Drug and Alcohol Dependence 204 (2019) 107576

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Full length article

Heated tobacco products: Cigarette complements, not substitutes

Jun Hyun Hwang[a], Dong Hee Ryu[b,c], Soon-Woo Park[a,*]

[a] Department of Preventive Medicine, Catholic University of Daegu School of Medicine, Daegu, Republic of Korea
[b] Department of Preventive Medicine, School of Medicine, Kyungpook National University, Daegu, Republic of Korea
[c] Department of Preventive Medicine, Regional Cancer Center, Kyungpook National University Medical Center, Daegu, Republic of Korea

ARTICLE INFO

Keywords:
Heated tobacco products
Heat-not-burn
Cigarettes
E-cigarettes
Intention to quit smoking

ABSTRACT

Background: In Korea, the sale of the first heated tobacco product (HTP), IQOS®, commenced in June 2017. This study evaluates the rates of HTP use and examines HTP users' smoking patterns of various tobacco products.
Methods: The study analyzed the 2018 Korea Community Health Survey data of a Korean provincial division, which includes 11 cities and 14 counties. Of 21,100 participants, the proportion of current HTP users was calculated and their smoking patterns, in regard to cigarette use, were examined. A multinomial logistic regression model was used to evaluate the related factors of HTP use.
Results: The proportion of current HTP users (HTP use within the past 30 days) was 2.13% of the study population. Of these current HTP users, 96.25% were dual users of cigarettes. The adjusted odds ratio (AOR) for current HTP use increased proportionately with frequency and amount of cigarette consumption with statistical significance. The AOR values showed a quadratic curve, descending after the peak value for moderate daily smokers (10–19 cigarettes/day) ($P_{trend} < 0.001$, $P_{quadratic} < 0.001$). Current cigarette smokers who also used HTPs were not associated with an intention to quit cigarette smoking within a month.
Conclusions: Given the smoking pattern of HTP users in terms of mutual use with cigarettes, HTPs might not be an alternative to cigarettes as tobacco companies claim.

1. Introduction

Heated tobacco products (HTPs), also known as heat-not-burn products, are electronic devices that generate nicotine-containing aerosols by heating a disposable tobacco stick without combustion (Auer et al., 2017; Liu et al., 2019). Philip Morris International (PMI) developed the IQOS® system, a type of HTP, that was test-marketed for the first time in Italy and Japan in 2014 (Liu et al., 2019). Under the vision of "offering smokers a better choice," PMI introduced IQOS® to the market as a "less harmful alternative" to the cigarettes, aiming "to replace cigarettes with the smoke-free products" (Philip Morris International, 2019). As of February 2019, IQOS® became available in 42 countries worldwide (Philip Morris International, 2019).

In contrast to PMI's marketing of IQOS® as a "less harmful alternative" according to the January 2018 findings of the Tobacco Product Scientific Advisory Committee (TPSAC) of the U.S. Food and Drug Administration (FDA), which reviewed the Modified Risk Tobacco Product (MRTP) application submitted in December 2016 by PMI, there is insufficient scientific evidence to support the claims that IQOS® presents fewer health risks than cigarettes. The modified risk claims were based on the premise that users switching completely from cigarettes to the IQOS® system 1) can reduce the risks of tobacco-related disease and that the IQOS® products 2) present less risk of harm than continuing to smoke cigarettes (FDA, 2018a,b). Independent researchers who reviewed the PMI data supported the TPSAC's determination (Glantz, 2018; Lempert and Glantz, 2018). Moreover, there was no evidence that HTPs were serving as cigarette substitutes for smokers. To our knowledge, only two online surveys have been conducted thus far in Japan and Korea to investigate use-patterns of tobacco products that include HTPs. Japan's online survey reported that 72% of HTP or electronic cigarette (e-cigarette) users were dual users of combustible cigarettes, while Korea's revealed that all eight current IQOS® users surveyed were triple users of cigarettes and e-cigarettes (Kim et al., 2018; Tabuchi et al., 2018). These studies indicated that HTPs might serve as complements to cigarettes rather than alternatives. The Korean survey found significant results, as it highlighted the need for government regulation of HTPs because—having been conducted in September 2017—it identified concerns regarding HTPs a mere three months after IQOS® launch (Kim et al., 2018). However, this survey contained certain limitations, that is, the survey targeted a specific age

* Corresponding author at: Department of Preventive Medicine, Catholic University of Daegu School of Medicine, 3056-6 Daemyung-4Dong, Nam-gu, Daegu 42472, Republic of Korea.
E-mail address: parksw@cu.ac.kr (S.-W. Park).

https://doi.org/10.1016/j.drugalcdep.2019.107576
Received 2 May 2019; Received in revised form 9 August 2019; Accepted 13 August 2019
Available online 21 September 2019
0376-8716/ © 2019 Elsevier B.V. All rights reserved.

group (19–24 years) and included a small number of subjects (n = 228) in Korea, with only eight current IQOS® users.

Under current conditions in which HTP-use is spreading, it is necessary to verify the claims of tobacco companies in different countries and cultures due the variable use patterns and acceptability of HTPs according to social backgrounds as only through such verification can consumers be thoroughly informed about HTPs (Hair et al., 2018). For example, unlike most countries where IQOS® is sold only in key cities, Korea experienced a national roll-out of IQOS® and the launching of domestic HTP products (KT&G, lil®) simultaneously (Hair et al., 2018; Kim, 2018; Lee, 2017).

Accordingly, this study was conducted to accurately identify the current status of HTP use in Korea using a one-on-one interview survey on a large scale that was more representative of the general population and to investigate the patterns of HTP and cigarette use.

2. Material and methods

2.1. Study design and population

Data were obtained from the Korea Community Health Survey (KCHS), which has been conducted annually since 2008 by the Korea Centers for Disease Control and Prevention (KCDC) to investigate community health statistics including health behaviors. The Korean territory is made up of 17 administrative divisions. Of these areas, KCHS is conducted in 253 smaller entities, where community health centers are located. Approximately 900 people per site participated in the survey. The sample houses were selected using stratified cluster sampling methods. All household members aged ≥19 years in the selected sample house were included as the study population. Well-trained interviewers visited the sample houses and collected data via one-on-one interviews. The survey was conducted from August to October 2018, one year after the IQOS® launch in Korea. The present study used the 2018 KCHS data from Kyungpook province, which includes 11 cities and 14 counties. This study used data of 21,100 participants, excluding 1076 participants who had incomplete responses for monthly household income. The KCHS was exempted from Institutional Review Board (IRB) review by the KCDC. Detailed information about the KCHS is available elsewhere (Kang et al., 2015).

2.2. Measures

2.2.1. Tobacco products use

The use of tobacco products examined in the present study included use of cigarettes, e-cigarettes, and HTPs. The study participants were asked whether they have ever used any of the tobacco products and, based on their responses, they were further classified as current users, former users, or never those who had never used tobacco products. For the use of HTPs, the participants were to answer the following questions: “Have you ever used the following products?” and “Have you ever used the following products within the past 30 days?” People who had used HTPs (heat-not-burn, e.g., IQOS®, glo®, etc.) within the past 30 days were defined as current HTP-users, while those who had never used HTP were classified as never HTP-users. Former HTP-users were defined as those who had used HTPs but not in the past 30 days. The study participants were also asked about the use of other tobacco products (snus, water pipes, cigar, chewing tobacco, pipes, rolling tobacco, snuff, and others) using the above question. However, the use of these other tobacco products within the past 30 days was rare (almost lower than 0.01%), and the aim of this study was to investigate the patterns of HTP and cigarette use, so we did not consider the use of other tobacco products in our analysis. E-cigarette use was evaluated the same way. Cigarette use was classified as never-cigarette smokers, former-cigarette smokers, and current-cigarette smokers. People who had never used cigarettes, or who had smoked less than 100 cigarettes in their lifetime, were defined as never-cigarette smokers while those who had smoked ≥100 cigarettes in their lifetime but quit were classified as former cigarette smokers. The amounts and frequency of daily cigarette consumption were considered for current cigarette smoker classifications (Lawrence et al., 2007; Okuyemi et al., 2001). The current cigarette smokers were further categorized into four types: non-daily smokers; light daily smokers (< 10 cigarettes/day); moderate daily smokers (10–19 cigarettes/day); and heavy daily smokers (20+ cigarettes/day).

2.2.2. Other characteristics

The general characteristics of the study participants, including sex, age, monthly household income, and residential area, were included due to their probable association with tobacco product use. Monthly household income was further categorized as < 1000, 1000–3000, 3000–5000, and ≥5000, and its unit was 1000 Korean won (KRW 1000), which is approximately similar to USD 1. The residential area was categorized as urban and rural.

2.3. Statistical analysis

Weighted percentages for former and current HTP use were calculated, and prevalence and proportion of poly-tobacco use (use of two or more tobacco product types within the past 30 days) patterns of three tobacco products (cigarettes, e-cigarettes, and HTPs) were calculated based on weighted percentages. Two multivariable multinomial logistic regression models were used to evaluate the related factors of HTP-use. For model 1, former and current HTP users were compared with never HTP users (reference group), while former HTP users were compared with current HTP users (reference group) in model two. Each model was adjusted for covariates including cigarette use, e-cigarette use, sex, age, monthly household income, and residential area. This permutation method (i.e., allowing each use category to serve as the reference group) allowed a comprehensive examination of the relationships between all groups included in the analysis. In multinomial logistic regression analyses, prevalence of current HTP users among never- or former-cigarette smokers was very small (0.01% in former cigarette smokers, 0.41% in never cigarette smokers). Accordingly, never- and former-cigarette smokers were combined into one group in the multinomial logistic regression analysis. To test the hypothesis that cigarette users will switch from cigarettes to HTPs, adjusted odds ratios (AORs) for intention to quit cigarette smoking within one month according to HTP-use were calculated among current cigarette smokers using multivariate logistic regression. All analyses were performed using SPSS version 19.0 (IBM, Armonk, NY, USA), and a p-value of < 0.05 was considered to indicate statistical significance. Based on the sample design structure, household or individual weightings were reflected in calculating the estimates (Kang et al., 2015). All results were presented after using complex SPSS sampling procedures to accurately represent the Korean adults.

3. Results

Characteristics of study population and HTP-use according to those characteristics are shown in Table 1. A total of 2.13% and 1.32% of all participants were current and former HTP users, respectively. A total of 12.85% of moderate daily smokers (10–19 cigarettes/day) were current HTP users, followed by heavy daily smokers (20+ cigarettes/day, 7.89%), light daily smokers (< 10 cigarettes/day, 7.27%), non-daily smokers (3.84%), former smokers (0.41%), and never smokers (0.01%). Almost half of the current e-cigarette users (44.70%) were current HTP users (Table 1). The prevalence of current cigarette use peaked with people in their 40 s (31.02%), while the prevalence of current HTP and e-cigarette use were the highest in people in their 30 s (HTPs 5.00%, e-cigarettes 5.21%), followed by people in their 20 s (aged 19–29) (Appendix Table 1 in Supplementary material).

Only 1.60% of current HTP users were single HTP users, and

Table 1
Characteristics of participants and heated tobacco products use according to characteristics.

	Full sample		Heated tobacco products use	
	Unweighted N	Weighted %[a]	Former user (Weighted %)	Current user [c] (Weighted %)
Total	21,100	100.0	1.32	2.13
Tobacco products use				
Cigarette use				
Never	13,246	59.77	0.04	0.01
Former	4205	18.67	0.89	0.41
Non-daily smoker	241	1.64	5.71	3.84
Light daily smoker (< 10 cigarettes/day)	472	2.72	4.53	7.27
Moderate daily smoker (10–19 cigarettes/day)	1310	8.63	5.21	12.85
Heavy daily smoker (20+ cigarettes/day)	1626	8.57	5.39	7.89
E-cigarette use				
Never	20,079	92.10	0.18	0.41
Former	717	5.48	17.46	12.10
Current[c]	304	2.42	8.08	44.70
Demographics				
Sex				
Male	9346	50.06	2.51	4.01
Female	11,754	49.94	0.12	0.24
Age (years)				
19–29	1402	14.80	2.86	4.34
30–39	1951	14.43	2.28	5.00
40–49	2751	18.07	1.95	2.94
50–59	3998	20.60	0.70	1.01
60–69	4631	15.36	0.37	0.10
≥70	6367	16.74	0.07	0.04
Monthly Household Income (KRW 1000)[b]				
< 1000	5400	16.21	0.49	0.45
1000–3000	7338	30.15	1.21	1.65
3000–5000	4649	27.87	1.71	2.67
≥5000	3713	25.78	1.54	3.14
Residential area				
Urban	5744	52.84	1.69	2.83
Rural	15,356	47.16	0.90	1.34

[a] Rows may not add up to 100% due to rounding off.
[b] KRW is South Korea's currency (KRW 1000 = USD 1).
[c] Current use of heated tobacco products or e-cigarette meant use over the past 30 days.

Table 2
Poly-tobacco use (current use of two or more tobacco products) patterns of three tobacco products among tobacco product users (Unweighted N = 21,100).

	Heated tobacco products		E-cigarettes		Cigarettes	
	Prevalence (Weighted %)	Proportion (Weighted %)	Prevalence (Weighted %)	Proportion (Weighted %)	Prevalence (Weighted %)	Proportion (Weighted %)
Total	2.13	100.00	2.42	100.00	21.56	100.00
Single user	0.03	1.60	0.12	4.89	18.29	84.85
Dual user 1 [a]	1.01	47.52	1.22	50.41	1.22	5.66
Dual user 2 [a]	0.05	2.14	0.05	1.88	1.01	4.69
Triple user	1.04	48.73	1.04	42.82	1.04	4.81

Values were weighted percentages.
Heated tobacco products: 1. HTPs and cigarettes; 2. HTPs and e-cigarettes.
E-cigarettes: 1. e-cigarettes and cigarettes; 2. e-cigarettes and HTPs.
Cigarettes: 1. cigarettes and e-cigarettes; 2. cigarettes and HTPs.
[a] Classification of dual user.

96.25% also used cigarettes (47.52%: dual users with cigarettes, 48.73%: triple users with cigarettes and e-cigarettes). Dual users of HTPs and e-cigarettes were few (2.14%). This poly-tobacco use (current use of two or more tobacco products) pattern was also detected in current e-cigarettes users, but was not observed in current cigarettes users, the majority of whom (84.85%) were single users (Table 2).

Table 3 represents the results of multinomial logistic regression analyses that examined related factors of HTP-use. The AORs for current HTP-use were significantly increased with frequency and amount of cigarette consumption. However, the AOR values showed a quadratic curve, descending after the peak value of 28.49 (95% confidence interval [CI] 9.63–84.32) for the moderate daily smokers (10–19 cigarettes/day) ($P_{trend} < 0.001$, $P_{quadratic} < 0.001$). Current e-cigarette users were more likely to be current HTP users compared with never e-cigarette users. The younger subjects were significantly more likely to be current HTP users ($P_{trend} < 0.001$), and the subjects aged 19–20 showed the highest AOR, 11.09 (95% CI 2.83–43.50). Compared with the never HTP users, the AOR values for former HTP-use were inversely proportionate to the amount of cigarette consumption ($P_{trend} = 0.022$), and former e-cigarette users were significantly more likely to be former HTP users (AOR 44.07, 95% CI 20.76–93.58). The younger subjects were significantly more likely to be former HTP users ($P_{trend} < 0.001$). Compared with current HTP users, the AORs for former HTP-use significantly decreased with frequency and amount of cigarette

Table 3
Evaluation of status of heated tobacco products use according to cigarette and e-cigarettes use pattern from multinomial logistic regression model.

	Current versus Never Heated tobacco products AOR(95% CI)	Former versus Never Heated tobacco products AOR(95% CI)	Former versus Current Heated tobacco products AOR(95% CI)
Unweighted N	21,100(Never used: 20,698, Former user: 154, Current user: 248)		
Tobacco products use			
Cigarette use			
Never/Former[a]	Ref	Ref	Ref
Non-daily smoker	**7.09(1.53–32.79)***	3.18(0.98–10.35)	**0.45(0.08–2.61)***
Light daily smoker (< 10 cigarettes/day)	**18.58(5.95–58.03)***	**3.12(1.23–7.93)***	**0.17(0.04–0.69)***
Moderate daily smoker (10–19 cigarettes/day)	**28.49(9.63–84.32)***	**2.77(1.40–5.46)***	**0.10(0.03–0.34)***
Heavy daily smoker (20+ cigarettes/day)	**17.62(5.65–54.97)***	**2.60(1.15–5.86)***	**0.15(0.04–0.58)***
	P_{trend} < 0.001*	**P_{trend} = 0.022***	**P_{trend} = 0.003***
	$P_{quadratic}$ < 0.001*	$P_{quadratic}$ = 0.055	**$P_{quadratic}$ = 0.004***
E-cigarette use			
Never	Ref	Ref	Ref
Former	**7.72(4.57–13.05)***	**44.07(20.76–93.58)***	**5.71(2.28–14.28)***
Current[b]	**33.34(18.57–59.85)***	**25.06(9.99–62.86)***	0.75(0.27–2.10)
	P_{trend} < 0.001*	**P_{trend} < 0.001***	**P_{trend} = 0.034***
	$P_{quadratic}$ = 0.137	**$P_{quadratic}$ < 0.001***	**$P_{quadratic}$ < 0.001***
Demographics			
Sex			
Male	1.42(0.66–3.06)	**3.88(1.55–9.72)***	2.74(0.82–9.08)
Female	Ref	Ref	Ref
Age (years)			
19–29	**11.09(2.83–43.50)***	**7.07(2.37–21.09)***	0.64(0.11–3.56)
30–39	**9.19(2.40–35.19)***	**4.41(1.42–13.68)***	0.48(0.09–2.67)
40–49	**5.68(1.46–22.09)***	**4.48(1.47–13.68)***	0.79(0.14–4.45)
50–59	3.85(0.96–15.43)	2.65(0.76–9.19)	0.69(0.11–4.33)
60–69	0.86(0.23–3.13)	2.31(0.70–7.65)	2.70(0.48–15.36)
≥70	Ref	Ref	Ref
	P_{trend} < 0.001*	**P_{trend} = 0.002***	P_{trend} = 0.314
Monthly Household Income (KRW 1000)[c]			
< 1000	Ref	Ref	Ref
1000–3000	2.06(0.76–5.56)	1.41(0.53–3.77)	0.69(0.17–2.75)
3000–5000	2.29(0.87–6.03)	1.38(0.50–3.84)	0.60(0.15–2.41)
≥5000	**3.06(1.19–7.87)***	1.38(0.49–3.90)	0.45(0.11–1.79)
	P_{trend} = 0.016*	P_{trend} = 0.766	P_{trend} = 0.1548
Residential area			
Urban	1.38(0.95–2.01)	1.21(0.79–1.85)	0.87(0.52–1.46)
Rural	Ref	Ref	Ref

Abbreviation: AORadjusted odds ratio; CIconfidence interval.
All models adjusted for sex, age, monthly household income, residential area, cigarette use, and e-cigarette use.
* Bold values were significantly associated (p < .05).
[a] Never used or former cigarette users among current or former heated tobacco products were too small both categories were united into one.
[b] Current use of Heated tobacco products or e-cigarettes meant use over the past 30 days.
[c] KRW is South Korea's currency (KRW 1000 = USD 1).

consumption. However, the AOR values showed a quadratic curve, ascending after the nadir value of 0.10 (95% CI 0.03-0.34) for the moderate daily smokers (10–19 cigarettes/day) (P_{trend} = 0.003, $P_{quadratic}$ = 0.004). Former e-cigarette users were significantly more likely to be former HTP users (AOR 5.71, 95% CI 2.28–14.28) (Table 3).

Among current cigarette users, younger, male, light smokers were more likely to have an intention to quit cigarette smoking within a month. However, the use of HTPs was not significantly related to the intention to quit (Table 4).

4. Discussion

The prevalence of current HTP users (past 30 days user) one year after the IQOS® launch was 2.13%, which was similar to the predicted prevalence, 2.3%, based on PMI's analysis (more than 1 million HTP users were secured by May 2018) (Diane, 2018). This was more than three times higher than Japan's two-year result (0.6% in 2016) (Tabuchi et al., 2018). This initial high market response to HTPs in Korea was presumably due to the following factors. First, although tobacco control policies have been steadily strengthening in recent years in Korea (Ministry of Health and Welfare, National Cancer Center, 2017), the legal basis for HTP regulation has not been established yet. The cigarette smoking prevalence in Korea has decreased since the reinforcement of tobacco control policies (Ministry of Health and Welfare, 2017). The policies included an 80% cigarette price increase, from KRW 2500 to KRW 4500 per pack, and banning smoking in all businesses in January 2015 (Ministry of Health and Welfare, National Cancer Center, 2017). In December 2016, a pictorial warning label was introduced on cigarette packaging (Kang and Cho, 2018). Thus, when IQOS® launched in June 2017 with a price of KRW 4300 per stick (YONHAP NEWS, 2017), this product was cheaper than cigarettes until December 2017 (The Korea Herald, 2017), and a pictorial warning label was not applied to HTP Stick packages until December 2018 (YONHAP NEWS, 2018). In addition, under the social conditions where smoke-free areas have been expanded continuously, permissive perceptions of HTP-use in smoke-free areas (e.g., indoors, around children) might have also raised interest in HTP-use among cigarette smokers as reported in the Japanese IQOS® consumer study (Hair et al., 2018). Second, marketing strategies of tobacco companies that targeted young adults ("less harmful alternatives") fit well with Korean consumers. Tobacco companies opened

Table 4
Association between intention to quit cigarette smoking with heated tobacco products among current cigarette smokers (Unweighted N = 3649).

	Unweighted N	Intention to quit cigarette smoking (within one month)	
		Weighted %	AOR(95% CI) (N = 3649)[1]
Tobacco products use			
Cigarette use			
Non-daily smoker	241	29.47	**20.03(11.77–34.07)***
Light daily smoker (< 10 cigarettes/day)	472	7.89	**3.89(2.18–6.95)***
Moderate daily smoker (10–19 cigarettes/day)	1,310	6.27	**2.65(1.59–4.44)***
Heavy daily smoker (20+ cigarettes/day)	1,626	2.4	Ref
			P_{trend} < 0.001*
E-cigarette use			
Never	2,815	7.17	Ref
Former	557	6.02	0.80(0.48–1.32)
Current[b]	277	4.9	0.52(0.27–1.03)
			P_{trend} = 0.053
Heated tobacco products use			
Never	3,286	6.76	Ref
Former	128	6.54	0.93(0.27–3.22)
Current[b]	235	6.22	1.25(0.64–2.43)
Demographics			
Sex			
Male	3,321	6.77	**2.41(1.18–4.92)***
Female	328	5.97	Ref
Age (years)			
19–29	259	9.46	**3.11(1.32–7.30)***
30–39	509	7.84	**2.93(1.21–7.10)***
40–49	784	6.41	**2.66(1.15–6.15)***
50–59	882	6.02	**2.63(1.15–5.99)***
60–69	695	4.99	1.7(0.75–3.85)
≥70	520	3.27	Ref
			P_{trend} = 0.022*
Monthly Household Income (KRW 1000)[a]			
< 1000	631	4.66	Ref
1000–3000	1,318	6.64	1.31(0.67–2.58)
3000–5000	980	7.42	1.19(0.60–2.36)
≥5,000	720	6.84	1.15(0.55–2.41)
			P_{trend} = 0.935
Residential area			
Urban	1,163	7.18	1.03(0.70–1.52)
Rural	2,486	6.08	Ref

Abbreviations: AOR – adjusted odds ratio; CI – confidence interval.
All models adjusted for sex, age, monthly household income, residential area, cigarette use, eage, monthly household income, residential area, cigarette use, e-cigarette use, and heated tobacco products use.
* Bold values were significantly associated (p < .05).
[a] KRW is South Korea's currency (KRW 1000 = USD 1).
[b] Current use of heated tobacco products or e-cigarette meant use over the past 30 days.

flagship stores in major cities that were similar to those of high-end smartphones and applied similar marketing strategies, appealing to consumers, especially young adults, via a clean and sophisticated look and feel about the product design and packaging (Kim, 2018). In addition, PMI introduced IQOS® as a safe alternative to cigarettes based on its own research ("˜ the levels of harmful chemicals are significantly reduced compared to cigarette smoke") and advertised that "around 6.6 million consumers have already chosen to switch from cigarettes to this product" on its website (Lempert and Glantz, 2018; Philip Morris International, 2019). While the consumer studies in Japan and Switzerland revealed that there was little potential health benefit of HTP compared to combustible tobacco products (Hair et al., 2018), the major reasons for using HTPs in Korea was its less harmful and less smelly characteristics (Kim et al., 2018). The fact that, in Korea, the prevalence of HTP users was higher among people in their 20 s and 30 s, in contrast to the high prevalence of cigarette users in their 30 s and 40 s demonstrated that the marketing strategies worked well. Third, as suggested by the NASDAQ, the high market response to HTPs in Korea could be explained by the early exposure of IQOS® from Japan, one of the nearest countries from Korea, and the tendency of Korean consumers to adopt innovative and new products quickly (Trefis Team, 2017).

The proportion of current HTP users who also use cigarettes or e-cigarettes in this study was 98%, while 72% of current HTP or e-cigarette users were dual users of combustible cigarettes in Japan. For those cigarette users who smoked less than one pack (20 cigarettes) per day, the possibility of being dual users increased with the amount of cigarette consumption. In addition, HTP and cigarette dual users were more likely to remain HTP users without cessation. The survey data that revealed most of the HTP users were dual users of cigarettes corresponded with a previous study conducted three months after the launch of IQOS® (Kim et al., 2018). Although sufficient evidence regarding the matter should be accumulated, it is difficult to accept that the dual use pattern discovered in Korean HTP users is a temporary phenomenon caused by a new tobacco product. In addition, the fact that HTP-use was not associated with the intention to quit smoking within a month also supported the idea that HTPs are not a cigarette substitute.

The mechanism of the dual use pattern of HTPs and cigarettes can be explained by the conceptual model of multiple tobacco product (MTP) use. Dynamic complementarity between different products exists when one product is used in contexts or situations, in which there are costs associated with using another product (Pacek et al., 2019). In other words, dual users of HTPs and cigarettes tend to use HTPs in a particular situation requiring smoke-free environments, such as indoors or when children are around, and switch to smoking cigarettes while outdoors or when drinking alcohol. The dual users of HTPs and cigarettes use a tobacco product that matches the particular context or situation as a complement rather than a substitute to maintain nicotine dependence. However, the possibility of being a dual user was slightly decreased in cigarette users who smoked heavily than those who smoked less than a pack per day. This may demonstrate that the value of using HTPs as dynamic complements for heavy smokers was reduced due to HTP characteristics such as high maintenance and cost (Hair et al., 2018), charging and cleaning (Hair et al., 2018), and lower level of nicotine delivery by the aerosol than cigarettes (Farsalinos et al., 2018).

This study had several limitations. First, since HTPs are recognized as a type of e-cigarettes in Korea (Kim, 2018), some study subjects may have categorized their HTP experiences as e-cigarette experiences. Although the prevalence of e-cigarette use may have been overestimated, the responses regarding HTPs probably would not have been affected since questionnaires were designed to ask about experience with cigarettes, e-cigarettes, and HTPs, respectively, in separate questions. Second, current HTP users were defined as people with HTP experience within the past 30 days and no detailed questions about amount and frequency of using HTPs were provided. Therefore, one-day-only trials of HTPs could have been included as current HTP-use such that cautions should be exercised when interpreting the results. A previous study conducted in Japan, showing a similar market response to HTPs to Korea, defined current HTP users as in the present study and reported that only 14% of the current HTP users were one-day-only users (Tabuchi et al., 2018). Third, the causal relationships of poly-tobacco product use patterns and the effects of HTP-use on smoking cessation could not be determined since the present study was cross-sectional. Dual or poly users of HTPs may represent individuals who are on their way to switching completely from cigarettes to HTPs or to complete cessation. Future longitudinal research is needed to evaluate this possibility.

Despite these limitations, the major strengths of this study are that it

suggests that HTPs are not likely to be a complete substitute for cigarettes. In addition, the present study suggested that comprehensive tobacco control policies, that include regulations on new tobacco products, should be established due to the nations' previous experience with the rapid expansion of HTP-use when legal regulation of HTPs was not prepared.

5. Conclusion

While most of the HTP users (96.25%) were dual users of cigarettes, only 1.6% were single HTP users. In fact, cigarette users who smoked less than one pack per day increased their likelihood of being dual users of cigarette and HTPs with the amount of cigarette consumption. In addition, HTP-use was not associated with an intention to quit smoking within a month. These results contrasted the tobacco companies' claim that HTPs are a substitute for cigarettes, instead supporting the idea that HTPs are complementary goods to cigarettes.

Role of funding sources

None

Contributors

All the authors participated in the interpretation of the results and contributed to the writing of the manuscript. J.H. Hwang analyzed the data and drafted the manuscript. S.W. Park designed the study and critically revised the manuscript. D.H. Ryu interpreted the analysis results and contributed to the critical revision of the manuscript.

Declaration of Competing Interest

No conflict declared.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2019.107576.

References

Auer, R., Concha-Lozano, N., Jacot-Sadowski, I., Cornuz, J., Berthet, A., 2017. Heat-not-burn tobacco cigarettes: smoke by any other name. JAMA Intern. Med. 177, 1050–1052.

Diane, C., 2018. Philip morris korea sold 2 million IQOS devices in a year. VapingPost. 2018 (May) (Accessed 20 February 2019). https://www.vapingpost.com/2018/05/24/philip-morris-korea-sold-2-million-iqos-devices-in-a-year/.

Farsalinos, K.E., Yannovits, N., Sarri, T., Voudris, V., Poulas, K., 2018. Nicotine delivery to the aerosol of a heat-not-burn tobacco product: comparison with a tobacco cigarette and E-cigarettes. Nicotine Tob. Res. 20, 1004–1009.

FDA, 2018a. TPSAC Meeting Materials and Information Transcript Day 1 (January 24-25, 2018) (Accessed 18 February 2019). https://www.fda.gov/downloads/AdvisoryCommittees/CommitteesMeetingMaterials/TobaccoProductsScientificAdvisoryCommittee/UCM599234.pdf.

FDA, 2018b. TPSAC Meeting Materials and Information Transcript Day 2 (January 24-25, 2018) (Accessed 18 February 2019). https://www.fda.gov/downloads/AdvisoryCommittees/CommitteesMeetingMaterials/TobaccoProductsScientificAdvisoryCommittee/UCM599235.pdf.

Glantz, S.A., 2018. Heated tobacco products: the example of IQOS. Tob. Control 27, s1–s6.

Hair, E.C., Bennett, M., Sheen, E., Cantrell, J., Briggs, J., Fenn, Z., Willett, J.G., Vallone, D., 2018. Examining perceptions about IQOS heated tobacco product: consumer studies in Japan and Switzerland. Tob. Control 27, s70–s73.

Kang, H., Cho, S.I., 2018. Cohort effects of tobacco control policy: evidence to support a tobacco-free norm through smoke-free policy. Tob. Control Epub ahead of print [15 December 2018].

Kang, Y.W., Ko, Y.S., Kim, Y.J., Sung, K.M., Kim, H.J., Choi, H.Y., Sung, C., Jeong, E., 2015. Korea community health survey data profiles. Osong Public Health Res. Perspect. 6, 211–217.

Kim, J., Yu, H., Lee, S., Paek, Y.J., 2018. Awareness, experience and prevalence of heated tobacco product, IQOS, among young Korean adults. Tob. Control 27, s74–s77.

Kim, M., 2018. Philip Morris International introduces new heat-not-burn product, IQOS, in South Korea. Tob. Control 27, e76–e78.

Lawrence, D., Fagan, P., Backinger, C.L., Gibson, J.T., Hartman, A., 2007. Cigarette smoking patterns among young adults aged 18–24 years in the United States. Nicotine Tob. Res. 9, 687–697.

Lee, M.H., 2017. KT&G's Heat-not-burn Cigar Overcomes Downsides of Competitors. December, 2017 (Accessed 20 February 2019). The Korea Times. http://www.koreatimes.co.kr/www/tech/2017/12/133_241123.html.

Lempert, L.K., Glantz, S.A., 2018. Heated tobacco product regulation under US law and the FCTC. Tob. Control 27, s118–s125.

Liu, X., Lugo, A., Spizzichino, L., Tabuchi, T., Pacifici, R., Gallus, S., 2019. Heat-not-burn tobacco products: concerns from the Italian experience. Tob. Control 28, 113–114.

Ministry of Health and Welfare, 2017. Ministry of Health and Welfare Korea Centers for Disease Control and Prevention, 2017. Korea Health Statistics 2017: Korea National Health and Nutrition Examination Survey (KNHANES VII-2). Ministry of Health and Welfare, Sejong.

Ministry of Health and Welfare, National Cancer Center, 2017. Overview of Tobacco Control Policy (Accessed 9 October 2018). http://www.nosmokeguide.go.kr/lay2/bbs/S1T33C36/H/21/view.do?article_seq=204&tag_name=&cpage=3&rows=10&condition=&keyword=&cat=&rn=22.

Okuyemi, K.S., Ahluwalia, J.S., Richter, K.P., Mayo, M.S., Resnicow, K., 2001. Differences among African American light, moderate, and heavy smokers. Nicotine Tob. Res. 3, 45–50.

Pacek, L.R., Wiley, J.L., McClernon, F.J., 2019. A conceptual framework for understanding multiple tobacco product use and the impact of regulatory action. Nicotine Tob. Res. 21, 268–277.

Philip Morris International, 2019. Smoke-Free Products IQOS (Accessed 14 February 2019). https://www.pmi.com/smoke-free-products/iqos-our-tobacco-heating-system.

Tabuchi, T., Gallus, S., Shinozaki, T., Nakaya, T., Kunugita, N., Colwell, B., 2018. Heat-not-burn tobacco product use in Japan: its prevalence, predictors and perceived symptoms from exposure to secondhand heat-not-burn tobacco aerosol. Tob. Control 27, e25–e33.

The Korea Herald, 2017. Phillip Morris to Hike e-cigarette Price by 4.7%. December 15, 2017. (Accessed 30 July 2019). http://www.koreaherald.com/view.php?ud=20171215000666.

Trefis Team, 2017. Why Is Korea Easier To Conquer For iQOS Than Europe? September 13, 2017. (Accessed 21 February 2019). NASDAQ. https://www.nasdaq.com/article/why-is-korea-easier-to-conquer-for-iqos-than-europe-cm845245.

YONHAP NEWS, 2017. Philip Morris Unveils New e-cigarette in S. Korea. May 17, 2017. (Accessed 30 July 2019). https://en.yna.co.kr/view/AEN20170517010800320.

YONHAP NEWS, 2018. S. Korea Changes Graphic Warnings on Cigarette Packs. December 23, 2018. (Accessed 30 July 2019). https://en.yna.co.kr/view/AEN20181221008400320.