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# Difference in Sugar-Sweetened Beverage Consumption before and during the COVID-19 Pandemic among Korean Adolescents

Munsu Park [1], Dahyun Kim [2], Mingee Choi [3,**], Jaeyong Shin [4,5,*]

[1] *Department of Medicine, Yonsei University College of Medicine, Seodaemun-gu, Seoul, Republic of Korea;* [2] *Department of Statistics, Sungshin Women's University, Seongbuk-gu, Seoul, Republic of Korea;* [3] *Department of Healthcare Management, Graduate School of Public Health, Yonsei University, Seoul, Republic of Korea;* [4] *Institute of Health Policy and Management, Yonsei University College of Medicine, Seodaemun-gu, Seoul, Republic of Korea;* [5] *Department of Preventive Medicine, Yonsei University College of Medicine, Seodaemun-gu, Seoul, Republic of Korea*

A B S T R A C T

**Background:** Previous studies have identified various factors associated with sugar-sweetened beverage (SSB) consumption among children and adolescents. Recent studies attempted to analyze changes in SSB consumption of adolescents during the COVID-19 pandemic and showed conflicting results.

**Objectives:** This study aimed to estimate the difference in SSB consumption before (2018–2019) and during (2020–2021) the COVID-19 pandemic among Korean adolescents.

**Methods:** The study population consisted of students ($n$ = 227,139) aged 12–18 y from the Korean Youth Risk Behavior Web-based Survey (KYRBWS). Data collection was done between 2018 and 2021. The primary outcome was the difference in the SSB consumption status (none/<7 times/wk, ≥7 times/wk) before and during the COVID-19 pandemic. Multinomial logistic regression was used to examine the association. Additional analysises were also conducted by gender, school grades, household income, grade point average, region, household members, fast-food intake, and fruit intake.

**Results:** The COVID-19 pandemic was associated with a decrease in adolescents' SSB intake. [(<7 times/wk) 2019: 59.4, 2020: 58.8, (≥7 times/wk) 2019: 35.3, 2020: 33.4].

**Conclusions:** The study found a difference in SSB consumption among Korean adolescents between before and during the COVID-19 pandemic. These findings are noteworthy considering the importance of continuous care in managing SSB intake.

*Keywords*: COVID-19, sugar-sweetened beverages, adolescents, KYRBWS, health policy

## Introduction

Since COVID-19 outbreak emerged in December 2019, the WHO declared the outbreak a public health emergency of international concern on 30 January, 2020, and a pandemic on 11 March, 2020 [1,2]. During the COVID-19 pandemic, the government tried to prevent the spread by implementing various policies to prevent contact between people, resulting in families spending more time at home [3]. In South Korea, the government implemented social distancing policies at 4 levels: working from home, closing schools and starting online classes, limiting the number of people at private gatherings, and reducing business hours and restricting large-scale indoor activities [4].

COVID-19 and its associated preventive policies have changed our lifestyles. Adequate nutrition is considered 1 of the most important factors for a healthy life, particularly for children and adolescents. It is essential to maintain a balanced diet as this influences the growth and development of children and adolescents. Recent studies have reported how COVID-19 has influenced dietary trends among children and adolescents from different countries during the pandemic [5]. The impact of COVID-19 may differ according to socioeconomic and personal factors. In Germany, the consumption of most dietary components—including carbohydrates, fat, protein, free sugar, and fruit—did not significantly change during the pandemic [5]; however, adolescents in Italy, Spain, Chile, Colombia, and Brazil

*Abbreviations:* CVD, Cardiovascular disease; GPA, Grade point average; KCDC, Korea Centers for Disease Control and Prevention; KYRBWS, Korean Youth Risk Behavior Web-based Survey; SSB, Sugar-sweetened beverage; WHO, World Health Organization.

* Corresponding author.

** Corresponding author. *E-mail addresses:* min903@yonsei.ac.kr (M. Choi), drshin@yuhs.ac (J. Shin).

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consumed more fruits, vegetables, fried foods, and sweet foods [5].

Sugar-sweetened beverages (SSB)—such as soft drinks, sports drinks, and fruit juices—are significant sources of sugar among children and adolescents. SSB consumption is closely linked to the development of obesity and metabolic syndrome in Korean children and adolescents [6]. It is well known that childhood obesity has an adverse effect on youth health. Associated diseases include hypertension, dyslipidemia, insulin resistance, fatty liver, sleep apnea, and orthopedic disorders [7]. Several studies have predicted that the consumption of SSB would increase during the COVID-19 pandemic, as many people consume sweet food and drinks as a coping mechanism when stressed [8, 9]. However, Colombian adolescents consumed less SSB during the pandemic [5]. A survey in Italy also reported a decline in SSB consumption during the pandemic [10]. These results are contrary to those of other studies showing that adolescents consumed more sugar during the pandemic [5,11].

Previous studies have identified various factors associated with SSB consumption among children and adolescents [12–14]. For example, students who usually purchase SSB from their school canteen were 2.9 times more likely to be high consumers [12]. Another study reported that peer and parent interactions, fast-food intake could affect adolescent SSB intake [13]. In addition, a 10-fold higher frequency of daily SSB consumption was observed among those facing new financial hardship caused by the COVID-19 pandemic than among those not facing any financial hardship [14]. We hypothesized that simultaneous changes in multiple factors caused by the COVID-19 pandemic and social distancing policies may have led to this situation. Therefore, we compared SSB consumption before the COVID-19 outbreak with that during the outbreak to examine the association between the COVID-19 pandemic and SSB consumption among Korean children and adolescents. The purpose of this study was to investigate the difference between SSB consumption before and during the COVID-19 pandemic by the different demographic (sex, school grade, household income, grade point average, region, living arrangements, fast-food intake, and fruit intake) groups.

## Methods

### Survey methodology and participants

The KYRBWS comprises national cross-sectional data obtained annually among Korean adolescents; it consists of a general health status questionnaire on smoking, drinking, physical activity, diet, mental health, awareness of damage and safety, and oral health. All the data used in this study are publicly available on the KYRBWS website [15].

The sample was selected using stratified random cluster sampling of students from 400 middle schools and 400 high schools. Students with long-term absence, those with special needs who could not participate in the investigation on their own, and those with literacy disabilities were excluded. Online self-administered questionnaire surveys were completed during class hours. Each adolescent's parents provided written consent for participation. Participating students were each allocated an identification number by their homeroom teachers; these numbers were used to anonymously log into the study website and complete the online questionnaire. Institutional review board or ethics committee approval was not required for this study given the use of publicly available data that lacked personal identifiers. SSBs were defined as sweet drinks or soda.

The primary outcome was the change in SSB consumption status before and during the COVID-19 pandemic. The survey measured SSB intake as a record for the last 7 d. SSB consumption status was analyzed based on sex, school grade, household income, GPA, region, household members, fast-food intake, and fruit intake. Questions on fast food (none, 1–6 times per week, everyday), fruit (none, 1 time or more per week), and SSB intake (none, 1–6 times per week, $\geq$7 times per week) were answered based on the adolescents' memory, and those on household income and GPA were answered subjectively.

### Data collection

The study population consisted of students ($n$ = 227,139) aged 12–18 y from the Korean Youth Risk Behavior Web-based Survey (KYRBWS) conducted between 2018 and 2021: 117,343 adolescents were in the prepandemic group (2018–2019) and 109,706 were in the pandemic group (2020–2021). The average response rate was 94.7%.

### Statistical analyses

All variables used in the analysis were categorical and compared using chi-square test. Multinomial logistic regression analyses were conducted to examine the association and interaction between SSB consumption status and the COVID-19 pandemic, adjusting for sex (male or female), fast-food intake (none, 1–6 times/wk, or 7 times or more/wk), fruit intake (none or 1 time or more /wk), household income (low, middle, or high), GPA (low, middle, or high), region (rural, city area, or metropolitan), school grade (7th, 8th, 9th, 10th, 11th, or 12th), and whether they lived with their families. Data were analyzed by applying weights because the KYRBWS data included multilevel sampling, layering, and clustering. All analyses were conducted using the survey procedures provided in the SAS version 9.4 (Cary, NC, USA), accounting for the complex survey design used. The analytical guidelines for the KYRBWS data from the Korea Centers for Disease Control and Prevention (KCDC) estimated nationally representative values and extrapolated the findings to the entire Korean population. The variance estimation method for complex survey designs uses the Taylor series linearization method. As it is an online survey, there were no missing values.

## Results

### Demographic characteristics of study participants

Table 1 presents the participants' general characteristics. The proportion of male and female before and during pandemic were the same at 52.0% and 48.0%, respectively. The proportion of each school grade before and during pandemic were similar, and the distribution was also similar in the case of household income, GPA, region, housemate, and the frequency of fast food and fruit intake.

### SSB consumption before and during COVID-19

Table 2 shows the difference in SSB intake during the pandemic by demographic subgroups. Overall, the COVID-19

**TABLE 1**
Demographic characteristics of study participants

| Category | Total (*n*) | Before COVID-19 (2018–2019) | | During COVID-19 (2020–2021) | |
|---|---|---|---|---|---|
| | | *n* | Percent | *n* | Percent |
| Total | 227,139 | 117,343 | 51.26 | 109,796 | 48.74 |
| Sex | | | | | |
| Male | 117,058 | 60,304 | 52.02 | 56,754 | 51.76 |
| Female | 110,081 | 57,039 | 47.98 | 53,042 | 48.24 |
| School grade | | | | | |
| 7th | 39,606 | 19,585 | 15.21 | 20,021 | 17.41 |
| 8th | 39,556 | 19,757 | 15.52 | 19,799 | 17.00 |
| 9th | 39,427 | 20,271 | 16.41 | 19,156 | 15.87 |
| 10th | 35,901 | 18,533 | 16.51 | 17,368 | 16.24 |
| 11th | 36,637 | 19,083 | 17.13 | 17,554 | 16.81 |
| 12th | 36,012 | 20,114 | 19.23 | 15,898 | 16.67 |
| Household income[1] | | | | | |
| High | 89,619 | 46,712 | 40.28 | 42,907 | 40.01 |
| Middle | 108,739 | 55,265 | 46.87 | 53,474 | 48.24 |
| Low | 28,781 | 15,366 | 12.86 | 13,415 | 11.75 |
| GPA[1] | | | | | |
| High | 86,037 | 45,363 | 38.42 | 40,674 | 37.00 |
| Middle | 68,248 | 34,760 | 29.74 | 33,488 | 30.57 |
| Low | 72,854 | 37,220 | 31.84 | 35,634 | 32.43 |
| Region[2] | | | | | |
| Metropolitan | 115,121 | 60,202 | 50.88 | 54,919 | 50.17 |
| City area | 98,467 | 50,113 | 44.47 | 48,354 | 45.34 |
| Rural | 13,551 | 7,028 | 4.65 | 6,523 | 4.49 |
| Living arrangements | | | | | |
| Family members | 215,679 | 110,921 | 95.29 | 104,758 | 96.19 |
| Nonfamily members | 11,460 | 6,422 | 4.71 | 5,038 | 3.81 |
| Fast-food intake | | | | | |
| None | 41,549 | 22,193 | 18.52 | 19,356 | 17.38 |
| 1–6 times/wk | 181,632 | 93,160 | 79.73 | 88,472 | 80.86 |
| 7 times or more/wk | 3,958 | 1,990 | 1.75 | 1,968 | 1.76 |
| Fruit intake | | | | | |
| None | 25,805 | 12,131 | 10.27 | 13,674 | 12.28 |
| 1 time or more/wk | 201,334 | 105,212 | 89.73 | 96,122 | 87.72 |

[1] The options for household income and GPA are composed of upper, middle, and lower, so the respondents are subjectively required to choose.

[2] Metropolitan means a city with a population of >500,000 people; city area means a city with a population of >200,000 people, and rural means an area other than metropolitan and city area.

pandemic was associated with a decrease in the SSB intake in adolescents, and in all subgroups, it was also associated with a decrease in SSB intake.

## Difference in SSB consumption before and during COVID-19

The estimated OR (with 95% CI) of SSB intake according to the pandemic group is presented in Table 3. Multinomial logistic regression analysis revealed a relationship between SSB consumption and other factors (such as sex, school grade, household, and other factors related to SSB intake) ($P < 0.05$). The SSB intake in the pandemic group was significantly lower among females [(none compared with 1–6 times/wk) OR = 0.82; 95% CI: 0.78, 0.86, (none compared with 7 times or more/wk) OR = 0.47; 95% CI: 0.44, 0.49] than among males. Compared with students who did not consume fast food, students who consumed fast food had high OR of SSB consumption before and during COVID-19. Specifically, the group with the highest OR value was the group that consumed fast food 7 times or more per a week [before COVID-19 (7 times or more/wk) OR = 36.18; 95% CI: 26.15, 50.06 and during COVID-19 (7 times or more/wk) OR = 34.4; 95% CI: 25.39, 46.6].

## Overall trends in adolescent SSB consumption

Figure 1 presents the overall adolescents' SSB consumption trends by sex. Overall, the proportion of adolescents consuming SSB < 7 times/wk was 0.7% points lower than before the COVID-19 pandemic. And the proportion of adolescents consuming SSB ≥ 7 times/wk was 1.4% points lower than before the COVID-19 pandemic. The same pattern was found when classified by sex and SSB intake rate was higher for males than females.

## Discussion

During the 2 y of the COVID-19 pandemic, the number of Korean adolescents who consumed SSB more than once weekly significantly decreased compared with that before the pandemic. This result is consistent with most of those from studies conducted in other countries [5,10]. In addition, lower odds of SSB consumption were consistently found in most subgroups based on sex, school grade, household income, GPA, region, household members, fast-food intake, and fruit intake. School closure, a social distancing policy, may have led to decreased SSB consumption in various ways. Adolescents were unable to buy SSB from their school canteen or vending machines. Buying SSB from school canteens and vending machines is associated with increased SSB consumption; therefore, attending classes online might have reduced the SSB consumption [12]. Dining out among Korean adolescents may also have been reduced due to school closures, as this is also known to be associated with SSB consumption [16]. In addition, the strong association between soda availability at home and adolescents' SSB consumption would have been strengthened by school closures because adolescents spent more time at home during the COVID-19 pandemic [13]. As many adolescents consumed SSB outside their homes before the COVID-19 pandemic, both the purchase sources and consumption locations declined during the pandemic [17].

In a study in Shanghai, China, ~21.4% of teenagers were satisfied with their lives during school closures [18], and the proportion of Korean adolescents experiencing severe mental health–related stress was lower in the first year of the pandemic. During the COVID-19 pandemic, it can be possible that the intake of SSB decreased due to low stress levels of adolescents [11,19].

Peer SSB consumption is linked to an individual's SSB consumption [13]. Although the questionnaire used in this study did not include any items on the time spent meeting with friends nor the number of friends who gathered, such opportunities were likely less while adolescents attended online classes; adolescents may have consumed SSB less frequently because they did not see their friends consuming SSB during the COVID-19 pandemic.

This study had several strengths but also some limitations. The KYRBWS is based on a large, representative, nationwide population of Korean youth. The KCDC collected the data, and the validity and reliability of the KYRBWS have been documented in other studies [20,21]. Many variables such as sex,

**TABLE 2**
Sugar-sweetened beverage consumption before and during COVID-19

| Category | Before COVID-19 (2018–2019) | | | | | | | | | During COVID-19 (2020–2021) | | | | | | | | | *P* value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | None | | | 1–6 times/wk | | | 7 times or more/wk | | | None | | | 1–6 times/wk | | | 7 times or more/wk | | | |
| | Percent | Std Err | 95% CI | Percent | Std Err | 95% CI | Percent | Std Err | 95% CI | Percent | Std Err | 95% CI | Percent | Std Err | 95% CI | Percent | Std Err | 95% CI | |
| Total | 5.5 | 0.1 | 5.3–5.7 | 59.7 | 0.2 | 59.3–60.0 | 34.8 | 0.2 | 34.4–35.2 | 7.5 | 0.1 | 7.4–7.7 | 59.0 | 0.2 | 58.7–59.4 | 33.4 | 0.2 | 33.0–33.8 | <0.0001 |
| Sex | | | | | | | | | | | | | | | | | | | |
| Male | 4.49 | 0.09 | 4.32–4.67 | 54.8 | 0.2 | 54.3–55.3 | 40.7 | 0.2 | 40.2–41.2 | 6.23 | 0.11 | 6.03–6.44 | 54.1 | 0.2 | 53.6–54.5 | 39.7 | 0.2 | 39.2–40.2 | <0.0001 |
| Female | 6.59 | 0.12 | 6.36–6.83 | 65 | 0.2 | 64.5–65.4 | 28.4 | 0.2 | 28.0–28.9 | 8.95 | 0.14 | 8.69–9.22 | 64.3 | 0.2 | 63.9–64.8 | 26.7 | 0.2 | 26.3–27.2 | <0.0001 |
| School grade | | | | | | | | | | | | | | | | | | | |
| 7th | 6.81 | 0.21 | 6.40–7.21 | 63.9 | 0.4 | 63.2–64.7 | 29.3 | 0.4 | 28.5–30.0 | 9.85 | 0.23 | 9.39–10.30 | 62.9 | 0.4 | 62.1–63.7 | 27.3 | 0.4 | 26.5–28.1 | <0.0001 |
| 8th | 5.65 | 0.18 | 5.31–6.00 | 61.3 | 0.4 | 60.5–62.0 | 33.1 | 0.4 | 32.3–33.8 | 8.4 | 0.22 | 7.97–8.84 | 60.65 | 0.4 | 59.9–61.4 | 30.9 | 0.4 | 30.2–31.7 | <0.0001 |
| 9th | 5.9 | 0.19 | 5.52–6.28 | 58.5 | 0.4 | 57.7–59.3 | 35.6 | 0.4 | 34.8–36.4 | 7.9 | 0.22 | 7.48–8.32 | 58.8 | 0.4 | 58.0–59.6 | 33.3 | 0.4 | 32.5–34.1 | <0.0001 |
| 10th | 4.68 | 0.16 | 4.37–4.99 | 58.6 | 0.4 | 57.8–59.4 | 36.7 | 0.4 | 35.9–37.6 | 6.16 | 0.18 | 5.80–6.52 | 58.6 | 0.4 | 57.8–59.5 | 35.2 | 0.4 | 34.4–36.0 | <0.0001 |
| 11th | 4.86 | 0.16 | 4.55–5.18 | 58.4 | 0.4 | 57.6–59.2 | 36.7 | 0.4 | 35.9–37.5 | 6.62 | 0.19 | 6.26–6.99 | 57.1 | 0.4 | 56.3–58.0 | 36.2 | 0.4 | 35.4–37.1 | <0.0001 |
| 12th | 5.28 | 0.17 | 4.95–5.62 | 58 | 0.4 | 57.2–58.9 | 36.7 | 0.4 | 35.8–37.6 | 6.22 | 0.21 | 5.81–6.62 | 55.9 | 0.5 | 54.9–56.8 | 37.9 | 0.5 | 36.9–38.9 | 0.0006 |
| Household income | | | | | | | | | | | | | | | | | | | |
| Low | 5.18 | 0.17 | 4.84–5.53 | 57.8 | 0.4 | 56.9–58.6 | 37 | 0.4 | 36.2–37.9 | 7.24 | 0.23 | 6.78–7.70 | 56.8 | 0.5 | 55.9–57.7 | 35.9 | 0.5 | 35.1–36.8 | <0.0001 |
| Middle | 5.37 | 0.11 | 5.16–5.58 | 60.7 | 0.2 | 60.3–61.2 | 33.9 | 0.2 | 33.4–34.4 | 7.16 | 0.11 | 6.94–7.39 | 59.8 | 0.2 | 59.4–60.3 | 33 | 0.3 | 32.5–33.5 | <0.0001 |
| High | 5.75 | 0.12 | 5.52–5.98 | 59 | 0.3 | 58.5–59.6 | 35.2 | 0.3 | 34.7–35.7 | 8.1 | 0.15 | 7.81–8.38 | 58.7 | 0.3 | 58.2–59.2 | 33.2 | 0.3 | 32.7–33.8 | <0.0001 |
| GPA[1] | | | | | | | | | | | | | | | | | | | |
| Low | 4.81 | 0.12 | 4.58–5.04 | 56.6 | 0.3 | 56.0–57.1 | 38.6 | 0.3 | 38.0–39.2 | 6.62 | 0.14 | 6.35–6.88 | 55.8 | 0.3 | 55.2–56.3 | 37.6 | 0.3 | 37.1–38.2 | <0.0001 |
| Middle | 5.37 | 0.13 | 5.12–5.62 | 60.8 | 0.3 | 60.3–61.4 | 33.8 | 0.3 | 33.2–34.3 | 7.44 | 0.16 | 7.13–7.75 | 60 | 0.3 | 59.4–60.5 | 32.6 | 0.3 | 32.0–33.2 | <0.0001 |
| High | 6.18 | 0.13 | 5.92–6.44 | 61.3 | 0.3 | 60.8–61.8 | 32.5 | 0.3 | 32.0–33.0 | 8.45 | 0.15 | 8.16–8.73 | 61.1 | 0.3 | 60.6–61.6 | 30.4 | 0.3 | 29.9–31.0 | <0.0001 |
| Region | | | | | | | | | | | | | | | | | | | |
| Rural | 5.28 | 0.35 | 4.59–5.98 | 60.9 | 0.8 | 59.3–62.6 | 33.8 | 1 | 31.9–35.7 | 6.2 | 0.38 | 5.45–6.95 | 59.6 | 1 | 57.7–61.6 | 34.2 | 1 | 32.1–36.2 | 0.3157 |
| City area | 5.53 | 0.13 | 5.27–5.79 | 59.7 | 0.3 | 59.1–60.2 | 34.8 | 0.3 | 34.2–35.4 | 7.25 | 0.13 | 6.99–7.51 | 58.7 | 0.3 | 58.2–59.3 | 34 | 0.3 | 33.4–34.6 | <0.0001 |
| Metropolitan | 5.5 | 0.1 | 5.29–5.70 | 59.6 | 0.3 | 59.0–60.1 | 34.9 | 0.3 | 34.4–35.5 | 7.93 | 0.13 | 7.68–8.19 | 59.2 | 0.3 | 58.7–59.7 | 32.8 | 0.3 | 32.3–33.4 | <0.0001 |
| Living arrangements | | | | | | | | | | | | | | | | | | | |
| Nonfamily members | 5.23 | 0.3 | 4.65–5.82 | 57.7 | 0.8 | 56.1–59.4 | 37 | 0.9 | 35.3–38.7 | 5.76 | 0.34 | 5.09–6.43 | 56.9 | 0.9 | 55.1–58.7 | 37.4 | 0.9 | 35.5–39.2 | 0.5877 |
| Family members | 5.51 | 0.08 | 5.36–5.67 | 59.8 | 0.2 | 59.4–60.1 | 34.7 | 0.2 | 34.3–35.1 | 7.62 | 0.09 | 7.44–7.80 | 59.1 | 0.2 | 58.7–59.5 | 33.3 | 0.2 | 32.9–33.7 | <0.0001 |
| Fast-food intake | | | | | | | | | | | | | | | | | | | |
| 1–6 times/wk | 3.49 | 0.07 | 3.35–3.62 | 58.6 | 0.2 | 58.2–59.0 | 37.9 | 0.2 | 37.5–38.4 | 5.52 | 0.08 | 5.36–5.69 | 58.5 | 0.2 | 58.1–58.9 | 36 | 0.2 | 35.6–36.5 | <0.0001 |
| 7 times or more/wk | 1.88 | 0.3 | 1.29–2.47 | 14.9 | 0.8 | 13.3–16.4 | 83.2 | 0.8 | 81.6–84.9 | 2.28 | 0.34 | 1.62–2.95 | 17.4 | 0.9 | 15.7–19.1 | 80.3 | 0.9 | 78.5–82.1 | 0.089 |
| Fruit intake | | | | | | | | | | | | | | | | | | | |
| 1 time or more /wk | 5.14 | 0.08 | 4.97–5.30 | 59.9 | 0.2 | 59.5–60.3 | 34.9 | 0.2 | 34.5–35.4 | 7.09 | 0.09 | 6.91–7.27 | 59.4 | 0.2 | 59.0–59.8 | 33.5 | 0.2 | 33.1–34.0 | <0.0001 |

**TABLE 3**
Difference of sugar-sweetened beverage consumption before and during COVID-19

| Category | Before COVID-19 (2018–2019) | | During COVID-19 (2020–2021) | |
|---|---|---|---|---|
| | 1–6 times/wk | 7 times or more/wk | 1–6 times/wk | 7 times or more/wk |
| | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) |
| Sex | | | | |
| Male | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |
| Female | 0.79 (0.75, 0.83) | 0.47 (0.44, 0.50) | 0.82 (0.78, 0.86) | 0.47 (0.44, 0.49) |
| Fast-food intake | | | | |
| None | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |
| 1–6 times/wk | 3.51 (3.33, 3.70) | 9.09 (8.57, 9.63) | 2.77 (2.63, 2.91) | 6.67 (6.29, 7.08) |
| 7 times or more/wk | 1.71 (1.22, 2.40) | 36.18 (26.15, 50.06) | 2.01 (1.47, 2.74) | 34.4 (25.39, 46.60) |
| Fruit intake | | | | |
| None | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |
| 1 time or more/wk | 1.75 (1.63, 1.89) | 1.87 (1.73, 2.02) | 1.62 (1.53, 1.73) | 1.71 (1.59, 1.82) |
| Household income | | | | |
| Low | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |
| Middle | 0.96 (0.89, 1.04) | 0.88 (0.81, 0.96) | 1.05 (0.97, 1.14) | 0.99 (0.91, 1.08) |
| High | 0.90 (0.83, 0.98) | 0.90 (0.83, 0.99) | 0.95 (0.87, 1.03) | 0.95 (0.87, 1.04) |
| GPA | | | | |
| Low | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |
| Middle | 0.96 (0.9, 1.03) | 0.82 (0.76, 0.88) | 0.98 (0.92, 1.04) | 0.83 (0.77, 0.88) |
| High | 0.86 (0.8, 0.92) | 0.67 (0.63, 0.72) | 0.90 (0.85, 0.96) | 0.70 (0.66, 0.74) |
| Region | | | | |
| Rural | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |
| City area | 0.93 (0.81, 1.06) | 0.96 (0.81, 1.13) | 0.83 (0.73, 0.95) | 0.82 (0.71, 0.95) |
| Metropolitan | 0.93 (0.82, 1.07) | 0.97 (0.83, 1.15) | 0.77 (0.68, 0.88) | 0.73 (0.63, 0.84) |
| School grade | | | | |
| 7th | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |
| 8th | 1.12 (1.04, 1.22) | 1.28 (1.17, 1.4) | 1.09 (1.01, 1.18) | 1.22 (1.12, 1.33) |
| 9th | 1.02 (0.93, 1.11) | 1.28 (1.16, 1.41) | 1.11 (1.02, 1.20) | 1.37 (1.26, 1.50) |
| 10th | 1.27 (1.16, 1.40) | 1.65 (1.48, 1.83) | 1.41 (1.30, 1.53) | 1.82 (1.66, 1.99) |
| 11th | 1.19 (1.08, 1.31) | 1.53 (1.38, 1.7) | 1.27 (1.17, 1.37) | 1.72 (1.57, 1.88) |
| 12th | 1.08 (0.98, 1.18) | 1.39 (1.25, 1.53) | 1.32 (1.21, 1.44) | 1.93 (1.75, 2.13) |
| Living arrangements | | | | |
| Nonfamily members | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |
| Family members | 1 (0.88, 1.12) | 0.98 (0.86, 1.11) | 0.83 (0.73, 0.95) | 0.8 (0.7, 0.93) |

Abbreviations: GPA, grade point average; SSB, sugar-sweetened beverage.
[1]SSB consumption was adjusted for all the variables in the table.

school grade, household income, GPA, region, household members, fast-food intake, and fruit intake were analyzed to examine whether they impacted SSB consumption during the COVID-19 pandemic. This study gathered data from the 2020–2021 cohort. Because these data are not longitudinal data, there is a limitation that the same youth group was not investigated to monitor changes in SSB intake. Due to the limitation of the data, only the number of times per week was used for analysis for

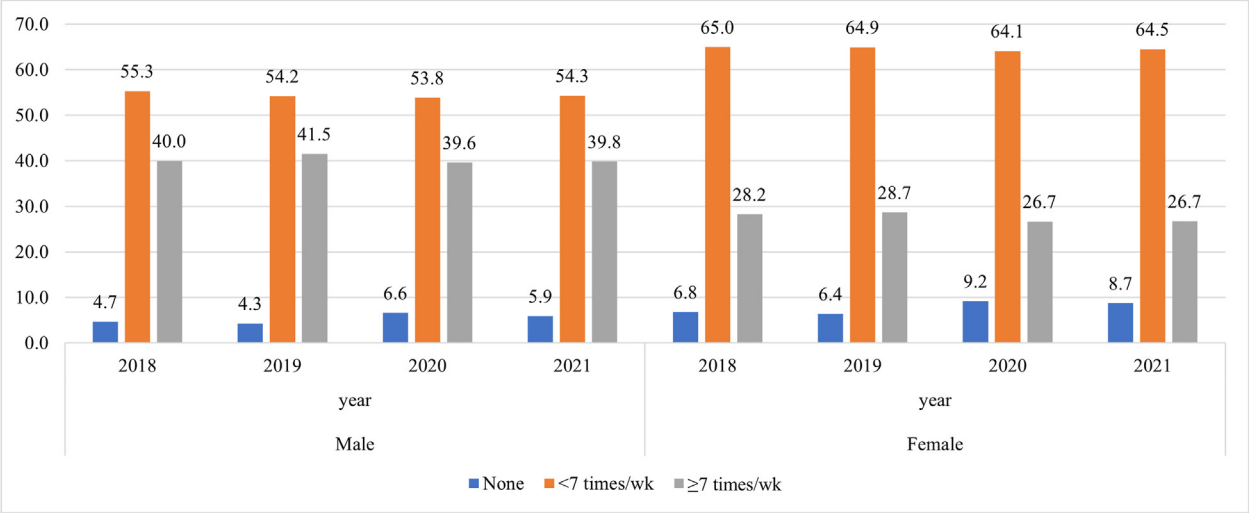


**FIGURE 1.** Overall trends of SBB consumption by sex. SSB, sugar-sweetened beverage.

various nutrition intake information. In future studies, in-depth analysis is required through a clearer comparison of the amount. Also, participants completed the survey based on their memory, which can lead to bias. Some of the question choices were also composed of vague. For example, the options for household income consist of upper, middle, and lower, which can change depending on the subjective status of the participant. Given that the survey participants changed annually, a longitudinal follow-up of each participant could not be conducted. Although peer interaction is associated with SSB consumption, the questionnaire did not include any items about the relationships with friends. Most of the participants have grown up in Korea throughout their lives; hence, cultural or social differences could be related to the reduced SSB consumption during the COVID-19 pandemic. Therefore, it cannot be generalized that the decrease in SSB consumption of adolescents during the COVID-19 occurred worldwide.

Worldwide, adolescents' SSB addiction is considered an important public health issue. Ingestion of SSB has been suggested in several studies as a risk factor for CVD [6,22,23] and has recently been found to pose a risk to the frailty of elderly women [24]. Therefore, to promote healthy eating habits that can be maintained throughout life, appropriate health-related policies are needed for children and adolescents. And further research is required to prevent the reduction in SSB consumption in adolescents from being only a temporary trend that occurred during the pandemic.

In conclusion, this study attempted to analyze the SSB intake of Korean adolescents' in-depth to provide the basis for desirable health policies, especially to examine changes in SSB consumption patterns according to the pandemic period. According to KYRBWS survey conducted by KCDC [15], the proportion of adolescents taking SSB during the COVID-19 was significantly lower than before the pandemic.

## Data availability

Data described in this manuscript are publicly and freely available without restriction on the KYRBWS website at https://www.kdca.go.kr/yhs/.

## Ethics approval and consent to participate

The KYRBWS was reviewed by the Korea Centers for Disease Control and Prevention's Institutional Bioethics Committee with government-approved statistics (Approval No. 11758) based on the National Health Promotion Act.

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