BMJ Open | Associations between time in bed and suicidal thoughts, plans and attempts in Korean adolescents

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ABSTRACT

Objectives: To examine the hypothesis that respondents with any of three specific sleep patterns would have a higher likelihood of suicidality than those without reports of these patterns in Korean adolescents.

Setting: Data from the 2011–2013 Korea Youth Risk Behavior Web-based Survey were used.

Participants: 191 642 subjects were included. The survey's target population was students in grades 7 through 12 in South Korea.

Independent variable: Sleep time.

Primary and secondary outcome measures: Suicidal thoughts, plans and attempts.

Results: The odds of suicidal thoughts in subjects with very short or long time in bed were 1.487-fold higher (95% CI 1.219 to 1.815) or 0.611-fold lower (95% CI 0.460 to 0.811), respectively, than for subjects with 7 h/day in bed; the odds were similar for suicidal plans. The odds of suicidal thoughts in subjects with early or late awakening times were 1.231-fold higher (95% CI 1.050 to 1.442) or 1.528-fold lower (95% CI 1.000 to 2.334), respectively, than for subjects with 7 h/day in bed; these odds were lower for suicidal plans and attempts. The odds of suicidal thoughts in subjects with early bedtime were 1.748-fold higher (95% CI 1.302 to 2.346), the odds of suicidal plans in people with an early bedtime were 2.494-fold higher (95% CI 1.671 to 3.722) and the odds of suicide attempts in subjects with late bedtime were 1.313-fold higher (95% CI 1.005 to 1.716) than for subjects with a bedtime of 23:00.

Conclusions: The sleep-related time is associated with suicide-related behaviours in Korean adolescents. Multilateral approaches are needed to identify the greatest risk factors for suicidal behaviours.

Strengths and limitations of this study

- This study used nationwide large representative 3-year aggregated survey data of adolescent students in grades 7 through 12. The large population sample size was representative of the overall population in grades 7 through 12, so these results can be generalised to the whole population of adolescents in grades 7 through 12 in South Korea.
- Respondent reports are subjective and imperfect measures, potentially affected by perception bias and adaptation of resources.
- We used representative data for our estimates, but the results possibly reflected reverse causality and bidirectional relationships when the associations between time in bed and suicidal behaviour patterns were assessed.

behaviours among adolescents are an emerging global public health problem and a socioeconomic burden. The highest prevalence of adolescent suicide is in Southeast Asia[4] and Eastern Europe,[5] and it is the second leading cause of death in the USA for teenagers aged 15–19 years.[6]

In South Korea, the overall rate of suicidal thoughts in young people aged 19–29 years was 15% in 2009 and the 1-year prevalence of suicidal thoughts was 2.6% in male subjects and 6.3% in female subjects aged between 18 and 29 years of age in 2011.[7] The suicide rate among adolescents between 10 and 19 years of age is 5.2 per 100 000 people in South Korea and is the leading cause of death among adolescents in this country. Although the adolescent suicide rate was stable during the 1990s in some countries, suicide is the fourth leading cause of death among adolescents aged 15–19 years and continues to be a major burden on social healthcare systems in many countries[8] as well as Korea.

Suicide attempts are a significant risk factor for subsequent death by suicide.[9] The prevalence rate of attempted suicides among

INTRODUCTION

Suicide is a leading cause of death among children and adolescents in many countries.[1] WHO estimated that suicide was the second highest cause of mortality in the 10–24-year age group and the rate continues to increase.

Suicidal behaviour includes suicidal thoughts, plans, attempts and death.[2,3] Suicidal

Korean adolescents between 13 and 18 years of age was reportedly 4.7%.[3]

Recent research has identified sleep problems as potentially important risk factors for suicidal thoughts and behaviours,[10] and investigated the epidemiological phenomena and the risk factors associated with suicidal behaviour. Tang et al[11] investigated 10 233 adolescent students in southern Taiwan and reported that variables including female gender, weekly alcohol use, illicit drug use, depression, significant family conflicts, poor family functioning, reduced interest in school, a low rank in school, low acceptance among peer groups and dropping out of school are associated with adolescent suicide attempts. Biological studies have indicated that considerable changes occur during adolescence, such as melatonin secretion and a need for a greater total time in bed, possibly owing to maturational changes in neuronal connectivity.[12]

In surveys of the general population, approximately one-third of adults reported one or more sleep complaints in the past year,[13] and study shows that the associations between sleep disorder, such as insomnia, and suicidal behaviour are seen in clinically depressed and anxious populations.[14] Insomnia was more strongly associated with suicidal thoughts than was poor-quality sleep[15 16] and seemed to lead to an increased risk for suicidal thoughts, attempts and death by suicide.[17]

Using data from the National Comorbidity Survey Replication study, Roth et al[18] determined that 16–25% of the adult population had had sleep problems lasting for ≥2 weeks in the past 12 months, 16.4% difficulty in falling sleep, 16.7% early morning awakening, 19.9% difficulty maintaining sleep and 25% non-restorative sleep.

Sleep problems are associated strongly with co-occurring psychiatric disorders,[19] which in turn are associated with an increased risk of suicide. Individuals with sleep difficulties have a higher probability of symptoms or a diagnosis of depression, anxiety disorder or a substance abuse disorder than those without sleep complaints.[20]

Previous studies have shown that sleep problems and depression are potentially major factors for suicidal thoughts or attempts,[21–23] particularly in adolescents.[24 25] In Korea, although suicidal thoughts and attempts were associated with depression and alcohol abuse disorders in adults according to previous studies, the potential association between sleep problems and suicide in Korean adolescents remains unclear.

Therefore, in this study, we hypothesised that respondents with any of three specific sleep patterns would have a higher likelihood of suicidality than those without these patterns. Additionally, we hypothesised that sleep problems would be associated with greater risks of suicidal thoughts, plans and attempts during the preceding 12 months, even after controlling for other established risk factors for suicidality, such as socioeconomic status, disease status and psychiatric comorbidities.

METHODS
Study sample and design
This study used data from the 2011–2013 Korea Youth Risk Behavior Web-based Survey (KYRBWS) conducted by the Korea Centers for Disease Control and Prevention (KCDCP). The KYRBWS was a retrospective epidemiological study with a complex sample design that included multistage sampling, stratification and clustering, and has been conducted annually as an anonymous, online, self-reporting survey. The survey consists of 128 questions assessing demographic characteristics and 14 areas of health-related behaviours, including cigarette smoking, alcohol consumption, obesity, physical activity, eating habits, injury prevention, sexual behaviours, mental health, oral health, allergic disorders, personal hygiene, internet addiction, drug abuse and health equity. The survey's target population was students in grades 7 through 12 in South Korea. From each grade level, one sample class was chosen and all students from the six sample classes of each school were chosen as the sample students. We submitted a data request form on the KCDCP website and after an internal review by KCDCP and approval, we obtained the KYRBWS-VI survey data with all private information treated anonymously. During the survey, participants were assigned identification (ID) numbers and guaranteed anonymity. Teachers assigned a computer to each student randomly and provided the survey information. After the process had been explained, each student accessed the website using his or her ID number and completed the survey.

The survey was completed by a total of 75 643 of 79 202 students in 2011—a 95.5% participation rate, 74 186 of 76 980 students in 2012—a 96.4% participation rate and 72 435 of 75 149 students—a 96.4% participation rate.

Independent variables of main interest
Self-reported time in bed, awakening time and bedtime were assessed for each adolescent by asking, "What time did you usually go to bed and wake-up last week?" The responses for awakening time were categorised as ≤5:00, 6:00, 7:00, 8:00 and ≥9:00 and the responses for bedtime were categorised as ≤21:00, 22:00, 23:00, 24:00, 1:00 and ≥2;00; numbers represent the military time of day.

The time in bed was calculated based on reported sleep and awakening times and the responses were ≤4, 5, 6, 7, 8, 9 and ≥10 h.

Dependent variables
1. Suicidal thought was investigated by asking the question, "Have you had suicidal thoughts in the past 12 months?" The responses were either "yes" or "no".
2. Suicidal plan was investigated by asking the question, "Have you had suicidal plans in the past 12 months?" The responses were either "yes" or "no".

3. A suicide attempt was investigated by asking the question, 'Have you attempted suicide in the past 12 months?' The responses were either "yes" or "no".

Covariate variables
Socioeconomic variables
The age range of participants was 12–18 years (middle- and high-school students). Type of residence data were obtained from the students' address; the categories were metropolitan, urban and rural. Economic status was evaluated by asking the question, "What is your parents' economic status?" Responses were categorised as low, middle and high. Scholastic performance during the previous year was categorised as low, middle and high. Disease status included conditions such as asthma, allergic rhinitis and atopic dermatitis.

Health risk and behavioural variables
Drug, smoking and alcohol use histories were evaluated for each participant by asking, "Have you ever used drugs such as gas?", "Have you ever smoked more than one cigarette?" and "Have you ever consumed more than one glass of alcohol?", respectively. Exercise was evaluated for each participant by asking, "In the last week, how many times did you exercise?" The responses were categorised as no exercise, 1–4 times a week and 5 times a week. The presence of depression was investigated by the question, "Have you ever experienced a deep sense of sadness or despair in the past 12 months?" The responses were either "yes" or "no".

Analytical approach and statistics
In this study, five different models were tested. Model 1 tested the relationship between awakening time and suicide-related behaviours, adjusted for socioeconomic, health risk and behavioural variables. Model 2 tested the relationship between bedtime and suicide-related behaviours, adjusted for socioeconomic, health risk and behavioural variables. Model 3 tested the relationship among awakening time, bedtime and suicidal thoughts, adjusted for socioeconomic, health risk and behavioural variables. Model 4 tested the relationship between time in bed and suicidal thoughts, adjusted for socioeconomic, health risk and behavioural variables. Model 5 tested the relationship among awakening time, bedtime and duration and suicidal thoughts, adjusted for socioeconomic, health risk and behavioural variables.

To analyse whether general characteristics, health status and health risk behaviour were associated with suicidal thoughts, t tests, χ^2 tests and multiple logistic regression analyses were used. For all analyses, a two-tailed p value ≤0.05 was considered to indicate statistical significance. All analyses were conducted using the SAS statistical software package V.9.2 (SAS Institute Inc, Cary, North Carolina, USA).

RESULTS
Prevalence of sleep problems
Table 1 lists the general characteristics of the covariates in this study, which included 191 642 participants. The weighted prevalence was 9.6% for very short sleep duration (≤4 h) and 1.0% for very long time in bed (≥10 h). The weighted prevalence was 1.5% for subjects with an early awakening time (≤5:00) and 0.1% for those with a late awakening time (≥9:00) (table 1). The weighted prevalence was 0.8% for subjects with an early bedtime (≤21:00) and 22.4% for those with a late bedtime (≥2:00). The weighted prevalences of suicidal thoughts, plans and attempts were 17.7%, 5.8% and 3.7%, respectively.

Association between sleep problems and suicide-related behaviours
Association between sleep problems and suicidal thoughts
Table 2 shows the association between variables and suicidal thoughts. In model 5, adjusted for socioeconomic, health risk and behavioural variables, the odds of suicidal thoughts in subjects with a very short time in bed was 1.487-fold higher (95% CI 1.219 to 1.815) than for those with 7 h/day in bed. The odds of suicidal thoughts in subjects with a very long time in bed were 0.611-fold lower (95% CI 0.460 to 0.811) than for those with 7 h/day in bed. The odds of suicidal thoughts in subjects with an early awakening time was 1.231-fold higher (95% CI 1.050 to 1.442) than in those with 7 h/day in bed. The odds of suicidal thoughts in subjects with a late awakening time were 1.528-fold lower (95% CI 1.000 to 2.334) than in those with 7 h/day in bed.

The odds of suicidal thoughts in subjects with an early bedtime was 1.748-fold higher (95% CI 1.302 to 2.346) than in those with a bedtime of 24:00.

Association between sleep problems and suicidal plan
Table 3 shows the association between variables and suicidal plans. In model 5, adjusted for socioeconomic, health risk and behavioural variables, the odds of suicidal plans in subjects with a very short time in bed were 1.744-fold higher (95% CI 1.318 to 2.306) than in those with a time in bed of 7 h/day. The odds of suicidal plans in subjects with a very long time in bed were 0.620-fold lower (95% CI 0.418 to 0.919) than in those with 7 h/day in bed. The odds of suicidal plans in subjects with an early awakening time were 1.485-fold higher (95% CI 1.187 to 1.858) than in those with a wakening time of 7:00. The odds of suicidal plans in subjects with an early bedtime was 2.494-fold higher (95% CI 1.671 to 3.722) than in those with a bedtime of 24:00.

Association between sleep problems and suicide attempt
Table 4 shows the associations between variables and suicide attempts. In model 5, adjusted for socioeconomic, health risk and behavioural variables, the odds of suicide attempts in subjects with an early awakening time were 1.819-fold higher (95% CI 1.404 to

Table 1 Demographic characteristics of the study population

Characteristics	Total N	%*	Suicidal ideation N	%*	No suicidal ideation N	%*	p Value†	Suicidal plan N	%*	No suicidal plan N	%*	p Value†	Suicide attempt N	%*	No suicide attempt N	%*	p Value†
Awakening time (military time)							<0.0001					<0.0001					<0.0001
≤5:00	3048	1.5	829	27.2	2219	72.8		364	11.9	2684	88.1		258	8.2	2790	91.8	
6:00	43 906	22.0	8700	19.7	35 206	80.3		2816	6.4	41 090	93.6		1830	4.1	42 076	95.9	
7:00	121 261	63.7	20 556	16.8	100 705	83.2		6540	5.3	114 721	94.7		4232	3.4	117 029	96.6	
8:00	23 199	12.6	4016	17.3	19 183	82.7		1465	6.3	21 734	93.7		979	4.1	22 220	95.9	
≥9:00	228	0.1	48	20.9	180	79.1		19	8.2	209	91.8		13	5.5	215	94.5	
Bedtime (military time)							<0.0001					<0.0001					<0.0001
≤21:00	1798	0.8	311	18.1	1487	81.9		141	8.6	1657	91.4		85	5.2	1713	94.8	
22:00	9980	4.6	1460	14.9	8520	85.1		603	6.3	9377	93.7		398	4.1	9582	95.9	
23:00	33 472	16.4	4766	14.2	28 706	85.8		1667	5.0	31 805	95.0		1024	3.1	32 448	96.9	
24:00	56 028	29.2	9082	15.9	46 946	84.1		2948	5.1	53 080	94.9		1956	3.3	54 072	96.7	
1:00	49 521	26.6	9006	17.9	40 515	82.1		3096	7.4	37 747	92.6		1763	3.4	47 758	96.6	
≥2:00	40 843	22.4	9524	22.9	31 319	77.1		2749	5.4	46 772	94.6		2086	5.0	38 757	95.0	
Time in bed (h)							<0.0001					<0.0001					<0.0001
≤4	17 653	9.6	4610	25.6	13 043	74.4		1613	8.8	16 040	91.2		1114	6.1	16 539	93.9	
5	34 078	18.3	6992	20.2	27 086	79.8		2104	6.1	31 974	93.9		1331	3.8	32 747	96.2	
6	46 513	24.7	8450	17.8	38 063	82.2		2629	5.5	43 884	94.5		1718	3.6	44 795	96.4	
7	47 892	24.8	7706	15.9	40 186	84.1		2485	5.1	45 407	94.9		1660	3.4	46 232	96.6	
8	32 423	16.3	4595	14.1	27 828	85.9		1635	5.1	30 788	94.9		1025	3.2	31 398	96.8	
9	10 984	5.3	1497	13.7	9487	86.3		599	5.4	10 385	94.6		370	3.2	10 614	96.8	
≥10	2099	1.0	299	14.8	1800	85.2		139	6.9	1960	93.1		94	5.1	2005	94.9	
Grade							<0.0001					<0.0001					<0.0001
13	30 904	15.4	5340	17.6	25 564	82.4		2078	6.9	28 826	93.1		1386	4.5	29 518	95.5	
14	31 201	15.8	5864	18.7	25 337	81.3		2229	7.1	28 972	92.9		1508	4.9	29 693	95.1	
15	31 992	16.6	5834	18.2	26 158	81.8		2056	6.5	29 936	93.5		1362	4.2	30 630	95.8	
16	32 420	17.4	5803	17.6	26 617	82.4		1755	5.3	30 665	94.7		1163	3.5	31 257	96.5	
17	32 540	17.3	5924	17.7	26 616	82.3		1695	5.0	30 845	95.0		1050	3.0	31 490	97.0	
18	32 585	17.5	5384	16.3	27 201	83.7		1391	4.2	31 194	95.8		843	2.5	31 742	97.5	
Gender							<0.0001					<0.0001					<0.0001
Male	95 800	51.8	12 955	13.6	82 845	86.4		4400	4.6	91 400	95.4		2408	2.5	93 392	97.5	
Female	95 842	48.2	21 194	22.1	74 648	77.9		6804	7.1	89 038	93.0		4904	5.1	90 938	94.9	
Region							0.2686					<0.0001					0.1894
Metropolitan	87 318	44.7	15 686	17.9	71 632	82.1		5130	5.8	82 188	94.2		3257	3.7	84 061	96.3	
Urban	81 286	49.0	14 394	17.5	66 892	82.5		4674	5.7	76 612	94.3		3119	3.8	78 167	96.2	
Rural	23 038	6.3	4069	17.6	18 969	82.4		1400	6.0	21 638	94.0		936	4.0	22 102	96.0	
Economic status							<0.0001											<0.0001
Low	42 507	21.6	10 464	24.4	32 043	75.6						<0.0001	2393	5.5	40 114	94.5	
Middle	91 299	47.3	14 643	15.9	76 656	84.1		3496	8.1	39 011	91.9		2949	3.2	88 350	96.8	
High	57 836	31.1	9042	15.7	48 794	84.3		4571	4.9	86 728	95.1		1970	3.4	55 866	96.6	

Continued

Table 1 Continued

Characteristics	Total N	%*	Suicidal ideation N	%*	No suicidal ideation N	%*	p Value†	Suicidal plan N	%*	No suicidal plan N	%*	p Value†	Suicide attempt N	%*	No suicide attempt N	%*	p Value†
Academic performance							<0.0001					<0.0001					<0.0001
Low	71 076	36.9	15 260	21.4	55 816	78.6		5259	7.3	65 817	92.7		3738	5.1	67 338	94.9	
Middle	52 533	27.5	8350	15.7	44 183	84.3		2540	4.7	49 993	95.3		1591	2.9	50 942	97.1	
High	68 033	35.6	10 539	15.3	57 494	84.7		3405	5.0	64 628	95.0		1983	2.9	66 050	97.1	
Disease							<0.0001					<0.0001					<0.0001
Yes	36 232	19.5	7773	21.1	28 459	78.9		2758	7.5	33 474	92.5		1805	4.9	34 427	95.1	
No	155 410	80.5	26 376	16.8	129 034	83.2		8446	5.3	146 964	94.7		5507	3.5	149 903	96.5	
Alcohol use							<0.0001					<0.0001					<0.0001
Yes	90 979	47.2	20 200	21.9	70 779	78.1		6943	7.5	84 036	92.5		4744	5.1	86 235	94.9	
No	100 663	52.8	13 949	13.9	86 714	86.1		4261	4.2	96 402	95.8		2568	2.5	98 095	97.5	
Smoking use							<0.0001					<0.0001					<0.0001
Yes	45 203	23.5	11 271	24.3	33 932	75.7		4318	9.3	40 885	90.7		3124	6.7	42 079	93.3	
No	146 439	76.5	22 878	15.6	123 561	84.4		6886	4.7	139 553	95.3		4188	2.8	142 251	97.2	
Drug use							<0.0001					<0.0001					<0.0001
Yes	1811	0.9	836	45.5	975	54.5		542	29.1	1269	70.9		400	21.1	1411	78.9	
No	189 831	99.1	33 313	17.4	156 518	82.6		10 662	5.5	179 169	94.5		6912	3.6	182 919	96.4	
Exercise							<0.0001					0.0372					0.0674
No	52 047	27.1	9973	18.9	42 074	81.1		3079	5.8	48 968	94.2		2003	3.8	50 044	96.2	
1–4 Times a week	114 725	60.0	20 050	17.4	94 675	82.6		6604	5.7	108 121	94.3		4307	3.7	110 418	96.3	
5 Times a week	24 870	12.9	4126	16.6	20 744	83.4		1521	6.1	23 349	93.9		1002	4.0	23 868	96.0	
Depressive symptoms							<0.0001					<0.0001					<0.0001
Yes	59 858	30.9	24 511	40.9	35 347	59.1		8495	14.1	51 363	85.9		5775	9.5	54 083	90.5	
No	131 784	69.1	9638	7.3	122 146	92.7		2709	2.0	129 075	98.0		1537	1.2	130 247	98.8	
Year							<0.0001					<0.0001					0.3321
2011	64 647	33.7	12 381	19.1	52 266	80.9		4047	6.2	60 600	93.8		2551	3.8	62 096	96.2	
2012	63 688	33.1	11 431	17.7	52 257	82.3		3754	5.8	59 934	94.2		2329	3.6	61 359	96.4	
2013	63 307	33.2	10 337	16.2	52 970	83.8		3403	5.3	59 904	94.7		2432	3.8	60 875	96.2	
Total	191 642	100.0	34 149	17.7	157 493	82.3		11 204	5.8	180 438	94.2		7312	3.7	184 330	96.3	

*weighted %; †weighted p value.

Table 2 Association between variables and suicidal ideation

	Model 1			Model 2			Model 3			Model 4			Model 5		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Awakening time (military time)															
≤5:00	1.460	1.320	1.614				1.556	1.406	1.723				1.231	1.050	1.442
6:00	1.126	1.085	1.169				1.164	1.121	1.208				1.033	0.960	1.111
7:00	1.000						1.000						1.000		
8:00	1.035	0.988	1.084				0.999	0.954	1.047				1.139	1.050	1.237
≥9:00	1.166	0.786	1.729				1.162	0.782	1.728				1.528	1.000	2.334
Bedtime (military time)															
≤21:00				1.173	0.998	1.380	1.112	0.946	1.306				1.748	1.302	2.346
22:00				0.938	0.869	1.012	0.910	0.843	0.983				1.197	1.011	1.417
23:00				0.906	0.863	0.950	0.898	0.856	0.942				1.029	0.941	1.126
24:00				1.000			1.000						1.000		
1:00				1.131	1.087	1.177	1.140	1.096	1.186				0.995	0.916	1.081
≥2:00				1.373	1.318	1.431	1.398	1.341	1.457				1.060	0.906	1.240
Time in bed (h)															
≤4										1.585	1.499	1.675	1.487	1.219	1.815
5										1.317	1.257	1.381	1.276	1.098	1.482
6										1.167	1.119	1.218	1.171	1.077	1.273
7										1.000			1.000		
8										0.916	0.870	0.964	0.876	0.798	0.962
9										0.909	0.842	0.980	0.770	0.649	0.912
≥10										0.937	0.812	1.081	0.611	0.460	0.811

Adjusted for grade, gender, region, economic status, academic performance, disease, alcohol use, smoking use, drug use, exercise, depressive symptoms and year.

2.357) than in those with a wakening time of 7:00. The odds of suicide attempts in subjects with a late bedtime were 1.313-fold higher (95% CI 1.005 to 1.716) than in those with a bedtime of 23:00.

DISCUSSION

In this study, we investigated the association between sleep problems (awakening time, bedtime and time in bed) and suicide-related behaviours among Korean adolescents

Table 3 Association between variables and suicidal plan

	Model 1			Model 2			Model 3			Model 4			Model 5		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Awakening time (military time)															
≤5:00	1.959	1.704	2.253				2.000	1.737	2.304				1.485	1.187	1.858
6:00	1.241	1.174	1.312				1.262	1.193	1.335				1.082	0.977	1.198
7:00	1.000						1.000						1.000		
8:00	1.052	0.980	1.130				1.030	0.959	1.107				1.202	1.068	1.354
≥9:00	1.291	0.739	2.255				1.300	0.744	2.271				1.772	0.989	3.175
Bedtime (military time)															
≤21:00				1.667	1.325	2.097	1.539	1.222	1.938				2.494	1.671	3.722
22:00				1.222	1.092	1.368	1.168	1.043	1.309				1.597	1.253	2.036
23:00				0.987	0.916	1.064	0.977	0.907	1.053				1.127	0.991	1.281
24:00				1.000			1.000						1.000		
1:00				1.102	1.033	1.176	1.113	1.042	1.188				0.939	0.831	1.060
≥2:00				1.383	1.294	1.479	1.414	1.322	1.513				0.978	0.783	1.222
Time in bed (h)															
≤4										1.740	1.597	1.896	1.744	1.318	2.306
5										1.315	1.218	1.420	1.369	1.103	1.700
6										1.177	1.098	1.261	1.236	1.094	1.397
7										1.000			1.000		
8										1.021	0.945	1.103	0.899	0.788	1.025
9										1.083	0.964	1.218	0.736	0.580	0.934
≥10										1.326	1.070	1.644	0.620	0.418	0.919

Adjusted for grade, gender, region, economic status, academic performance, disease, alcohol use, smoking use, drug use, exercise, depressive symptoms and year.

Table 4 Associations between variables and suicide attempt

	Model 1			Model 2			Model 3			Model 4			Model 5		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Awakening time (military time)															
≤5:00	1.961	1.666	2.308				2.012	1.707	2.371				1.819	1.404	2.357
6:00	1.217	1.135	1.306				1.242	1.158	1.332				1.178	1.042	1.330
7:00	1.000						1.000						1.000		
8:00	1.109	1.018	1.207				1.081	0.992	1.177				1.120	0.964	1.300
≥9:00	1.332	0.678	2.615				1.342	0.679	2.652				1.399	0.676	2.895
Bedtime (military time)															
≤21:00				1.437	1.087	1.900	1.338	1.011	1.770				1.343	0.803	2.246
22:00				1.198	1.049	1.369	1.151	1.006	1.317				1.281	0.948	1.732
23:00				0.944	0.861	1.036	0.938	0.855	1.028				0.987	0.838	1.163
24:00				1.000			1.000						1.000		
1:00				1.072	0.991	1.160	1.079	0.997	1.168				1.043	0.899	1.211
≥2:00				1.415	1.308	1.532	1.440	1.330	1.560				1.313	1.005	1.716
Time in bed (h)															
≤4										1.762	1.590	1.951	1.241	0.884	1.741
5										1.237	1.130	1.356	0.995	0.767	1.291
6										1.148	1.054	1.249	1.073	0.923	1.247
7										1.000			1.000		
8										0.976	0.888	1.073	0.966	0.820	1.137
9										0.987	0.861	1.131	0.846	0.625	1.145
≥10										1.500	1.165	1.931	1.127	0.681	1.865

Adjusted for grade, gender, region, economic status, academic performance, disease, alcohol use, smoking use, drug use, exercise, depressive symptoms and year.

using a nationally representative sample. Because the likely association between sleep problems and suicide-related behaviours depends on different processes in adolescents than in adults, conducting additional studies to verify this association in adolescents is important.

Overall, in this study, sleep problems tended to be associated with suicide-related behaviours and awakening time and bedtime patterns were U-shaped, similar to our previous study in Korean adults.[26]

In order to detect the existence and multicollinearity between time in bed, awakening time and bedtime in our analysis model, the variance inflation factor (VIF) was used to assess the extent to which the variances of the estimated coefficients were inflated. A predictor with VIF>10 is considered to be indicative of serious multicollinearity.[27] We examined the VIF in the regression coefficients of all variables, including time in bed, awakening time and bedtime for 0<VIF<3. Suicide attempts among subjects with early awakening times showed a greater effect than did suicide thoughts and suicide plans (model 5). Suicide plans in subjects with early bedtime showed a greater effect than did suicidal thoughts, and a late bedtime (≥2:00) was associated with a high probability of suicide attempts (model 5). However, unlike in our previous study,[26] the correlation of time in bed with suicide-related behaviours was not U-shaped, and although suicide attempts were not associated with time in bed after adjusting for awakening time and bedtime, subjects with extreme time in bed showed decreased suicidal thoughts and suicidal plans.

Sleep loss can cause various psychological and physiological impairments, with endocrine and immunological changes.[28] Although the association between inappropriate sleep patterns and suicidal behaviours requires plausible physiological mechanisms for such a cause-and-effect relationship, several researchers have proposed that inhibition of the serotonin (5-hydroxytriptamine) system plays a significant role in both suicide and sleep.[29]

These associations were independent of sociodemographic variables (age, gender, region and economic status), health risk behaviour variables (alcohol, smoking and drug use history and exercise), health status (depressive symptoms and disease), academic performance and the year.

Adequate sleep is essential for good health and optimal physical and cognitive performance.[30]

However sleep problems in adolescents are common and sleep disruption is associated with a wide range of behavioural, cognitive and mood impairments in adolescents.[31]

Many clinical studies in adolescents have consistently reported that reduced hours of sleep are associated with emotional problems such as depression and anxiety,[16 17] in addition to self-harm and suicidal thoughts.[22] Poor sleep has also been correlated with increased aggression, irritability and hostility in both adults and adolescents, conducive to problems and bullying behaviour in school children and habitual substance misuse, self-injurious behaviours and suicide attempts overall.[32]

This study has a number of clinical implications for adolescents in Korea.[33 34] First, a comprehensive

evaluation of suicide behaviours should include a sleep time assessment, irrespective of whether or not an individual reports other medical conditions including mental disorder, and continual screening and treatment are necessary. Second, sleep problems should alert treatment providers to a possible high risk of suicide. Finally, the causes of the unique patterns and the high prevalence of suicidal behaviours in Korean adolescents are unclear, which suggests that multidisciplinary efforts and studies, including psychiatric, familial and social aspects, are urgently required to solve the problem. Future research is needed.

This study had several strengths and limitations. One strength was that the participants in the survey were representative of the overall adolescent student population attending in grades 7 through 12. Additionally, the number of participants was large; therefore the results can be generalised to the overall adolescent population in South Korea.

Nevertheless, limitations in sample bias existed. First, all data collected were derived from a self-reported questionnaire, including the individual mean number of sleep hours, suicide-related behaviours, stress-related factors and drug use, which might have affected the results; however, all participants were informed that their responses would remain anonymous. In addition, self-evaluation tools may be affected by cognitive biases, including recall bias, erroneous self-perception, as well as the desire to please, displease or provoke, particularly in adolescents. Second, disadvantages of web-based surveys should be considered, including the lack of access to clinical information and the fact that not all participants were equally computer literate. Third, since data on various mental disorders or the general mental health of the study participants were not available, controlling for their possible contribution was difficult. Although results of various studies[15][35][36] investigating the insomnia–suicide risk link and the psychological mechanisms underpinning the association were observed, insomnia variable was not included for analysis because of lack of information. Therefore, future studies should refine our understanding through more in-depth studies. Finally, owing to the cross-sectional nature of this study, determining a causal relationship between coping behaviour and suicidal thoughts was not possible and future studies using a longitudinal design are needed to evaluate this relationship.

CONCLUSION

The findings of our large, representative, population-based study indicate an association between sleep problems and suicide-related behaviours among adolescents in South Korea. Based on the results of this study, we conclude that multilateral strategies for adolescents would be helpful in dealing with the risks of suicidality, and improved strategies are needed to identify subjects at greatest risk of suicidal behaviour.

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