

# Associations between adolescents' sleep duration, sleep satisfaction, and suicidal ideation

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## ABSTRACT

### Introduction

Both sleep and suicide are important issues among adolescents. Despite the extensive literature explaining short sleep duration as an important suicide risk factor, most previous studies did not consider sleep quality.

### Objective

This study identified associations between sleep duration, sleep satisfaction, and suicidal ideation in adolescents.

### Method

This cross-sectional study analyzed 58 848 adolescents using raw data from the tenth Korea Youth Risk Behavior Web-based Survey conducted by Korea's Center for Disease Control and Prevention. Analyses incorporated sampling weights to account for the complex sampling design.

### Results

In multivariate analysis, suicidal ideation of participants sleeping less than four hours was 1.36 times higher than that of participants sleeping more than nine hours. Sleep satisfaction was 1.20 times higher when moderate, 1.38 times higher when dissatisfied, and 1.64 times higher when very dissatisfied than when very satisfied.

### Discussion and conclusion

It is necessary not only to improve sleep quality, but also to extend sleep duration in order to prevent adolescent suicide. If it is actually difficult to extend sleep duration due to school, a plan to increase subjective sleep satisfaction by improving sleep quality is required. This study showed the association between sleep duration and sleep satisfaction in adolescents. Therefore, in order to prevent adolescent suicide, it is necessary not only to extend their sleep duration, but also to improve their sleep quality.

**Key words:** Adolescent, sleep, personal satisfaction, suicidal ideation.

## RESUMEN

### Antecedentes

Tanto el sueño como el suicidio son temas importantes que afectan a los adolescentes. Pese a la abundante literatura que describe una corta duración del sueño como un importante factor de riesgo de suicidio, muchas investigaciones anteriores no han considerado la calidad del sueño.

### Objetivo

Este estudio identificó algunas asociaciones entre la duración del sueño, la satisfacción del sueño y la ideación suicida en adolescentes.

### Método

Este estudio transversal analizó los casos de 58 848 adolescentes a partir de los datos brutos de la décima encuesta basada en la Página Web de Comportamiento Riesgoso de la Juventud Coreana realizada por el Centro Coreano para el Control y la Prevención de Enfermedades. Los análisis incluyeron pesos de muestreo para dar cuenta del complejo diseño de muestreo.

### Resultados

En el análisis multivariado, la ideación suicida de los participantes que dormían menos de cuatro horas fue 1.36 veces mayor que la de los participantes que dormían durante más de nueve horas. La satisfacción del sueño era 1.20 veces mayor en los casos moderados, 1.38 veces mayor en los insatisfechos y 1.64 veces mayor en los casos muy insatisfechos que en los muy satisfechos.

### Discusión y conclusión

Es necesario mejorar la calidad del sueño y alargar también su duración con el fin de prevenir el suicidio adolescente. Si es difícil extender la duración del sueño debido a los horarios escolares, se debe aplicar un plan para aumentar la satisfacción subjetiva del sueño mediante la mejora de la calidad del sueño. Este estudio demostró la asociación entre la duración y la satisfacción del sueño en los adolescentes. Por lo tanto, con el fin de prevenir el suicidio adolescente, es necesario alargar no sólo la duración del sueño, sino mejorar también su calidad.

**Palabras clave:** Adolescente, sueño, satisfacción personal, ideación suicida.

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## INTRODUCTION

Sleep plays an important role in the brain's reparative and integrative processes.<sup>1</sup> In particular, adolescence is the time when circadian rhythm changes; it is also time for adolescents to easily suffer from lack of sleep because bedtimes become later but school time is fixed. Thus, there is a high risk for sleep problems.<sup>2</sup> Generally, a sleep duration of at least 8.5 hours per day is recommended for adolescents,<sup>3</sup> but in reality the sleep duration of many adolescents falls short of this. Actually, only 62% of the European adolescents and 15.5%<sup>4</sup> of the Korean adolescents slept for more than eight hours on weekdays,<sup>5</sup> indicating that short adolescent sleep duration is a serious concern in Korea. In fact, short sleep duration causes adverse consequences in individuals' physical and mental health.<sup>3,6,7</sup> Therefore, sufficient sleep duration is important to prevent social and public health problems.<sup>8</sup>

In 2015, Korean adolescents (12–21 year old) accounted for 12.1% or 6139000 of the total population of 50617000.<sup>9</sup> According to the Organization for Economic Cooperation and Development (OECD), the suicide rate per 100000 Koreans is 29.1, which is the highest among OECD countries.<sup>10</sup> Korea's suicide rate for 2013 was 1.3 per 100000 individuals for ages 10–14, 7.9 for ages 15–19, and 14.5 for ages 20–24, showing that suicide deaths increase as adolescence progresses.<sup>11</sup> Additionally, Korea's suicide rate is increasing among adults as well. Prevention education and intervention for adolescent suicide are urgent because youngsters in the suicide high-risk group are highly likely to proceed to the high-risk group even in adulthood.<sup>12</sup> Therefore, both suicide and short sleep duration are key health issues for Korean adolescents.

According to previous research, youth suicidal ideation is caused by multi-dimensional components such as psychological factors including depression, stress, and low self-esteem;<sup>13,14</sup> family factors including family support;<sup>15,16</sup> and external factors including school life, friends, relationships, etc.<sup>15–17</sup> Moreover, several studies have investigated the possible association between sleep and suicide. Short sleep duration has now been identified as a potential suicidality risk factor among adolescents.<sup>1,5,18,19</sup> Despite the extensive literature exposing short sleep duration as an important suicide risk factor, most previous studies did not consider sleep quality. However, subjective sleep satisfaction should be also considered because individual sleep duration is relatively rather than absolutely determined.<sup>20</sup> Moreover, most sleep-related studies are limited by small sample sizes and do not represent the general population.<sup>8</sup> Therefore, this study identified the association between adolescents' sleep satisfaction and suicidal ideation as well as self-reported sleep duration using a nationally representative sample to ultimately prevent problems due to adolescents' short sleep duration and suicide. The specific purposes of this study are

as follows: 1. To evaluate the differences in suicidal ideation by demographic characteristics of adolescents; 2. To examine the relationship of suicidal ideation with sleep satisfaction depending on the sleeping time of adolescents; and 3. To investigate the association between sleep duration, sleep satisfaction, and suicidal ideation of adolescents.

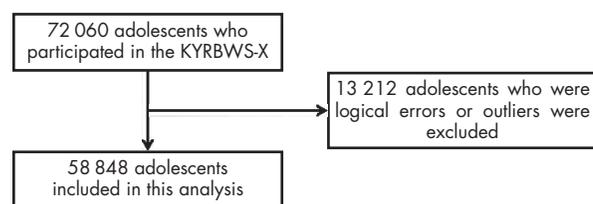
## METHOD

### Study design and study sample

This cross-sectional study identified the association of sleep duration, sleep satisfaction, and suicidal ideation in Korean adolescents. We used the raw data of the tenth Korea Youth Risk Behavior Web-based Survey (KYRBWS-X) conducted by Korea's Center for Disease Control and Prevention (KCDC).

KYRBWS is an anonymous self-administered online survey targeting middle school freshmen to high school seniors to identify health behaviors of Korean adolescents. It was conducted using a complex sample design involving stratification, clustering, and multistage sampling methods. In order to minimize sampling errors in the population stratification stage, the researcher divided the population into 129 levels using the area group and schools (middle schools, academic high schools, and specialized professional high schools) as a stratification variable and then allocated the number of sample schools by applying the proportional allocation method to ensure that the sample composition ratio and the composition ratio of population by stratification variable is consistent. Finally, sampling was done by the stratification colony extraction method with school as the first extraction unit and class as the second extraction unit.<sup>21</sup> More details about sampling strategies and analysis guidelines for raw data are shown on the center's homepage (<http://yhs.cdc.go.kr>).<sup>21</sup>

KYRBWS-X surveyed 74167 individuals from 400 middle and 400 high schools; 72060 people participated in the survey, showing a participation rate of 97.2%.<sup>22</sup> Of these, data from 13212 adolescents were processed as missing because the measured values of the variables for age (aged 12 or younger or 19 or older), wake up time (before 4:00 a.m., after 9:00 a.m.), sleeping time (4:00 a.m. – 8:00 p.m.) were



**Figure 1.** The flowchart of recruitment process.

**Table 1.** Suicidal ideation according to demographic characteristics (N = 58 848)

Variable	Classification	n (%) or Mean ± SE	Suicidal ideation		t or $\chi^2$ (p)
			No % (SE) or Mean ± SE	Yes % (SE) or Mean ± SE	
Age	(years)	15.03 ± 0.02	15.02 ± 0.02	15.22 ± 0.02	0.775 (.439)
Body mass index	(kg/m <sup>2</sup> )	20.73 ± 0.01	20.72 ± 0.04	20.83 ± 0.04	2.626 (.009)
Sleep duration	(hr)	6.33 ± 0.01	6.38 ± 0.02	6.01 ± 0.02	19.737 (< .001)
Gender	Male	29 143 (51.1)	52.4 (1.3)	41.8 (1.4)	287.155 (< .001)
	Female	29 705 (48.9)	47.6 (1.3)	58.2 (1.4)	
School type	Middle school	28 876 (47.4)	47.1 (0.7)	49.1 (1.0)	9.940 (.008)
	High school	29 972 (52.6)	52.9 (0.7)	50.9 (1.0)	
Urban scale	Big cities	26 452 (44.0)	43.9 (0.7)	45.1 (0.9)	4.544 (.204)
	Medium sized cities	27 846 (49.8)	50.0 (0.8)	48.7 (1.1)	
	Country area	4 552 (6.2)	6.2 (0.5)	6.3 (0.6)	
Living with parents	Both	51 927 (88.6)	89.0 (0.2)	85.3 (0.4)	90.258 (< .001)
	Only father or mother	6 113 (10.2)	9.8 (0.2)	13.0 (0.4)	
	None	808 (1.3)	1.2 (0.1)	1.7 (0.2)	
Father's educational background	Below middle school	1 691 (2.7)	2.6 (0.1)	3.4 (0.2)	27.656 (< .001)
	High school	18 138 (30.3)	30.3 (0.4)	30.4 (0.7)	
	Above college	29 502 (51.4)	51.3 (0.5)	52.2 (0.8)	
	Unknown	9 517 (15.5)	15.7 (0.3)	14.0 (0.5)	
Mother's educational background	Below middle school	1 471 (2.4)	2.2 (0.1)	3.2 (0.2)	39.571 (< .001)
	High school	23 323 (39.5)	39.5 (0.4)	40.0 (0.7)	
	Above college	24 835 (43.0)	43.0 (0.5)	43.3 (0.8)	
	Unknown	9 219 (15.1)	15.3 (0.3)	13.5 (0.5)	
Perceived economic status	Very high	4 495 (7.7)	7.8 (0.2)	7.1 (0.3)	474.497 (< .001)
	High	15 683 (26.9)	27.2 (0.3)	24.6 (0.6)	
	Moderate	29 021 (49.0)	49.8 (0.3)	43.7 (0.6)	
	Low	7 948 (13.4)	12.7 (0.2)	18.9 (0.5)	
	Very low	1 701 (2.9)	2.5 (0.1)	5.7 (0.3)	
Perceived school performance	Very high	7 401 (12.4)	12.7 (0.2)	10.8 (0.4)	293.313 (< .001)
	High	15 143 (25.7)	26.1 (0.2)	22.8 (0.5)	
	Moderate	16 790 (28.6)	29.0 (0.2)	25.8 (0.5)	
	Low	13 812 (23.6)	23.2 (0.2)	26.1 (0.5)	
	Very low	5 702 (9.7)	9.0 (0.1)	14.5 (0.4)	
Subjective health status	Good	41 961 (71.3)	73.7 (0.2)	54.8 (0.6)	1459.033 (< .001)
	Moderate	13 297 (22.6)	11.3 (0.2)	31.3 (0.5)	
	Poor	3 591 (6.1)	5.0 (0.1)	13.9 (0.4)	
Sleep satisfaction	Very satisfied	4 262 (7.1)	7.6 (0.1)	3.8 (0.2)	1506.778 (< .001)
	Satisfied	11 013 (18.7)	19.8 (0.2)	11.2 (0.4)	
	Moderate	18 905 (32.2)	33.1 (0.2)	25.9 (0.5)	
	Unsatisfied	16 779 (28.5)	27.8 (0.3)	33.4 (0.6)	
	Very unsatisfied	7 889 (13.5)	11.7 (0.2)	25.8 (0.5)	
Stress awareness	Yes	21 699 (36.8)	31.3 (0.3)	74.5 (0.5)	5186.298 (< .001)
	No	37 149 (63.2)	68.7 (0.3)	25.5 (0.5)	
Depression awareness	Yes	43 625 (74.1)	19.1 (0.2)	26.7 (0.5)	9902.154 (< .001)
	No	15 223 (25.9)	80.9 (0.2)	73.3 (0.5)	
Lifetime drinking experience	Yes	24 665 (42.4)	41.0 (0.4)	52.6 (0.6)	355.248 (< .001)
	No	34 183 (57.6)	59.0 (0.4)	47.7 (0.6)	
Lifetime smoking experience	Yes	10 734 (18.7)	17.7 (0.4)	26.3 (0.6)	314.124 (< .001)
	No	48 114 (81.3)	82.3 (0.4)	73.7 (0.6)	
Experience of sexual intercourse	Yes	2 522 (4.6)	4.1 (0.1)	7.9 (0.3)	220.529 (< .001)
	No	56 326 (95.4)	95.9 (0.1)	92.1 (0.3)	
Lifetime drug experience	Yes	376 (0.6)	0.5 (0.0)	1.6 (0.1)	133.328 (< .001)
	No	58 472 (99.4)	99.5 (0.0)	98.4 (0.1)	

SE = Standard error.

logical errors or outliers (see parenthetical ranges) and were thus excluded from study analysis. Therefore, the responses of 58 848 adolescents were analyzed in this study (figure 1).

## Study variables

### *Sleep duration and sleep satisfaction*

In this study, sleep duration was calculated by using the responses to "For the last seven days, what time do you usually go to bed and wake up on weekdays?" Sleep satisfaction used a five-point scale (1 point: *not sufficient at all*, 5 points: *quite sufficient*) to "For the last 7 days, do you think your sleep duration was enough to recover from fatigue?"

### *Suicidal ideation*

In this study, we used responses to "For the last 12 months, have you ever seriously thought about suicide? (yes/no)" for suicidal ideation.

### *Demographic characteristics*

In this study, the following demographic characteristics were used: age, gender, body mass index (BMI), school type (middle and high school), urban scale (big and medium sized cities and country areas), living with parents (both parents, only parent, and none), parents' educational backgrounds (below middle school, high school, above college and unknown), perceived economic status (very high, high, moderate, low, and very low), perceived school performance (very high, high, moderate, low, and very low), subjective health status (good, moderate, and poor), stress awareness (yes/no), depression awareness (yes/no), and experiences of lifetime drinking (yes/no), lifetime smoking (yes/no), lifetime drug use (yes/no), and lifetime sexual intercourse (yes/no).

## Statistical analysis

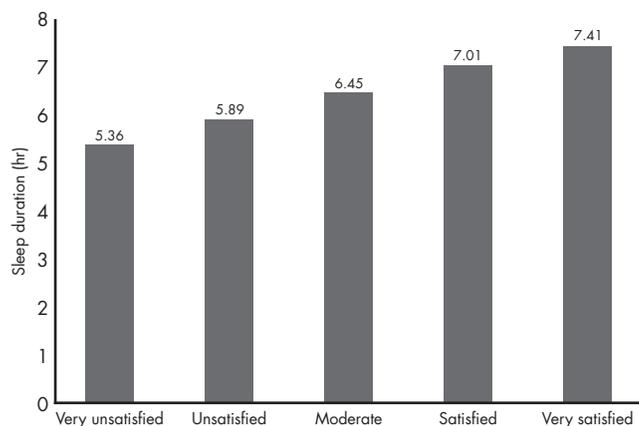
Statistical analysis was performed using the SPSS Complex Sample, version 19.0 (SPSS Inc., Chicago, IL, USA) reflecting sampling weights and using nationally representative estimates according to KCDC guidelines. That is, all of the data were analyzed using a weighted value, stratification variable, and colony variable, which are complex sample design elements; of these, weighted value used a value presented by KCDC by using the extraction rate, response rate, and post correction rate (the sum of weighted values by grade, school, and gender in the area group is calculated to be equal to the national number of middle and high school students as of 2014).

Continuous variables (general participant characteristics) are presented as mean (SE) values, while categorical variables are presented as percentage (SE) values. The t-test and  $\chi^2$  tests were used to compare suicidal ideation by demographic characteristics. Logistic regression analyses were

performed to determine associations between sleep duration, sleep satisfaction, and suicidal ideation. Odds ratios (ORs) and confidence intervals (CIs) were estimated after adjusting for BMI, gender, school type, living with parents, parents' educational backgrounds, perceived economic status, subjective health status, stress awareness, depression awareness, lifetime drinking experience, lifetime smoking experience, experience of sexual intercourse, and lifetime drug experience. A cut-off value of  $p < .05$  was used to select the adjusted variables in table 1. A  $p$ -value of  $< .05$  was considered statistically significant.

## RESULTS

Differences in suicidal ideation according to adolescents' demographic characteristics are shown in table 1. The rate of suicidal ideation was statistically significantly higher with: lower BMI; short sleep duration; females; the participant did not live with both parents; low parents' educational backgrounds; lower perceived economic status; lower subjective health status; unsatisfactory sleep; perceived stress or depression; experience of lifetime drinking, smoking, or drug use experience; and experience with sexual intercourse. The relationship between actual participant sleep duration and perceived sleep satisfaction is shown in figure 2. As sleep satisfaction improved, actual sleep duration also increased and there was a statistically significant difference. The associations between adolescents' sleep duration, sleep satisfaction, and suicidal ideation are shown in table 2. In univariate analysis, participant suicidal ideation was 1.35 times higher if sleeping for 5–6 hours and 2.12 times higher if sleeping for less than four hours than participants sleeping for more than nine hours. Sleep satisfaction was 1.58 times higher when moderate, 2.43 times higher when unsatisfied, and 4.44 times higher when very unsatisfied than when very satisfied. In multivariate analysis, participant suicidal



**Figure 2.** Association between sleep duration and sleep satisfaction among adolescents.

**Table 2.** Association between sleep duration, sleep satisfaction and suicidal ideation among adolescents (*N* = 58848)

Variables	Classification	Suicidal ideation	
		Model 1	Model 2
		OR [95% CI]	OR [95% CI]
Sleep duration	≥ 9 hours	1	1
	7 – 8 hours	1.013 [0.867–1.184]	0.973 [0.817–1.158]
	5 – 6 hours	1.345 [1.153–1.569]	1.111 [0.932–1.325]
	≤ 4 hours	2.122 [1.802–2.500]	1.367 [1.130–1.652]
Sleep satisfaction	Very satisfied	1	1
	Satisfied	1.147 [0.992–1.326]	1.091 [0.932–1.278]
	Moderate	1.580 [1.385–1.803]	1.204 [1.038–1.396]
	Unsatisfied	2.432 [2.126–2.781]	1.385 [1.192–1.609]
	Very unsatisfied	4.442 [3.872–5.097]	1.645 [1.410–1.919]

Model 1: univariate; Model 2: adjusted for BMI, gender, school type, living with parents, father's or mother's educational background, perceived economic status, subjective health status, stress awareness, depression awareness, lifetime drinking experience, lifetime smoking experience, experience of sexual intercourse and lifetime drug experience.

Note: OR = Odds ratio; CI = Confidence interval.

ideation was 1.36 times higher if sleeping for less than four hours than participants sleeping for more than nine hours. Sleep satisfaction was 1.20 times higher when moderate, 1.38 times higher when unsatisfied, and 1.64 times higher when very unsatisfied than when very satisfied.

## DISCUSSION AND CONCLUSION

As Korean adolescent suicide emerges as a major cause of juvenile deaths, social interest in its prevention is increasing.

Previous studies have also reported that being female, poor academic grades, low economic status, living with their parents, parents' poor educational background, subjective health status, drinking, smoking, stress, and depression affect suicidal ideation of adolescents; the results were similar to those of this study.<sup>14,15,23–26</sup> It was also reported that drug experiences and sexual activity affect suicide attempts.<sup>26</sup> Therefore, active interest and measures are needed to prevent suicidal ideation in female adolescents with low academic grades or difficult socio-economic status. Preventive education and programs for health risk behaviors are also required to prevent suicide. In multivariate logistic analysis, participant suicidal ideation for those sleeping for less than four hours was 1.36 times higher than participants sleeping for more than nine hours even after correcting for suicidal ideation impact factors. This is similar to the results of several previous studies<sup>1,5,18,19,28</sup> completed across various cultural backgrounds that short sleep duration is a suicide impact factor. According to this study's results, the risk of suicidal ideation increased when sleep duration was less than four hours; previous studies<sup>5</sup> in Korea also reported that the suicidal ideation risk of adolescents sleeping for less than five hours is high. However, studies in the U.S.<sup>2</sup> found

that the risk of suicidal ideation of adolescents sleeping for less than six hours was high. Particularly in Korean adolescents, the suicidal ideation risk increased statistically significantly in relatively shorter sleep durations compared to American<sup>2</sup> or European adolescents.<sup>4</sup> We propose the need for a cross-cultural study to determine if this result is a racial difference or related to the social environment. In the results of this study, suicidal ideation was 1.20 times higher when sleep satisfaction was moderate, 1.38 times higher when unsatisfied, and 1.64 times higher when very unsatisfied than when very satisfied. This is similar to the results of previous research<sup>23</sup> showing lower suicidal ideation when sleep satisfaction is moderate or high and that insufficient sleep is related to suicidal ideation.<sup>1,29</sup> Given that adolescents' lack of sleep increases the occurrence of emotional instability, depression, stress, etc.,<sup>30,31</sup> increased risk of suicide due to short sleep duration or unsatisfactory sleep may be a natural result. On the other hand, negative thoughts such as stress, depression, or anxiety make sleep difficult and also cause disruption in sleep duration.<sup>32–34</sup> However, what is interesting in this study is that the suicidal ideation risk also increases when sleep satisfaction perceived by adolescents is moderate even after adjusting for suicidal ideation impact factors. This suggests clearly and strongly how important it is to achieve a satisfying sleep as well as to extend sleep duration in order to prevent adolescents' suicidal ideation. Sleep disturbances may damage individuals' emotional regulation, impulse control, and problem solving ability, which in turn increases the risk of adolescent suicidality.<sup>35–38</sup>

The relationship between actual sleep duration reported by adolescents and perceived sleep satisfaction was assessed. Higher satisfaction in adolescents' sleep increased actual sleep duration and this showed a statistically significant difference. Recommended sleep duration for adoles-

cents is 8.5 hours per day.<sup>3</sup> According to the results of this study, adolescents perceived that a sleep duration of about seven hours was indicated a satisfactory sleep. When considering this from a comprehensive perspective, it is necessary not only to improve sleep quality, but also to extend sleep duration in order to prevent adolescent suicide. Additionally, the underlying neurobiological factors can partially explain the relationship between sleep and suicide. That is, serotonergic neurotransmission was found to play a significant role in both sleeping and suicide.<sup>39,40</sup> In reality, if it is difficult to extend sleep duration due to school, a plan to increase subjective sleep satisfaction by improving sleep quality is required. This study is significant in having identified the association between sleep satisfaction and suicidal ideation as well as sleep duration of adolescents. It also targeted a large and representative sample and corrected for all variables known to affect suicidal ideation.

Despite these strengths, the limitations of this study are as follows. This study considered only weekday sleep duration and did not include weekend sleep duration. Therefore, we suggest a study considering sleep duration of both weekdays and weekends. We also suggest the need for a further longitudinal study because this study is a cross-sectional study and cannot explain any causal relationship between sleep duration, sleep satisfaction, and suicidal ideation. Therefore, the time or quality of sleep may be degraded due to suicidal ideation. Finally, this study analyzed only the associations between sleep duration, sleep satisfaction, and suicidal ideation. Therefore, it is suggested that large-scale research considering additional factors involved in adolescent suicidal ideation is needed.

This study showed that suicidal ideation risk is high when sleep duration is less than four hours and sleep satisfaction is less than moderate. Therefore, lack of sleep in addition to rapid physical changes and mental confusion are likely to increase suicidal ideation risk. This may lead to suicide attempts and suicides. In order to break this vicious cycle, teachers and parents need to instruct adolescents to sleep for more than five hours a day or improve subjective sleep satisfaction by improving sleep quality.

### Ethical considerations

The KYRBWS is a statistical survey approved by the government (Approval No. 11758) that underwent KCDC institutional review board review (2014-06EXP-02-P-A). We requested permission from the KCDC to use the KYRBWS survey results for research purposes; we also submitted a data use plan and posted a written pledge on the KYRBWS homepage.

Ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, have been completely monitored by the author.

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This study was not funded.

### Conflict of interests

The authors have no conflict of interest to declare.

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