Heated tobacco products use in Chinese adults in Hong Kong: a population-based cross-sectional study

Wu Yongda Socrates[1], Wang Man Ping[1], Ho Sai Yin Daniel[2], Li Ho Cheung William[1], Cheung Yee Tak Derek[1], Tabuchi Takahiro[3], Kwong Antonio[4], Lai Vienna[4], Lam Tai Hing[2]

1. School of Nursing, The University of Hong Kong
2. School of Public Health, The University of Hong Kong
3. Cancer Control Center, Osaka International Cancer Institute
4. Hong Kong Council on Smoking and Health

Corresponding: Wang Man Ping

Postal address: 4/F, School of Nursing, William M.W. Mong Block, 21 Sassoon Road, Pokfulam, Hong Kong

Email: mpwang@hku.hk

Tel: 852-39176636

Fax: 852-28726079

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Abstract

Introduction
We investigated Heated tobacco products (HTPs) use and associated factors in Chinese adults in Hong Kong where HTPs are not formally marketed yet, and cigarette smoking prevalence was the lowest in the developed world.

Methods
A population-based landline telephone survey in 2017 interviewed 5131 (45.2% male; 26.7% aged ≥60) adults to collect information on awareness, intention to use, ever use of HTPs, cigarette smoking status, and sociodemographic characteristics. Descriptive statistics were weighted by the age, sex and smoking status of the Hong Kong adult population. Sociodemographics were mutually adjusted in logistic regression to yield adjusted odds ratios (AORs) for awareness of HTPs, controlling for smoking status.

Results
Overall, 11.3% (95% CI 10.0-12.7%) were aware of HTPs and 1.0% (0.8-1.2%) had ever used it. Awareness was associated with aged 40-49 years (AOR 1.37, 95% CI 1.01-1.87) or 30-39 years (1.65, 1.13-2.43) (vs. ≥60 years), born in Hong Kong (1.37, 1.11-1.68), and higher monthly household income (P for trend 0.001). Ever HTP users had higher educational attainment and monthly household income, and more were aged 30-39 and economically active (All P <0.003). In never HTP users, intention to use HTPs (7.3%, 4.9-10.8%) were more prevalent in respondents with similar characteristics (All P < 0.008). More current (vs. never) smokers were aware of HTPs, intent to use HTPs and had ever used HTPs (All P <0.001).

Conclusion
Higher socioeconomic status was associated with HTP use and intention to use. Public health education on HTPs is needed especially for this high-risk group.

(249 words)

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Introduction

Heated tobacco products (HTPs) are an emerging smoking product with tobacco sticks heated to produce aerosols for users to inhale. [1] The tobacco sticks are made of compressed tobacco and other chemicals heated by the specially designed electronic heating system. Big tobacco companies which developed HTPs alleged that the heating temperature (about 300°C) is much lower than that in a burning conventional cigarette (referred to as "cigarette" hereafter unless otherwise specified) (>900°C), leading to fewer harmful constituents in aerosols. [1] One of the leading HTP companies, the Philip Morris (PM), is applying for a modified risk tobacco product registration of its HTP (i.e. IQOS) to the U.S. Food and Drug Administration (FDA). [2] Independent studies reported inconsistent findings of the levels of toxicants (e.g. tar) in HTP aerosol compared with those from conventional cigarettes. [3] The low heating temperature of tobacco and flavors could also lead to different toxicants. [4] The health effects of long-term HTP use remain uncertain although acute adverse effects on the respiratory system have been reported. [5]

HTPs were first launched in late 2014 in Japan and Italy and are now being test-marketed in more than 30 countries. [6] Aggressive promotions with a focus on harm reduction and quitting conventional cigarettes have increased interest and usage in the public. [7] Average monthly volume of Google search on HTPs from Japan increased by 1426% from 2015 to 2016, which outpaced that of electronic cigarettes (e-cig) from the United States. [8] The prevalence of past 30-day IQOS use in Japanese also increased from 0.3% in 2015 to 3.6% in 2017. [9] HTPs become increasingly popular in European countries, with one fifth (19.5%) Italian adults being aware of IQOS and 1.4% had tried it in 2017. [6] Nearly 1 in 10 (9.3%) adults in the United Kingdom (UK) were aware of IQOS and 0.8% were current users in February to March 2017,

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shortly after IQOS's launch in December 2016. [10] Little is known about HTPs in places where HTPs are not formally marketed yet such as in China, which has the largest smoking population in the world. Hong Kong, being the most westernized and developed city of China, has the lowest prevalence of cigarette smoking in the developed world (10.0% daily cigarette smoking in 2017). [11] In Hong Kong, the heating devices are sold as electronic devices freely in retail stores and online, although HTPs are not formally marketed yet. The sale of tobacco sticks (the duty not paid) is not permitted, but transactions are mostly online (e.g. Facebook, Instagram, WhatsApp, Taobao). To help inform public health and regulatory decisions, we investigated the awareness, intention to use, ever use of HTPs and the associated factors in Chinese adults in Hong Kong.

Methods

Study design

Data were from the Tobacco Control Policy-related Survey 2017, which was funded by the Hong Kong Council on Smoking and Health (COSH) with the consultancy of Schools of Nursing and Public Health of the University of Hong Kong. Ethical approval was granted by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (Ref: UW15-108). The fieldwork was conducted by the Public Opinion Program (POP), the University of Hong Kong, one of the most renowned local survey agencies. The survey procedures were similar to those used in a similar population-based survey conducted in 2015 and reported elsewhere. [12] Telephone numbers were drawn from a list which was generated by using the "plus/minus one/two" method (to capture unlisted numbers) on a residential telephone

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directory. An eligible respondent (in a household with multiple eligible family members) whose birthday was the nearest to the survey date would be invited for the interview. Respondents who smoked at least 1 cigarette in the past 7 days were regarded as current smokers and those who had abstained from cigarettes and reported no cigarette use in the past 7 days were regarded as ex-smokers (never cigarette users were referred to as never smokers). In 5131 Cantonese or Putonghua-speaking respondents (POP response rate: 71.9%, 5131 completed cases over 7136 eligible cases) aged 15 years or above, current smokers (N=1704) and ex-smokers (N=1715) were oversampled to improve the precision of estimates because the cigarette smoking prevalence was low (10% in 2017). [11] Oversampling was controlled in data analysis using inverse probability weighting (IPW) by age, sex and cigarette smoking status to approximate a representative sample of the 2015 Hong Kong adult population. [13]

Measurements

Respondents were asked if they were aware of HTPs (including heard of HTPs, saw photos of HTPs, saw HTPs, versus not aware). Those who were aware were asked if they had ever used it, even a single puff (yes/no). Intention to use HTPs in the next 12 months (definitely will, probably will, probably not vs. definitely not) was also asked. Information on sociodemographic characteristics (sex, age, educational attainment, marital status, employment, monthly household income, having a child, place of birth) and ever use of e-cig was collected. Employment status was dichotomized into economically active (being an employer, employee or self-employed) vs economically non-active (being a student, housekeeper, unemployed or retired) for analysis. Current smokers were asked about their intention to quit (quit within 30 days, quit after 30 days, and undecided vs. no intention to quit). [14]

Statistical analysis

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Awareness and ever use of HTPs, and intention to use HTPs in never HTP users were weighted by the age, sex and cigarette smoking status distributions of the 2015 Hong Kong adult population to estimate the population prevalence. We calculated mutually adjusted odds ratios (AORs) from multivariable logistic regressions to identify sociodemographic characteristics associated with awareness of HTPs in all respondents, controlling for cigarette smoking status (current, ex- and never smokers). We also explored the associations of ever HTP use and intention to use HTPs with intention to quit and ever e-cig use in all current smokers with descriptive statistics. All analyses were conducted using Stata (Version 13.1, TX: StataCorp LP, College Station, TX, USA). A 2-sided statistical significance level of 0.05 was adopted for all analyses. Missing value was handled by listwise deletion since it was minimum for most variables (< 3%) and the outcomes were similar (all $p < 0.05$) in participants with or without income information (13.5%).

Results

Table 1 shows the weighted socio-demographic characteristics and smoking status of the sample. Near half of the respondents were male, economically active and had tertiary education or above. Over a quarter were aged 60 or above and one-third had a monthly household income of HK$ 40000 or above (US$ 1= HK$ 7.8). Only 3.8% (95% CI 3.2-4.4%) had ever used e-cig. Ever use of HTPs were more prevalent in respondents who were current smokers (8.9% vs. 0.05% in never smokers), ever e-cig users (16.7% vs. 0.4%), aged 30-39 (2.3% vs. 0.1% in aged ≥ 60) and economically active (1.8% vs. 0.1%), had tertiary or above education (1.1% vs. 0.1% in primary or below education) and a monthly household income ≥HK$ 40000 (1.7% vs. 0.5% in income ≤19999) (All $P < 0.003$). Similar associations were also observed in current smokers (All

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P < 0.001, data not shown in tables). Intention to use HTPs in never HTP users were more prevalent in respondents with similar characteristics (All P < 0.008).

Table 2 shows that overall 11.3% (weighted, 95% CI 10.0-12.7%) were aware of HTPs. Awareness was higher in current smokers (27.2%) and 20.4% of all current smokers had seen HTPs. The weighted prevalence of ever HTP use was 1.0% (95% CI 0.8-1.2%), which was more common in current smokers (8.9%) than in ex-smokers (0.6%) or never smokers (0.05%) (P < 0.001). In respondents who were aware of HTPs but had never used them, 7.3% (weighted, 95%CI 4.9-10.8%) had intention to use in the coming 12 months, and intention to use was significantly higher in current smokers (28.8%) than in ex-smokers (0.6%) or never smokers (0.05%) (P < 0.001).

In all respondents, awareness of HTPs was associated with aged 40-49 years (AOR 1.37, 95% CI 1.01-1.87) or 30-39 years (AOR 1.65, 95% CI 1.13-2.43) (vs. aged ≥60 years), born in Hong Kong (AOR 1.37, 95% CI 1.11-1.68), and having higher monthly household income (P for trend 0.001) (Table 3). A marginally significant association was found for higher educational attainment (P for trend 0.06). More current smokers than never smokers were aware of HTPs (AOR 2.91, 95% CI 2.27-3.73)

In all current smokers, more of those who had intention to quit (11.5% vs. 6.7%, P = 0.006) and had ever used e-cig (24.2% vs. 3.9%, P < 0.001) had used HTPs. In current smokers who had not used HTPs, intention to use them was more prevalent in ever e-cig users (47.9% vs. 23.1% P = 0.002), but not in those had intention to quit (P > 0.05) (Data not shown in tables).

Discussion

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To our knowledge, this is the first report on the awareness, intention to use and ever use of HTPs in a very low cigarette prevalence region where HTPs are not launched yet. We found that 11.3% of Hong Kong adults were aware of HTPs and higher awareness (27.2%) in current smokers. Ever HTP use was rare in the general population but 8.9% of current smokers had already used it. The weighted prevalence of ever HTP use was comparable to that in the UK (1.8%) and in Italy (1.4%) in 2017. [6,10] In Hong Kong adults who had never used HTPs, few had intention to use HTPs in the coming 12 months but nearly one-third of current smokers would like to try, which was higher than those in Italy (general population: 2.3%, current smokers: 5.0%). [6]

Many people in Hong Kong travel to Korea and Japan, the two nearby countries where HTPs are increasingly popular (in 2017: Hong Kong population 7.4 million; visits to Korea over 650 thousand; visits to Japan over 2.2 million). [15–17] Many have become aware of HTPs when they see advertisements, people using them or the products in retail stores, and some buy the device and the tobacco sticks during their trip and bring back to Hong Kong, with or without declaring to customs officers. Cultures and goods from these 2 countries, especially those from Japan, are popular in Hong Kong and can be easily found locally, [18,19] which may also contribute to the increasing awareness, use and intention to use of HTPs. HTP promotion is intensive on social media. For example, using the term “iqos Hong Kong” for a search yielded more than 15 Facebook groups for participants to share information, to buy and sell HTPs, with over one thousand members in each group (as of 15 August 2018). These results are alarming. HTPs are not yet launched in Hong Kong but is increasingly promoted locally such that the prevalence of use is approaching that of e-cig (3.8% in the same survey), which first appeared more than a decade ago before HTPs. Continuous surveillance is warranted to monitor HTPs awareness and in both current, ex- and never smokers as more and more will be attracted by its

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high-tech appearance and aggressive marketing. The Hong Kong Special Administrative Region Government recently proposed to totally ban e-cig, HTPs, and other new tobacco products. The PM and other tobacco industry stakeholders advocate for less strict regulation and the sale of HTPs with a much lower tax rate than that on conventional cigarettes. [20]

Current smokers being economically active and having higher monthly household income were prone to use HTPs, possibly because of the high prices of the heating devices (HK$ 800-1000) and the products cannot be bought legally in Hong Kong. [21,22] Highly educated smokers, more likely to be health conscious and have the intention to quit cigarette smoking, tend to use HTPs, which was also found in Japan. [21,23] HTP promotions featuring harm reduction or quitting may attract these smokers, which was supported by the higher use prevalence in current smokers with greater intention to quit in this study and echoed a similar association in e-cig users. [24,25] These associations suggest that HTPs would be less likely to benefit smokers with low SES, among whom cigarette smoking is more prevalent [26], even if HTPs can reduce harms when replacing cigarette smoking. Of note, there is currently no evidence that HTPs are effective smoking cessation aids. This highlights that HTPs may worsen social inequalities caused by cigarette smoking. [27]

Our study had some limitations. We are uncertain about the temporal sequence between risk factors and HTP use and intention to use particularly for intention to quit and e-cig use. Prospective studies are needed to confirm these associations. More detailed measurement on HTP use (e.g. frequency, type of product) will yield more information on the use pattern. Because of the low prevalence of HTP use, the small sample size of current (rather than ever) HTPs was too small for analysis. If HTPs were allowed to enter the Hong Kong market, there would be more users and studies with greater sample size become feasible and warranted.

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Conclusions

About one-tenth of Hong Kong adults were aware of heated tobacco products and had intention to use them, but ever use of HTPs was uncommon as they were not yet legally approved on the market. Higher socioeconomic status (indicated by higher educational attainment and monthly household income) was associated with HTP use and intention to use in a place where conventional cigarette smoking prevalence is low. Public health education on HTPs is needed especially for the high-risk group.

What this paper adds:

What is already known on this subject
Heated tobacco products (HTPs) are promoted as healthier than combustible cigarettes and emerging worldwide. Reports on the prevalence of use and risk factors in countries where they have launched are increasing.

What important gaps in knowledge exist on this topic
Little is known about the prevalence of HTP use and risk factors in countries where HTPs are not yet legally marketed and widely available.

What this study adds
HTP use is associated with higher socioeconomic status in Hong Kong where the prevalence of conventional cigarette smoking is low.

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Competing Interests

None declared.

Contributors

WMP had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: WMP, HSYD, LHCW, CYTD, TT, KA, LV and LTH.

Obtained funding: WMP, HSYD, CYTD, and LTH.

Survey administration: WMP, LHCW, and CYTD.

Statistical analysis: WYS and MPW.

Drafting of the manuscript: WYS and MPW.

Critical revision of the manuscript for important intellectual content: WMP, HSYD, LHCW, CYTD, TT, KA, LV and LTH.

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Table 1. Sociodemographic characteristics and smoking-status of all respondents and their associations with awareness, ever use and intention to use of Heated tobacco products (HTPs)

	All respondents (N=5131)		Awareness of HTPs (N=719)			Ever use of HTPs (N=115)			Intention to use HTPs in never HTP users (N=593) [a]		
	n	%	n	%	P-value	n	%	P-value	n	%	P-value
Sex					**<0.001**			**<0.001**			**<0.001**
Male	3422	45.2	517	14.0		92	1.7		54	11.1	
Female	1709	54.8	201	9.1		23	0.4		18	2.9	
Age, years					**0.009**			**<0.001**			**0.008**
≥60	2453	26.7	240	9.4		12	0.1		11	2.5	
50-59	1029	19.2	136	9.3		16	0.7		10	3.0	
40-49	703	17.5	140	14.7		31	1.4		16	8.7	
30-39	387	17.7	107	14.6		34	2.3		20	15.5	
15-29	536	19.0	93	9.7		22	0.9		15	6.6	
Educational attainment					**0.05**			**0.003**			**0.002**
Primary or below	1041	11.7	92	7.1		4	0.1		2	0.9	
Secondary	2634	44.2	377	11.9		55	1.1		32	4.7	
Tertiary or above	1434	44.1	246	11.8		56	1.1		38	11.2	
Marital status					0.52			**0.01**			**0.05**
Single	971	32.0	181	11.1		48	1.4		29	12.1	
Married/cohabited	3531	59.4	461	11.8		56	0.8		38	5.4	
Divorced/widowed	580	8.6	71	9.3		10	0.8		5	5.0	
Employment					**<0.001**			**<0.001**			**<0.001**
Economically non-active	2878	50.4	294	8.8		15	0.1		15	2.3	
Economically active	2185	49.6	415	14.0		99	1.8		56	11.0	
Monthly household income (HK$)					0.29			**<0.001**			**0.004**
≤19999	1768	30.3	182	10.0		14	0.5		12	3.2	
20000-39999	1389	33.1	208	11.7		30	0.9		19	5.2	
≥40000	1284	36.6	247	13.0		61	1.7		33	12.5	
Had children					0.28			**<0.001**			0.15
Yes	3702	60.7	466	10.8		51	0.7		37	5.6	
No	1303	39.4	240	12.3		63	1.5		34	9.9	
Place of birth					0.051			0.052			**0.04**
Others	1955	27.8	204	9.3		18	0.6		14	4.0	
Hong Kong	3089	72.2	506	12.2		97	1.2		58	8.5	
Smoking status					**<0.001**			**<0.001**			**<0.001**
Never smokers	1712	84.2	156	9.4		1	0.05		3	2.7	
Ex-smokers	1715	5.6	186	12.1		6	0.6		6	3.5	
Current smokers	1704	10.2	376	27.1		108	8.9		63	28.8	
Ever use of e-cig					**<0.001**			**<0.001**			**<0.001**
No	4718	96.3	586	10.5		40	0.4		51	5.6	
Yes	413	3.8	132	30.9		75	16.7		21	39.8	

Note:

[a] 593 of 719 respondents who were aware of HTPs but had never used it.

The proportions were weighted by age, gender and conventional cigarette smoking status distribution of 2015 Hong Kong; the observations (n) were unweighted.

US$ 1= HK$ 7.8; P-values were from Chi-squared test.

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Table 2. Awareness, ever use of HTPs and intention to use HTPs in respondents with different smoking status

	All n (%)	Never smokers n (%)	Ex-smokers n (%)	Current smokers n (%)	P-value
In all respondents					
Awareness					<0.001
Not aware	4366 (88.7)	1539 (90.6)	1516 (87.9)	1311 (72.8)	
Heard of HTPs	218 (3.9)	69 (3.9)	74 (4.0)	75 (4.2)	
Saw photos of HTPs	104 (2.3)	37 (2.3)	29 (1.7)	38 (2.5)	
Saw HTPs	397 (5.1)	50 (3.2)	83 (6.4)	263 (20.4)	
Ever use	115 (1.0)	1 (0.05)	6 (0.6)	108 (8.9)	<0.001
In respondents who were aware of HTPs but had never used them					
Intention to use					<0.001
Definitely not	521 (92.7)	152 (97.3)	170 (96.5)	199 (71.2)	
Probably not/Probably will/Definitely will	72 (7.3)	3 (2.7)	6 (3.5)	63 (28.8)	

Note:
The proportions were weighted by age, gender and conventional cigarette smoking status distribution of 2015 Hong Kong; the observations (n) were unweighted.
P-values were from by Chi-squared test.

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Table 3. Association of sociodemographic characteristics with awareness of Heated tobacco products (HTPs)

	Awareness of HTPs	
	Crude OR (95% CI)	AOR (95% CI) [a]
Sex		
Male	1	1
Female	0.75 (0.63-0.90) **	0.93 (0.75-1.16)
Age, years		
≥60	1	1
50-59	1.40 (1.12-1.76) **	0.94 (0.71-1.26)
40-49	2.28 (1.82-2.87) ***	**1.37 (1.01-1.87)** *
30-39	3.50 (2.70-4.54) ***	**2.03 (1.41-2.91)** ***
15-29	1.92 (1.48-2.49) ***	1.23 (0.81-1.87)
Educational attainment		
Primary or below	1	1
Secondary	1.72 (1.35-2.19) ***	1.22 (0.91-1.62)
Tertiary or above	2.12 (1.64-2.73) ***	1.38 (0.99-1.92)
P for trend	**<0.001**	0.06
Marital status		
Single	1	1
Married/cohabited	0.66 (0.54-0.79) ***	0.93 (0.64-1.36)
Divorced/widowed	0.61 (0.45-0.82) **	1.16 (0.74-1.82)
Employment		
Economically non-active	1	1
Economically active	2.05 (1.75-2.41) ***	1.15 (0.92-1.45)
Monthly household income (HK$)		
<=19999	1	1
20000-39999	1.53 (1.24-1.90) ***	1.19 (0.93-1.51)
>=40000	2.07 (1.68-2.55) ***	**1.50 (1.16-1.94)** **
P for trend	**<0.001**	**0.001**
Had children		
Yes	1	1
No	1.57 (1.32-1.86) ***	1.06 (0.77-1.45)
Place of birth		
Others	1	1
Hong Kong	1.67 (1.41-1.99) ***	**1.37 (1.11-1.68)** **
Smoking status		
Never smokers	-	1
Ex-smokers	-	**1.40 (1.07-1.83)** *
Current smokers	-	**2.91 (2.27-3.73)** ***

Note:

[a] Mutually adjusted in logistic regression and adjusting for smoking status.

Employment status was dichotomized into economically active (being an employer, employee or self-employed) vs economically non-active (being a student, housekeeper, unemployed or retired)

US$ 1= HK$ 7.8; * P<0.05; ** P<0.01; *** P<0.001

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