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Soft Drink Consumption and Suicide Attempts in Adolescents: The Korean Youth Risk Behavior Web-Based Survey

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Abstract

Evidence regarding mental health problems caused by related to excessive beverage intake is growing, but it is unclear which types of beverage increase mental health risks and at what level of consumption. We investigated the association between beverage intake and suicide attempts in a nationally representative sample of Korean adolescents. We used the cross-sectional data of the 11th Korean Youth Risk Behavior web-based Survey, which adopted an internet-based, self-reported questionnaire with anonymity. We estimated the odds ratios (ORs) and used 95% confidence intervals (95% CIs) with multiple logistic regression models. In total, 68,043 adolescents participated in this study, and 1,662 (2.4%) reported a suicide attempt in the last 12 months. Students who drink carbonated beverages more than 5–6 times per week had higher odds of attempting suicide (OR, 3.237; 95% CI, 2.272–4.613). Adolescents who drink energy drinks more than three times per day had approximately five times higher odds of attempting suicide (OR, 5.203; 95% CI, 3.194–8.474). Beverage intake of more than three times a day was positively associated with suicide attempt in Korean adolescents. In particular, energy drink consumption was in robust, positive association with suicide attempt.

Keywords: Adolescent; Carbonated beverage; Energy drinks; Suicide attempt

Introduction

Suicide is one of many public health challenges in developed countries, particularly among the youths, being the second leading cause of mortality in individuals aged 10–24 years according to the World Health Organization [1]. In the Republic of Korea, suicide was the largest cause of death among people in their twenties as well as the second largest among teenagers in 2014 [2]. Suicidal behaviors can be triggered by impulsivity and aggressiveness, which may play a more important role among younger individuals, even among those without depression [3,4].

For decades, the consumption of soda drinks has been of great public health interest, which may have been provoked by sugar's adverse effects such as obesity [5–7]. However, there is growing evidence of the potential mental health effects of the chemicals in such beverages. Aspartame, an artificial sweetener, may also be a neurotoxin that releases methanol and induces oxidative stress in the brain [8]. A case report has described that the excessive consumption of energy drinks (high-caffeine drinks) may cause impulsiveness and suicidal tendencies [9], although moderate caffeine consumption may be associated with lower suicide rates, as suggested in large epidemiological studies [10,11].

There have been a few studies on the effects of beverage intake on adolescents' mental health. A US study found that a higher consumption of carbonated soft drinks was associated with violence, depressed mood, and suicidal ideation and behaviors in high school students [12]. A Chinese study reported a positive association between higher soft drink consumption and suicidal behaviors [13]. In the Republic of Korea, soda drinks intake (drinkers vs. non-drinkers) was presented as an influencing factor of suicide attempts in adolescents [14]. Another Korean study reported a relationship between soda drinks intake frequency and suicide ideation [15].

Evidence regarding mental health problems due to excessive beverage intake is growing, but it is unclear what type of beverage increases mental health risks, and at what level of consumption. Furthermore, suicide attempts in adolescents are more likely to be impulsive, so their relationship with beverages that may cause aggressiveness and impulsiveness such as high-caffeine drinks [9] would need to be identified for suicide prevention.

Thus, we investigated the association between beverage intake and suicide attempts in a nationally representative sample of Korean adolescents. We divided the beverage into types such as soda, high-caffeine, and other sweetened drinks, and compared the strengths of their associations with suicide attempts.

Methods

Study participants

The Korean Youth Risk Behavior web-based Survey (KYRBS) has been performed annually in the Republic of Korea by the Ministry of Education, Korea Centers for Disease Control and Prevention, and the Ministry of Health since 2005 [16]. In this study, we used the data of the 11th survey, which was conducted in 2015. Using a proportional allocation method and stratified cluster sampling to seek a nationally representative sample, the 11th survey sampled 400 middle schools and 400 high schools with 70,362 adolescents, and it was conducted in 797 schools in June 2015 with a participation rate of 96.7% (N = 68043). The survey adopted an internet-based, self-reported questionnaire format with anonymity. The KYRBS was approved by the institutional review board of Korea Centers for Disease Control and Prevention (2014-06EXP-02-P-A).

Measures

Beverage intake habits were assessed using the question "How often have you consumed beverages over the last seven days?". Beverages were classified as soda, high-caffeine drinks (i.e., energy drinks), and other sweetened drinks (e.g., sports drinks, fruit drinks, tea, and coffee drinks). The intake frequency was categorized as none, 1–2 times per week, 3–4 times per week, 5–6 times per week, once per day, twice per day, and three times or more per day.

The dependent variable was suicide attempts over the last 12 months, which was assessed by the question "Have you ever attempted suicide over the last 12 months?". In addition to demographic variables such as grade and sex, we considered the confounders that were reported such as reasons for perceived stress by our study subjects including academic performance, subjective health status, subjective body image, household economic status, and frequency of being a victim of violence. Depressed mood was assessed with the question "Have you felt such severe sadness or hopelessness lasting two weeks or longer that you had difficulty in your daily activities over the last 12 months?". Perceived stress level was also evaluated by the question "How much do you usually feel stress?". Household economic status,

academic performance, subjective health status, and perceived stress level were classified into five ratings. Subjective body image was categorized as very thin, thin, moderate, heavy, or very heavy. The frequency of being a victim of violence was assessed with the question "How often have you received treatment in medical institutions for violence inflicted by friends, seniors, or adults over the last 12 months?" with categories of 0, 1, 2, 3, 4, 5, and ≥ 6 times. Other risk behaviors such as drinking and smoking were regarded in this study with the dichotomous variable of lifetime experience status.

Statistical analysis

All analyses were performed with SAS version 9.3 (SAS institute, Cary, NC). Chi-squared tests were used to compare characteristics between suicide attempters and non-attempters for categorical variables, with weighted percentages estimated using "PROC SURVEYFREQ." We calculated the odds ratios (ORs) and 95% confidence intervals (95% CIs) with multiple logistic regression models ("PROC SURVEYLOGISTIC"), adjusting for age, sex, alcohol consumption lifetime experience, smoking lifetime experience, academic performance, subjective health status, subjective body image, depressed mood, perceived stress level, frequency of experiencing violence and treatment, and household economic status. All statistical tests were two-tailed, and statistical significance was set at $P < 0.05$.

Results

In total, 68,043 adolescents participated in this study, and 1,662 (2.4%) reported a suicide attempt during the last 12 months (Table 1). The numbers of those with drinking and smoking lifetime experiences were 27,201 (40.8%) and 11,628 (17.4%) in the total population, and 903 (55.0%) and 548 (33.5%) in those who had attempted suicide. The proportion of those who had experienced violence and were treated more than six times during the last 12 months was 0.3% in the total population, but 4.5% in those who had attempted suicide. Adolescents who had higher stress levels, lower academic performance, lower household economic status, and heavier subjective body image were more likely to have attempted suicide during the last 12 months.

Table 1: General characteristics of study population.

| Grade (age, years), N(%) | Total (N = 68,043) | Suicide attempt (N = 1,662) | p* |
|------------------------------|--------------------|-----------------------------|---------|
| 1st grade middle school (13) | 10,786 (13.72) | 333 (17.80) | < 0.001 |
| 2nd grade middle school (14) | 11,442 (15.61) | 323 (18.36) | |
| 3rd grade middle school (15) | 12,071 (17.66) | 301 (18.31) | |
| 1st grade high school (16) | 11,122 (17.39) | 240 (15.94) | |
| 2nd grade high school (17) | 11,113 (17.55) | 222 (14.02) | |
| 3rd grade high school (18) | 11,509 (18.07) | 243(15.58) | |

| | | | |
|---|----------------|---------------|---------|
| Females, N(%) | 32,839 (47.86) | 983 (58.10) | < 0.001 |
| Alcohol consumption lifetime experience, N(%) | 27,201 (40.8) | 903 (54.95) | < 0.001 |
| Smoking lifetime experience, N(%) | 11,628 (17.41) | 548 (33.50) | < 0.001 |
| Frequency of being a victim of violation during the last 12 months, N(%) | | | |
| 0 | 66,486 (97.70) | 1,379 (82.34) | < 0.001 |
| 1 | 620 (0.89) | 60 (3.55) | |
| 2 | 317 (0.46) | 62 (3.88) | |
| 3 | 274 (0.43) | 57 (3.65) | |
| 4 | 103 (0.16) | 26 (1.42) | |
| 5 | 44 (0.06) | 10 (0.68) | |
| ≥ 6 | 199 (0.30) | 68 (4.47) | |
| Subjective health status, N(%) | | | |
| Very healthy | 18,065 (26.32) | 338 (19.69) | < 0.001 |
| Healthy | 31,492 (46.35) | 585 (35.28) | |
| Moderate | 14,598 (21.56) | 470 (27.64) | |
| Unhealthy | 3,648 (5.38) | 215 (13.42) | |
| Very unhealthy | 240 (0.39) | 54 (3.97) | |
| Depressed mood, N(%) | 15,894 (23.56) | 1,284 (77.90) | < 0.001 |
| Perceived stress level, N(%) | | | |
| Very high | 5,933 (8.79) | 616 (37.91) | < 0.001 |
| High | 18,025 (26.59) | 591 (34.56) | |
| Moderate | 29,849 (44.05) | 319 (19.04) | |
| Low | 11,678 (16.90) | 74 (4.54) | |
| Very low | 2,558 (3.68) | 62 (3.94) | |
| Academic performance, N(%) | | | |
| Very high | 8,615 (12.60) | 220 (13.05) | < 0.001 |
| High | 17,075 (25.06) | 289 (18.00) | |
| Moderate | 18,952 (27.92) | 381 (22.50) | |
| Low | 15,994 (23.60) | 389 (22.41) | |
| Very low | 7,407 (10.81) | 383 (24.03) | |
| Household economic status, N(%) | | | |
| Very high | 6,214 (9.14) | 189 (11.34) | < 0.001 |
| High | 18,316 (27.24) | 370 (23.15) | |
| Moderate | 31,962 (46.75) | 606 (35.45) | |
| Low | 9,330 (13.66) | 305 (18.35) | |
| Very low | 2,22 (3.21) | 192 (11.71) | |
| Subjective body images, N(%) | | | |
| Very thin | 2,981 (4.43) | 103 (6.01) | < 0.001 |
| Thin | 15,046 (22.24) | 332 (20.48) | |

| | | | |
|--|----------------|-------------|--|
| Moderate | 23,727 (34.83) | 490 (28.46) | |
| Heavy | 22,285 (32.76) | 548 (33.30) | |
| Very heavy | 4,004 (5.74) | 189 (11.75) | |
| All percentages were weighted | | | |
| *Significance of differences between those who have attempted suicide over the last 12 months and those who have not | | | |

In terms of beverage intake (Table 2), the respective percentages of those in the total population who had not drunk soda, energy drinks, or other sweetened drinks during the last seven days were 23.6%, 88.1%, and 15.0%. The proportions of students who drank three types of beverage

three times per day or more were 6.3% for soda, 3.8% for energy drinks, and 6.1% for the other sweetened drinks in suicide attempters, and 1.0%, 0.3%, and 1.2% in the total population.

Table 2: Beverage intake frequency of study population.

| | Total (N = 68,043) | Suicide attempt (N = 1,662) | p* |
|--|--------------------|-----------------------------|---------|
| Soda drinks, N (%) | | | |
| None | 16102 (23.56) | 358 (21.37) | < 0.001 |
| 1–2 times a week | 32790 (48.10) | 651 (38.54) | |
| 3–4 times a week | 13041 (19.32) | 337 (19.85) | |
| 5–6 times a week | 3118 (4.68) | 114 (7.51) | |
| Once a day | 1604 (2.35) | 65 (4.23) | |
| Twice a day | 679 (0.96) | 39 (2.20) | |
| Three times or more a day | 709 (1.03) | 98 (6.30) | |
| Energy drinks, N (%) | | | |
| None | 59836 (88.12) | 1223 (73.01) | < 0.001 |
| 1–2 times a week | 6015 (8.63) | 215 (12.78) | |
| 3–4 times a week | 1247 (1.85) | 87 (5.42) | |
| 5–6 times a week | 420 (0.63) | 46 (2.92) | |
| Once a day | 259 (0.38) | 25 (1.48) | |
| Twice a day | 98 (0.14) | 10 (0.63) | |
| Three times or more a day | 168 (0.26) | 56 (3.77) | |
| Other sweetened drinks, N (%) | | | |
| None | 10270 (15.00) | 242 (14.53) | < 0.001 |
| 1–2 times a week | 29457 (43.13) | 572 (32.93) | |
| 3–4 times a week | 17940 (26.53) | 431 (26.92) | |
| 5–6 times a week | 5495 (8.15) | 188 (11.20) | |
| Once a day | 2978 (4.38) | 96 (5.80) | |
| Twice a day | 1087 (1.63) | 40 (2.51) | |
| Three times or more a day | 816 (1.18) | 93 (6.12) | |
| All percentages were weighted | | | |
| *Significance of differences between those who had attempted suicide during the last 12 months and those who had not | | | |

In the multivariate results (Table 3), students who drank soda drinks more than 5–6 times per week had higher odds of having attempted suicide (OR, 3.237; 95% CI, 2.272–4.613). In

terms of energy drinks, those who drank them even 1–2 times a week showed higher odds of suicide attempt (OR, 1.292; 95% CI, 1.081–1.546). Adolescents who had energy drinks

three times per day or more had approximately five times higher odds of having attempted suicide (OR, 5.203; 95% CI, 3.194–8.474). Meanwhile, having other sweetened drinks was

not significantly associated with attempting suicide, with the exception of when such drinks were consumed three times per day or more (OR, 2.583; 95% CI, 1.825–3.656).

Table 3: Odds ratios* of suicide attempt in relation to beverage intake frequency in adolescents.

| | Soda drinks | Energy drinks | Other sweetened drinks |
|---|---------------------|---------------------|------------------------|
| | OR (95% CI) | OR (95% CI) | OR (95% CI) |
| Frequency during the last seven days | | | |
| None | Referent | Referent | Referent |
| 1–2 times per week | 0.859 (0.741–0.996) | 1.292 (1.081–1.546) | 0.788 (0.661–0.938) |
| 3–4 times per week | 0.933 (0.789–1.104) | 1.901 (1.434–2.520) | 0.961 (0.797–1.158) |
| 5–6 times per week | 1.157 (0.901–1.486) | 2.41 (1.590–3.651) | 1.088 (0.872–1.357) |
| Once per day | 1.378 (0.998–1.902) | 2.159 (1.285–3.626) | 0.912 (0.687–1.210) |
| Twice per day | 1.4 (0.911–2.153) | 2.684 (1.208–5.964) | 0.938 (0.620–1.419) |
| Three times or more per day | 3.237 (2.272–4.613) | 5.203 (3.194–8.474) | 2.583 (1.825–3.656) |
| OR: Odds ratio, 95% CI: 95% confidence interval | | | |
| *From multiple logistic regression analyses adjusting for age, sex, alcohol consumption lifetime experience, smoking lifetime experience, academic performance, subjective health status, subjective body image, depressed mood, perceived stress level, frequency of being a victim of violence, and household economic status | | | |

Discussion

In the nationally representative sample of Korean adolescents, we found that higher beverage intake was positively associated with suicide attempts. In particular, energy drinks showed the strongest association, with an approximately five-times higher likelihood when consumed three times per day or more compared to non-drinkers.

Considering the possibility that energy drink consumption increases impulsivity and aggressiveness [9], it is plausible that high-caffeine drinks may increase the risk of attempting suicide. Additionally, the link between energy drinks and suicide attempts might be partly due to conduct problems. Excessive energy drink consumption may be related to risky behaviors such as violence, substance abuse, and alcohol dependence, probably via difficulty with impulse control [17]. Meanwhile, we observed significant associations between intake frequency and suicide attempt for soda drinks and other sweetened drinks only when consumed three times per day or more. Excessive soft drink consumption is associated with hyperactivity and conduct problems [18], which might trigger suicidal behaviors. Moreover, adolescents with depression who are at higher risk for attempting suicide may be more susceptible to sugar addiction [19]. Nonetheless, it is unclear whether excessive sugar consumption affects adolescents' mental health or binge drinking of beverages is associated with suicidal behaviors. An alternative explanation is that aspartame may induce brain oxidative stress [8] in a manner related to suicidal behaviors, although we could not differentiate between aspartame and sucrose in carbonated beverages.

Previous studies have investigated associations between soft drinks and adolescents' suicidal behaviors. A Chinese

study revealed that students who consumed soft drinks three times per day or more showed 3.5 times greater odds of suicide attempt compared to those consuming less than one per day [13], which was consistent with our results for soda drinks. In terms of high-caffeine drinks, we observed a strong dose-response relationship with suicide attempts. In the Chinese study, soft drinks were only exemplified by carbonated beverages such as Cola and Sprite, so energy drinks might have not have been regarded in the investigation, even though soft drinks included both soda and energy drinks. A Korean study found that a carbonated beverage intake of once or more per week was an influencing factor for suicide attempts in adolescents compared to non-drinkers [14]. This study dealt with only soda drinks and did not consider energy drinks, and did not focus on the dose-response relationship, as intake was treated as a dichotomous variable: drinkers or non-drinkers. Another Korean study reported the association between carbonated beverage intake frequency and adolescents' suicide ideation with ORs of 1.3–1.7 [15]. In this study, all categories of intake frequency had statistical significance, but the ORs did not increase in a dose-response manner. In our study, only those who drank soda drinks three times per day or more had a significant association, but the strength was higher than in the previous study by Yim [15]. Meanwhile, it is noteworthy that we observed lower likelihoods of attempting suicide in those drinking soda drinks four times or fewer a week compared to non-drinkers, which was also observed for other sweetened drinks. The Chinese study also revealed that non-drinkers were 1.3 times more likely to attempt suicide compared to those drinking such drinks less than once per day [13]. A recent experiment showed that sucrose beverage consumption lowered the salivary cortisol release induced by stress [20], which means that sugar beverages may function as a stress reliver. Thus, sugar's stress-relieving effects might be

related to the lower likelihoods of suicide attempt in those with moderate carbonated beverage intake that were observed in our study. However, the experiment's intervention was sugar beverage consumption of three times per day for two weeks, which was considered an acute high dose, while our study focused on the long-term effects of beverage intake. In addition, the experiment suggested that aspartame had no stress-relieving effect, but our study did not specify the carbonated beverages' content such as sucrose and aspartame, which makes it difficult to apply the experiment's results to the interpretation of our study.

The present study used a nationally representative sample of Korean adolescents, and found that energy drink consumption was in a robust, positive association with suicide attempt. We considered age- and culture-specific confounders related to psychological stress that may lead to suicidal behaviors, such as being victim of school violence and subjective body image. However, our study was cross-sectional, so there is the possibility of reverse causation. In particular, beverage intake frequency and suicide attempt were assessed with different recall periods of during the last week and during the last year, respectively. However, this may not distort the present results, because the survey was completed in all schools in the same month.

In conclusion, an intake of carbonated beverages or other sweetened beverages of three times or more per day was positively associated with suicide attempts in adolescents. Energy drink consumption strongly increased the likelihood of adolescents attempting suicide, which may be due to increased impulsivity and aggression. Our findings highlight the negative mental health effects of energy drink consumption, even in moderate amounts, among adolescents. Because of increasing energy drink consumption among adolescents, the relationship with suicide attempts observed in the present study may be of public health interest and need to be considered in suicide prevention strategies.

Competing interests

There are no conflicts of interest to declare.

References

1. http://www.who.int/mediacentre/multimedia/podcasts/2009/suicide_prevention_20090915/en/
2. http://kostat.go.kr/portal/korea/kor_nw/2/6/2/index.board
3. Brent DA, Kolko DJ, Wartella ME, Boylan MB, Moritz G, et al. (1993) Adolescent psychiatric inpatients' risk of suicide attempt at 6-month follow-up. *J Am Acad Child Adolesc Psychiatry* 32: 95-105.
4. Apter A, Gothelf D, Orbach I, Weizman R, Ratzoni G, et al. (1995) Correlation of suicidal and violent behavior in different diagnostic categories in hospitalized adolescent patients. *J Am Acad Child Adolesc Psychiatry* 34: 912-918.
5. Malik VS, Schulze MB, Hu FB (2006) Intake of sugar-sweetened beverages and weight gain: a systematic review. *Am J Clin Nutr* 84: 274-288.
6. Ludwig DS, Peterson KE, Gortmaker SL (2001) Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet* 357: 505-508.
7. Vartanian LR, Schwartz MB, Brownell KD (2007) Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *Am J Public Health* 97: 667-675.
8. Iyyaswamy A, Rathinasamy S (2012) Effect of chronic exposure to aspartame on oxidative stress in the brain of albino rats. *J Biosci* 37: 679-688.
9. Szpak A, Allen D (2012) A case of acute suicidality following excessive caffeine intake. *J Psychopharmacol* 26: 1502-1510.
10. Kawachi I, Willett WC, Colditz GA, Stampfer MJ, Speizer FE, et al. (1996) A prospective study of coffee drinking and suicide in women. *Arch Intern Med* 156: 521-525.
11. Tanskanen A, Tuomilehto J, Viinamaki H, Vartiainen E, Lehtonen J, et al. (2000) Heavy coffee drinking and the risk of suicide. *Eur J Epidemiol* 16: 789-791.
12. Solnick SJ, Hemenway D. (2014) Soft drinks, aggression and suicidal behaviour in US high school students. *Int J Inj Contr Saf Promot* 21: 266-273.
13. Pan X, Zhang C, Shi Z (2011) Soft drink and sweet food consumption and suicidal behaviours among Chinese adolescents. *Acta Paediatr* 100: e215-222.
14. Park E (2008) The influencing factors on suicide attempt among adolescents in South Korea. *Taehan Kanho Hakhoe Chi* 38: 465-473.
15. Yim S (2015) Relationships between dietary behaviors and suicidal ideation among Korean adolescents. *Indian Journal of Science and Technology* 8: 1-5.
16. Korea Centers for Disease Control and Prevention. The Eleventh Korea Youth Risk Behavior Web-based Survey, 2015, Ministry of Education, Ministry of Health and Welfare, Korea Centers for Disease Control and Prevention.
17. Miller KE (2008) Energy drinks, race, and problem behaviors among college students. *J Adolesc Health* 43: 490-497.
18. Lien L, Lien N, Heyerdahl S, Thoresen M, Bjertness E, et al. (2006) Consumption of soft drinks and hyperactivity, mental distress, and conduct problems among adolescents in Oslo, Norway. *Am J Public Health* 96: 1815-1820.
19. Willner P, Benton D, Brown E, Cheeta S, Davies G, et al. (1998) "Depression" increases "craving" for sweet rewards in animal and human models of depression and craving. *Psychopharmacology (Berl)* 136: 272-283.
20. Tryon MS, Stanhope KL, Epel ES, Mason AE, Brown R, et al. (2015) Excessive sugar consumption may be a difficult habit to break: a view from the brain and body. *J Clin Endocrinol Metab* 100: 2239-2247.