Sleep duration and school performance in Korean adolescents

Dong-il Seo,[1] Wi-Young So[2]

SUMMARY

Background

This study investigated the relationship between sleep duration and school performance in Korean adolescents.

Methods

In 2012, 63 688 adolescents participated in the 8th Korea Youth Risk Behavior Web-Based Survey (KYRBWS-VIII) project. The relationship between sleep duration and school performance was evaluated by multivariate logistic regression analysis after adjustment for covariate variables, including body mass index, age, parental education, economic status, mental stress, smoking, alcohol consumption, breakfast patterns, and three measures of physical activity.

Results

For boys, but not for girls, 5–6 hours of sleep/night were related to average or better academic performance (OR: 1.094, 95% CI [1.011–1.182], p=0.025) compared to ≤4 hours/night. For both boys and girls, nine or more hours/night were negatively related to academic performance (boys: 0.657, [0.554–0.779; p<0.001]; girls: ≥9 hours/night, 0.664 [0.572–0.771], p<0.001) compared to ≤4 hours/night.

Conclusion

Whilst it may appear that five to six hours of sleep are necessary to maintain average or better than average school performance for boys, nine or more hours are detrimental to school performance for both groups. This study was limited by the following factors: data were collected only for weekdays and it is. Other sleep variables, such as quality of sleep and sleepiness, should be investigated for a further understanding of these results.

Key words: Adolescents, Korea Youth Risk Behavior Web-based Survey, school performance, sleep duration.

RESUMEN

Antecedentes

En este estudio se investigó la relación entre la duración del sueño y el desempeño escolar en adolescentes coreanos.

Métodos

En 2012, 63 688 adolescentes participaron en el octavo proyecto de Estudio de Conducta de Riesgo Juvenil Basado en la Red (KYRBWS-VIII, por sus siglas en inglés). La relación entre la duración del sueño y el desempeño escolar se evaluó mediante un análisis de regresión logística multivariada tras ajustar para las variables covariadas, incluyendo índice de masa corporal, edad, nivel educativo de los padres, posición económica, estrés mental, consumo de tabaco, consumo de alcohol, patrones en el desayuno y tres mediciones de actividad física.

Resultados

En el caso de los chicos, pero no así en el de las chicas, de cinco a seis horas de sueño por noche se relacionaron con un desempeño académico promedio o mejor que el promedio (R.M.: 1.094, 95% CI [1.011-1.182], p=0.025) en comparación con ≤ cuatro horas/noche. Tanto para los chicos como para las chicas, nueve o más horas/noche se relacionaron de forma negativa con el desempeño académico (chicos: 0.657 [0.554-0.779; p<0.001]; chicas ≥9 horas/noche, 0.664 [0.572-0.771], p<0.001) en comparación con ≤4 horas/noche.

Conclusión

Para los chicos, de cinco a seis horas de sueño son necesarias para mantener un desempeño escolar promedio o mejor que el promedio, en tanto que nueve o más horas son perjudiciales para el desempeño escolar de tanto los chicos como las chicas. Otras variables del sueño, como la calidad del sueño y la somnolencia, deben investigarse para obtener una mejor comprensión de estos resultados.

Palabras clave: Adolescentes, Korea Youth Risk Behavior Web-Based Survey, desempeño escolar, duración del sueño.

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INTRODUCTION

It is well known that sleep duration is associated with health status. According to the Centers for Disease Control and Prevention (CDC), inadequate sleep is associated with cardiovascular disease, obesity, diabetes, and depression.[1] Therefore, getting enough sleep is important for the prevention of social and public health problems.

At the beginning of adolescence, adolescents go to bed later than children due to changing circadian rhythms.[2] On a school day, during the semester, adolescents also must wake up earlier to go to school, an external requirement not affected by circadian rhythms. The combination of late bedtimes and early wake up times may lead to insufficient sleep during the school week.[2]

Recent studies have shown that sleep duration is related to school performance in adolescents because it negatively affected learning capacity and neurobehavioral functions.[3-5] Furthermore, in a meta-analysis Dewald et al. (2010) reported that sleep duration was significantly but modestly related to school performance.[6]

However, even though several meta-analytic studies suggest a relationship between sleep duration and school performance, only a few studies have been published internationally on the matter. Moreover, most sleep duration studies are limited by small sample sizes and, therefore, do not represent the general population. To our knowledge, no study has examined the relationship between sleep duration and school performance in Korean adolescents. Therefore, the purpose of the present study was to determine whether sleep duration is related to school performance in Korean adolescents across the country.

METHODS

Participants

The Eighth Korea Youth Risk Behavior Web-Based Survey (KYRBWS-VIII) was a national school-based survey conducted by the Ministry of Education, Science and Technology, the Ministry of Health and Welfare, and the Korea Centers for Disease Control and Prevention to examine health behavior risks in Korean adolescents from middle school first (7th) to high school third (12th) grade students (aged 12-18).[7]

The KYRBWS-VIII is an epidemiologic cross-sectional study that uses a complex sample design with methods of stratification, clustering, and multistage sampling. The KYRBWS-VIII uses the 43-cluster sample strategy, with 129 strata identified, and covers all of South Korea with this survey-sampling frame. In total, 400 middle-schools and 400 high-schools were sampled by the KYRBWS-VIII to assess the relationship between sleep duration and school performance, while taking into account potential covariate variables such as body mass index (BMI), age, parental education, economic status, mental stress, smoking, alcohol consumption, breakfast patterns, and the frequencies of vigorous physical activity (PA), moderate PA, and muscular strength exercises. It has been established to have sufficient validity and reliability.[8-9] The data collection procedures are described and published by the Ministry of Education, Science and Technology, the Ministry of Health and Welfare, and the Korea Centers for Disease Control and Prevention.[7]

The students were assigned unique identification numbers (ID) by their classroom teachers. With this ID, the students accessed the survey web-page and were first asked if they were willing to participate. The students who chose to enroll in the survey completed the questionnaire anonymously at their school. The response rate was 96.4% (74 186 of 76 980 students), including 38 221 boys and 35 965 girls. The 10 498 students, who did not respond to the item about sleep duration, were excluded. Therefore, the responses of 63 688 students (32 318 boys and 31 370 girls) were analyzed in this study.

As the KYRBWS-VIII did not collect any private information, such as name, social security number, school name, telephone number, and home address, ethical approval was not required. The characteristics of participants are shown in table 1.

Independent variables

Sleep duration was evaluated for each participant by the following question: "[Q1] On a school day in the last week, what time did you go to bed and wake up?" The participants answered with an average bedtime and wake up time. On the basis of their sleep duration, the participants were divided into four groups: [1] ≤4 hours, [2] 5-6 hours, [3] 7-8 hours, and [4] ≥9 hours.

Dependent variables

School performance was rated by responses to the following question: "How well do you do in school?" There were five possible responses: [1] excellent, [2] good, [3] average, [4] poor, and [5] very poor. On the basis of these responses, participants were divided into two groups: [1] below average school performance (reference group) and [2] average school performance or higher for multivariate regression.

Covariate variables

The variables were reported by the students and rated or calculated in the following manner.
[1] BMI: BMI was calculated from KYRBWS-VIII data on height and weight (kg/m2).

Table 1. Participant characteristics

Variables		Boys (n = 32 318)		Girls (n = 31 370)		Total (N = 63 688)	
Age (years)		14.94 ± 1.75		14.94 ± 1.76		14.94 ± 1.76	
Height (cm)		169.29 ± 8.29		159.70 ± 5.47		164.57 ± 8.52	
Weight (kg)		60.33 ± 11.97		51.89 ± 7.97		56.17 ± 11.04	
Body mass index (kg/m²)		20.93 ± 3.28		20.30 ± 2.67		20.62 ± 3.01	
School performance - N (%)	Excellent	3 903	(12.1)	3 025	(9.6)	6 928	(10.9)
	Good	7 806	(24.2)	7 771	(24.8)	15 577	(24.5)
	Average	8 508	(26.3)	8 708	(27.8)	17 216	(27.0)
	Poor	7 883	(24.4)	8 105	(25.8)	15 988	(25.1)
	Very poor	4 218	(13.1)	3 761	(12.0)	7 979	(12.5)
Sleep duration - N (%)	≤4 hours per night	3 598	(11.1)	5 607	(17.9)	9 205	(14.5)
	5-6 hours per night	13 302	(41.2)	14 547	(46.4)	27 849	(43.7)
	7-8 hours per night	13 123	(40.6)	10 016	(31.9)	23 139	(36.3)
	≥9 hours per night	2 295	(7.1)	1 200	(3.8)	3 495	(5.5)
Education level of father - N (%)	Middle school or lower	1 416	(4.4)	1 333	(4.2)	2 749	(4.3)
	High school	10 868	(33.6)	11 193	(35.7)	22 061	(34.6)
	College or higher	14 316	(44.3)	13 712	(43.7)	28 028	(44.0)
	Unknown	5 718	(17.7)	5 132	(16.4)	10 850	(17.0)
Education level of mother - N (%)	Middle school or lower	1 358	(4.2)	1 355	(4.3)	2 713	(4.3)
	High school	13 657	(42.3)	14 672	(46.8)	28 329	(44.5)
	College or higher	11 318	(35.0)	10 854	(34.6)	22 172	(34.8)
	Unknown	5 985	(18.5)	4 489	(14.3)	10 474	(16.4)
Family economic status - N (%)	Very rich	2 512	(7.8)	1 451	(4.6)	3 963	(6.2)
	Rich	8 085	(25.0)	7 024	(22.4)	15 109	(23.7)
	Average	14 602	(45.2)	15 493	(49.4)	30 095	(47.3)
	Poor	5 480	(17.0)	5 939	(18.9)	11 419	(17.9)
	Very poor	1 639	(5.1)	1 463	(4.7)	3 102	(4.9)
Mental stress - N (%)	Very high	2 842	(8.8)	4 567	(14.6)	7 409	(11.6)
	High	8 362	(25.9)	11 116	(35.4)	19 478	(30.6)
	Average	14 187	(43.9)	12 069	(38.5)	26 256	(41.2)
	Low	5 748	(17.8)	3 265	(10.4)	9 013	(14.2)
	Very low	1 179	(3.6)	353	(1.1)	1 532	(2.4)
Frequency of smoking - N (%)	No smoking	27 171	(84.1)	29 697	(94.7)	56 868	(89.3)
	1–2 day(s) per month	892	(2.8)	412	(1.3)	1 304	(2.0)
	3–5 days per month	383	(1.2)	182	(0.6)	565	(0.9)
	6–9 days per month	318	(1.0)	118	(0.4)	436	(0.7)
	10–19 days per month	481	(1.5)	157	(0.5)	638	(1.0)
	20–29 days per month	504	(1.6)	170	(0.5)	674	(1.1)
	Every day	2 569	(7.9)	634	(2.0)	3 203	(5.0)
Frequency of alcohol consumption - N (%)	Non-drinker	25 057	(77.5)	26 550	(84.6)	51 607	(81.0)
	1–2 day(s) per month	4 104	(12.7)	3 164	(10.1)	7 268	(11.4)
	3–5 days per month	1 476	(4.6)	855	(2.7)	2 331	(3.7)
	6–9 days per month	802	(2.5)	371	(1.2)	1 173	(1.8)
	10–19 days per month	562	(1.7)	283	(0.9)	845	(1.3)
	20–29 days per month	227	(0.7)	121	(0.4)	348	(0.5)
	Every day	90	(0.3)	26	(0.1)	116	(0.2)

Table 1. Continued

Variables		Boys (n = 32 318)		Girls (n = 31 370)		Total (N = 63 688)	
Frequency of eating breakfast - N (%)	No breakfast	4 330	(13.4)	3 481	(11.1)	7 811	(12.3)
	1 day per week	1 609	(5.0)	1 797	(5.7)	3 406	(5.3)
	2 days per week	1 907	(5.9)	2 264	(7.2)	4 171	(6.5)
	3 days per week	2 096	(6.5)	2 235	(7.1)	4 331	(6.8)
	4 days per week	1 742	(5.4)	2 002	(6.4)	3 744	(5.9)
	5 days per week	3 098	(9.6)	3 624	(11.6)	6 722	(10.6)
	6 days per week	3 038	(9.4)	3 436	(11.0)	6 474	(10.2)
	Every day	14 498	(44.9)	12 531	(39.9)	27 029	(42.4)
Frequency of vigorous physical activity - N (%)	No vigorous PA	4 767	(14.8)	12 892	(41.1)	17 659	(27.7)
	Once per week	5 794	(17.9)	7 209	(23.0)	13 003	(20.4)
	Twice per week	6 784	(21.0)	5 258	(16.8)	12 042	(18.9)
	3 times per week	5 694	(17.6)	3 069	(9.8)	8 763	(13.8)
	4 times per week	2 970	(9.2)	1 183	(3.8)	4 153	(6.5)
	5 times per week or more	6 309	(19.5)	1 759	(5.6)	8 068	(12.7)
Frequency of moderate physical activity - N (%)	No moderate PA	5 837	(18.1)	10 375	(33.1)	16 212	(25.5)
	Once per week	6 584	(20.4)	7 845	(25.0)	14 429	(22.7)
	Twice per week	7 007	(21.7)	6 172	(19.7)	13 179	(20.7)
	3 times per week	5 361	(16.6)	3 684	(11.7)	9 045	(14.2)
	4 times per week	2 429	(7.5)	1 358	(4.3)	3 787	(5.9)
	5 times per week or more	5 100	(15.8)	1 936	(6.2)	7 036	(11.0)
Frequency of muscular strength exercises - N (%)	No muscular strength exercises	11 981	(37.1)	21 404	(68.2)	33 385	(52.4)
	Once per week	6 576	(20.3)	4 885	(15.6)	11 461	(18.0)
	Twice per week	4 568	(14.1)	2 268	(7.2)	6 836	(10.7)
	3 times per week	3 673	(11.4)	1 336	(4.3)	5 009	(7.9)
	4 times per week	1 608	(5.0)	512	(1.6)	2 120	(3.3)
	5 times per week or more	3 912	(12.1)	965	(3.1)	4 877	(7.7)

Data are expressed as mean ± standard deviation or N (%).

[2] Age: the participants' ages were taken from the survey data.

[3] Parental education: the possible responses ranged from 1 (middle school or lower), 2 (high school), 3 (college or higher), and 4 (unknown).

[4] Economic status: the possible responses ranged from 1 (very rich) to 5 (very poor).

[5] Mental stress: the possible responses ranged from 1 (very high) to 5 (very low).

[6] Smoking: the possible responses ranged from 1 (non-smoker) to 7 (every day).

[7] Alcohol consumption: the possible responses ranged from 1 (non-drinker) to 7 (every day).

[8] Breakfast patterns: the possible responses ranged from 1 (do not eat) to 8 (eat every day).

[9] Vigorous PA: included activities such as digging, aerobics, heavy lifting, or fast cycling, with possible responses ranging from 1 (no vigorous exercise) to 6 (5 times per week or more).

[10] Moderate PA: included activities such as cycling at a regular pace, carrying light loads, or playing doubles tennis during the week, with possible responses ranging from 1 (no moderate exercise) to 6 (5 times per week or more).

[11] Muscular strength exercises: included activities such as sit-ups, push-ups, and weight lifting or weight training, with possible responses ranging from 1 (no training) to 6 (5 times per week or more).

Statistical analysis

All of the results from this study are reported as mean±standard deviation. Multivariate logistic regression analyses were conducted to determine whether sleep duration was related to school performance after accounting for the covariates. The analyses were performed using the SPSS Complex Sample™, version 18.0 (Chicago, IL, USA), and statistical significance was set at $p < 0.05$.

RESULTS

The results of the multivariate logistic regression analyses for school performance in relation to sleep duration are shown in table 2. For the boys, the odds ratios (ORs; 95% confidence interval [CI]) to achieve average or higher academic performance according to sleep duration were 5–6 hours/night, 1.094 (1.011–1.182; p=0.025); 7–8 hours/night, 0.971 (0.885–1.067; p=0.544); and ≥9 hours/night, 0.657 (0.554–0.779; p<0.001), compared to ≤4 hours/night. For the girls, the ORs (95% CI) to achieve average or higher academic performance according to the sleep duration were 5–6 hours/night, 1.090 (0.986–1.206; p=0.093); 7–8 hours/night, 0.899 (0.802–1.008; p=0.067); and ≥9 hours/night, 0.664 (0.572–0.771; p<0.001), compared to ≤4 hours/night.

DISCUSSION

The purpose of this study was to examine the relationship between sleep duration and school performance in Korean adolescents. This study found that sleeping for 5–6 hours/ night increased school performance by 9.4% for boys; however, sleeping ≥9 hours/night decreased school performance by 34.3% when compared to ≤4 hours/night. There were no significant positive relationships between sleep duration and school performance for the girls, but a sleep duration of ≥9 hours/night decreased school performance by 33.6% when compared to ≤4 hours/night.

Previous studies have reported that the average sleep time required by adolescents is approximately 9 hours/night.[10] However, these results also found that 45% of the adolescents sleep less than eight hours/night.[10-11] Interestingly, our study reported that 94.5% of the adolescents slept less than eight hours/night. We believe that this insufficient sleep duration is strongly related to Korean cultural attitudes, including a strong social pressure to excel, pressure for academic achievement by parents, a high academic workload, and rapid economic growth compared to other countries.[12] Because the Korean society has these complex cultural influences on school achievement, adolescents may have more to accomplish during waking hours, which leads to late bedtimes and early wake-up times, resulting in insufficient sleep.

Based on the evidence, insufficient sleep during adolescence can impair prefrontal cortex area functions (executive function)[13-14] and, as a result, cause a decrease in learning abilities and academic performance.[15-16] However, our results indicated that when both boys and girls slept ≥9 hours/night, school performance decreased by 34.3% and 33.6%, respectively.

We have two possible explanations for this result. First, according to the study by Dewald et al. (2010), the effect of sleep duration is significantly smaller than the effect of either sleep quality or sleepiness.[6] This finding suggests that sleepiness has more negative consequences on neurobehavioral functioning than sleep duration[17] and that sleep quality contributes to school performance, as opposed to sleep duration.[18] In short, sleep duration is a less important factor than sleepiness or sleep quality in school performance outcomes. For this reason, sleep duration is not a good measure for examining factors influencing school performance. Future studies should focus more on the effects of sleepiness and sleep quality on school performance.

Second, adolescence is a phase of psychological change that culminates in sexual maturity and includes rapid physical growth and increased hormone levels.[19] During adolescence, physical growth and physiological domains, including brain functions, are at their peak. Thus, we suggest that sleep duration might not significantly affect school performance due to these peaks in physiological domains. On the other

Table 2. Results of multivariate logistic regression analyses for school performance in relation to sleep duration (N = 63 688)

Sleep duration		Case	Beta	S.E.	OR	95% CI	p-value
					Below-average academic achievement vs. average academic achievement or higher		
Boys	≤4 hours	3 598	Reference		1.000		
	5–6 hours	13 302	0.090	0.040	1.094	1.011 -1.182	0.025*
	7–8 hours	13 123	-0.029	0.048	0.971	0.885 - 1.067	0.544
	≥9 hours	2 295	-0.421	0.087	0.657	0.554 -0.779	<0.001***
Girls	≤4 hours	5 607	Reference		1.000		
	5–6 hours	14 547	0.086	0.051	1.090	0.986 -1.206	0.093
	7–8 hours	10 016	-0.107	0.058	0.899	0.802 -1.008	0.067
	≥9 hours	1 200	-0.409	0.076	0.664	0.572 -0.771	<0.001***

S.E.: Standard error, OR: Odds ratio, CI: Confidence interval.
*p < 0.05, ***p < 0.001.
Multivariate logistic regression analysis adjusted for covariate variables such as body mass index, age, education level of parents, family economic status, mental stress, and frequency of smoking, alcohol consumption, eating breakfast, muscular strength exercises, vigorous physical activity, and moderate physical activity.

hand, school performance is also often affected by the amount of learning time. During adolescence, school performance might suffer because sleeping ≥9 hours/night might reflect a smaller amount of learning time for both boys and girls.

Interestingly, 5–6 hours/night of sleep were significantly related to an increase in school performance for boys (9.4%, p=0.025) and were of borderline significance (9.0%, p=0.093) for girls. Although adolescence is a phase that includes physical and psychological peaks, too little sleep (≤4 hours/night) is detrimental to school performance. From these results, we recommend that adolescents sleep at least 5–6 hours/night to maintain a good academic record in Korean adolescents.

Nevertheless, this study has some limitations. First, not only sleep duration, but also sleep quality and sleepiness, are important factors in school performance; however, the KYRBWS-VIII did not investigate either of these variables. Moreover, self-reported sleep duration in adolescents is not usually accurate.[20] Furthermore, because we did not investigate sleep duration on weekends, generalizability might be limited. Second, because the KYRBWS-VIII was a cross-sectional retrospective cohort study, we are unable to draw causal conclusions; instead, we simply present the observed relationships. Third, covariate variables such as economic status and parental education were reported by adolescents; therefore, these values could be inaccurate. Furthermore, the adolescents reported their height and weight online. As these variables were not measured objectively, the BMI of participants might be lower because adolescents tend to overestimate their height and underestimate their weight.[21] However, this study, in contrast to a previous smaller regional case study, included participants from across South Korea, and our sample was large (n=63 688). Therefore, we believe that the results from this study accurately represent the relationship between sleep duration and school performance in Korean adolescents.

CONCLUSION

We conclude that sleeping 5–6 hours/night for boys increased school performance. However, for both boys and girls, ≥9 hours/night decreased school performance compared with ≤4 hours/night. We therefore recommend Korean adolescents to have at least 5–6 hours of sleep per night if they want to fare well in school. Future studies should examine other sleep related variables to more fully understand the relationship between sleep and school performance.

Ethical considerations

Ethical issues (including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Declaration of conflict of interests: None

RESPUESTAS DE LA SECCION AVANCES EN LA PSIQUIATRIA
Autoevaluación

1. D
2. A
3. C
4. B
5. D
6. A
7. B
8. B
9. A
10. B
11. C
12. B
13. D
14. A
15. B