

# Energy drink consumption among Korean adolescents: prevalence and associated factors

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**Background:** Energy drinks are gaining popularity among young people worldwide. However, little is known about their consumption among Korean adolescents.

**Purpose:** To examine the prevalence and factors associated with energy drink consumption among Korean adolescents.

**Methods:** This study used data from the Korea Youth Risk Behavior Surveys conducted in 2014–2017 and in 2019. A total of 325,210 participants aged 12–18 years were included. The prevalence of energy drink consumption (with 95% confidence intervals) was estimated. Multivariable logistic regression analyses examined the association between energy drink consumption and sociodemographic and individual factors.

**Results:** The prevalence of consuming energy drinks 3 or more times during the previous 7 days increased significantly from 3.2% in 2014 to 12.2% in 2019 ( $P$  for trend < 0.001). This increasing trend was observed in all subgroups regardless of sex, school grade, region of residence, subjective economic status, family cohabitation status, and academic achievement. Data from the 2014–2017 and 2019 surveys revealed that boys, high schoolers, city-dwelling adolescents, adolescents with low economic status, those not living with their families, and those with low academic achievement were more likely to consume energy drinks. However, the relationship between energy drink consumption and the associated factors differed by survey year and school grade. In 2019, higher energy drink consumption among middle schoolers was associated with sex (male), low economic status, not living with family, and low academic achievement; however, higher energy drink consumption among high schoolers was associated with city-dwelling, high economic status, not living with family, and high academic achievement.

**Conclusion:** Energy drink consumption is common, has recently increased among Korean adolescents, and varies according to sociodemographic and individual factors. Fur-

ther research to monitor the energy drink consumption of adolescents and understand their attitudes toward and factors influencing energy drink consumption is needed to develop policies and educational strategies for energy drink consumption.

**Key words:** Energy drinks, Adolescents, Sociodemographic factors, Health-related behaviors, Korea Youth Risk Behavior Survey

## Key message

**Question:** How prevalent is energy drink consumption among Korean adolescents and what are the associated factors?

**Findings:** The prevalence of energy drink consumption among Korean adolescents increased from 3.2% in 2014 to 12.2% in 2019. Energy drink consumption varies according to sociodemographic and individual factors.

**Meaning:** Policies and educational strategies are needed to reduce energy drink consumption in adolescents.

## Introduction

Energy drinks are nonalcoholic beverages that contain caffeine, nonnutritive bioactive substances (such as taurine, and guarana), vitamins, and sugar.<sup>1)</sup> Caffeine and bioactive ingredients in energy drinks stimulate the brain and nervous system and support the development and function of skeletal muscle and nervous system, temporarily improving cognitive and physical performance.<sup>1)</sup> Thus, energy drinks are marketed as focus and endurance enhancers and fatigue relievers and are often confused with functional beverages. However, energy drink is a new category of beverages that is different from these beverages.<sup>1,2)</sup>

Energy drinks have been marketed in more than 165 countries since it was first launched in Austria in 1987.<sup>2,3)</sup> It has gained popularity, especially among the young popula-

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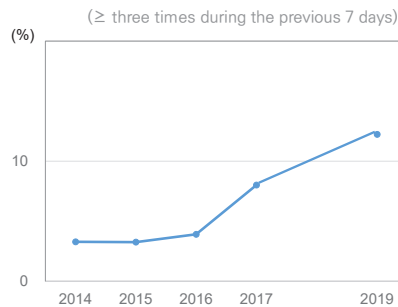
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# Energy drink consumption among Korean adolescents

## Data source and study population

- Korea Youth Risk Behavior Surveys from 2014–2017 and 2019 (Nationwide school-based anonymous online survey)
- 325,210 Korean middle and high school students (aged 12–18 y)

## Prevalence of energy drink consumption



Graphical abstract.

tion, and its annual growth rate is the fastest in the global beverage market. This expansion of the energy drink market is expected to continue.<sup>4)</sup> In Korea, “Bacchus,” a Korean-style energy drink, was launched in 1963, and “Hot6,” “Red Bull,” and “Monster Energy” were introduced in the early 2010s. Sales of energy drinks in the domestic market, which have gradually increased since their introduction, have recently surged.<sup>5,6)</sup>

There is growing evidence addressing the adverse health effects of energy drink consumption; both acute and chronic energy drink consumption is related to cardiovascular symptoms (e.g., fast heartbeat, increased blood pressure), sleep impairment (e.g., insomnia, sleep dissatisfaction), nervousness and gastrointestinal symptoms (including stomachaches, headache, irritation), and mental and metabolic health (including anxiety, depressive symptoms, obesity, and type 2 diabetes).<sup>1,7–9)</sup> Moreover, energy drink consumption is associated with an unhealthy lifestyle (such as poor dietary habits, sedentary lifestyle) and is implicated as a trigger for substance use (such as tobacco, alcohol, drugs) and other risk behaviors (such as gambling, screen addiction, violence, driving while intoxicated).<sup>10–12)</sup> Previous studies have revealed that the prevalence of energy drink consumption is the highest among adolescents.<sup>1,10)</sup> A 2011 study by the European Food Safety Authority revealed that energy drink consumption in adolescents was more than twice as high as that in adults. In the same year, the American Academy of Pediatrics raised significant concerns about the potential health risks related to energy drink consumption in adolescents.<sup>13)</sup>

However, little is known about the prevalence and trend of energy drink consumption among Korean adolescents and the factors associated with energy drink consumption.

## Association between energy drink consumption and sociodemographic and individual resource

	OR
Sex   boys vs girls	1.29
School grade   high school vs middle school	1.38
Residence   county vs metropolitan city	0.90
Economic status   low vs high	1.13
Economic status   middle vs high	0.64
Cohabitation   not with family vs with family	1.70
Academic achievement   low vs high	1.15

※ Odds ratio (OR) was adjusted for all variables in the table.

Thus, this study aimed to examine the recent trends in energy drink consumption among Korean adolescents and investigate the association between energy drink consumption and sociodemographic and individual factors.

## Methods

### 1. Data source and study population

This study used data from the Korea Youth Risk Behavior Survey (KYRBS), a nationwide school-based survey conducted to evaluate the status and trends in health and health-related behaviors among Korean adolescents. The KYRBS has been conducted annually since 2005 in cooperation with the Korea Centers for Disease Control and Prevention Agency (KDCA) and the Korean Ministry of Education. The target population for the survey was middle and high school students aged 12–18 years. To obtain a representative sample of Korean middle and high school students, survey samples were selected using a two-stage cluster sampling design. A total of 800 schools each year were selected as the primary sample units among all public and private middle and high schools in 17 provinces in Korea, and one class of each grade within each primary sample unit was selected as the secondary sample unit. All the students in the selected classes were eligible for participation. Diverse information on health, health-related behaviors, and health equity was collected using an anonymous self-administered web-based questionnaire. The participants completed the survey in the classroom and it took one class time (approximately 45–50 minutes) to complete the questionnaire. Each year from 2014 to 2019, approximately 70,000 students were invited to participate in

the survey; the response rate was approximately 95%; the survey from 2014 to 2019 was performed in June of each year. More details on the sampling, data collection, and questionnaire are available elsewhere.<sup>14,15)</sup>

Energy drink consumption has been included in the survey since 2014 and has been investigated intermittently since 2017. Thus, this study included 325,210 participants in the KYRBS in 2014 (n=72,060), 2015 (n=68,043), 2016 (n=65,528), 2017 (n=62,276), and 2019 (n=57,303) when energy drink consumption was surveyed.

The KYRBS protocol was approved by the Institutional Review Board (IRB) of the KDCA. The present study was approved by the IRB of Severance Hospital (Yonsei University Health System, Seoul, Korea; approval no. 4-2023-0594).

## 2. Energy drink consumption

The frequency of energy drink consumption was surveyed by the question “Over the past 7 days, how often did you drink energy drinks, such as HOT6, Red Bull, or Bacchus?” with 7 response options: no, 1–2 times a week, 3–4 times a week, 5–6 times a week, once a day, twice a day, and more than thrice a day. The distribution by frequency of energy drink consumption over the past 7 days among Korean adolescents is shown in Fig. 1. Energy drink consumers were defined as those who had consumed energy drinks 3 or more times during the past 7 days.

## 3. Sociodemographic and individual variables

Data on sex, school grade (middle or high school), region of residence (metropolitan city, other cities, or county), subjective economic status, cohabitation type, and academic achievement were collected. The subjective economic status of the households was investigated using the following 5 response options: high, middle-high, middle, middle-low,

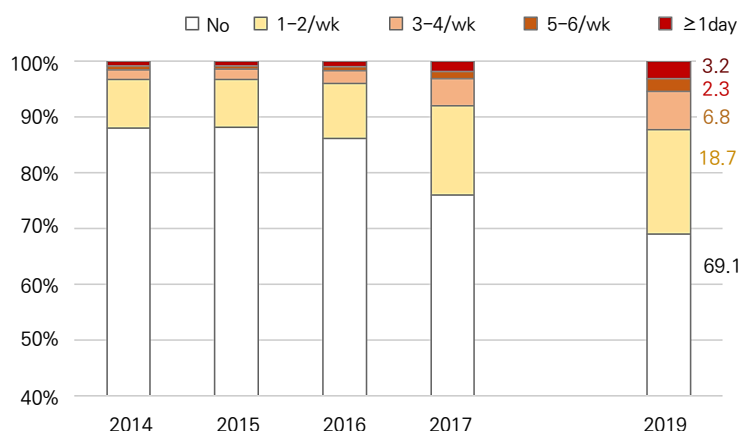
and low. The variable was categorized as high, middle (middle-high, middle, or middle-low), and low. Academic achievement over the past 12 months was assessed using the same 5 response options and categorized as high (high or middle-high), middle, and low (middle-low or low). The cohabitation types comprised living with families, living with relatives, boarding or lodging, and living in dormitories or childcare centers; the variable was categorized as living and not living with families.

## 4. Statistical analyses

Prevalence estimates and 95% confidence intervals (CIs) of energy drink consumption were computed in the total study population and in subgroups divided by sex, school grade, region of residence, subjective economic status, cohabitation type, and academic achievement. Linear regression models were used to analyze the annual changes and linear trends in the prevalence of energy drink consumption in the total population and subgroups during 2014–2017 and 2019.

The association between energy drink consumption and sociodemographic and individual factors was examined using multivariable logistic regression analyses. The multivariable model included sex, survey year, school grade, region of residence, subjective economic status, cohabitation type, and academic achievement, and the analyses were performed in the total study population and by school grade. Multivariable logistic regression analyses were also performed using only data from KYRBS 2014 and 2019 to understand the association between energy drink consumption and the sociodemographic and individual factors across the time points in 2014 and 2019, respectively. The results are presented as adjusted odds ratios (ORs) and 95% CIs.

All analyses were performed using the SAS 9.4 (SAS Insti-



**Fig. 1.** Distribution according to frequency of energy drink consumption during the previous 7 days among Korean adolescents (KYRBS 2014–2017 and 2019). KYRBS, Korea Youth Risk Behavior Survey.

tute Inc., Cary, NC, USA). In all the analyses, we considered the complex survey design of the KYRBS and applied the sampling weights provided by the KDCA. Results were considered statistically significant at  $P$ -value  $<0.05$ .

## Results

Table 1 shows the distribution of general characteristics of the total study population, including sex, age, school grade, region of residence, subjective economic status, cohabitation with family, and academic achievement. Among a total of 325,210 participants, 52.1% were boys and the mean age was 15.1 years. There were no differences in the proportion of sex, school grade, and cohabitating with family (all  $P>0.05$ ), whereas the mean age slightly increased within the study period ( $P=0.014$ ).

**Table 1. General characteristics of the study population and KYRBS administered in 2014–2017 and 2019**

Characteristic	2014	2015	2016	2017	2019	Total
Total (n)	72,060	68,043	65,528	62,276	57,303	325,210
Sex						
Boys	52.2	52.1	52.2	52.1	52.0	52.1
Girls	47.8	47.9	47.8	47.9	48.0	47.9
Age (yr)	15.0	15.1	15.1	15.1	15.1	15.1
School grade						
Middle school	48.3	47.0	45.4	45.3	47.9	46.8
1st year	14.9	13.7	14.7	14.8	15.9	14.8
2nd year	16.8	15.6	14.4	15.4	15.3	15.5
3rd year	16.6	17.7	16.4	15.1	16.6	16.5
High school	51.7	53.0	54.6	54.7	52.1	53.2
1st year	17.0	17.4	18.4	17.1	17.1	17.4
2nd year	17.4	17.6	17.9	19.0	16.5	17.7
3rd year	17.3	18.1	18.2	18.6	18.5	18.1
Region of residence						
Metropolitan city	43.6	43.5	43.3	43.1	42.5	43.2
Other cities	49.9	50.1	50.8	50.8	51.9	50.7
County	6.5	6.3	5.8	6.1	5.6	6.1
Subjective economic status						
High	7.9	9.1	9.6	11.0	11.2	9.7
Middle	88.2	87.6	87.5	86.5	86.6	87.3
Low	3.8	3.2	2.9	2.6	2.2	3.0
Cohabitation						
With family	95.9	95.7	95.5	95.4	95.4	95.6
Not with family	4.1	4.3	4.5	4.6	4.6	4.4
Academic achievement						
High	37.0	37.7	38.1	39.2	38.1	38.0
Middle	28.0	27.9	28.6	28.7	30.1	28.6
Low	35.0	34.4	33.3	32.1	31.8	33.4

Values are presented as numbers or percentages, as appropriate.  
KYRBS, Korea Youth Risk Behavior Survey.

## 1. Prevalence of energy drink consumption and trend from 2014 to 2019

The annual distribution of the surveyed Korean adolescents according to the energy drink consumption frequency over the past 7 days is presented in Fig. 1. In 2014, approximately nine in 10 adolescents (88.0%) did not consume energy drinks over the past 7 days; the remaining 8.7%, 1.8%, 0.6%, and 0.9% of adolescents consumed energy drinks 1–2 times per week, 3–4 times per week, 5–6 times per week, and at least once a day, respectively. However, energy drink consumption became prevalent in 2019; approximately one in 2 adolescents consumed energy drinks over the past 7 days, with 26.4%, 12.1%, 4.3%, and 5.9% consuming energy drinks 1–2 times per week, 3–4 times per week, 5–6 times per week, and at least once a day, respectively.

The prevalence of those who consumed energy drinks 3 or more times over the past 7 days greatly increased from 3.2% in 2014 to 12.3% in 2019 among overall adolescents, with an annual change in the prevalence of 1.90% ( $P<0.001$ ) (Table 2). Overall, the prevalence of energy drink consumption was high in boys, high school students, adolescents with low economic status, those not living with their families, and those with low academic achievement; conversely, the prevalence was low in county-dwelling adolescents. However, significant upward trends were observed during 2014–2017 and 2019 across all subgroups, regardless of sex, school grade, region of residence, subjective economic status, cohabitation type, and academic achievement (all  $P<0.001$ ).

## 2. Association between energy drink consumption and sociodemographic and individual factors

Table 3 shows the results of the analysis of the association between energy drink consumption and the sociodemographic and individual factors performed using data from KYRBS 2014–2017 and 2019. For the total study population, after adjusting for all variables included in the table and for the survey year, the ORs for energy drink consumption were higher in boys, high school students, those with low economic status, those not living with their families, and those with low academic achievement; however, the ORs were lower in county-dwelling adolescents. The patterns of the associations differed slightly according to the school grade. For middle school students, no associations were noted between energy drink consumption and region of residence; for high school students, no differences in the likelihood of energy drink consumption were noted between those with high and low academic achievement.

Tables 4 and 5 show the results of the analysis of the association between energy drink consumption and the sociodemographic and individual factors in 2014 and 2019. In the total population in 2014, energy drink consumption was associated with the male sex (OR, 1.89; 95% CI, 1.70–2.09),

**Table 2. Prevalence of and trends in energy drink consumption among Korean adolescents, KYRBS 2014–2017 and 2019**

Variable	Prevalence of energy drink consumption										Annual change	P-linear trend
	2014		2015		2016		2017		2019			
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI		
Total	3.2	3.1–3.5	3.3	3.1–3.4	3.9	3.7–4.1	8.0	7.7–8.3	12.2	11.8–12.6	1.90	<0.001
Sex												
Boys	4.3	4.0–4.5	3.9	3.6–4.2	4.3	4.1–4.6	8.9	8.5–9.3	12.8	12.3–13.3	1.85	<0.001
Girls	2.2	2.0–2.4	2.6	2.4–2.8	3.5	3.2–3.7	7.0	6.7–7.4	11.6	11.0–12.2	1.95	<0.001
School grade												
Middle school	3.1	2.9–3.3	2.9	2.7–3.2	3.3	3.0–3.5	6.8	6.5–7.1	9.2	8.8–9.6	1.33	<0.001
High school	3.4	3.2–3.7	3.5	3.2–3.8	4.5	4.2–4.8	9.0	8.5–9.5	15.0	14.4–15.6	2.41	<0.001
Region of residence												
Metropolitan city	3.2	2.9–3.4	3.4	3.1–3.6	4.1	3.8–4.4	7.9	7.5–8.3	12.7	12.2–13.3	1.98	<0.001
Other cities	3.3	3.1–3.5	3.1	2.8–3.3	3.8	3.5–4.1	8.2	7.8–8.6	12.0	11.4–12.6	1.89	<0.001
County	3.9	3.3–4.5	3.9	3.2–4.7	3.5	2.7–4.2	7.5	6.3–8.6	10.6	9.2–12.0	1.40	<0.001
Subjective economic status												
High	5.8	5.1–6.6	5.0	4.4–5.6	6.2	5.4–6.9	10.4	9.6–11.2	14.3	13.3–15.2	1.93	<0.001
Middle	2.9	2.7–3.0	2.9	2.8–3.1	3.5	3.4–3.7	7.6	7.3–7.9	11.8	11.4–12.3	1.89	<0.001
Low	7.9	6.7–9.0	6.8	5.7–7.9	7.5	6.1–8.8	12.9	11.1–14.7	17.3	15.0–19.7	1.95	<0.001
Cohabitation												
With family	3.1	2.9–3.2	3.1	2.9–3.2	3.7	3.5–3.9	7.9	7.6–8.1	12.0	11.6–12.4	1.78	<0.001
Not with family	8.3	7.0–9.5	7.8	6.6–9.1	8.1	6.8–9.5	11.4	9.9–13.0	16.8	14.9–18.7	1.90	<0.001
Academic achievement												
High	2.9	2.7–3.2	3.1	2.8–3.3	3.9	3.6–4.2	7.8	7.3–8.2	12.1	11.6–12.7	1.95	<0.001
Middle	2.8	2.5–3.1	2.8	2.6–3.1	3.6	3.3–3.9	7.5	7.0–7.9	11.9	11.3–12.5	1.92	<0.001
Low	4.1	3.8–4.3	3.8	3.5–4.1	4.3	3.9–4.6	8.8	8.3–9.2	12.7	12.1–13.3	1.85	<0.001

KYRBS, Korea Youth Risk Behavior Survey.

**Table 3. Association between energy drink consumption and sociodemographic and individual resources, KYRBS 2014–2017 and 2019**

Variable	Total	Middle school students	High school students
Sex			
Boys	1.29 (1.24–1.34)	1.33 (1.26–1.41)	1.25 (1.18–1.32)
Girls	1.00	1.00	1.00
School grade			
Middle school	1.00	-	-
High school	1.38 (1.32–1.43)	-	-
Region of residence			
Metropolitan city	1.00	1.00	1.00
Other cities	0.96 (0.93–1.01)	1.00 (0.94–1.06)	0.95 (0.90–1.01)
County	0.90 (0.82–0.97)	1.04 (0.94–1.15)	0.82 (0.72–0.92)
Subjective economic status			
High	1.00	1.00	1.00
Middle	0.64 (0.61–0.67)	0.69 (0.64–0.74)	0.59 (0.55–0.64)
Low	1.13 (1.03–1.23)	1.42 (1.23–1.65)	0.98 (0.87–1.10)
Cohabitation			
With family	1.00	1.00	1.00
Not with family	1.70 (1.58–1.83)	2.93 (2.55–3.37)	1.45 (1.33–1.58)
Academic achievement			
High	1.00	1.00	1.00
Middle	0.99 (0.95–1.03)	1.06 (0.99–1.13)	0.92 (0.87–0.97)
Low	1.15 (1.11–1.20)	1.49 (1.40–1.58)	0.95 (0.90–1.00)

Values are presented adjusted OR (95% CI).

OR was adjusted for all variables included in the table and survey year.

KYRBS, Korea Youth Risk Behavior Survey; OR, odds ratio; CI, confidence interval.



**Table 4. Association between energy drink consumption and sociodemographic and individual resources, KYRBS 2014**

Variable	Total		Middle school students		High school students	
	%	Adjusted OR (95% CI)	%	Adjusted OR (95% CI)	%	Adjusted OR (95% CI)
<b>Sex</b>						
Boys	4.3	1.89 (1.70–2.09)	4.0	1.74 (1.50–2.01)	4.6	2.01 (1.73–2.34)
Girls	2.2	1.00	2.2	1.00	2.2	1.00
<b>School grade</b>						
Middle school	3.1	1.00	-	-	-	-
High school	3.4	1.03 (0.93–1.14)	-	-	-	-
<b>Region of residence</b>						
Metropolitan city	3.2	1.00	3.1	1.00	3.3	1.00
Other cities	3.3	1.01 (0.91–1.13)	3.1	1.00 (0.89–1.16)	3.5	1.02 (0.87–1.19)
County	3.9	1.12 (0.94–1.33)	3.7	1.10 (0.89–1.37)	4.1	1.16 (0.89–1.52)
<b>Subjective economic status</b>						
High	5.8	1.00	4.9	1.00	7.5	1.00
Middle	2.9	0.47 (0.41–0.55)	2.7	0.53 (0.44–0.65)	3.0	0.40 (0.32–0.50)
Low	7.9	1.08 (0.87–1.34)	10.3	1.37 (0.97–1.93)	6.8	0.86 (0.64–1.15)
<b>Cohabitation</b>						
With family	3.1	1.00	2.9	1.00	3.2	1.00
Not with family	8.3	2.56 (2.14–3.05)	15.2	4.19 (3.13–5.61)	6.6	2.00 (1.60–2.50)
<b>Academic achievement</b>						
High	2.9	1.00	2.5	1.00	3.4	1.00
Middle	2.8	1.08 (0.95–1.23)	2.5	1.09 (0.89–1.32)	3.1	1.05 (0.88–1.24)
Low	4.1	1.45 (1.31–1.62)	4.4	1.78 (1.52–2.09)	3.7	1.17 (1.04–1.36)

KYRBS, Korea Youth Risk Behavior Survey; OR, odds ratio; CI, confidence interval.  
OR was adjusted for all variables included in the table.

not living with family (OR, 2.56; 95% CI, 2.14–3.05), and low academic achievement (OR, 1.45; 95% CI, 1.31–1.62); however, it was not associated with the school grade, region of residence, and low subjective economic status (Table 4). In the total population in 2019, the ORs for energy drink consumption were significantly higher for the male sex (OR, 1.10; 95% CI, 1.02–1.18) and not living with family (OR, 1.27; 95% CI, 1.11–1.46), but the strength of the association was weakened compared to that in 2014 (Table 5). Conversely, the likelihood of energy drink consumption noticeably differed by the school grade and region of residence (OR, 1.74; 95% CI, 1.62–1.87 for high school students; OR, 0.78; 95% CI, 0.67–0.91 for county residence). Among middle school students, boys, those not living with their families, and those with low academic achievement consumed more energy drinks than their counterparts. Among high school students, city-dwelling adolescents, those with high economic status, those not living with their families, and those with high academic achievement consumed more energy drinks than their counterparts.

## Discussion

The present study found that the prevalence of energy drink consumption (3 or more times during the past 7 days) in Korean adolescents increased substantially, nearly

quadrupling from 3.2% in 2014 to 12.2% in 2019. This upward trend persisted regardless of sex, school grade, region of residence, subjective economic status, family cohabitation status, and academic achievement. The likelihood of energy drink consumption varied with sociodemographic and individual factors. In 2019, higher energy drink consumption among middle school students was associated with sex (boys), low economic status, not living with families, and low academic achievement; however, higher energy drink consumption among high school students was associated with city-dwelling, high economic status, not living with families, and high academic achievement.

Previous studies on energy drink consumption among adolescents have mainly been conducted in Australasia, North America, and Europe, where energy drink sales are markedly higher.<sup>16)</sup> Issues with energy drink consumption have been reported using several definitions, including lifetime,<sup>3,17,18)</sup> past 30-day,<sup>18,19)</sup> past 7-day consumption,<sup>11,13,20,21)</sup> and frequent use (>20 days during the past 30 days or 4–5 or more days per week).<sup>3)</sup> In Australia, approximately half of the adolescents reported having ever consumed energy drinks.<sup>17)</sup> The lifetime prevalence of energy drink consumption among adolescents in Germany, the United States, Italy, and Canada ranged from 61.7% to 73.8%.<sup>3,18,22,23)</sup>

In the United States, analysis of data from the Youth Risk Behavior Surveillance System<sup>20)</sup> revealed a high prevalence of energy drink consumption among adolescents, with

52.3% reporting energy drink consumption over the past 7 days. The prevalence of past 7-day energy drink consumption among Korean adolescents (estimated as 30.9% in KYRBS 2019, data not shown) is lower than that in American adolescents, but higher than that in Finnish adolescents.<sup>13)</sup>

The global popularity of energy drinks among adolescents and young adults has not stopped. The prevalence of energy drink consumption worldwide has been reported to consistently increase in previous studies, regardless of the survey method or definition.<sup>3,13,20,24)</sup> This continuous increase in energy drink consumption can be estimated from trends in the energy drinks sales market. The global energy drink market had grown approximately thrice between 2004 and 2013<sup>25)</sup> and energy drink sales increased more than 30% between 2014 and 2019.<sup>4)</sup> Sales are still remarkably high in North America, Australasia, and Western Europe, and Asia's energy drink market is relatively small.<sup>4,16,25)</sup> However, sales in Asian countries are projected to lead the global energy drink market because Asian countries have the fastest growth rates.<sup>16,25)</sup> South Korea's domestic energy drink market has been growing steadily at an average annual rate of 6% since 2015, followed by concerns over the trend of consumption growth.<sup>6)</sup>

The present study found that energy drink consumption among Korean adolescents was more prevalent among boys and high school students after adjusting for other sociodemographic and individual characteristics. Significant sex

differences in adolescent energy drink consumption were consistent with the results of previous studies.<sup>3,11,13,17-19,24,26)</sup> Energy drinks are usually advertised as having the potential to boost energy and improve physical performance.<sup>7,26)</sup> Compared with girls, boys are more influenced by energy drink advertisements that emphasize masculine and active images; consequently, it is estimated that boys consume more energy drinks than girls.<sup>27)</sup> The positive association between older age and energy drink consumption during adolescence is also consistent with the results of previous studies.<sup>13,17,18,24)</sup> This may be because older adolescents' consumption is due to self-directed choices away from the influence of parental monitoring, or older students, who have a greater academic burden than younger ones, intentionally consume more energy drinks to compensate for sleep deprivation and continue the study.<sup>23)</sup> Interesting findings regarding the association between energy drink consumption and academic achievement were observed. Previous studies on Finnish and German adolescents have indicated that energy drink consumption is associated with lower academic achievement and worse school performance.<sup>13,18)</sup> Similar results were found in the total population in the present study, including middle and high school students. However, recent data revealed different aspects of the association according to the school grade. For middle school students, those with low academic achievement had a higher OR for energy drink consumption; however, for high

**Table 5. Association between energy drink consumption and sociodemographic and individual resources, KYRBS 2019**

Variable	Total		Middle school students		High school students	
	%	Adjusted OR (95% CI)	%	Adjusted OR (95% CI)	%	Adjusted OR (95% CI)
<b>Sex</b>						
Boys	12.8	1.10 (1.02–1.18)	9.9	1.16 (1.05–1.28)	15.5	1.07 (0.96–1.18)
Girls	11.6	1.00	8.5	1.00	14.4	1.00
<b>School grade</b>						
Middle school	9.2	1.00	-	-	-	-
High school	15.0	1.74 (1.62–1.87)	-	-	-	-
<b>Region of residence</b>						
Metropolitan city	12.7	1.00	9.3	1.00	15.8	1.00
Other cities	12.0	0.94 (0.87–1.01)	9.1	0.98 (0.88–1.08)	14.7	0.93 (0.84–1.03)
County	10.6	0.78 (0.67–0.91)	9.1	0.95 (0.78–1.15)	11.8	0.70 (0.56–0.87)
<b>Subjective economic status</b>						
High	14.3	1.00	10.8	1.00	19.5	1.00
Middle	11.8	0.76 (0.70–0.83)	8.8	0.78 (0.69–0.88)	14.5	0.75 (0.66–0.84)
Low	17.3	1.06 (0.88–1.28)	17.7	1.47 (1.08–1.99)	17.1	0.92 (0.73–1.16)
<b>Cohabitation</b>						
With family	12.0	1.00	9.1	1.00	14.9	1.00
Not with family	16.8	1.27 (1.11–1.46)	17.6	1.90 (1.40–2.58)	16.6	1.17 (1.00–1.36)
<b>Academic achievement</b>						
High	12.1	1.00	8.4	1.00	16.8	1.00
Middle	11.9	0.96 (0.89–1.02)	8.7	1.08 (0.96–1.22)	14.4	0.87 (0.80–0.94)
Low	12.7	1.00 (0.93–1.08)	11.0	1.36 (1.22–1.53)	13.9	0.83 (0.76–0.90)

KYRBS, Korea Youth Risk Behavior Survey; OR, odds ratio; CI, confidence interval.  
OR was adjusted for all variables included in the table.

school students, those with higher academic achievement had a higher likelihood of energy drink consumption. This seems to be because, owing to the pressure to go to college, high school students with higher school achievement habitually consume energy drinks to reduce sleep and continue studying late. In contrast, among middle school students with less study pressure, those with low academic achievement consumed more energy drinks, which is probably due to curiosity about trying energy drinks and frequent exposure to energy drink advertisements.<sup>18)</sup> In the present study, the prevalence of energy drink consumption was slightly lower in the middle economic status group than in the high or low groups. The likelihood of energy drink consumption showed the same pattern after adjusting for sociodemographic and individual characteristics. These findings are slightly different from those of previous studies conducted in other countries, such as the United Kingdom and Belgium,<sup>11,24)</sup> which revealed that adolescents from lower-income households were more likely to consume energy drinks. In Korea, highly educated parents with high occupational status (and thus maybe parents with high income) have strong enthusiasm for their children's education and tend to be obsessed with getting their children into top universities. Therefore, adolescents from these households may feel a greater burden of good academic scores and academic advancement and thus may habitually consume energy drinks. Some studies have observed positive effects of energy drinks on cognitive function; however, the effect was only acute and not always, and there are considerable concerns about negative effects.<sup>21,28)</sup> Therefore, it is necessary to help adolescents and parents understand the nutritional characteristics and deleterious effects of energy drinks.

To the best of our knowledge, this is the first study to address the status and trends of and the factors associated with energy drink consumption among Korean adolescents. Our study has several strengths. The data used here were obtained from the KYRBS. Approximately 2% of all middle and high school students in Korea were selected as survey samples, and the response rate is remarkably high at >95%.<sup>14)</sup> Moreover, although the survey was conducted at school, an anonymous web-based questionnaire was used to protect privacy and reduce the effects of social desirability bias.<sup>14)</sup> Finally, beverage consumption varies depending on the season<sup>29)</sup> and students' high-caffeine drink consumption varies depending on the school exam period. Thus, it is important to check the timing of the survey, especially when studying the trends in students' energy drink consumption. Although there have been some changes in the timing of the KYRBS since the first survey began in 2005 (e.g., the 2020-2022 survey was conducted from August to October of the year due to COVID-19), all the surveys from 2014 and 2019 were conducted in June of the year, allowing for a consistent

comparison.<sup>14)</sup>

However, this study has some limitations. First, although the proportions of out-of-school adolescents among middle and high school-age adolescents are only estimated to be 0.8% and 1.7%, respectively,<sup>30)</sup> the KYRBS included only school-attending students. Thus, our findings may not be representative of all adolescents in Korea. Second, the survey collected information through self-reporting by the participants. Thus, there is a possibility of underreporting of energy drink consumption. Finally, in the KYRBS, only the frequency of energy drink consumption was surveyed, and there was no information on the understanding of energy drinks, reason for consumption, attitude toward consumption, and timing of initial consumption. Thus, no evidence could be found to help seek strategies to reduce adolescents' energy drink consumption.

In conclusion, energy drink consumption among Korean adolescents is common, has increased recently, and varies according to sociodemographic and individual factors. Further studies are required to continuously monitor energy drink consumption patterns among adolescents, understand attitudes toward and factors influencing energy drink consumption, and develop policy and educational strategies.

## Footnotes

Conflicts of interest: The authors have no conflicts of interest to declare for this study.

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