



■ Original Article

# Unhealthy Weight Control Behaviors according to the Status of Combustible Cigarette and Noncombustible Nicotine or Tobacco Product Use among Korean Adolescents with Experience Attempting to Reduce or Maintain Their Body Weight: The 15th Korea Youth Risk Behavior Survey, 2019

A Ra Bong<sup>1</sup>, Young Gyu Cho<sup>2\*</sup>, Hyun Ah Park<sup>3</sup>, Kyo Woon Kim<sup>1</sup>

<sup>1</sup>Department of Family Medicine, Seoul Paik Hospital, College of Medicine, Inje University, Seoul, Korea

<sup>2</sup>Department of Family Medicine, Busan Paik Hospital, College of Medicine, Inje University, Busan, Korea

<sup>3</sup>Department of Family Medicine, Sanggye Paik Hospital, College of Medicine, Inje University, Seoul, Korea

**Background:** Noncombustible nicotine or tobacco product (NNTP) use, and cigarette smoking are associated with a high likelihood of unhealthy weight control behaviors (UWCBs) among adolescents. However, no study has addressed the differences in UWCBs among non-users, single users of combustible cigarettes (CCs) or NNTPs and dual users. This study compared the frequencies of weight control behaviors according to the status of CC and NNTP use among Korean adolescents.

**Methods:** This was a cross-sectional study of 25,094 adolescents who had attempted to reduce or maintain their body weight during the past 30 days, using data from the 15th Korea Youth Risk Behavior Survey, 2019. Data on the status of CC and NNTP use, weight status, and weight control behaviors were obtained using self-report questionnaires. Subjects were categorized into four groups: non-users, cigarette-only users, NNTP-only users, and dual users.

**Results:** Among boys and girls, current smokers and NNTP users were 8.9%±0.3% and 5.5%±0.3%, and 4.2%±0.2% and 1.7%±0.1%, respectively. Among boys, NNTP-only users were more likely to engage in extreme weight control behaviors than non-users. Among girls, users of either CCs or NNTPs were more likely to engage in extreme weight control behaviors and less extreme weight control behaviors than non-users.

**Conclusion:** This study shows that users of either CCs or NNTPs are more likely to engage in UWCBs, and NNTP-only users are the most likely to do so.

**Keywords:** Cigarette Smoking; Electronic Nicotine Delivery Systems; Weight Loss; Adolescent Behavior; Problem Behavior; Korea

Received: August 18, 2021, Revised: January 16, 2024, Accepted: March 7, 2024

\*Corresponding Author: Young Gyu Cho <https://orcid.org/0000-0003-1017-8884>

Tel: +82-51-890-6227, Fax: +82-51-894-3666, E-mail: 109454@paik.ac.kr

## INTRODUCTION

Noncombustible nicotine or tobacco products (NNTPs), including electronic cigarettes (ECs) and heated tobacco products (HTPs), have been introduced into the Korean market in recent decades.<sup>1)</sup> Although NNTP use has rapidly become popular among adolescents in many countries, it has remained at a low level among Korean adolescents. The prevalence of current EC and HTP use among Korean adolescents was 3.2% and 2.6% in 2019, respectively.<sup>2)</sup> It is concerning that NNTP use can function as a gateway to use of combustible cigarettes (CCs) and other substances in adolescents.<sup>3)</sup> Factors such as flavors, high-tech design, and lack of odor of NNTPs influence adolescents (even those who adhere to social norms) to try those.<sup>4)</sup> Although NNTPs are advertised as safer and less harmful than CCs, the long-term health implications of NNTPs are uncertain.<sup>5)</sup>

Some adolescents may use NNTPs as a means of weight control. Nicotine in NNTPs, is known to suppress appetite and increase resting metabolic rate.<sup>6)</sup> Furthermore, tobacco companies have been innovating NNTPs to support weight loss.<sup>7)</sup> Mantey et al.<sup>8)</sup> found that EC users were more likely to have weight loss intentions (odds ratio [OR], 1.38; 95% confidence intervals [CI], 1.07 to 1.78) among high school students. Previous studies have shown that smoking CCs is associated with a high likelihood of engaging in unhealthy weight control behav-

iors (UWCBs) among Korean adolescents.<sup>9)</sup> Recently, Lee and Lee<sup>10)</sup> demonstrated that Korean adolescents with EC use, as well as cigarette smoking were more likely to engage in UWCBs. However, no study has addressed the differences in UWCBs between non-users, single users of CCs or NNTPs, and dual users.

This study was conducted to compare the frequencies of weight control behaviors according to the status of CC and NNTP use in Korean adolescents who had attempted to reduce or maintain their body weight during the past 30 days. We expected that users of either CCs or NNTPs would be more likely to engage in UWCBs than non-users, and that dual users would be more likely to engage in them among the four groups according to the status of CC and NNTP use.

## METHODS

### 1. Study Subjects

Data were obtained from the 15th Korea Youth Risk Behavior Survey (KYRBS), 2019, designed by the Korea Centers for Disease Control and Prevention to monitor health-risk behaviors among Korean middle and high school students. The KYRBS is an ongoing national cross-sectional survey that uses a stratified, multi-stage, cluster-sampling design. Students completed the anonymous, self-administered, online questionnaire in a computer room of their school.<sup>11)</sup> A total of 60,100

**Table 1.** General characteristics according to the status of CC and NNTP use in boys

Characteristic	Non-users	Cigarette-only users	NNTP-only users	Dual users	P-value*
Unweighted no. of participants	9,625	451	97	451	
Age (y)	14.91±0.04	15.95±0.08	15.65±0.17	16.28±0.07	<0.001
School grade					<0.001
Middle school	52.2 (1.2)	23.3 (2.2)	31.4 (5.1)	16.0 (1.8)	
High school	47.8 (1.2)	76.7 (2.2)	68.6 (5.1)	84.0 (1.8)	
Body mass index (kg/m <sup>2</sup> )	23.94±0.04	24.56±0.18	23.73±0.39	24.38±0.17	<0.001
Weight status					0.253
Underweight	1.1 (0.1)	0.3 (0.2)	0.9 (0.8)	0.7 (0.4)	
Normal weight	54.3 (0.6)	57.0 (2.4)	58.8 (5.3)	53.9 (2.3)	
Overweight	19.0 (0.4)	14.9 (1.7)	13.8 (3.4)	20.8 (1.9)	
Obese	25.6 (0.5)	27.9 (2.1)	26.5 (4.9)	24.6 (2.0)	
Body shape perception					0.190
Thin	7.7 (0.3)	8.4 (1.5)	10.7 (3.4)	9.2 (1.3)	
Average	33.3 (0.5)	33.5 (2.3)	42.0 (5.0)	36.1 (2.1)	
Obese	58.9 (0.5)	58.1 (2.4)	47.3 (5.0)	54.7 (2.1)	
Depressive mood	22.4 (0.5)	35.3 (2.4)	33.6 (4.7)	43.9 (2.3)	<0.001
Current alcohol intake	13.2 (0.4)	55.5 (2.4)	45.6 (5.3)	77.0 (2.0)	<0.001
Living with family	95.5 (0.3)	94.9 (1.2)	84.9 (3.4)	93.3 (1.1)	<0.001
Perceived economic status					<0.001
Lower	11.8 (0.3)	17.4 (1.6)	18.6 (4.1)	18.0 (1.8)	
Middle	43.4 (0.5)	45.4 (2.4)	43.7 (4.9)	39.5 (2.5)	
Upper	44.8 (0.6)	37.2 (2.2)	37.7 (4.8)	42.5 (2.4)	
Residential district					0.079
Rural area	5.7 (0.7)	8.2 (1.7)	6.0 (2.2)	7.9 (1.4)	
Middle city	51.2 (1.2)	51.2 (2.9)	57.0 (5.1)	54.5 (2.8)	
Large city	43.1 (1.2)	40.6 (2.7)	37.0 (4.8)	37.6 (2.6)	

Values are presented as unweighted number of participants, weighted mean±SE, or weighted % (SE).

CC, combustible cigarette; NNTP, noncombustible nicotine or tobacco product; SE, standard error.

\*P-value by general linear model or chi-square test.

students from 400 sampled middle schools and 400 sampled high schools were selected for the survey. Among them, 57,303 students participated in the survey (response rate=95.3%).<sup>2)</sup> Students with missing values on age, height, and/or weight (n=1,555) were excluded, leaving 55,748 students. Finally, 25,094 students who answered that they had attempted to reduce or maintain their body weight over the past 30 days were included in the analysis. Informed consent was obtained from all individual participants during the process of KYRBS, and the study protocol was approved by the Institutional Review Board (IRB) of Inje University Seoul Paik Hospital (IRB no., PAIK 2021-06-002).

## 2. Measurements

Current smokers were those who reported smoking at least one cigarette during the past 30 days, and current NNTP users were those who reported using ECs containing nicotine or HTPs for at least 1 day over the past 30 days. Depending on the definitions of current smokers and current NNTP users, the participants were categorized into the following four groups: non-users (using neither product), cigarette-only users (smoking CCs but not using NNTPs), NNTP-only users (using NNTPs but not smoking CCs), and dual users (using both products).

Body mass index (BMI, body weight [kg]/squared height [m<sup>2</sup>]) was calculated using self-reported height and body weight. Weight status

was classified into the following four groups: obese ( $\geq 95$ th BMI percentile for age and sex), overweight ( $< 95$ th but  $\geq 85$ th BMI percentile for age and sex), normal weight ( $< 85$ th but  $\geq 5$ th BMI percentile for age and sex), and underweight ( $< 5$ th BMI percentile for age and sex) based on the 2017 Korean National Growth Chart for children and adolescents.<sup>12)</sup> Self-perception of body shape was asked with the following response options: very thin, slightly thin, average, slightly obese, and very obese. The responses were divided into the following three groups: thin (very/slightly thin), average, and obese (very/slightly obese).

The participants were asked to report whether they had attempted to control their body weight over the past 30 days. Subsequently, those who reported attempting to reduce or maintain their body weight were asked to indicate any behaviors that they had attempted for weight control with the following 10 response options: regular exercise, eating less food, one-food diet, fasting, dietary supplements, Korean herbal medicine, prescription diet pills, nonprescription diet pills, laxatives or diuretics, and vomiting after meals. Weight control behaviors were categorized into healthy weight control behaviors (HWCBs), less extreme weight control behaviors (LWCBs), and extreme weight control behaviors (EWCBs), based on the study by Sim et al.<sup>9)</sup> Regular exercise and eating were categorized under less food in HWCBs; one-food diet, fasting, dietary supplements, and Korean herbal medicine

**Table 2.** General characteristics according to the status of CC and NNTP use in girls

Characteristic	Non-users	Cigarette-only users	NNTP-only users	Dual users	P-value*
Unweighted no. of participants	13,824	401	37	208	
Age (y)	14.92±0.04	15.65±0.10	15.94±0.24	15.87±0.11	<0.001
School grade					<0.001
Middle school	52.4 (1.2)	29.4 (2.9)	30.3 (8.0)	26.1 (3.4)	
High school	47.6 (1.2)	70.6 (2.9)	69.7 (8.0)	73.9 (3.4)	
Body mass index (kg/m <sup>2</sup> )	21.40±0.03	21.93±0.16	23.52±0.59	21.24±0.19	0.009
Weight status					0.287
Underweight	1.8 (0.1)	1.3 (0.6)	2.8 (2.5)	2.0 (0.9)	
Normal weight	75.7 (0.4)	71.4 (2.3)	69.3 (7.7)	81.5 (3.1)	
Overweight	11.6 (0.3)	14.3 (1.9)	11.9 (6.0)	7.1 (2.2)	
Obese	10.9 (0.4)	13.0 (1.8)	16.0 (5.9)	9.4 (2.1)	
Body shape perception					0.007
Thin	9.7 (0.3)	7.2 (1.4)	22.9 (7.5)	13.3 (2.8)	
Average	41.0 (0.4)	35.9 (2.2)	40.5 (7.6)	37.8 (3.5)	
Obese	49.3 (0.5)	57.0 (2.4)	36.6 (8.2)	48.9 (3.5)	
Depressive mood	36.0 (0.5)	63.7 (2.5)	57.8 (8.6)	69.7 (3.6)	<0.001
Current alcohol intake	11.7 (0.3)	75.8 (2.1)	68.4 (6.7)	86.3 (2.5)	<0.001
Living with family	96.2 (0.3)	94.0 (1.3)	84.4 (6.6)	94.6 (1.3)	<0.001
Perceived economic status					<0.001
Lower	12.5 (0.3)	18.3 (1.8)	37.9 (8.0)	19.8 (3.3)	
Middle	49.5 (0.5)	49.9 (2.5)	36.2 (7.3)	51.0 (4.5)	
Upper	38.0 (0.5)	31.8 (2.3)	25.9 (5.1)	29.2 (3.5)	
Residential district					0.688
Rural area	5.9 (0.6)	6.1 (2.1)	8.9 (4.8)	7.2 (2.1)	
Middle city	51.6 (1.3)	53.7 (3.4)	50.4 (8.7)	57.2 (4.3)	
Large city	42.5 (1.2)	40.1 (3.3)	40.7 (8.7)	35.6 (4.0)	

Values are presented as unweighted number of participants, weighted mean±SE, or weighted % (SE).

CC, combustible cigarette; NNTP, noncombustible nicotine or tobacco product; SE, standard error.

\*P-value by general linear model or chi-square test.

were included in LWCBs; and prescription diet pills, nonprescription diet pills, laxatives or diuretics, and vomiting after meals were grouped in EWCBs.<sup>9)</sup>

Additionally, depressive mood, current alcohol intake, living with family, perceived economic status, and residential district were assessed as covariates.

### 3. Statistical Analyses

Complex sample analyses were performed using PASW SPSS ver. 18.0 (SPSS Inc., Chicago, IL, USA), based on the guidelines for the use of raw KYRBS data. A chi-square test was used to calculate the frequency of weight control behaviors according to the status of CC and NNTP use. Logistic regression analyses were performed to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) of the effects of CC and NNTP on weight control behaviors. A P-value less than 0.05 was considered statistically significant.

## RESULTS

The participants were Korean adolescents who attempted to reduce or maintain their body weight during the past 30 days in the KYRBS, 2019.

Their mean age was 14.99±0.02 years (15.03±0.04 years in boys; 14.95±0.34 years in girls). Among boys and girls, current smokers and NNTP users accounted for 8.9%±0.3% and 5.5%±0.3%, and 4.2%±0.2% and 1.7%±0.1%, respectively. Overweight and obesity were diagnosed based on the 2017 Korean National Growth Chart for Korean children and adolescents, finding 18.8%±0.4% and 25.7%±0.5% of boys and 11.6%±0.3% and 11.0%±0.3% of girls fitting these categories, respectively. LWCBs and EWCBs were attempted in 20.1%±0.4% and 3.3%±0.2%, and 29.9%±0.4% and 7.5%±0.3%, of boys and girls, respectively.

General characteristics according to the status of CC and NNTP use are presented in Tables 1 and 2. Users of either CCs or NNTPs were older than non-users for boys and girls. There was no significant difference in weight status (boys: P-value=0.253; girls: P-value=0.287) among the four groups. Users of either CCs or NNTPs were more likely to feel depressed, drink alcohol, and perceive themselves to have a low economic status than non-users of both genders.

The frequencies of weight control behaviors in which participants attempted to reduce or maintain their body weight were assessed in four groups according to the status of CC and NNTP use. Boys attempted regular exercise most commonly, and girls consumed less

**Table 3.** Frequencies of weight control behaviors according to the status of CC and NNTP use

Variable	Non-users	Cigarette-only users	NNTP-only users	Dual users	P-value*
<b>Boys</b>					
Unweighted no. of participants	9,625	451	97	451	
Regular exercise	81.4 (0.5)	81.0 (1.8)	81.2 (3.9)	79.6 (2.0)	0.808
Eating less food	65.2 (0.5)	72.4 (2.1)	63.5 (4.8)	74.0 (2.1)	<0.001
One-food diet	5.4 (0.2)	6.8 (1.1)	8.4 (3.2)	8.9 (1.3)	0.007
Fasting	8.7 (0.3)	13.8 (1.7)	16.3 (3.5)	14.5 (1.7)	<0.001
Dietary supplements	6.6 (0.2)	5.3 (1.0)	8.2 (2.6)	9.0 (1.3)	0.093
Korean herbal medicine	5.0 (0.2)	2.5 (0.7)	7.7 (2.4)	3.1 (0.9)	0.018
Prescription diet-pills	1.3 (0.1)	0.5 (0.3)	6.9 (2.4)	2.1 (0.6)	<0.001
Nonprescription diet-pills	1.7 (0.1)	0.8 (0.4)	6.3 (2.3)	3.9 (0.9)	<0.001
Laxatives or diuretics	1.3 (0.1)	0.5 (0.3)	4.3 (2.1)	1.7 (0.6)	0.014
Vomiting after meals	1.6 (0.1)	1.2 (0.5)	6.1 (2.6)	3.3 (0.8)	<0.001
LWCBs <sup>†</sup>	19.5 (0.4)	24.6 (2.1)	24.4 (4.2)	25.9 (2.0)	<0.001
EWCBs <sup>‡</sup>	3.1 (0.2)	3.0 (0.8)	9.7 (3.0)	6.1 (1.1)	<0.001
<b>Girls</b>					
Unweighted no. of participants	13,824	401	37	208	
Regular exercise	67.5 (0.5)	63.1 (2.3)	53.6 (6.8)	69.0 (3.5)	0.074
Eating less food	83.9 (0.3)	91.3 (1.4)	88.0 (4.5)	90.2 (1.9)	<0.001
One-food diet	10.0 (0.3)	22.8 (1.8)	23.5 (7.6)	20.1 (2.7)	<0.001
Fasting	12.4 (0.3)	29.5 (2.2)	40.8 (8.6)	35.0 (3.5)	<0.001
Dietary supplements	14.6 (0.3)	29.5 (2.0)	30.5 (8.2)	21.4 (2.5)	<0.001
Korean herbal medicine	2.9 (0.1)	4.6 (1.0)	5.3 (3.3)	1.9 (0.7)	0.083
Prescription diet-pills	1.4 (0.1)	2.3 (0.7)	7.8 (4.2)	2.2 (0.7)	<0.001
Nonprescription diet-pills	3.9 (0.2)	12.8 (1.6)	24.0 (6.9)	12.6 (2.5)	<0.001
Laxatives or diuretics	1.5 (0.1)	4.2 (1.1)	8.1 (3.9)	5.6 (1.6)	<0.001
Vomiting after meals	2.3 (0.1)	9.1 (1.5)	17.8 (6.1)	9.4 (1.9)	<0.001
LWCBs <sup>†</sup>	28.8 (0.4)	54.1 (2.3)	57.7 (7.9)	50.0 (3.4)	<0.001
EWCBs <sup>‡</sup>	6.9 (0.2)	19.9 (1.9)	35.7 (7.6)	22.2 (2.9)	<0.001

Variables are presented as unweighted number of participants or weighted % (standard error).

CC, combustible cigarette; NNTP, noncombustible nicotine or tobacco product; LWCBs, less extreme weight control behaviors; EWCBs, extreme weight control behaviors.

\*P-value by chi-square test. <sup>†</sup>LWCBs include one-food diet, fasting, dietary supplements, and Korean herbal medicine. <sup>‡</sup>EWCBs include prescription diet-pills, nonprescription diet-pills, laxatives or diuretics, and vomiting after meals.

food most commonly, regardless of CC and NNTP use status. There were significant differences in the frequencies of weight control behaviors among the four groups according to the CC and NNTP use status (Table 3). Among boys, NNTP-only users engaged most frequently in EWCBs and cigarette-only users did least. LWCBs were attempted most frequently by dual users and least frequently by non-users. Among girls, NNTP-only users engaged most frequently in both EWCBs and LWCBs, whereas non-users engaged the least.

The adjusted ORs and 95% CIs of the status of CC and NNTP use on weight control behaviors were calculated using multiple logistic regression analysis. Among boys, NNTP-only users were more likely to engage in EWCBs (OR, 2.45; 95% CI, 1.16 to 5.18) compared to non-users. There was no significant difference in the odds of engaging in LWCBs among the four groups. Regarding individual weight control behaviors, NNTP-only users were more likely to attempt prescription diet

pills (OR, 4.54; 95% CI, 2.00 to 10.31), nonprescription diet pills (OR, 2.55; 95% CI, 1.11 to 5.89), and vomiting after meals (OR, 2.59; 95% CI, 1.02 to 6.60) and cigarette-only users were less likely to attempt dietary supplements (OR, 0.65; 95% CI, 0.43 to 0.98), Korean herbal medicine (OR, 0.52; 95% CI, 0.28 to 0.96), nonprescription diet pills (OR, 0.28; 95% CI, 0.10 to 0.80), and laxatives or diuretics (OR, 0.31; 95% CI, 0.11 to 0.92) than non-users (Table 4). Among girls, users of either CCs or NNTPs were more likely to engage in EWCBs (OR, 1.78; 95% CI, 1.34 to 2.37 in cigarette-only users; OR, 4.87; 95% CI, 2.51 to 9.46 in NNTP-only users; OR, 2.03; 95% CI, 1.40 to 2.96 in dual users) and LWCBs (OR, 1.91; 95% CI, 1.55 to 2.36 in cigarette-only users; OR, 2.50; 95% CI, 1.31 to 4.78 in NNTP-only users; OR, 1.56; 95% CI, 1.18 to 2.07 in dual users) compared to non-users. The odds of engaging in most individual weight control behaviors categorized as EWCBs and LWCBs were significantly higher for users of either CCs or NNTPs than for non-users

**Table 4.** Odds ratio of the status of CC and NNTP use on weight control behaviors in boys<sup>†</sup>

Variable	Non-users	Cigarette-only users	NNTP-only users	Dual users
Regular exercise	1.00 (Reference)	1.02 (0.80–1.30)	1.01 (0.61–1.68)	0.90 (0.69–1.18)
Eating less food	1.00 (Reference)	1.02 (0.82–1.27)	0.79 (0.52–1.22)	0.99 (0.77–1.27)
One-food diet	1.00 (Reference)	1.03 (0.71–1.50)	1.33 (0.57–3.08)	1.21 (0.84–1.73)
Fasting	1.00 (Reference)	1.16 (0.86–1.58)	1.50 (0.88–2.56)	1.04 (0.76–1.43)
Dietary supplements	1.00 (Reference)	0.65 (0.43–0.98)*	1.11 (0.55–2.25)	1.02 (0.72–1.43)
Korean herbal medicine	1.00 (Reference)	0.52 (0.28–0.96)*	1.54 (0.80–2.98)	0.59 (0.31–1.13)
Prescription diet-pills	1.00 (Reference)	0.32 (0.10–1.03)	4.54 (2.00–10.31)*	1.13 (0.54–2.34)
Nonprescription diet-pills	1.00 (Reference)	0.28 (0.10–0.80)*	2.55 (1.11–5.89)*	1.28 (0.72–2.27)
Laxatives or diuretics	1.00 (Reference)	0.31 (0.11–0.92)*	2.39 (0.86–6.62)	0.84 (0.33–2.11)
Vomiting after meals	1.00 (Reference)	0.50 (0.20–1.27)	2.59 (1.02–6.60)*	1.19 (0.66–2.14)
LWCBs <sup>‡</sup>	1.00 (Reference)	1.08 (0.85–1.38)	1.12 (0.70–1.77)	1.01 (0.81–1.28)
EWCBs <sup>§</sup>	1.00 (Reference)	0.67 (0.39–1.18)	2.45 (1.16–5.18)*	1.20 (0.75–1.92)

Values are presented as odds ratio (95% confidence interval).

CC, combustible cigarette; NNTP, noncombustible nicotine or tobacco product; LWCBs, less extreme weight control behaviors; EWCBs, extreme weight control behaviors.

\*P<0.05 (by logistic regression analysis). <sup>†</sup>Adjusted by grade in school, weight status, body shape perception, depressive mood, current alcohol intake, living with family, perceived economic status, and residential district. <sup>‡</sup>LWCBs include one-food diet, fasting, dietary supplements, and Korean herbal medicine. <sup>§</sup>EWCBs include prescription diet-pills, nonprescription diet-pills, laxatives or diuretics, and vomiting after meals.

**Table 5.** Odds ratio of the status of CC and NNTP use on weight control behaviors in girls<sup>†</sup>

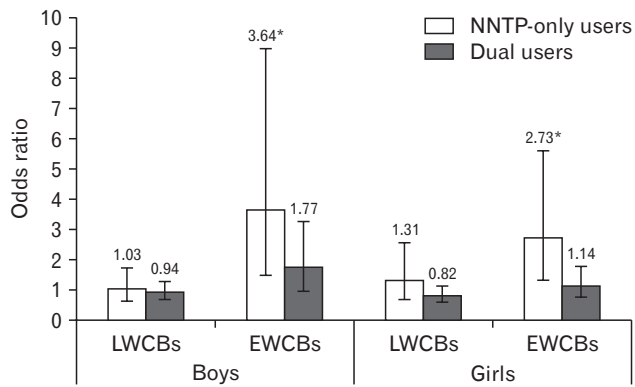
Variable	Non-users	Cigarette-only users	NNTP-only users	Dual users
Regular exercise	1.00 (Reference)	0.84 (0.67–1.05)	0.61 (0.35–1.05)	1.14 (0.80–1.62)
Eating less food	1.00 (Reference)	1.19 (0.82–1.72)	1.11 (0.51–2.40)	1.09 (0.70–1.69)
One-food diet	1.00 (Reference)	1.76 (1.38–2.24)*	2.03 (0.91–4.50)	1.42 (0.98–2.04)
Fasting	1.00 (Reference)	1.86 (1.46–2.37)*	3.45 (1.63–7.30)*	2.25 (1.63–3.11)*
Dietary supplements	1.00 (Reference)	1.61 (1.30–1.99)*	1.99 (1.00–3.96)*	1.05 (0.77–1.42)
Korean herbal medicine	1.00 (Reference)	1.54 (0.91–2.60)	1.75 (0.45–6.78)	0.66 (0.29–1.51)
Prescription diet-pills	1.00 (Reference)	1.07 (0.56–2.03)	4.20 (1.08–16.35)*	1.16 (0.57–2.37)
Nonprescription diet-pills	1.00 (Reference)	1.83 (1.31–2.56)*	5.19 (2.56–10.54)*	1.85 (1.13–3.01)*
Laxatives or diuretics	1.00 (Reference)	1.56 (0.88–2.77)	3.24 (1.01–10.39)*	1.97 (1.01–3.84)*
Vomiting after meals	1.00 (Reference)	2.01 (1.32–3.05)*	4.91 (1.92–12.51)*	1.88 (1.14–3.12)*
LWCBs <sup>‡</sup>	1.00 (Reference)	1.91 (1.55–2.36)*	2.50 (1.31–4.78)*	1.56 (1.18–2.07)*
EWCBs <sup>§</sup>	1.00 (Reference)	1.78 (1.34–2.37)*	4.87 (2.51–9.46)*	2.03 (1.40–2.96)*

Values are presented as odds ratio (95% confidence interval).

CC, combustible cigarette; NNTP, noncombustible nicotine or tobacco product; LWCBs, less extreme weight control behaviors; EWCBs, extreme weight control behaviors.

\*P<0.05 (by logistic regression analysis). <sup>†</sup>Adjusted by grade in school, weight status, body shape perception, depressive mood, current alcohol intake, living with family, perceived economic status, and residential district. <sup>‡</sup>LWCBs include one-food diet, fasting, dietary supplements, and Korean herbal medicine. <sup>§</sup>EWCBs include prescription diet-pills, nonprescription diet-pills, laxatives or diuretics, and vomiting after meals.





**Figure 1.** Odds ratio<sup>†</sup> of noncombustible nicotine or tobacco product (NNTP)-only users and dual users on less extreme weight control behaviors (LWCBs)<sup>‡</sup> and extreme weight control behaviors (EWCBs)<sup>§</sup> using cigarette-only users as the reference. Error bars represent 95% confidence intervals. \* $P < 0.05$  (by logistic regression analysis). <sup>†</sup>Adjusted by grade in school, weight status, body shape perception, depressive mood, current alcohol intake, living with family, perceived economic status, and residential district. <sup>‡</sup>LWCBs include one-food diet, fasting, dietary supplements, and Korean herbal medicine. <sup>§</sup>EWCBs include prescription diet-pills, nonprescription diet-pills, laxatives or diuretics, and vomiting after meals.

(Table 5).

In addition, we obtained the adjusted ORs and 95% CIs of NNTP-only users and dual users on LWCBs and EWCBs using cigarette-only users as the reference. NNTP-only users were found to be more likely to engage in EWCBs compared to cigarette-only users (OR, 3.64; 95% CI, 1.48 to 8.98 in boys, OR, 2.73; 95% CI, 1.33 to 5.61). The odds to engage in LWCBs among NNTP-only users and dual users were not significantly higher than among cigarette-only users (Figure 1).

## DISCUSSION

This study compared the frequencies of weight control behaviors according to the status of CC and NNTP use among Korean adolescents attempting to reduce or maintain their body weight. Among boys, NNTP-only users were more likely to engage in EWCBs, whereas among girls, users of either CCs or NNTPs were more likely to engage in EWCBs and LWCBs. Additionally, NNTP-only users had the greatest odds of engaging in UWCBs among the four groups according to CC and NNTP use status. This finding differs from our expectation that dual users would be the most likely to engage in UWCBs.

It is well known that smoking CCs may co-exist with UWCBs among adolescents.<sup>9,13</sup> Risk behaviors in adolescents tend to be correlated due to shared predisposing factors.<sup>14</sup> UWCBs are risk- and sensation-seeking behaviors common in adolescents. Some adolescents adopt weight-control behaviors with potentially harmful side effects to achieve rapid weight reduction. Furthermore, adolescents with weight concerns may smoke cigarettes for weight control.<sup>15</sup> Nicotine from cigarettes acts as a sympathomimetic, increasing energy expenditure, inducing anorexic effects, and reducing energy intake.<sup>6,16</sup> Recently, it has been reported that the use of EC, a type of NNTPs, is also associated with UWCBs among adolescents.<sup>10,17</sup> Some adolescents believe that

NNTPs are safe and attractive alternatives to CCs. Thus, adolescents with weight concerns may use NNTPs instead of CCs. It has been reported that EC use is related to the intention to lose weight.<sup>8</sup> Previous studies have shown that EC use is also related to various school- and substance-related risk behaviors among adolescents.<sup>18,19</sup> NNTP use may coexist with UWCBs among adolescents, as it is one of the multiple risk behaviors common in adolescence.

We found that NNTP-only users were the most likely to engage in UWCBs among the four groups according to CC and NNTP use status. This finding contradicts our expectation that dual users would be the most likely to engage in UWCBs. Previous studies have shown that EC-only users have intermediate levels of school- and substance-related risk factors between non-users and dual users.<sup>18,20</sup> However, UWCBs differ from other adolescent risk behaviors in that they are related to outward appearance. UWCBs are associated with the desire to achieve thinner body and distorted body perceptions.<sup>21</sup> The main motivations for weight reduction in adolescents are better appearance and peer acceptance.<sup>22</sup> NNTPs are more appealing to adolescents than CCs for various reasons, including trendy design, youth-friendly flavors, lack of odor, easy availability, and convenient use. Sapru et al.<sup>23</sup> suggested that the sense of fashion associated with ECs may encourage adolescents to use them. Adolescent perceptions that NNTP use is attractive and enviable may partially explain the finding that NNTP-only users are most likely to engage in UWCBs.

In this study, cigarette smoking or NNTP use were more strongly associated with UWCBs in girls than boys. This finding is consistent with the results of previous studies.<sup>9,10,17</sup> Korean society imposes stricter social norms regarding smoking and body image on females than on males. Girls who smoke are generally perceived more negatively than boys who smoke.<sup>24</sup> In a society with prejudice against female smoking, girls may use tobacco products as an instrument to attain the desired self-image, including maturity, independence, sexuality, and sociability.<sup>25</sup> In addition, women are under more intense socio-cultural pressure to be thin than men. Thin ideals begin to be internalized in girls from an early age.<sup>26</sup> Accordingly, girls are more likely than boys to use tobacco products with the intention of losing weight.<sup>8,27</sup> Moreover, we found that boys who exclusively used CCs were less likely to attempt Korean herbal medicine, nonprescription diet pills, and laxatives or diuretics than boys who exclusively used NNTPs. These weight control behaviors may be relatively expensive. Her<sup>28</sup> reported that adolescents with higher family economic status were more likely to use ECs than CCs. Familial and personal affluence may be partly responsible for the differences in the frequencies of these weight control behaviors according to the type of tobacco product used by boys.

This study had some limitations that need to be addressed. As this was a cross-sectional study using the KYRBS data, temporal and causal inferences could not be drawn. In this study, EC and HTP users were categorized as NNTP users because the number of participants using only HTPs was insufficient to treat them as a separate group. HTP users may have different weight control behavior characteristics than EC users. However, HTPs have been marketed and appeal to adolescents

in a manner similar to ECs. Additionally, HTPs are generally considered a type of ECs in Korea.<sup>29)</sup> We classified weight control behaviors into HWCBs, LWCBs, and EWCBs based on a previous study.<sup>9)</sup> However, this classification may be controversial. For example, prescription diet pills may be considered a type of LWCBs because some diet pills have been approved by the US Food and Drug Administration for the management of adolescent obesity.<sup>30)</sup> However, there were no significant changes in the main results, even though prescription diet pills were classified as a type of LWCBs. In addition, we present the frequencies of individual weight control behaviors according to the status of CC and NNTP use.

Despite these limitations, this study showed that users of either CCs or NNTPs were more likely to engage in UWCBs, and that NNTP-only users were most likely to do so. Tobacco companies have been rapidly developing new devices for tobacco use and innovating these devices to appeal to adolescents with weight concern. These companies also use the weight loss effects of tobacco products, including ECs and HTPs, as promotional strategies to recruit adolescents. In order to prevent the use of tobacco products among adolescents with weight concerns, marketing and promotional activities related to the weight loss effects of tobacco products should be prohibited and closely monitored, and healthy strategies to control body weight should be developed and encouraged.

## CONFLICT OF INTEREST

Young Gyu Cho has been an associate editor of the *Korean Journal of Family Medicine* but had no role in the decision to publish this article. Except for that, no potential conflict of interest relevant to this article was reported.

## ORCID

A Ra Bong: <https://orcid.org/0000-0001-8749-1727>

Young Gyu Cho: <https://orcid.org/0000-0003-1017-8884>

Hyun Ah Park: <https://orcid.org/0000-0003-2343-8964>

Kyo Woon Kim: <https://orcid.org/0000-0002-3438-9232>

## REFERENCES

- Lee S, Kim J. Evolution of tobacco products. *J Korean Med Assoc* 2020;63:88-95.
- Ministry of Education; Ministry of Health and Welfare; Korea Centers for Disease Control and Prevention. The 15th Korea Youth Risk Behavior Web-based Survey, 2019. Cheongju: Korea Centers for Disease Control and Prevention; 2019.
- Cho YG. Electronic and conventional cigarette use and drinking behaviors in Korean adolescents. *Korean J Fam Med* 2019;40:201-3.
- Chun J, Yu M, Kim J, Kim A. E-cigarette, cigarette, and dual use in Korean adolescents: a test of problem behavior theory. *J Psychoactive Drugs* 2020;52:27-36.
- Lee S, Kimm H, Yun JE, Jee SH. Public health challenges of electronic cigarettes in South Korea. *J Prev Med Public Health* 2011;44:235-41.
- Audrain-McGovern J, Benowitz NL. Cigarette smoking, nicotine, and body weight. *Clin Pharmacol Ther* 2011;90:164-8.
- Singh H, Kennedy RD, Lagasse LP, Czaplicki LM, Cohen JE. E-cigarettes and weight loss-product design innovation insights from industry patents. *Nicotine Tob Res* 2018;20:1010-4.
- Mantey DS, Omega-Njemnobi O, Kelder SH. E-cigarette use is associated with intentions to lose weight among high school students. *Nicotine Tob Res* 2020;22:838-42.
- 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.
- Lee Y, Lee KS. Relationship between unhealthy weight control behaviors and substance use patterns among Korean adolescents: results from the 2017 National Youth Risk Behavior Survey. *Public Health* 2019;174:56-64.
- Kim Y, Choi S, Chun C, Park S, Khang YH, Oh K. Data resource profile: the Korea Youth Risk Behavior Web-based Survey (KYRBS). *Int J Epidemiol* 2016;45:1076.
- Korea Centers for Disease Control and Prevention. 2017 Korean children and adolescents national growth chart: commentary [Internet]. Cheongju: Korea Centers for Disease Control and Prevention; 2017 [cited 2024 Mar 16]. Available from: [https://knhanes.kdca.go.kr/knhanes/sub08/sub08\\_01.do](https://knhanes.kdca.go.kr/knhanes/sub08/sub08_01.do)
- Johnson JL, Eaton DK, Pederson LL, Lowry R. Associations of trying to lose weight, weight control behaviors, and current cigarette use among US high school students. *J Sch Health* 2009;79:355-60.
- Jessor R. Risk behavior in adolescence: a psychosocial framework for understanding and action. *J Adolesc Health* 1991;12:597-605.
- 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.
- 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.
- Wang M, Wang H, Hu RY, Gong WW, Pan J, Yu M. Associations between trying to control weight, weight control behaviors and current electronic cigarette usage in middle and high school students: a cross-sectional study in Zhejiang Province, China. *Tob Induc Dis* 2020;18:28.
- McCabe SE, West BT, Veliz P, Boyd CJ. E-cigarette use, cigarette smoking, dual use, and problem behaviors among U.S. adolescents: results from a national survey. *J Adolesc Health* 2017;61:155-62.
- Kristjansson AL, Mann MJ, Sigfusdottir ID. Licit and illicit substance use by adolescent e-cigarette users compared with conventional cigarette smokers, dual users, and nonusers. *J Adolesc Health* 2015;57:562-4.
- Wills TA, Knight R, Williams RJ, Pagano I, Sargent JD. Risk factors for exclusive e-cigarette use and dual e-cigarette use and tobacco use in adolescents. *Pediatrics* 2015;135:e43-51.
- Pollina-Pocallet M, Artigues-Barbera E, Tort-Nasarre G, Sol J, Azlor L, Foguet-Boreu Q, et al. Self-perception and self-acceptance are related to unhealthy weight control behaviors in Catalan adolescents: a cross-sectional study. *Int J Environ Res Public Health* 2021;18:4976.
- Silva DE, Sena-Evangelista KC, Lyra CO, Pedrosa LF, Arrais RF, Lima

- SC. Motivations for weight loss in adolescents with overweight and obesity: a systematic review. *BMC Pediatr* 2018;18:364.
23. Sapru S, Vardhan M, Li Q, Guo Y, Li X, Saxena D. E-cigarettes use in the United States: reasons for use, perceptions, and effects on health. *BMC Public Health* 2020;20:1518.
24. Kim YH, Kim KW, Kang MO, Kim NH. A phenomenological study on smoking experience in female adolescents. *J Korean Acad Child Health Nurs* 2010;16:10-9.
25. French SA, Perry CL. Smoking among adolescent girls: prevalence and etiology. *J Am Med Womens Assoc (1972)* 1996;51:25-8.
26. You S, Shin K. Body esteem among Korean adolescent boys and girls. *Sustainability* 2019;11:2051.
27. Boles SM, Johnson PB. Gender, weight concerns, and adolescent smoking. *J Addict Dis* 2001;20:5-14.
28. Her W. Factors influencing type of cigarette smoked among adolescents: focusing on the differences between conventional cigarette and electronic cigarette. *Health Soc Welf Rev* 2020;40:489-519. <https://doi.org/10.15709/hswr.2020.40.1.489>
29. McKelvey K, Popova L, Kim M, Chaffee BW, Vijayaraghavan M, Ling P, et al. Heated tobacco products likely appeal to adolescents and young adults. *Tob Control* 2018;27(Suppl 1):s41-7.
30. Woodard K, Louque L, Hsia DS. Medications for the treatment of obesity in adolescents. *Ther Adv Endocrinol Metab* 2020;11:2042018820918789.