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Original Research

Relationship between unhealthy weight control behaviors and substance use patterns among Korean adolescents: results from the 2017 national youth risk behavior survey

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ABSTRACT

Objective: Unhealthy weight control behaviors (UWCBs) can lead to numerous health problems. Adolescents who engage in UWCB are more likely to abuse substances than other adolescents. However, few studies have examined the relationship between UWCB and substance use, despite the fact that their co-occurrence can result in greater morbidity and mortality. The aim of this study was to examine the association between UWCB and substance use patterns among Korean adolescents using nationally representative data.

Study design: This study involved an analysis of statistical data collected from 27,284 adolescent participants (13–18 years old) in the 2017 Korean Youth Risk Behavior Web-based Survey.

Methods: The Chi-squared test and multiple logistic regression analysis were performed to demonstrate the association between substance use patterns (energy drink intake, alcohol use, cigarette smoking, electronic cigarette use, and drug use) and UWCB (one-food diets, fasting, diet pill use, and purging). All statistical analyses were performed to reflect complex sampling weights.

Results: More female than male adolescents reported to be engaged in any of the following UWCBs: one-food diets (female: 9.6%, male: 4.8%), fasting (female: 11.6%, male: 7.4%), diet pill use (female: 2.9%, male: 1.5%), and purging (female: 4.1%, male: 2.2%). The prevalence of all UWCBs tended to increase as energy drink intake ($P < 0.001$), cigarette smoking ($P < 0.001$), and electronic cigarette use ($P < 0.001$) increased.

Conclusions: Health professionals who work with adolescents need to be aware of the importance of screening for UWCB, including one-food diets, fasting, diet pill use, and purging, especially as a co-occurrence with substance use.

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Introduction

Adolescence is a crucial period during which health risk behaviors, including unhealthy eating behaviors and substance use, can begin and persist until adulthood.[1,2] Adolescence is also a developmental period during which significant bodily and identity changes occur; thus, adolescents may begin to pay more attention to their appearance and may try to control their body shape to match the aspects of attractiveness conveyed by the media. As Asian countries become industrialized and westernized, social and cultural tendencies that emphasize appearance and view a slender body as a beauty standard have emerged,[3] as demonstrated in weekly magazines, women's magazines, and newspapers. Social media use and magazines have been associated with adolescents' self-sexualization, which influences body image and appearance-related behaviors; thus, early adolescents may believe that an ideal and attractive appearance will be rewarded.[4]

As the prevalence of thin and lean body types has overwhelmingly increased in many societies, a desire for thin body has become pervasive among Korean adolescents.[3] One study revealed that many adolescents have distorted body images and high levels of body dissatisfaction, observing that 26.2% of adolescents perceived themselves as obese when only 13.9% of adolescents were actually obese.[5] Many normal and underweight adolescents perceive themselves as overweight or obese, engage in unnecessary weight loss practices and use inappropriate methods to reduce their weight.[6] The prevalence of unhealthy weight loss behaviors among Korean adolescents increased from 16.1% in 2015 to 19.4% in 2017.[5]

Unhealthy weight control behaviors (UWCBs), including extreme food restriction, self-induced vomiting, use of laxatives or diuretics, or diet pill consumption for weight control purposes,[7] can lead to numerous health problems.[8] UWCB can progress to eating disorders, including anorexia and bulimia.[9,10] Adolescents who engage in UWCB are more likely to be obese,[11] perceive themselves as overweight,[12] suffer from depressive symptoms,[11,12] and be suicidal.[13,14]

Several possible explanations for disordered eating behaviors among adolescents have been previously described. Problem behavior theory is a social-psychological framework that focuses on explaining adolescents' adoption of high-risk behaviors, lifestyles, and resulting heath-compromising outcomes.[15] Problem eating behaviors might be a part of a syndrome of problem behaviors among adolescents.[16] According to the problem behavior theory, the adoption of problem behaviors can arise from general skepticism about social values, a rejection of its norms, and a readiness for non-conformity.[16] Psychosocial proneness to problem behavior comprised three correlated systems: the personality system (having lower values or lower expectations for academic recognition), the perceived environmental system (highly influenced by friends or their approval for problem behavior), and the behavior system (becoming involved in delinquent behavior).[16] This psychosocial proneness to problem behavior can take the form of a differential readiness to adopt developmental change by initiating new transition behaviors, which can be risk behaviors.[16] Researchers have also focused on how childhood adverse experiences, such as violence and bullying, can affect developmental progress and lead to health-harming behaviors.[17,18] In addition, recent research by Froreich et al.[19] demonstrated that deficiency of psychological need satisfaction, which is defined as the satisfaction of needs for autonomy, competence, and relatedness, was associated with disordered eating.

UWCBs are associated with substance use. According to studies on the relationship between UWCB and substance use, adolescents who control their weight inappropriately are more likely to abuse substances.[8,12,20] Substance use is related to weight loss tactics including diet pill use, vomiting, or laxative consumption and can occur as early as middle school years.[21] Binge-purge frequency is also associated with more frequent use of alcohol, cannabis, tobacco, and other substances.[22] Furthermore, a high amount of caffeine ingestion is also associated with purging behaviors, as caffeine is used as an appetite suppressant or meal replacement.[23,24] Compared with non-users, more substance users reportedly believed that substances helped them lose weight.[21] According to a qualitative study, adolescents who had purge behavior typically used substances to relieve anger, avoid eating, relax, or escape their problems.[24]

A previous study published in 1986 by Lacey and Evans[25] found that there were women with significant eating disorders such as bulimic behaviors, in a clinical population; in recent years, these impulsive behaviors have become more deeply entrenched in the general population, with an especially high prevalence in Korean women.[26] UWCBs are prevalent across nearly all adolescent social groups, including gender, socio-economic status, and race/ethnicity.[27] UWCBs are also prevalent among Korean adolescents, regardless of age, sex, and socio-economic status.[28] UWCBs occurring during early-to-late adolescence stage tend to persist through young adulthood.[11] However, only a few studies have examined the relationship between UWCB and substance use, despite evidence of their co-occurrence causing greater morbidity and mortality.[29] Even a single behavior can be noteworthy because adolescents with these behaviors may be experiencing the early stages of a disorder.[8] Therefore, this study aimed to examine the association between UWCB and caffeinated energy drink intake, alcohol use, cigarette smoking, electronic cigarette use, and lifetime drug use among Korean adolescents using nationally representative data.

Methods

Study population

The Korea Youth Risk Behavior Web-based Survey (KYRBWS) is a nationally representative survey conducted with middle- and high-school students (13- to 18-years-old) to understand the health behaviors of South Korean adolescents, including smoking, alcohol use, obesity, diet, and physical activities. The KYRBWS is an anonymous self-administered online survey that has been conducted annually since 2005 by the Korea Center for Disease Control and Prevention (KCDC). The 13th KYRBWS, which was conducted in 2017, included 123 questionnaire items in 15 sections including smoking, drinking,

and physical activity and calculated 107 health indicators. Surveys and indicators were developed through domestic and international data and field expert advisory committees. The target population for the survey was defined as national middle- and high-school students as of April 2017.

Teachers were given unique sets of identification numbers represented on tags. The self-administered online questionnaire was conducted by positioning at random and allocating one student to one computer in the computer room at a school who used a unique identification number. The survey was conducted with 64,991 students from 800 schools (400 middle schools and 400 high schools). Totally, 799 schools and 62,276 students participated in the survey, so the overall participation rate was 95.8%.

From a total of 62,276 students, we excluded the following participants: those who did not make an effort to control their weight during the past 30 days (29,479 participants), those who made an effort to gain weight (4488 participants), and those who did not provide age, height, or weight information (1025 participants). Totally, we included 27,284 participants (10,809 men and 16,475 women). Informed consent was obtained from all students who participated in this survey, a government-approved statistical survey. This consent procedure was approved by the Institutional Review Board of KCDC. This study was reviewed and received approval from the Institutional Review Board at the Catholic University of Korea (approval no. MC18QESI0068) for using secondary data from KYRBWS, 2017.

Study variables

Body mass index and subjective body perception

Body mass index (BMI) was obtained based on self-reported height and weight and using the 2007 Korean National Growth Charts for Korean children and adolescents.[30] BMI status was classified into four groups: underweight (<5th BMI percentile), normal weight (<85th but ≥5th BMI percentile), overweight (<95th but ≥85th BMI percentile), and obese (≥95th BMI percentile). Subjective body perception was assessed by the question 'What do you think about your body shape?' Based on the answers, participants were categorized into three groups: underweight, normal weight, and overweight.

Unhealthy weight control behaviors

UWCBs were assessed based on whether participants had tried any of the following behaviors to control weight in the past 30 days with yes/no response options: one-food diets, fasting (skipping meals for >24 h), diet pill use (taking diet pills without a doctor's prescription), and purging (vomiting or using laxatives or diuretics).

Substance use patterns

Caffeinated energy drink intake was assessed by the question 'How often did you drink highly caffeinated or energy drinks in the past 7 days?' Based on the answers, participants were categorized into four groups: None, 1–2/week, 3–6/week, and >1/day. Alcohol use patterns were measured using the following question: 'Have you ever had a drink except in situations such as performing ancestral rites, attending memorial ceremonies, or receiving Holy Communion in your lifetime?' Based on the answers, participants were categorized into three groups: never, ever, and current. Current smoking patterns were assessed by the question 'How many cigarettes a day did you smoke during the last 30 days on average?' Based on their answers, participants were categorized into three groups: none, light (1–9), and heavy (≥10). Electronic cigarette (EC) use patterns were measured by the question 'Have you ever used electronic cigarettes in your lifetime?' Based on their answers, participants were categorized into three groups: never, ever, and current. Lifetime drug use was assessed by the question 'Have you ever used drugs, inhaled butane gas, or sniffed glue habitually or intentionally in your lifetime?' Based on their answers, participants were categorized into current, never, and ever groups. However, there were only a few current users of purging and diet pill among women. Therefore, they were eventually categorized in the never and ever groups.

Statistical analysis

Data analysis was performed using IBM SPSS ver. 25.0 (IBM Co., Armonk, NY, USA) to reflect the complex sample. The Chi-squared test was used to calculate participants' general characteristics and UWCB prevalence by substance use patterns. Multiple logistic regression analysis was performed after adjusting variables including grades, perceived school performance, economic status, and BMI to calculate the adjusted odds ratios and corresponding 95% confidence intervals. A P value of <0.05 was considered to be statistically significant.

Results

Participants' general characteristics

Differences in participants' general characteristics by gender are shown in Table 1. Male adolescents were more likely to be overweight or obese than female adolescents ($P < 0.001$). Male adolescents more often considered themselves to be overweight than female adolescents ($P < 0.001$). More female than male adolescents reported to be engaged in UWCBs, including one-food diets ($P < 0.001$), fasting ($P < 0.001$), diet pill use ($P < 0.001$), and purging ($P < 0.001$).

Prevalence of unhealthy weight control behaviors by substance use patterns

UWCB prevalence according to energy drink intake, alcohol use, cigarette smoking, EC use, and lifetime drug use by gender is presented in Table 2. The prevalence of all UWCBs tended to increase when energy drink intake ($P < 0.001$) and cigarette smoking ($P < 0.001$) frequency increased among males and females. The prevalence of all UWCBs tended to increase when alcohol use ($P < 0.001$) increased among females. The prevalence of all UWCBs was also higher in lifetime drug users than in non-users among both male and female adolescents. Overall, almost half of the female adolescents who smoked >10 cigarettes a day on average reported fasting (42.0%), whereas one-fifth of men who smoked >10 cigarettes a day on average reported fasting (20.6%).

Table 1 – Participants' general characteristics (N = 27,284).[a]

Variables	Category	All participants (n = 27,284)	Male (n = 10,809)	Female (n = 16,475)	p
School grade	Middle school 1st	4850 (16.2)	2014 (16.7)	2836 (15.9)	0.395
	Middle school 2nd	4776 (16.5)	1888 (16.3)	2888 (16.5)	
	Middle school 3rd	4646 (15.6)	1703 (14.6)	2943 (16.2)	
	High school 1st	4366 (16.8)	1657 (16.3)	2709 (17.1)	
	High school 2nd	4591 (18.6)	1879 (18.8)	2712 (18.5)	
	High school 3rd	4055 (16.4)	1668 (17.3)	2387 (15.8)	
Perceived academic achievement	High	3378 (12.3)	1588 (14.7)	1790 (10.6)	<0.001
	Middle high	7029 (25.5)	2760 (25.3)	4269 (25.7)	
	Middle	7996 (29.4)	3037 (28.1)	4959 (30.3)	
	Middle low	6331 (23.3)	2357 (21.7)	3974 (24.4)	
	Low	2550 (9.6)	1067 (10.2)	1483 (9.1)	
Perceived economic status	High	2948 (11.1)	1586 (14.7)	1362 (8.5)	<0.001
	Middle high	8147 (30.3)	3397 (31.7)	4750 (29.3)	
	Middle	12335 (44.8)	4387 (40.2)	7948 (47.9)	
	Middle low	3192 (11.4)	1167 (10.8)	2025 (11.9)	
	Low	662 (2.4)	272 (2.6)	390 (2.3)	
Body mass index	Underweight	378 (1.4)	123 (1.1)	255 (1.6)	<0.001
	Normal weight	19543 (71.9)	6744 (62.6)	12799 (78.3)	
	Overweight	4517 (16.6)	2350 (22.0)	2167 (12.8)	
	Obese	2846 (10.2)	1592 (14.4)	1254 (7.3)	
Subjective body perception	Underweight	2571 (9.1)	927 (8.2)	1644 (9.8)	<0.001
	Normal weight	10002 (36.7)	3554 (32.9)	6448 (39.4)	
	Overweight	14711 (54.2)	6328 (58.9)	8383 (50.9)	
One-food diet	No	25149 (92.3)	10277 (95.2)	14872 (90.4)	<0.001
	Yes	2135 (7.7)	532 (4.8)	1603 (9.6)	
Fasting	No	24547 (90.1)	9989 (92.6)	14558 (88.4)	<0.001
	Yes	2737 (9.9)	820 (7.4)	1917 (11.6)	
Diet pill use	No	26625 (97.6)	10652 (98.5)	15973 (97.1)	<0.001
	Yes	659 (2.4)	157 (1.5)	502 (2.9)	
Purging	No	26356 (96.7)	10564 (97.8)	15792 (95.9)	<0.001
	Yes	928 (3.3)	245 (2.2)	683 (4.1)	

[a] Weighted percentages followed complex sample analysis.

Associations between unhealthy weight control behaviors and substance use patterns among male adolescents

The associations between UWCB and energy drink intake, alcohol use, cigarette smoking, EC use, and lifetime drug use among male adolescents are shown in Table 3. The ORs for male adolescents who consumed >1 energy drink per day were 3.79, 3.05, 4.72, and 3.69 for one-food diets, fasting, diet pill use, and purging, respectively. Male adolescents who were current alcohol users, were heavy cigarette smokers, or were current EC users had significantly higher odds of one-food diets, fasting, diet pill use, and purging. Male adolescents with lifetime drug use were 5.25 times more likely to have purging behaviors than those who did not ever use drugs.

Associations between unhealthy weight control behaviors and substance use patterns among female adolescents

The associations between UWCB and energy drink intake, alcohol use, cigarette smoking, EC use, and lifetime drug use among female adolescents are shown in Table 4. The ORs for female adolescents who consumed >1 energy drink per day were 2.28, 2.90, 2.73, and 2.63 for one-food diets, fasting, diet pill use, and purging, respectively. Female adolescents who were current alcohol users, were heavy cigarette smokers, or were current EC users had significantly higher odds of one-food diets, fasting, diet pill use, and purging. Female adolescents with lifetime drug use were almost 6 times more likely to have purging behaviors than those who had never used drugs.

Discussion

Our findings, obtained from a large representative survey of South Korean adolescents aged 13–18 years, demonstrated that both male and female adolescents with energy drink intake, alcohol use, cigarette smoking, EC use, or lifetime drug use were more likely to engage in UWCBs, including one-food diets, fasting, diet pill use, and purging.

Several substances likely suppress appetite and control weight. Our study suggests that caffeinated energy drink intake is associated with UWCB. A case study reported that women with eating disorders who drank large quantities of caffeinated beverages believed that caffeine ingestion could boost their energy, alleviate hunger, and burn unnecessary calories.[31] In female patients with eating disorders, purging behaviors have been shown to have a strong association with caffeine use.[23] In particular, girls with purging behaviors also had high caffeine consumption levels because of its appetite-

Table 2 – Weighted prevalence (%) of unhealthy weight control behaviors by substance use patterns among Korean adolescents.

Behavior	One-food diet		Fasting		Diet pill use		Purging	
	Male	Female	Male	Female	Male	Female	Male	Female
Energy drink intake								
None	3.9	8.5	6.4	9.9	1.2	2.5	1.8	3.6
1–2/week	5.5	12.7	8.6	16.6	2.1	3.7	3.0	4.6
3–6/week	8.9	15.2	10.5	19.5	2.4	5.3	3.4	7.6
>1/day	13.5	17.8	18.1	24.9	5.8	7.4	6.9	9.4
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Alcohol use								
Never	4.5	8.1	5.8	9.1	1.2	2.1	2.0	2.6
Ever	4.6	10.6	7.9	13.3	1.5	3.4	1.9	4.9
Current	6.0	14.6	11.0	19.4	2.3	5.6	3.3	8.9
P value	0.017	<0.001	<0.001	<0.001	0.006	<0.001	0.004	<0.001
Cigarette smoking								
None	4.6	9.4	6.8	11.1	1.4	2.8	2.0	3.8
Light (1–9)	6.2	18.3	11.0	27.2	2.2	7.9	3.7	11.4
Heavy (≥10)	10.7	24.3	20.6	42.0	6.0	14.3	9.5	17.8
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
EC use								
Never	4.6	9.4	6.9	11.2	1.3	2.8	2.0	3.9
Ever	5.0	19.0	8.9	27.3	2.1	7.8	2.9	10.0
Current	10.8	21.8	16.5	31.0	5.3	11.7	7.4	13.6
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lifetime drug use								
No	4.7	9.6	7.2	11.5	1.4	2.9	2.1	4.0
Yes	11.5	23.5	21.4	30.0	8.3	12.6	13.1	19.9
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

EC, electronic cigarette.

Table 3 – Associations between unhealthy weight control behaviors and energy drink intake, alcohol use, cigarette smoking, EC use, and lifetime drug use (expressed as AOR 95% [CI]) among Korean male adolescents (N = 10,809).[a]

Behavior	One-food diet	Fasting	Diet pill use	Purging
Energy drink intake				
None	1.00	1.00	1.00	1.00
1–2/week	1.40 (1.11–1.76)	1.34 (1.11–1.62)	1.79 (1.22–2.61)	1.63 (1.17–2.25)
3–6/week	2.35 (1.77–3.11)	1.60 (1.27–2.03)	2.02 (1.22–3.35)	1.82 (1.19–2.79)
>1/day	3.79 (2.57–5.59)	3.05 (2.19–4.24)	4.72 (2.70–8.25)	3.69 (2.20–6.18)
p for trend	<0.001	<0.001	<0.001	<0.001
Alcohol use				
Never	1.00	1.00	1.00	1.00
Ever	1.20 (1.08–1.34)	1.41 (1.29–1.54)	1.33 (1.10–1.60)	1.42 (1.20–1.68)
Current	1.79 (1.59–2.01)	2.20 (1.98–2.44)	2.19 (1.79–2.68)	2.55 (2.17–3.01)
p for trend	<0.001	<0.001	<0.001	<0.001
Cigarette smoking				
None	1.00	1.00	1.00	1.00
Light (1–9)	1.25 (0.96–1.64)	1.41 (1.09–1.83)	1.39 (0.82–2.37)	1.65 (1.06–2.57)
Heavy (≥10)	2.12 (1.24–3.62)	2.51 (1.68–3.75)	3.41 (1.64–7.10)	4.02 (2.33–6.93)
p for trend	0.010	<0.001	0.004	<0.001
EC use				
Never	1.00	1.00	1.00	1.00
Ever	1.05 (0.74–1.49)	1.13 (0.89–1.44)	1.52 (0.94–2.45)	1.37 (0.89–2.11)
Current	2.20 (1.52–3.18)	2.05 (1.47–2.85)	3.30 (1.80–6.05)	3.18 (1.97–5.15)
p for trend	<0.001	<0.001	<0.001	<0.001
Lifetime drug use				
No	1.00	1.00	1.00	1.00
Yes	2.42 (1.43–4.09)	2.96 (1.96–4.48)	4.11 (2.07–8.17)	5.25 (3.12–8.84)
P value	0.001	<0.001	<0.001	<0.001

EC, electronic cigarette; AOR, adjusted odds ratio; CI, confidence interval.

[a] Adjusted by grade, perceived school performance, economic status, body mass index, and subjective body perception.

Table 4 – Associations between unhealthy weight control behaviors and energy drink intake, alcohol use, cigarette smoking, EC use, and lifetime drug use (expressed as AOR [95% CI]) among Korean female adolescents (N = 16,475)[a].

	One-food diet	Fasting	Diet pill use	Purging
Energy drink intake				
None	1.00	1.00	1.00	1.00
1–2/week	1.52 (1.33–1.73)	1.76 (1.55–2.01)	1.47 (1.17–1.86)	1.26 (1.01–1.57)
3–6/week	1.84 (1.50–2.27)	2.11 (1.78–2.49)	1.96 (1.47–2.60)	2.03 (1.57–2.64)
>1/day	2.28 (1.63–3.18)	2.90 (2.14–3.94)	2.73 (1.67–4.44)	2.63 (1.65–4.19)
p for trend	<0.001	<0.001	<0.001	<0.001
Alcohol use				
Never	1.00	1.00	1.00	1.00
Ever	1.29 (1.13–1.48)	1.49 (1.32–1.68)	1.39 (1.11–1.74)	1.69 (1.36–2.11)
Current	1.77 (1.52–2.06)	2.23 (1.94–2.56)	2.11 (1.65–2.68)	2.97 (2.43–3.63)
P value for trend	<0.001	<0.001	<0.001	<0.001
Cigarette smoking				
None	1.00	1.00	1.00	1.00
Light (1–9)	1.77 (1.34–2.34)	2.41 (1.87–3.09)	2.33 (1.56–3.46)	2.49 (1.81–3.41)
Heavy (≥10)	2.63 (1.41–4.90)	4.56 (2.73–7.61)	4.57 (2.22–9.42)	3.81 (1.68–8.65)
p for trend	<0.001	<0.001	<0.001	<0.001
EC use				
Never	1.00	1.00	1.00	1.00
Ever	1.87 (1.41–2.48)	2.40 (1.80–3.19)	2.21 (1.42–3.45)	2.04 (1.37–3.04)
Current	2.32 (1.47–3.65)	2.82 (1.90–4.18)	3.76 (2.04–6.92)	3.25 (1.89–5.62)
p for trend	<0.001	<0.001	<0.001	<0.001
Lifetime drug use				
No	1.00	1.00	1.00	1.00
Yes	2.71 (1.61–4.57)	3.13 (1.86–5.28)	4.82 (2.55–9.10)	5.86 (3.41–10.09)
P value	<0.001	<0.001	<0.001	<0.001

EC, electronic cigarette; AOR, adjusted odds ratio; CI, confidence interval.
[a] Adjusted by grade, perceived school performance, economic status, body mass index, and subjective body perception.

suppressing effects or role as a meal substitute.[24] Caffeine consumption has been associated with eating disorders, particularly anorexia nervosa in young girls.[32] Energy drink consumption among college students was reportedly associated with unhealthy dietary behaviors.[33] Energy drink use among US undergraduate students was reportedly associated with diet pill use, vomiting, or laxative consumption.[34] However, total caffeine consumption was significantly associated with weight loss but not specifically related to energy drink intake.[35] It is noteworthy that the association between energy drink intake and UWCB was strong among both male and female students in this study.

Alcohol use has been associated with unhealthy eating behaviors among adolescents. In a meta-analysis, alcohol use disorders were reportedly associated with purging in women.[36] Attempts made to lose weight were associated with binge drinking among high-school girls.[37] Fasting or purging was associated with heavy and problematic alcohol use among college women.[38–40]

Although previous studies have usually been focused on women, our study found that the associations between one food diet/diet pill use and alcohol use patterns were higher in men than in women. Similar to our study, Pisetsky et al.[8] found that binge drinking was associated with disordered eating in male and female adolescents. It is likely that individuals trying to lose weight are likely to use alcohol to suppress negative emotions arising from body image problems.[8,40] Alcohol is not only used as an appetite suppressant to maintain or lose weight[40,41] but also as an indication of impulsivity when alcohol intake is high.[8,42]

We observed a strong association between heavy smoking and UWCB among adolescents in this study. Cigarette smoking has been thought to support weight control, particularly among adolescents.[43–45] This tendency is reportedly stronger in girls and those who perceived themselves as overweight.[43–45] Sim et al.[46] found that current smokers (stronger relationship observed for girls than for boys) were more likely to engage in UWCBs. A 10-year cohort study showed that girls who perceived themselves as overweight were more likely to be young adult smokers.[47] Tobacco industries have attempted to enhance the effects of appetite-suppressing agents inside some cigarettes, which is appealing to smokers who care about weight control.[48] Previous research suggested that poor diet and physical inactivity were associated with heavy smoking, indicating that smoking behavior is a key determinant of an unhealthy lifestyle; thus, it is important to make efforts to reduce smoking among adolescents.[49] Adolescent smokers were less likely to eat healthy foods, including fruits and vegetables, and more likely to eat fast foods than nonsmoking adolescents.[50]

Although nicotine (present in both cigarettes and ECs) has an appetite-suppressing effect,[51] to our knowledge, no studies have been conducted on the association between EC use and UWCB among adolescents. A study conducted among adults demonstrated that EC users wanting to lose or control weight were more likely to vape frequently.[52] This behavior was related to poor impulse control ability.[52] Based on prior evidence that smokers may use smoking as an alternative to eating, it is possible that the motivation for vaping is also related to weight concerns.[53] The reason given by many

adolescents for using ECs was that EC flavors were more appealing.[54] EC makers offer newer brands encompassing new flavors including those of snacks, candy, or alcohol, which mimic high-calorie foods or beverages that are avoided by people who are trying to control their weight.[55] Various EC industries worldwide are making efforts to add ingredients including laxatives, appetite suppressants, and antiobesity agents to e-liquids.[56] ECs appeared to be a tool for smokers who fear weight gain after quitting smoking, but there is no evidence that ECs actually eliminated food craving.[56]

Many previous studies have indicated that women are more likely to report drug use as a means to lose or control weight than men.[56,57] Women with weight-related concerns in substance abuse treatment programs were reportedly more prone to purging behaviors.[57] Illicit use of stimulants, including marijuana, cocaine, heroin, amphetamine, methamphetamine, and ecstasy, reportedly increased with laxative misuse.[58] Laxative abuse, representative of purging behaviors, may lead to illicit substance use—similar to the gateway theory of substance use caused by intense compensatory behaviors.[58,59] Our study revealed strong associations between purging behavior and lifetime drug use in both male and female adolescents.

There are some important limitations to this study. First, KYRBWS used cross-sectional data, so causal inferences between UWCBs and substance use patterns could not be drawn; thus, prospective studies are required to identify causality. Second, this study was based on self-reported data, so the risk of self-presentation bias exists during the assessment of substance use and UWCBs. Biological samples to confirm substance use and the frequencies of UWCBs or combinations of UWCBs were not assessed. This failed to capture diverse aspects of UWCBs, including repetitiveness of severity types. Third, the KYRBWS sampling frame was limited to adolescents who were attending middle and high schools; thus, out-of-school adolescents were not included. Considering that out-of-school adolescents are more likely to be exposed to risk behaviors,[60] future studies need to include out-of-school adolescents to supplement the findings of this study.

Despite these limitations, this study utilized data from a large, nationally representative South Korean adolescent survey to examine the relationship between UWCBs and substance use patterns. Previous studies about UWCBs have focused almost exclusively on female populations, but our study revealed moderate or strong associations between substance use patterns and each UWCB among male adolescents. Our study provided results for each UWCB, so we can understand the symptoms associated with each substance; this can indicate which substance is associated with which unhealthy diet behavior in each sex. Energy drink intake was most strongly related to fasting among women, whereas diet pill use was most strongly related to fasting among men. Cigarette smoking was most strongly associated with diet pill use among women, whereas purging was most strongly associated among men. Finally, the association of caffeinated energy drink intake and EC use and UWCBs rarely has been studied among adolescent populations, yet our findings highlight the need for increased attention to these hazardous substances.

Preventing UWCBs or implementing interventions to address UWCBs can prevent adolescents from developing more negative health risks. Health promotion should focus on launching campaigns to provide both female and male adolescents with education and counseling regarding eating problems so that adolescents can maintain a healthy lifestyle and select appropriate weight control methods. Health professionals who work with adolescents need to be aware of the importance of screening for UWCBs, including one-food diets, fasting, diet pill use, and purging, and to be especially aware of their co-occurrence with substance use. Regarding the finding that adolescents with low economic status are more likely to engage in UWCBs,[28] community-level interventions that provide proper resources for maintaining a healthy lifestyle, including healthy eating, physical activity, and access to healthcare services, are needed for this population.[61] In accordance with a recent study that demonstrated the importance of preventive school-based programs for eating disorders in reducing harmful behaviors in adolescents,[62] health professionals should design and offer applicable long-term prevention programs that involve both genders. Above all, the health policy should provide environmental support for healthy weight control behaviors in connection with schools, public health centers, and local governments, to develop and implement effective strategies for adolescents.

Author statements

Ethical approval

This consent procedure was approved by the Institutional Review Board of KCDC. This study was reviewed and received approval from the Institutional Review Board at the Catholic University of Korea (approval no. MC18QESI0068) for using secondary data from KYRBWS, 2017.

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Competing interests

None declared.

Author contribution

Yeji Lee and Kang-Sook Lee designed the study and wrote the protocol. Yeji Lee conducted literature searches and provided summaries of previous research studies. Yeji Lee also conducted the statistical analysis. Kang-Sook Lee suggested new methods or models. Both the authors wrote the first draft of the manuscript and contributed to and have approved the final manuscript.

REFERENCES

1. Bulik CM. Eating disorders in adolescents and young adults. *Child Adolesc Psychiatric Clin North Am* 2002;**11**:201–18.

2. Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 1998;**101**:518–25.
3. Pike KM, Dunne PE. The rise of eating disorders in Asia: a review. *J Eat Disord* 2015;**3**:33.
4. Trekels J, Karsay K, Eggermont S, Vandenbosch L. How social and mass media relate to youth's self-sexualization: taking a cross-national perspective on rewarded appearance ideals. *J Youth Adolesc* 2018. https://doi.org/10.1007/s10964-018-0844-3.
5. Korea Centers for Disease Control and Prevention. *The statistics of 13th Korea Youth risk behavior Web-based survey (KYRBWS)*. Seoul: KCDC; 2017. http://www.cdc.go.kr/CDC/contents/CdcKrContentView.jsp?cid=139405&menuIds=HOME006-MNU2802-MNU2895. [Accessed 4 May 2018].
6. Choi JS, Kim JS. Mediating effect of body image distortion on weight loss efforts in normal-weight and underweight Korean adolescent girls. *J Sch Health* 2017;**87**:217–24.
7. Austin SB. The blind spot in the drive for childhood obesity prevention: bringing eating disorders prevention into focus as a public health priority. *AJPH (Am J Public Health)* 2011;**101**:e1–4.
8. Pisetsky EM, Chao YM, Dierker LC, May AM, Striegel-Moore RH. Disordered eating and substance use in high-school students: results from the Youth Risk Behavior Surveillance System. *Int J Eat Disord* 2008;**41**:464–70.
9. Stice E, Marti CN, Durant S. Risk factors for onset of eating disorders: evidence of multiple risk pathways from an 8-year prospective study. *Behav Res Ther* 2011;**49**:622–7.
10. Stephen EM, Rose JS, Kenney L, Rosselli-Navarra F, Weissman RS. Prevalence and correlates of unhealthy weight control behaviors: findings from the national longitudinal study of adolescent health. *J Eat Disord* 2014;**2**:16.
11. Solmi F, Sonneville KR, Easter A, Horton NJ, Crosby RD, Treasure J, et al. Prevalence of purging at age 16 and associations with negative outcomes among girls in three community-based cohorts. *J Child Psychol Psychiatry* 2015;**56**:87–96.
12. Haley CC, Hedberg K, Leman RF. Disordered eating and unhealthy weight loss practices: which adolescents are at highest risk? *J Adolesc Health* 2010;**47**:102–5.
13. Johnson ER, Weiler RM, Barnett TE, Pealer LN. Extreme weight-control behaviors and suicide risk among high school students. *J Sch Health* 2016;**86**:281–7.
14. Brausch AM, Gutierrez PM. The role of body image and disordered eating as risk factors for depression and suicidal ideation in adolescents. *Suicide Life Threat Behav* 2009;**39**:58–71.
15. Jessor R. Risk behavior in adolescence: a psychosocial framework for understanding and action. *J Adolesc Health* 1991;**12**:597–605.
16. Jessor R. Problem-behavior theory, psychosocial development, and adolescent problem drinking. *Br J Addict* 1987;**82**:331–42.
17. Public Health Wales. *ACEs and their impact on health-harming behaviours in the Welsh adult population*. 2015. http://www.wales.nhs.uk/sitesplus/888/page/88504. [Accessed 25 January 2019].
18. French SA, Leffert N, Story M, Neumark-Sztainer D, Hannan P, Benson PL. Adolescent binge/purge and weight loss behaviors: associations with developmental assets. *J Adolesc Health* 2001;**28**:211–21.
19. Froreich FV, Vartanian LR, Zawadzki MJ, Grisham JR, Touyz SW. Psychological need satisfaction, control, and disordered eating. *Br J Clin Psychol* 2017;**56**:53–68.
20. Vidot DC, Messiah SE, Prado G, Hlaing WM. Relationship between current substance use and unhealthy weight loss practices among adolescents. *Matern Child Health J* 2016;**20**:870–7.
21. Garry JP, Morrissey SL, Whetstone LM. Substance use and weight loss tactics among middle school youth. *Int J Eat Disord* 2003;**33**:55–63.
22. Mann AP, Phil DOM, Accurso EC, Stiles-Shields C, Capra L, Labuschagne Z, et al. Factors associated with substance use in adolescents with eating disorders. *J Adolesc Health* 2014;**55**:182–7.
23. Haug NA, Heinberg LJ, Guarda AS. Cigarette smoking and its relationship to other substance use among eating disordered inpatients. *Eat Weight Disord* 2001;**6**:130–9.
24. Stock SL, Goldberg E, Corbett S, Katzman DK. Substance use in female adolescents with eating disorders. *J Adolesc Health* 2002;**31**:176–82.
25. Lacey JH, Evans CD. The impulsivist: a multi-impulsive personality disorder. *Br J Addict* 1986;**81**:641–9.
26. *Health Insurance Review and assessment service*. Korea: Disease Information in Statistics; 2012. https://www.hira.or.kr/re/stcIlnsInfm/stcIlnsInfmView.do?pgmid=HIRAA030502000000&sortSno=162;. [Accessed 25 January 2019].
27. Austin SB, Spadano-Gasbarro J, Greaney ML, Richmond TK, Feldman HA, Osganian SK, et al. Disordered weight control behaviors in early adolescent boys and girls of color: an under-recognized factor in the epidemic of childhood overweight. *J Adolesc Health* 2011;**48**:109–12.
28. Kim Y, Austin SB, Subramanian SV, Thomas JJ, Eddy KT, Franko DL, et al. Risk factors for disordered weight control behaviors among Korean adolescents: multilevel analysis of the Korea Youth Risk Behavior Survey. *Int J Eat Disord* 2018;**51**:124–38.
29. Pearlstein T. Eating disorders and comorbidity. *Arch Womens Ment Health* 2002;**4**:67e78.
30. Moon JS, Lee SY, Nam CM, Choi JM, Choe BK, Seo JW, et al. Korean National Growth Charts: review of developmental process and an outlook. *Korean J Pediatr* 2007;**51**:1–25. 2008.
31. Sours JA. Case reports of anorexia nervosa and caffeinism. *Am J Psychiatry* 1983;**140**:235–6.
32. Striegel-Moore RH, Franko DL, Thompson D, Barton B, Schreiber GB, Daniels SR. Caffeine intake in eating disorders. *Int J Eat Disord* 2006;**39**:162–5.
33. Poulos NS, Pasch KE. Energy drink consumption is associated with unhealthy dietary behaviours among college youth. *Perspect Public Health* 2015;**135**:316–21.
34. Jeffers AJ, Vatalaro Hill KE, Benotsch EG. Energy drinks, weight loss, and disordered eating behaviors. *J Am Coll Health* 2014;**62**. 336e42.
35. Mahoney CR, Giles GE, Marriott BP, Judelson DA, Glickman EL, Geiselman PJ, et al. Intake of caffeine from all sources and reasons for use by college students. *Clin Nutr* 2018;**10**(18):668–75. pii: S0261-5614.
36. Gadalla T, Piran N. Co-occurrence of eating disorders and alcohol use disorders in women: a meta-analysis. *Arch Womens Ment Health* 2007;**10**:133–40.
37. Schlissel AC, Skeer MR. Trying to lose weight and alcohol misuse among high school girls: findings from the U.S. National 2011 Youth Risk Behavior Survey. *Subst Use Misuse* 2015;**50**:1599–605.
38. Anderson DA, Martens MP, Cimini MD. Do female college students who purge report greater alcohol use and negative alcohol-related consequences? *Int J Eat Disord* 2005;**37**:65–8.
39. Adams TB, Araas TE. Purging and alcohol-related effects in college women. *Int J Eat Disord* 2006;**39**:240–4.
40. Martin JL, Groth G, Longo L, Rocha TL, Martens MP. Disordered eating and alcohol use among college women: associations with race and big five traits. *Eat Behav* 2015;**17**:149–52.

41. Cochrane C, Malcolm R, Brewerton T. The role of weight control as a motivation for cocaine abuse. *Addict Behav* 1998;**23**:201–7.
42. Higgs S, Eskenazi T. Dietary restraint and disinhibition are associated with increased alcohol use behaviours and thoughts in young women social drinkers. *Eat Behav* 2007;**8**:236–43.
43. Austin SB, Gortmaker SL. Dieting and smoking initiation in early adolescent girls and boys: a prospective study. *Am J Public Health* 2001;**91**:446–50.
44. Fulkerson JA, French SA. Cigarette smoking for weight loss or control among adolescents: gender and racial/ethnic differences. *J Adolesc Health* 2003;**32**:306–13.
45. Pénzes M1, Czeglédi E, Balázs P, Foley KL. Factors associated with tobacco smoking and the belief about weight control effect of smoking among Hungarian adolescents. *Cent Eur J Public Health* 2012;**20**:11–7.
46. Sim WY, Cho YG, Kang JH, Park HA, Kim KW, Hur YI, et al. The relationship between smoking and unhealthy weight control behaviors among Korean adolescents: the Tenth Korea Youth Risk Behavior Web-Based Survey, 2014. *Korean J Fam Med* 2017;**38**:28–33.
47. Koval JJ, Pederson LL, Zhang X, Mowery P, McKenna M. Can young adult smoking status be predicted from concern about body weight and self-reported BMI among adolescents? Results from a ten-year cohort study. *Nicotine Tob Res* 2008;**10**:1449–55.
48. Gonseth S, Jacot-Sadowski I, Diethelm PA, Barras V, Cornuz J. The tobacco industry's past role in weight control related to smoking. *Eur J Public Health* 2012;**22**:234–7.
49. Lohse T, Rohrmann S, Bopp M, Faeh D. Heavy smoking is more strongly associated with general unhealthy lifestyle than obesity and underweight. *PLoS One* 2016;**11**:e0148563.
50. Lee B, Yi Y. Smoking, physical activity, and eating habits among adolescents. *West J Nurs Res* 2016;**38**:27–42.
51. Chiolero A, Faeh D, Paccaud F, Cornuz J. Consequences of smoking for body weight, body fat distribution, and insulin resistance. *Am J Clin Nutr* 2008;**87**:801–9.
52. Morean ME, Wedel AV. Vaping to lose weight: predictors of adult e-cigarette use for weight loss or control. *Addict Behav* 2017;**66**:55–9.
53. Kovacs MA, Correa JB, Brandon TH. Smoking as alternative to eating among restrained eaters: effect of food prime on young adult female smokers. *Health Psychol* 2014;**33**:1174–84.
54. Kong G, Morean ME, Cavallo DA, Camenga DR, Krishnan-Sarin S. Reasons for electronic cigarette experimentation and discontinuation among adolescents and young adults. *Nicotine Tob Res* 2015;**17**:847–54.
55. Zhu SH, Sun JY, Bonnevie E, Cummins SE, Gamst A, Yin L, et al. Four hundred and sixty brands of e-cigarettes and counting: implications for product regulation. *Tob Control* 2014;**23**. iii3–9.
56. Singh H, Kennedy RD, Lagasse L, Czaplicki LM, Cohen JE. E-cigarettes and weight loss - product design innovation insights from industry patents. *Nicotine Tob Res* 2017. https://doi.org/10.1093/ntr/ntx112.
57. Warren CS, Lindsay AR, White EK, Claudat K, Velasquez SC. Weight-related concerns related to drug use for women in substance abuse treatment: prevalence and relationships with eating pathology. *J Subst Abuse Treat* 2013;**44**:494–501.
58. Bruening AB, Perez M, Ohrt TK. Exploring weight control as motivation for illicit stimulant use. *Eat Behav* 2018;**30**:72–5.
59. Kandel DB, Yamaguchi K, Chen K. Stages of progression in drug involvement from adolescence to adulthood: further evidence for the gateway theory. *J Stud Alcohol* 1992;**53**:447–57.
60. Reingle Gonzalez JM, Salas-Wright CP, Connell NM, Jetelina KK, Clipper SJ, Businelle MS. The long-term effects of school dropout and GED attainment on substance use disorders. *Drug Alcohol Depend* 2016;**158**:60–6.
61. Becker AE, Hadley Arrindell A, Perloe A, Fay K, Striegel-Moore RH. A qualitative study of perceived social barriers to care for eating disorders: perspectives from ethnically diverse health care consumers. *Int J Eat Disord* 2010;**43**:633–47.
62. Gumz A, Weigel A, Daubmann A, Wegscheider K, Romer G, Löwe B. Efficacy of a prevention program for eating disorders in schools: a cluster-randomized controlled trial. *BMC Psychiatry* 2017;**17**:293.