.77)
12 th		2 487 883 ± 26 622	(16.3)	5.42 (5.40-5.44)
	Total	15 292 682 ± 112 951		6.34 (6.33-6.36)
Sleep group		Estimated population size	(percent)	
	<5 hour	3 074 046 ± 35 191	(20.2)	
	5-6 hour	3 659 396 ± 33 463	(24.0)	
	6-7 hour	3 941 353 ± 35 388	(25.9)	
	7-8 hour	3 167 004 ± 32 390	(20.8)	
	8-9 hour	1 143 885 ± 14 956	(7.5)	
	>9 hour	241 647 ± 5 170	(1.6)	
	Total	15 227 330 ± 112 540		

7th-9th grade: Middle school 1st to 3rd year
 10th-12th grade: high school 1st to 3rd year
 Estimated population size: Estimate counts ± standard error (% in sleep group)
 Sleep duration: Estimated mean duration (95% CI)

Table 1: Estimated population size and sleep duration by grade for 5 years.

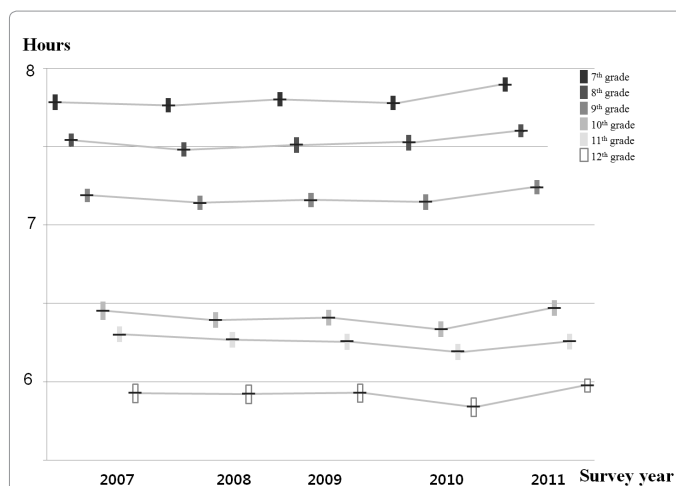


Figure 1: Estimated duration of sleep by grade and survey year.

Mean of sleep duration for 5 years were 7.30 ± 0.01 (estimated mean ± standard error) hours in 7th grade, 7.02 ± 0.01 for 8th grade, 6.66 ± 0.01 for 9th grade, 5.89 ± 0.01 for 10th grade, 5.72 ± 0.01 for 11th grade, 5.37 ± 0.01 for 12th grade. This figure shows that sleep duration was significantly different from each grade; however, yearly patterns were almost similar with a few exceptions. Sleep durations in 7th, 10th 11th and 12th in 2010 were statistically shorter than those of the other years without explanatory reasons.
 7th-9th grade: Middle school 1st to 3rd year, 10th - 12th grade: high school 1st to 3rd year, cross bar: estimated time, upper and lower margin of vertical line: 95% CI

		<5	5-6	6-7	7-8	8-9	>9
Survey Year							
	2007	17.9	18.0	19.4	19.5	19.7	19.3
	2008	19.2	19.5	19.7	19.4	19.0	18.2
	2009	20.9	21.7	20.7	20.4	20.6	21.7
	2010	20.9	20.0	19.1	18.8	17.6	17.1
	2011	21.1	20.8	21.1	21.8	23.1	23.6
Sex							
	Boy	44.8	49.1	52.6	58.6	66.0	67.6

% in sleep group

Table 2: Estimated rate in sleep group by survey year.

over 9 hours, respectively (Figure 2); however, as students became senior grade, the ratio of sleep deficient groups was increased, with the percentage of students sleeping 7-9 hours decreasing, and those sleeping more than 9 hours nearly disappearing.

Mood and sleep groups

The more sleep participants had, the more their feelings of happiness increased, with the highest self-reported rates of happiness in those who slept over 8-9 hours and the lowest rates in those who slept less than 5 hours when we combined the “very happy” and “happy” rates (Table 3). In the item of feeling stress, the more sleep participants had, the more their feelings of stress decreased. There was the highest rate of “extremely stressed” and “very stressed” in less than 5 hour sleep group and the lowest in 8-9 hour sleep group.

Correcting for the effects of survey year, gender, and grade, those who slept less than 5 hours were 2.19 (95%CI 1.87-2.57) and 1.57 (95%CI 1.46-1.70) times more likely to be “very unhappy” and “unhappy,” respectively, than those who slept 8-9 hours; furthermore, those sleeping 5-6 hours were 1.59 (95%CI 1.35-1.86) and 1.33 (95%CI 1.24-1.43) times more likely to choose these options, respectively (Figure 3). Furthermore, those who slept less than 5 hours were 5.10 (95%CI 4.33-6.02) and 3.27 (95%CI 2.81-3.82) times more likely to report feeling “extremely stressed” and “very stressed,” respectively, than those who slept 8-9 hours (Figure 4).

Of those who slept less than 5 hours, 46.4% reported the experience of depression during the preceding 12 months, 24.6% contemplated suicide, and 5.6% attempted suicide (Table 3). The rates of depression, suicidal ideation and attempt were mostly high in the sleep deficiency groups but the lowest in the 8-9 hour sleep group. However, in the >9 hour sleep group showed rather increasing the rate of depression, suicidal ideation and attempt indicating the coexistence of potential psychological problems. After correcting for the effects of survey year, sex, and grade, those who slept less than 5 hours were 1.94 (95%CI 1.86-2.03) times more likely to report depression than the reference group; furthermore, the 5-6 hours group was 1.50 (95%CI 1.4-1.56) times more likely to feel this way, the 6-7 hours group 1.29 (95%CI 1.24-1.35) times, the 7-8 hours group 1.08 (95%CI 1.04-1.13) times, and the over 9 hours group 1.18 (95%CI 1.09-1.29) times (Figure 5). Suicidal ideation showed similar patterns; it was 1.95 (95% CI 1.85-2.06) times more likely in those who slept less than 5 hours; 5-6 hours, 1.48 (95% CI 1.40-1.56) times; 6-7 hours, 1.27 (95% CI 1.20-1.34) times; and over 9 hours, 1.23 (95%CI 1.11-1.36) times. Estimated odds ratio of suicidal attempts were 1.39 (95%CI 1.24-1.55), 1.2 (95%CI 1.01-1.25) in < 5 hour, 5-6 hour sleep group, respectively.

Discussion

The goal of this study was to identify the relationship between

sleep duration and emotional state in Korean adolescents. This study highlighted the fact that over 90% of Korean adolescents have chronic sleep deficiency. As the students became senior grade, the amount of sleep dramatically decreases: average sleep duration for 7th graders in the present study was 7.30 hours; by 9th grade, students averaged less than 7 hours, and those in 10th-12th grade averaged less than 6 hours. Twelfth grade students in the present study averaged 5.37 hours per night, indicating a sleep deficit of 2-3.25 hours per night, according to their commendations of 8-9.25 hours for adolescents [10]. Moreover this shortage of sleep is not contemporary but constant during many years, as shown in this study. Our findings indicate that Korean middle school students have mild to moderate sleep deficiency, and high school students have severe sleep deficiency.

In the present study, the rate of those who got an optimal amount of sleep (8-9 hours) was only 18.9% in 7th grade, decreasing steeply to a low of 1.5% by 12th grade. While the KYRBWS did not account for sleeping in on weekends or daytime napping, which may be important

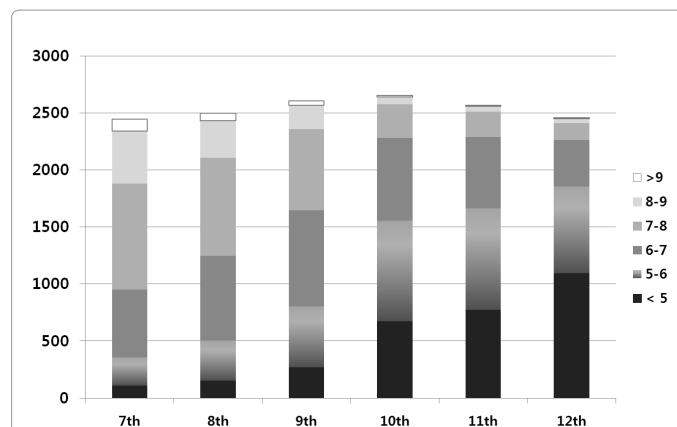


Figure 2: Estimated population size of sleep group by grade (X1000 people).

This figure clearly shows that sleep duration was dramatically decreased as students became senior grade.

7th-9th grade: Middle school 1st to 3rd year, 10th-12th grade: high school 1st to 3rd year
Percent in grade

	Sleep group						Total
	<5	5-6	6-7	7-8	8-9	>9	
Happiness							
Very happy	13.5	14.9	16.5	19.7	23.2	25.0	16.8
Happy	35.5	37.9	37.6	38.0	37.3	33.3	37.2
Moderate	34.2	33.1	33.1	31.2	29.1	30.1	32.6
Unhappy	13.8	11.8	11.0	9.4	8.8	9.6	11.2
Very unhappy	3.0	2.3	1.9	1.6	1.6	2.0	2.1
Stress							
Extremely stressful	18.8	12.8	10.9	8.9	8.4	10.4	12.4
Very stressful	37.4	34.1	30.6	26.9	23.9	24.7	31.4
Stressful	34.7	41.3	43.2	44.0	43.2	38	41.1
Few stressful	7.9	10.5	13.6	17.6	20.7	21.2	13.2
Rarely stressful	1.2	1.3	1.7	2.7	3.9	5.6	1.9
Depression							
Suicidal ideation	24.6	20.3	18.8	16.5	15.7	18.5	19.6
Suicidal attempt	5.6	4.2	4.3	3.9	3.7	5.0	4.4

7th-9th grade: Middle school 1st to 3rd year, 10th-12th grade: high school 1st to 3rd year
% Percentage in sleep group

Table 3: Emotional status and sleep duration in adolescents.

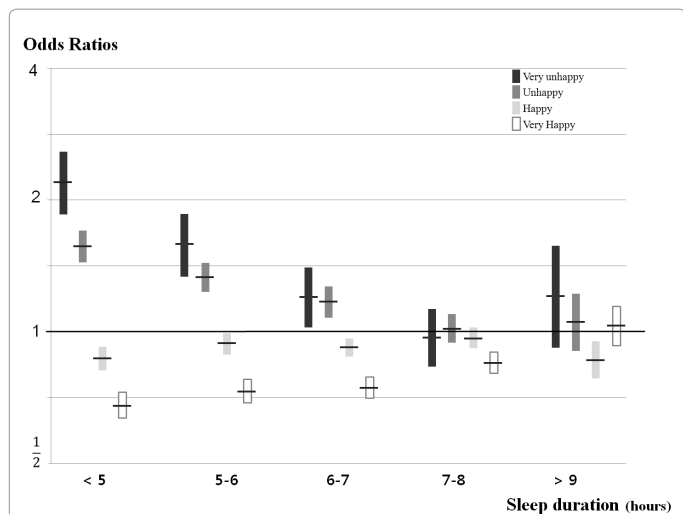


Figure 3: Sleep duration and happiness.

Students were likely to choose “feel very unhappy” (dark blue) 2.19, 1.59, and 1.20 times more in less than 5 hour, 5-6 hour, and 6-7 hour sleep group, respectively. “Feel very happy” (white blank) was likely to be chosen 0.68, and 0.73 times more in less than 5 hour and 5-6 hour sleep group, respectively. Reference: sleep 8-9 hours, feel neutral
Upper limit and lower limit: 95% CI, mid cross line: estimated odds ratio
Corrected factor: survey year, grade (school year) and sex

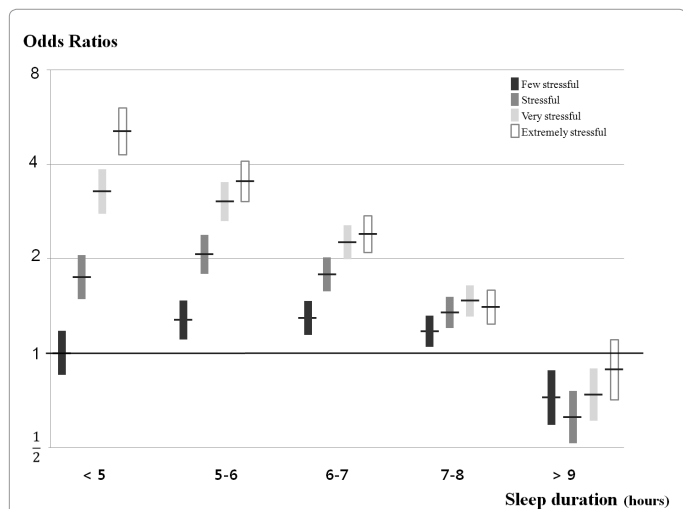


Figure 4: Sleep duration and stress feeling.

As sleep duration was decreased, adolescents more likely to feel. “Extremely stressed” (white blank in left graph) was likely to be chosen 5.10 times more in less than 5 hour sleep group and 3.54 times in 5-6 hour sleep group. Reference: sleep 8-9 hours, feel no stress
Upper limit and lower limit: 95% CI, mid cross line: estimated odds ratio
Corrected factor: survey year, grade (school year) and sex

sources of sleep in this population, a previous authors’ study on sleep duration on students from grades 5-12, both in and near Seoul, can supply some potential answers to this question [19]. In this study, sleep durations were as follows: 7.95 ± 1.05 hours for 5th-6th grade, 7.57 ± 1.05 hours for 7th-9th grade, and 5.78 ± 1.13 hours for 10th-12th grade. However, unlike the present study, this study did account for daytime sleep, which significantly differed across school year: 0.21 ± 0.50 hours, 0.60 ± 0.79 hours, and 1.09 ± 1.00 hours, respectively. By adding these means for daytime sleep duration, the total sleep durations of these

groups were 8.15 ± 1.12 hours, 8.17 ± 1.20 hours, and 6.87 ± 1.40 hours, respectively. In this study, it was reported that 5.6% of high school students did not nap, 45.7% napped for less than 1 hr, 42.4% napped for 1-3 hours, and 6.2% napped 3-5 hours. This data on adolescent napping indicates that Korean adolescents have extreme daytime sleepiness due to their severe sleep deficit, leading to excessive napping during the day-potentially during class time-which would adversely affect school performance. Although daytime nap data were not collected in the KYRBWS, the findings for nighttime sleep were similar to those in the study on students in Seoul, so overall sleep patterns are likely comparable.

Sleep problems are commonly associated with suicidal ideation and attempts. In a study with 8,098 healthy adults, Goodwin and Marusic reported that short sleepers had more suicidal ideation and suicide attempts, regardless of the presence or absence of psychotic disease [24,28]. This relationship has also been noted in adolescents. Liu reported that sleeping less than 8 hours and nightmares were correlated with suicidal ideation [15]. In South Korea, a survey by Lee et al. reported that, in a sample of 8,010 students from 7th-11th grade, sleeping less than 7 hours was an independent risk factor for higher scores of suicidal ideation using the Beck 19-item Scale for Suicidal Ideation [25]. Lee et al. further insisted that behaviorally induced sleep insufficiency could also increase the risk of suicide [25].

In the study about the relationship between insufficient sleep and depression, Gangwisch et al. reported that adolescents permitted to go to sleep only after midnight were 1.28 times more likely to have depression and 1.25 times more likely to have suicidal ideation than those permitted to go to sleep before 10 pm [23]. They took these findings to mean that sleep is an important factor in depression, and that parents must encourage adolescents to go to sleep early to prevent depression and suicidal ideation. These results also mean that enough sleep is important for preventing depression and suicide. This correlation between insufficient sleep and suicidal ideation was seen

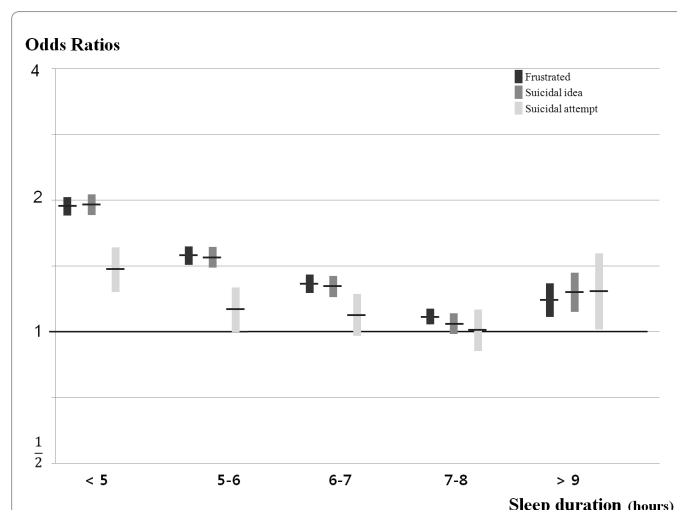


Figure 5: Depression and suicidality according to sleep group.

As sleep was decreased, adolescents more likely to feel stressful and frustrated, think suicide and attempt suicide. “Frustrated feeling” (depression) was likely to be selected 1.94 times, suicidal thinking 1.95 times in less than 5 hour sleep group. Reference: sleep 8-9 hours, feel no stress
Upper limit and lower limit: 95% CI, mid cross line: estimated odds ratio
Corrected factor: year of study, grade (school year) and sex

in the present study, with depression, suicidal ideation, and suicide attempts strongly associated with insufficient sleep.

The limitations of the present study are the missing data on daytime and weekend sleep, sleep quality, and existence of any sleep or psychiatric disorders. As a result, in spite of the clear correlation between sleep duration and depression, it was not easy to verify the causality of nocturnal sleep restriction and depression in this observational study. In addition, it would be more reliable to assess sleep and mood with objective methods, as opposed to subjective self-report. We would therefore recommend incorporating the Pediatric Daytime Sleepiness Scale, as well as items assessing daytime and weekend sleeping in the next KYRBWS [29]. We cannot enrolled the absent or students with special needs or literacy disabilities who might feel more frustrated, unhappy and unhealthy. However, based on the present findings, we can identify weekday sleep patterns associated with sad or suicidal moods in adolescents, which would be important to preventing suicide in this population and identifying at-risk individuals. This nationwide study makes a compelling case that 90% of Korean adolescents have insufficient sleep, providing a clue for the direction of national health policy to best enhance adolescents' emotional health.

Acknowledgement

Raw data were downloaded from homepage of KCDC with consents (<http://yhs.cdc.go.kr/result/data.asp>) [27].

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