■ Original Article

Comparison of Tobacco Use and Cessation Behavior between Conventional Cigarette and Heated Tobacco Product Users: Based on the Analyses of the Eighth Korea National Health and Nutrition Examination Survey 2019

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Background: After the advent of heated tobacco products (HTPs) in 2017, domestic cigarette sales declined until 2019, but have increased in South Korea since 2020. This study aimed to analyze tobacco use and cessation behavior among HTP users compared with conventional cigarette (CC) users.

Methods: We analyzed data from the eighth Korea National Health and Nutrition Examination Survey (2019). Of 6,188 study participants, 1,181 were current tobacco product users (single, dual, and triple), including all combinations of CCs, HTPs, and electronic cigarettes (ECs). Tobacco use and cessation behaviors among single and dual users of CCs and HTPs were assessed using various categorical methods.

Results: In 2019, proportions of HTP use in men and women aged ≥19 years in South Korea were 8.8% and 1.5%, respectively, and those of single, dual, and triple users were 23.6%, 58.0%, and 18.4%, respectively. Dual users had more tobacco use than CC only and HTP only users (all P<0.001). Each daily user accounted for a lower percentage of attempt and preparation stages for cessation than intermittent users (all P<0.001, except for dual users).

Conclusion: In this study, we analyzed the differences in tobacco use and cessation behavior among CC and HTP users in various populations in South Korea. Additionally, we found that all novel tobacco product users had already experienced CCs in adulthood. Further studies that address HTP's harmful effects in humans are necessary.

Keywords: Electronic Nicotine Delivery System; Smoking, Non-Tobacco Product; Tobacco Use; Tobacco Use Cessation

INTRODUCTION

Since the first century B.C., humans have smoked cigarettes; this has become widespread in the 20th century when tobacco production grew robustly. In Korea, it has only been about four centuries since cigarettes came in 1616, after the Japanese Invasion of Korea in 1592, according to the Annals of the Joseon Dynasty, and it became widely used. As of 2016, the overall smoking prevalence (among those >15 years) in South Korea was 33.5% in males and 8.8% in females.[1]

As it is well known, tobacco use is the world's "leading preventable cause" of death today. Globally, people suffer from tobacco-related health problems, such as cardiovascular diseases, stroke, lung cancer, and other respiratory diseases that lead to death in serious cases, which will continue to occur in the future.[2]

The World Health Organization (WHO) Framework Convention on Tobacco Control, "the first international treaty" with legislative effects on public health, was enrooted in 2003 and has evolved since then.[3] Such and other regulatory actions were mostly effective on smokers' behavior mirrored by socioeconomic indicators. The figures related to cigarette smoking have been useful for authorities to establish tobacco product regulation policies to prevent the excessive economic cost of tobacco use and other secondary socioeconomic losses.[4]

Various regulations have put tobacco companies on the brink of existence, and they have begun to use new strategies for their own survival. Novel tobacco products have landed on the market with shrewd tactics, being "fancy" contour and hyped up as lesser harmful than conventional ones, thereby enticing smokers using conventional cigarettes (CCs) into having hands on them with or without hope of smoking cessation. Novel tobacco products include electronic cigarettes or e-cigarettes (ECs), and heated tobacco products (HTPs). EC is an electronic device that applies heat to a solution that dissolves nicotine in a particular solvent using its own battery and vaporizes it, which makes users inhale. HTP is a hybrid form of CC and EC that heats a uniquely designed cigarette up to 350°C (lower than CC), vaporizes, and delivers it to users.[5] In South Korea, the world's second largest market for HTPs, HTP has been expanding its market share since 2017, after EC was briefly introduced and before going off the market. A substantial proportion of polytobacco use has been reported around the same time.[3]

The tobacco market in South Korea has been facing changes since the introduction of novel tobacco products. Smoking rate is in line with cigarette sales in South Korea, which is usually the lowest in the first quarter of every year and increases until the next year. In other words, the rate increases when sales rise and tends to decrease when the sales reduce. Contrary to previous trend, the decline in tobacco sales has slowed gradually and then turned into an uptrend since 2020, with the appearance of novel tobacco products. Furthermore, the number of visits to smoking cessation clinics decreased during the same period.[4] Novel tobacco products have also changed the behavior of tobacco users. People who switched from CCs to HTPs had less intention to quit tobacco than CC users, as documented in previous studies.[4,6] It has been demonstrated that polytobacco users were more dependent on nicotine and less willing to quit tobacco use than sole users.[7]

This study aimed to verify the results of previous studies using a representative sample, the Korea National Health and Nutrition Examination Survey (KNHANES). It represents the general health behavior and nutritional status of Koreans and is indicative of tobacco use status. We attempted to substantiate two points: whether dual users are highly dependent on nicotine in terms of the amount of tobacco use and time to first cigarette (TTFC) or stick, and whether their intention to use tobacco decreases, as expressed by the proportions of an attempt to quit using tobacco over the past year and the preparation stage of tobacco cessation.
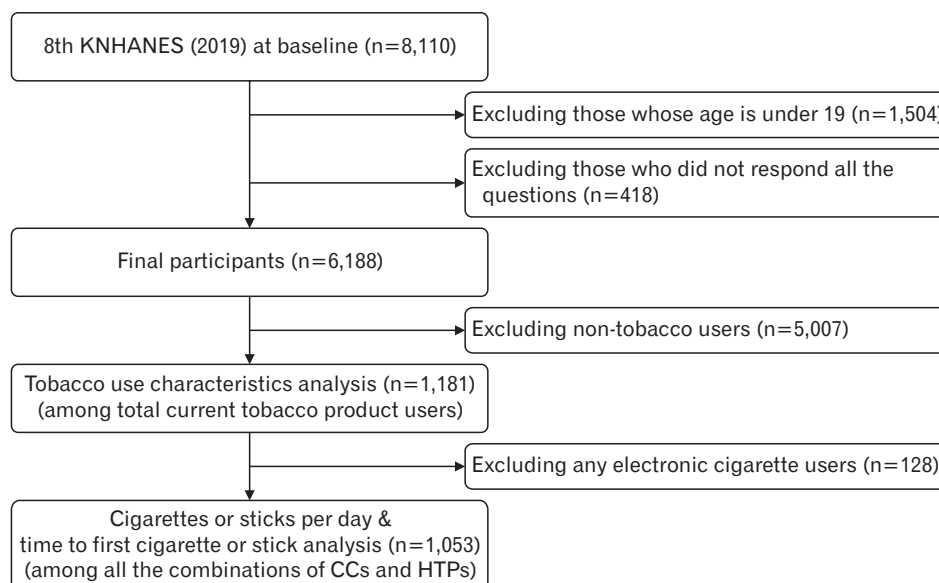
Figure 1. Flowchart of the study population. KNHANES, Korea National Health and Nutrition Examination Survey; CC, conventional cigarettes; HTP, heated tobacco products.

METHODS

1. Research Scheme and Data Collection

Raw data from the eighth KNHANES 2019, run by the Korea Center for Disease Control and Prevention (currently Korea Disease Control and Prevention Agency) were used in this study. As a representative database of the overall population of South Korea, the data were sampled using complex cluster sampling with two-stage stratification. We found the total number of KNHANES respondents to be 8,110. Surveys of novel tobacco products have been conducted since 2011 for ECs and 2019 for HTPs. This study was exempted by the Institutional Review Board of Seoul National University Hospital (2107-183-1237) because the KNHANES is open to the public. The personal identifiers of all study participants were de-identified. The requirement for obtaining informed consent was waived.

2. Setting Eligibility Criteria

Of the 8,110 respondents in the baseline data, those who were 19 years of age at the time of the survey (n=1,504) and did not complete the questionnaire (n=418) were excluded from the study (Figure 1). Finally, 6,188 participants were included in the study. The participants were divided into various groups, depending on whether they used tobacco products, and if so, what kind of products they used.

3. Definition of Variables

We used the term "user" instead of "smoker" for tobacco use, considering that existing smoking terms do not fully reflect the use of novel tobacco products; for example, vaping and heating are differentiated from smoking. Tobacco use status among different types of products was classified into three groups: current, former, and never users, including smokers, as mentioned in a previous study.[8] In the case of CCs, current and former smokers were defined as those who smoked more than five packs (equivalent to 100 cigarettes) in their lifetime, but they were sorted according to whether they smoke or not at the time of the survey, i.e., "yes" for the current smokers and "no" for the former ones. Current smokers were subdivided into daily and intermittent us-

Table 1. General characteristics of study participants by gender

Characteristic	Category	Total (n=6,188, N=42,408,587)				P-value*
		Male (49.7%, n=2,743, N=21,061,794)		Female (50.3%, n=3,445, N=21,346,793)		
		No.	% (SE)	No.	% (SE)	
Age (y)	<30	388	18.8 (1.0)	361	16.6 (1.0)	0.003
	30–39	423	18.1 (1.2)	491	16.1 (1.0)	
	40–49	483	19.7 (1.0)	624	19.0 (0.9)	
	≥50	1,449	43.4 (1.5)	1,969	48.4 (1.3)	
Residential area	Metropolitan	1,222	44.8 (2.2)	1,570	46.1 (2.1)	0.484
	Another city	1,005	39.5 (3.0)	1,252	38.8 (3.0)	
	Rural area	516	15.7 (2.7)	623	15.1 (2.5)	
Educational level	<High school	569	14.5 (1.0)	1,071	24.4 (1.2)	<0.001
	High school	943	35.9 (1.1)	1,036	32.5 (1.1)	
	>High school	1,098	44.8 (1.5)	1,192	39.0 (1.4)	
Occupation	Manual labor or unemployed	2,242	79.8 (1.0)	2,905	82.8 (0.8)	0.051
	Professional jobs	363	15.2 (1.0)	393	13.0 (0.7)	
Household income	Low	467	12.2 (0.8)	738	18.0 (1.1)	<0.001
	Middle-low	710	25.2 (1.3)	891	25.5 (1.1)	
	Middle-high	709	27.9 (1.2)	839	25.4 (1.0)	
	High	845	34.1 (1.6)	962	30.5 (1.6)	
Marital status	Married	1,963	67.6 (1.3)	2,276	65.1 (1.1)	<0.001
	Never married	609	27.7 (1.2)	457	18.3 (1.0)	
	Divorced or separated	110	3.4 (0.4)	206	5.4 (0.5)	
	Widowed	61	1.3 (0.2)	505	11.2 (0.7)	
Type of tobacco products and related products use	Non-tobacco user	1,762	62.0 (1.1)	3,245	93.6 (0.6)	<0.001
	Any CC	897	34.7 (1.1)	182	5.9 (0.6)	
	Any EC	104	4.3 (0.5)	24	1.0 (0.3)	
	Any HTP	202	8.8 (0.7)	41	1.5 (0.3)	
Alcohol consumption frequency	≤1/mo	961	34.9 (1.1)	1,904	55.8 (1.0)	<0.001
	2–4/mo	727	28.8 (1.0)	602	19.1 (0.8)	
	At least weekly	929	32.4 (1.1)	376	11.4 (0.7)	

Values are presented as unweighted sample size (n), weighted sample size (N), and % (SE). Non-tobacco user is defined as the sum of former and never users among all tobacco product users.

SE, standard error; CC, conventional cigarette; EC, electronic cigarette; HTP, heated tobacco product.

*Derived from chi-square analyses.

ers, depending on the frequency of use, especially for dual users, in a similar manner according to a study by Borland et al.[9]

This description was also applied to ECs and HTPs, albeit with slightly different definitions. Lifetime experience with ECs and HTPs was defined as not equal to CCs, but "ever-use in their lifetime" and so was current experience as "ever-use in the past one month" at the same period. Former users were those who answered "not applicable" in current use for EC users and did so in the same way as CC for HTP users.

We first defined new terms "total current tobacco product users" and "non-tobacco users," as mentioned in the following: All current tobacco users, including CCs, ECs, and HTPs were defined as total current tobacco users (n=1,181), and former (n=1,228) and never (n=3,779) users, as non-tobacco users (n=5,007).

The combinations of current tobacco product users were indicated as follows: any users were defined as those who currently use at least one type, single users for only one type, dual users for two types, and triple users for all three types of products. Each group was represented by the following terms: "any CC," "any EC," and "any HTP" for any users of each type, "CC only," "EC only," and "HTP only" for single users of it and "CC+HTP dual," "CC+EC dual," "EC+HTP dual," and "CC+EC+HTP triple" for redundant users. The "+" sign between the letters stands for combination.

4. Tools for Tobacco Use and Cessation Behavior

Targeted for all current tobacco product users, we analyzed tobacco use and cessation behavior using several measures. First, as indices of nicotine dependence, the terms cigarettes per day (CPD) and TTFC in the morning in the Fagerström Test for Nicotine Dependence were used with slight modifications to the definition in the study, reflecting changes in tobacco use behavior: CPD as cigarettes or sticks per day and TTFC as time to first cigarette or stick in the morning. They were applied only to the CC and HTP users, and not the EC users because of the absence of a measure for them. Cigarettes or sticks per day were divided into four groups: ≤10, 11–20, 21–30, and >30 cigarettes or sticks. TTFC was split into four groups: 5 or less, 6 to 30, 31 to 60, and more than 60 minutes (1 hour). Both tools were evaluated through respondents answering the question, "How many cigarettes or sticks do you use per day?" and "How long does it take to use your first cigarette or stick in the morning?"

Second, attempts and motivation to quit using tobacco were assessed using a transtheoretical model for those who responded to the question, "Have you ever ceased to use tobacco for more than a day (24 hours) with the intention of quitting in the past year?" and "Do you have any plan to quit using tobacco in the next month?" Answers were distinguished by "yes" or "no" for the first one and "within 1 month," "within 6 months," "not within 6 months, but someday," and "not at all at the moment," for the other one, which is thought to be a "preparation stage (only for the first option)" and "others (including the others)," respectively.

5. Sociodemographic Characteristics

As shown in Table 1, sociodemographic factors, such as age, gender, residential area, educational level, occupation, household income, marital status, and frequency of alcohol consumption were included in the analysis. Household income was divided into quartiles as follows: "Low (less than 1 million in South Korean won [KRW])" for the first, "middle-low (between 1 and 2 million KRW)" for the second, "middle-high (between 2 and 3 million KRW)" for the third, and "high (more than 3 million KRW)" for the last quartile. In the employment survey, except for military services, those who answered, "managers, experts, and associated workers" were deemed "professional jobs" and the others "manual labor or unemployed."

6. Statistical Analyses

We conducted weighted analyses to comprehensively understand the changes in population behavior. The chi-square test was used to investigate the association between tobacco use and smoking cessation behavior in all combinations made by CC and HTP, that is, CC only, HTP only, and CC+HTP dual users, with a P-value of <0.05, which was considered statistically significant. Statistical analyses were carried out using STATA ver. 16.1 (Stata Corp., College Station, TX, USA) throughout the study.

RESULTS

1. General Characteristics of Study Participants

The general characteristics of the study participants according to gender are listed in Table 1. Of the 42.4 million participants, males and females were 21.1 million (49.7%) and 21.3 million (50.3%), respectively. They were 47.8 years old on average, and nearly half of them lived in metropolitan areas with above college graduates. Most participants were manual laborers or unemployed, and their household income was distributed in the middle of the quartile. Approximately 60% of them were married and drank alcohol less than once a week. Among the various types of tobacco products and related products used, CC users were the most common (34.7% for males and 5.9% for females), followed by HTP (8.8% and 1.5%), and EC (4.3% and 1.0%), regardless of gender. Non-tobacco users accounted for a greater percentage of females than males (93.6 versus 62.0%, P<0.001).

2. Current Status and Characteristics of Tobacco Use by Each Product Group

Of the 1,181 current tobacco product users, more detailed tobacco use status, including concurrent, former, and never experience of any other product for each type by gender, is presented in Table 2. Any CC users were mostly single users, but any EC or HTP users were mostly dual users irrespective of gender, as depicted in Figure 2. In each subtype of tobacco product user group, single users were prevalent (more than 70% in each gender) in any CC users, while dual users made up the largest proportion (approximately 40%–50%) of any EC and any HTP users. Notably, there was no "never CC experience" for all novel

Table 2. Comparison of tobacco use characteristics of each product group by gender among total current tobacco product users

Variable	Total current tobacco product users (n=1,181, N=9,378,753)							
	Male (85.3%, n=981, N=8,003,071)				Female (14.7%, n=200, N=1,375,682)			
	Any CC	Any EC	Any HTP	Total	Any CC	Any EC	Any HTP	Total
No.	897	104	202	981	182	24	41	200
% (SE)	34.7 (1.1)	4.3 (0.5)	8.8 (0.7)	38.0 (1.1)	5.9 (0.6)	1.0 (0.3)	1.5 (0.3)	6.4 (0.6)
Single	26.8 (0.6)	0.7 (0.2)	2.1 (0.3)	29.6 (1.0)	4.4 (0.3)	0.2 (0.1)	0.3 (0.1)	4.9 (0.5)
Dual	6.5 (0.6)	2.1 (0.2)	5.2 (0.3)	6.9 (0.7)	1.0 (0.2)	0.4 (0.1)	0.7 (0.1)	1.0 (0.3)
Triple	1.4 (0.3)	1.4 (0.2)	1.4 (0.2)	1.4 (0.3)	0.4 (0.2)	0.4 (0.1)	0.4 (0.1)	0.4 (0.2)
Never								
EC	67.5 (2.0)		44.2 (4.0)		71.4 (5.2)		42.8 (7.8)	
CC		0	0			0	0	
HTP	61.6 (2.0)	31.5 (5.2)			63.3 (4.9)	26.4 (8.8)		
Former								
EC	23.4 (1.8)		34.6 (4.4)		15.9 (3.8)		23.3 (7.0)	
CC		26.2 (4.6)	29.2 (3.4)			26.6 (10.9)	23.0 (6.1)	
HTP	20.4 (1.7)	24.7 (5.4)			17.3 (3.7)	24.5 (12.0)		
Current								
EC	9.1 (1.1)		21.2 (3.1)		12.7 (3.7)		33.8 (7.0)	
CC		73.8 (4.6)	70.8 (3.4)			73.4 (10.9)	77.0 (6.1)	
HTP	18.0 (1.7)	43.8 (5.5)			19.3 (3.4)	49.0 (11.9)		

Values are presented as unweighted sample size (n), weighted sample size (N), and % (SE). All proportions, except for male and female users and never, former, and current status, are expressed as percentages in all general population. The percentage of male and female represent the proportion of users in total current tobacco product users. Never, former, and current represent the proportion of users of different types over time in each product type.
CC, conventional cigarette; EC, electronic cigarette; HTP, heated tobacco product; SE, standard error.
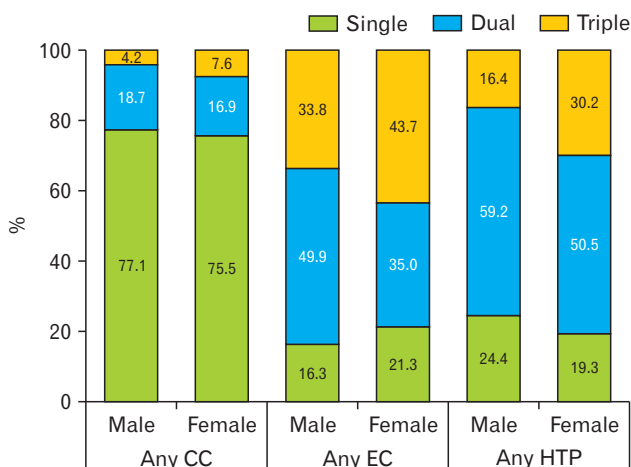
Figure 2. Distribution of each tobacco use combination by type and gender (in stacked column chart). Values are presented as weighted proportions (%) in each type of combination. CC, conventional cigarette; EC, electronic cigarette; HTP, heated tobacco product.

tobacco product users in contrast to "a little" experience with the product among any CC users.

3. Association between Tobacco Use and Cessation Behavior between CC and HTP Users

We analyzed tobacco use and cessation behavior between CC and HTP users who contributed to an expansion of market share, divided into CC only, HTP only, and CC+HTP dual users, as shown in Table 3.

Among the three groups, most of them (<90% in each group) were daily users and a significant difference in cigarettes or sticks per day was observed (P<0.001). The CC+HTP dual users had more cigarettes or sticks per day than CC only and HTP only users (mean value, 20.0, 13.2, and 12.9, respectively; all P<0.001), but no significant difference was observed between the CC only and HTP only users (P=0.96). There was no significant difference in the TTFC among the three groups. In terms of tobacco cessation, none of the pairwise differences among the groups in an attempt to quit tobacco use or the preparation stage of tobacco cessation were statistically significant. Markedly, regardless of statistics, the percentage of those who did not try to pull out of tobacco use "most recently" was "numerically" lowest in the HTP only users among the groups, which had a different trend from that of "in the past year," the whole minus the other part: that of quit using tobacco in the past year.

As shown in Table 4, regardless of the type of product used, it was confirmed that there was a heterogeneous pattern of tobacco use and cessation behavior among daily and intermittent users. Significant differences in both cigarettes or sticks per day and TTFC were identified; daily CC+HTP dual users had more cigarettes or sticks per day than daily users of CC and HTP only (mean value 21.9, 14.4, and 13.8, respectively; all P<0.001). Daily users of CC only and CC+HTP dual users had more cigarettes or sticks per day than intermittent ones (mean value 14.4 versus 5.2 for CC only and 21.9 versus 9.1 for dual users, all P<0.001). Daily CC-only users had less TTFCs than intermittent users (P<0.001).

The difference in trying and preparing to quit tobacco use between

Table 3. Tobacco use behavior of each product group by the type and combination among CC and HTP users

Variable	Category	CC only	HTP only	CC+HTP dual	P-value*
Size and proportions (total n=1,053, N=8,261,462)	% (SE)	79.8 (1.7)	6.2 (0.9)	14 (1.4)	
	n	865	62	126	
	N	6,590,350	513,286	1,157,826	
Frequency	Daily	86.6 (1.4)	89.5 (3.8)	85.6 (3.9)	0.785
	Intermittent	13.4 (1.4)	10.5 (3.8)	14.4 (3.9)	
Cigarettes/sticks per day	≤10	48.4 (1.8)	51.8 (7.1)	20.9 (4.5)[†,‡]	<0.001
	11–20	46.0 (1.8)	43.6 (7.1)	44.4 (4.6)[†,‡]	
	21–30	4.8 (0.9)	2.0 (1.4)	20.2 (3.9)[†,‡]	
	>30	0.9 (0.3)	2.6 (2.6)	14.5 (3.3)[†,‡]	
Time to first cigarette/stick (min)	>60	27.6 (1.8)	25.7 (6.1)	33.8 (5.1)	0.262
	31–60	18.2 (1.7)	22.2 (5.7)	17.0 (3.6)	
	6–30	28.7 (1.6)	27.6 (6.4)	31.1 (4.3)	
	≤5	25.5 (1.8)	23.8 (6.2)	18.1 (3.6)	
Quit tobacco in the past year	Yes	52.8 (1.7)	45.6 (6.9)	54.1 (5.0)	0.140
Readiness to quit using tobacco	Preparation	19.4 (1.6)	14.6 (4.4)	11.5 (3.0)	<0.05
	Others	80.6 (1.6)	84.7 (4.5)	88.5 (3.0)	
Methods of tobacco cessation[§]	By themselves	65.4 (2.0)	85.1 (5.4)	58.9 (4.5)	
	Telephone counselling for tobacco cessation	2.1 (0.6)	0	0	
	Visiting tobacco cessation clinics in public health center[‖]	10.9 (1.0)	12.8 (4.2)	15.4 (3.7)	
	Buying and using NRT[¶] themselves at the pharmacy	3.8 (0.8)	7.9 (3.6)	6.5 (2.4)	
	Using NRT through hospital or treatment with prescription medication	3.7 (0.7)	6.0 (3.3)	2.4 (1.2)	
	By online resources such as No Smoke Guide[#]	1.1 (0.4)	0	4.5 (2.0)	
	Others**	0.4 (0.2)	3.1 (3.1)	1.6 (1.1)	
	No attempt "most recently"	23.0 (1.7)	4.7 (3.6)	24.2 (4.3)	

Values are presented as unweighted sample size (n), weighted sample size (N), and % (SE). All proportions are expressed as fractions within each group.
CC, conventional cigarette; HTP, heated tobacco product; SE, standard error.
*Derived from chi-square analyses. [†]P-values are calculated between CC only and CC+HTP dual users (all P<0.001). [‡]P-values are calculated between HTP only and CC+HTP dual users (all P<0.001). [§]Multiple responses were available. [‖]Including stop smoking service support services such as counselling and nicotine replacement therapy, etc. [¶]Nicotine replacement therapy; including low doses of nicotine in the form of gum, patches, and candies, etc. [#]No Smoke Guide is a representative non-smoking portal site operated by the Ministry of Health and Welfare and the National Cancer Center in South Korea. Available from: https://www.nosmokeguide.go.kr/index.do. **Others include the following items: forceful situations in military camps (by others), using nicotine patches from the military, herbal cigarettes (as known as Kumyeoncho), stop smoking pipes, non-nicotine electronic cigarettes, mint-scented straws, and plain candies, and taking nicotine patches and the prescription medications given by an acquaintance.

the three groups was also significant; daily users showed a lower percentage of both attempts to quit using tobacco (less than 50%) and preparation stage (about 10%) of tobacco cessation than intermittent users (all P<0.001), except for the following: there was no significant difference in the preparation stage between daily and intermittent users of CC+HTP dual users (9.4 versus 24.1%, P=0.92). Both intermittent HTP only and intermittent CC+HTP dual users showed a significant difference in their attempt to quit from intermittent CC only users (all P<0.05).

DISCUSSION

The release of novel tobacco products has had a tremendous impact on individuals and society in the global tobacco market. Since its debut in the market in 2003, it has been reported that EC has numerous potential risks to humans at various levels. Its use was restricted after an outbreak of e-cigarette or vaping use-associated lung injury (EVALI) in 2019, defined by the Centers for Disease Control and Prevention as

an acute or subacute pulmonary disorder with a mixture of respiratory symptoms and death. The pathogenesis of EVALI is unclear, but vitamin E acetate in the component of EC is considered one of the major causes of EVALI.[10]

Launched in 2014, HTP is rapidly expanding its market share. Based on Euromonitor data in 2019, the world's largest market for HTPs is Japan (8.6 billion in US dollar [USD]), followed by South Korea (1.6 billion USD), Italy (1 billion USD), Russia (rapidly increasing two times in the market since 2018), and other European countries.[11] The most popular brand of HTP is IQOS made by Phillip Morris International, sold in 66 countries as of March 2021, and is expected to expand to 100 countries by 2025. Other brands, such as Glo and Lil, made by the British American Tobacco and Korea Tobacco & Ginseng Corporation (KT&Q), respectively, account for substantial market share. The number one tobacco manufacturer in South Korea, KT&Q, introduced Lil to the domestic market in the fourth quarter of 2017, contributing to the market share of novel tobacco products.[12,13]

It is well known that younger generations access HTPs by virtue of

Table 4. Tobacco use behavior of each product group by the frequency of use among CC and HTP users

Variable	Category	CC only		HTP only		CC+HTP dual		P-value*
		Daily	Intermittent	Daily	Intermittent	Daily	Intermittent	
Size and proportions (total n=1,053, N=8,261,462)	% (SE)	69.1 (1.9)	10.7 (1.1)	5.6 (0.9)	0.7 (0.2)	12.0 (1.3)	2.0 (0.6)	0.785
	n	754	111	55	7	110	16	
	N	5,710,099	880,251	459,160	54,126	990,989	166,837	
Cigarettes/sticks per day	≤10	41.3 (1.9)	94.4 (2.9)[†]	47.9 (6.7)	85.0 (15.5)	11.4 (3.0)[‡,§]	77.2 (14.4)[†]	<0.001
	11–20	52.3 (1.9)	4.8 (2.8)[†]	47.0 (6.6)	15.0 (15.5)	48.0 (4.1)[‡,§]	22.8 (14.4)[†]	
	21–30	5.4 (1.0)	0.8 (0.8)[†]	2.2 (1.4)	0	23.6 (4.0)[‡,§]	0.0[†]	
	>30	1.0 (0.4)	0[†]	2.9 (2.9)	0	16.9 (3.9)[‡,§]	0.0[†]	
Time to first cigarette/stick (min)	>60	21.3 (1.7)	68.6 (4.9)[†]	22.9 (5.3)	49.5 (16.9)	28.1 (5.1)	67.5 (12.8)	<0.001
	31–60	19.2 (1.9)	11.4 (3.7)[†]	20.5 (4.5)	36.7 (16.8)	18.8 (3.4)	6.4 (4.9)	
	6–30	31.4 (1.8)	11.0 (2.5)[†]	29.2 (5.1)	13.8 (1.1)	32.8 (4.1)	20.9 (14.0)	
	≤5	28.1 (1.9)	8.9 (3.8)[†]	26.6 (6.5)	0	20.3 (3.9)	5.2 (5.6)	
Quit tobacco in the past year	Yes	48.1 (1.9)	83.5 (3.6)[†]	39.1 (5.3)	100.0[†,ǁ]	46.6 (5.1)	98.6 (0.2)[†,ǁ]	<0.001
Readiness to quit using tobacco	Preparation	14.8 (1.4)	49.6 (5.6)[†]	6.2 (3.1)	86.2 (1.1)[†]	9.4 (2.4)	24.1 (11.9)	<0.001
	Others	85.2 (1.4)	50.4 (5.6)[†]	93.0 (3.1)	13.8 (1.1)[†]	90.6 (2.4)	75.9 (11.9)	

Values are presented as unweighted sample size (n), weighted sample size (N), and % (SE). All proportions are expressed as fractions within each group.

CC, conventional cigarette; HTP, heated tobacco product; SE, standard error.

*Derived from chi-square analyses. [†]P-values are calculated between daily and intermittent users of each product group (all P<0.001). [‡]P-values are calculated between daily users of CC only and CC+HTP dual (all P<0.001). [§]P-values are calculated between daily users of HTP only and CC+HTP dual (all P<0.001). [ǁ]P-values are calculated between intermittent users of CC only and HTP only and that of CC only and CC+HTP dual (all P<0.05).

their ease of use and the pursuit of healthy features. Many factors, such as health, financial, physical, practical, psychological, and social factors, are related to HTP use and its relevant behavior independently and with one another.[14,15] Even though the majority of tobacco manufacturers insist that HTP contains less nicotine level that will make smokers less dependent on and then get healthier than any other CC user, a lot of the facts have not yet been elucidated regarding the health impact on humans.

Given that the WHO argued to explore and implement strategies to minimize net impairment of health consumption regardless of how many nicotine-containing products are consumed, tobacco harm reduction strategies seem to be effective not only for conventional smokers but also for novel product users willing to reduce their own amount of tobacco use.[16]

Several pieces of evidence contradict this argument. In contrast to the manufacturer's opinion, several independent researchers reported that there was a comparable level of nicotine and other additives, such as volatile materials, heavy metals, and even unknown materials, which will have an adverse effect on humans through a collection of undisclosed mechanisms.[17] Even a small amount of tobacco use can elevate the risk of cardiovascular diseases[18,19]; even one-cigarette smoking can affect health. Chang et al.[20] reported that total mortality and cardiovascular diseases cannot be reduced even if smoking amount is reduced, meaning that the novel tobacco products still pose a detrimental effect on health in a small amount. There is no doubt that it will take several decades to shed light on the long-term harmful effects of tobacco use, and in the case of HTPs, there are some studies for only a short period of time, but no long-term effects.[21]

Despite many efforts to reduce the harmful consequences of tobac-

co use, tobacco use and cessation practices have moved away from the existing trend after the introduction of novel tobacco products. The awkward trend has been accelerating since 2017 when HTPs were introduced in South Korea. The overall tobacco sales, sum of CCs, and novel tobacco products have not diminished since 2017, albeit with a decrease in that of CCs. Along with the fact that the number of visits to tobacco cessation clinics has declined during the same period, the novel tobacco products are considered successful in the market for tobacco manufacturers against the pre-existing endeavor for tobacco cessation. Although many countries have established regulation policies, including for novel products, the type and extent of methods vary greatly among them, and it is difficult to control the subsequent short- and long-term effects of product use. To determine what is going on tobacco use status per se by previous surveys consisting of a questionnaire related to CCs, it will be necessary to investigate the changes in the pattern over time to establish and execute tobacco control policies based on national statistics reflecting the behavior of novel tobacco product use.[5,22]

More serious problems related to tobacco use remain among the adolescents. Adolescents are disposed of using dual products and are associated with allergic diseases with the entrance of novel tobacco products into the market.[23] Moreover, they are vulnerable to substance abuse, such as alcohol use problems, especially in females, and proper action is needed to establish a sustainable and healthy society.[24,25]

Among the different types of current tobacco users, the finding in Table 1 that CC users were the most followed by any HTP and any EC users regardless of gender reflects the recent boom and steady upward trend of HTPs in South Korea, similar to the percentage of HTP use in the previous study.[26] This is more noticeable in Table 2, which shows

each product user's own behavior with tobacco product use by gender, especially among female users. In females with a small proportion of current tobacco product users, the relative ratio of HTP to CC and EC use, even in a very small percentage, was by no means small, consistent with a previous study that reported a gradual increase in female HTP users, from 5.5% in 2015 to 7.5% in 2018 for adult women, and from 2.7% in 2016 to 3.8% in 2019 for adolescent women.[4]

It is noteworthy that the finding that there were about 70% of concurrent CC users among any EC and HTP users (Table 2) and more than 70% of redundant users among HTP users, as shown in Figure 2, has a similar trend to that of Kim et al.[3] and Tabuchi et al.[27]; however, with slightly different proportions because they were based on online survey data. Another finding that no "never CC experience" and a substantial fraction of "current CC experience" as shown in Table 2 suggests that all novel tobacco product users have already experienced and are currently experiencing CCs in adults. That should be noted because it shows the possibility against an existing theory, "Gateway theory," which states that novel tobacco products could be a gateway to nicotine addiction through subsequent use and moving on to the "harder" step by vulnerable users, such as adolescents,[28] as shown in a previous study with higher concurrent use of CC and EC among them.[29] A longitudinal study of Korean adolescents is necessary to confirm this hypothesis.

Furthermore, among all combinations of CC and HTP, comprising the largest proportion of total current tobacco product users, it is remarkable that there was the lowest percentage of HTP users who have tried tobacco cessation in the past year and most recently, but different proportions, as shown in Table 3, which is in line with previous studies.[4,6]

Considering that the respondents could make duplicate answers to the survey on how to quit tobacco use, HTP only users had the highest percentage of direct actions, such as by themselves and visiting tobacco cessation clinics in public health centers, pharmacies, and hospitals compared to the others. The discrepancy between attempts to quit tobacco use at different periods could be explained by two factors. First, those who had strived for tobacco cessation in the past year did the same thing most recently, leading to a response at a lower rate. Second, inconsistent responses would be possible, given the decrease in different rates from quitting tobacco in the past year to most recently among the groups in Table 3.

Given the finding of different tobacco use and cessation behaviors among daily and intermittent users of any type of tobacco products in Table 4, it is presumed that there were different degrees of nicotine dependence among them–higher in dual users than single users and in daily users than intermittent ones, which is similar to the study by Borland et al.,[9] except that it dealt with ECs rather than HTPs.

This study has several limitations. It is difficult to know specific behavioral changes in the tobacco product users in view of the fact that it is based on cross-sectional research in 2019. Because the study is based on a self-reporting questionnaire, there are vague expressions, for example, "most recently," and the criteria for when is unclear. This can confuse respondents, requiring more definite questions to accurately reflect their behavior and reduce the gap; about 40% reported in the previous study—between survey results and the real world.[30]

It is difficult to explain the reversal of trends in cigarettes or sticks per day for daily CC+HTP dual users; they were distributed in order from the lower category of cigarettes or sticks per day in other users but not in CC+HTP dual users. This was similar to the lower rate at the preparation stage in cessation for intermittent CC+HTP dual users than the daily ones. A blow-by-blow analysis, including the tobacco use trajectory of the users will be necessary to determine the reasons why those users have unique characteristics.

Despite these restrictions, this study has strengths. It analyzed tobacco use and cessation behavior with a sample group, representing the whole population in South Korea. Notably, this is the first study to summarize the terms total current tobacco users and non-tobacco users related to the use of CCs and novel tobacco products to reflect changes in behavior of tobacco use, with a slight modification to the existing terms, CPD and TTFC. Moreover, it is the first research to assess daily and intermittent HTP users with more detailed questionnaire items of HTPs in 2019, different ever before in South Korea. Additionally, it is the first study to suggest that existing the "gateway theory" needs to be tested for adolescents in South Korea afterwards.

In summary, the prevalence of HTP use in men and women aged ≥19 years in South Korea in 2019 was 8.8% and 1.5%, respectively. The proportions of single, dual, and triple users of HTPs were 23.6%, 58.0%, and 18.4%, respectively. Among single and dual users, consisting of CC and HTP, differences in the behavior of tobacco use and cessation were observed, which were similar when the users were subdivided into frequency of use. Dual users were more dependent on nicotine than single users and so were daily users than intermittent users of each product group.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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