

Polytobacco product use among current cigarette smokers in Hong Kong, China: results from population surveys (2015-17)

Siu Long Chau

the University of Hong Kong

Man Ping Wang (✉ mpwang@hku.hk)

<https://orcid.org/0000-0003-4000-2388>

Yongda Wu

University of Hong Kong

Yee Tak Cheung

University of Hong Kong

Cho-shing Kwong

Hong Kong Council on Smoking and Health

Vienna Lai

Hong Kong Council on Smoking and Health

Tai Hing Lam

University of Hong Kong

Sai Yin Ho

University of Hong Kong

Research article

Keywords: Poly-tobacco product, current smokers, smokeless tobacco product, concomitant use, co-use, Chinese

Posted Date: December 4th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-27896/v2>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published on February 6th, 2021. See the published version at <https://doi.org/10.1186/s12889-021-10341-7>.

Abstract

Background Poly-tobacco product use is increasingly popular, but little is known about the prevalence, trend, and risk factors of such use particularly in non-western countries.

Method A representative sample of 1139 current cigarette smokers aged 15+ (84.1% male) were telephone interviewed in Tobacco Control Policy-related Surveys in 2015-2017. Information collected included poly-tobacco use (PTU), smoking and socio-demographic characteristics. Associations of current PTU with related risk factors were analyzed using logistic regression with adjustment for confounders. Prevalence was weighted by age and sex of current cigarette users in the general population.

Results 84.1% (95% CI 81.4-86.6%) were exclusive cigarette smokers. 15.9% (13.4-18.6%) were current poly-users, 12.3% (10.2-14.8%) used one tobacco product and 2.52% (1.59-3.97%) used two tobacco products in addition to cigarette. Cigarette use with cigar was more common (6.28%, 4.75-8.27%), and the least used product with cigarette was e-cigarette (1.05%, 0.44-2.50%). The changes in overall prevalence of PTU by number of products use varied in three years. Current PTU was associated with being male (AOR 2.01, 95% CI 1.12-3.61), younger age (AORs range from 1.34-4.65, *P* for trend < .001) and less ready to quit (2.08, 1.09-3.97).

Conclusions Prevalence of PTU increased slowly by year, one tobacco product use with cigarette was more common. The most used tobacco product with cigarette was cigar. Being male, younger and less ready to quit were associated with current PTU.

Background

Poly-tobacco product use (PTU) refers to concomitantly using two or more tobacco products, such as current manufactured cigarette, cigar, self-rolling cigarette, waterpipe and electronic cigarette (EC).¹ The worldwide cigarette consumption prevalence has been declining in recent decades, but the use of alternative tobacco products has been rising globally.² In the United States, the sale of cigarette decreased by 18% in 2000-2007, but cigar sales surged by 37%.² Concomitant use of EC and waterpipe also increased dramatically from 1.5% to 16% and 4.1% to 7.2% in 2011-2015, respectively.³ Asian countries reported high prevalence of PTU, especially in Korea.⁴ Asian regions accounted for 250 million of poly-tobacco users globally.⁵ PTU affected more than 70 low, middle and high-income countries.⁶

Tobacco industries targeted young population (aged 18-24) and have been advertising alternative tobacco products as viable smoking cessation and harm reduction tool for quitting cigarette.⁷ Youth were more likely to explore different tobacco products.⁸⁻⁹ Over 80% of poly-tobacco product users reported starting PTU in young adult age (aged 18-35)¹⁰ and continued to use in lives.⁸ Most research on PTU was conducted in western countries (e.g. U.S.). Several risk factors were identified associated with PTU, including younger age,^{2 11} being male,¹² having no intention to quit cigarette,¹³ and high

nicotine dependence.¹³⁻¹⁴ Little is known whether the associations are generalizable to other regions of the world. Particularly in China, one of the biggest tobacco products selling markets in the world.

Foreign and local tobacco companies have been rapidly expanding business in China targeting youth.¹⁵ Hong Kong is the most westernized city of China with remarkably low cigarette smoking prevalence compared with other Asian regions (10% in 2017),¹⁶ but the use of EC and waterpipe had increased in the past few years.¹⁷⁻¹⁸ In Hong Kong, any sale promotions of tobacco products are prohibited, but marketing and purchasing via social media (e.g. Facebook and Instagram) are not strictly regulated by the government.¹⁹ Many of these tobacco products are readily available for purchase in the Internet without age restriction.²⁰ Such grey area in regulations created a loophole for promotion and sale of alternative tobacco products for PTU.

We investigated the overall prevalence and trends of PTU. We also identified the association of PTU with socio-demographic characteristics and modifiable risk factors (Heaviness of Smoking Index and intention to quit smoking cigarette).

Methods

Study design

Details of the survey method has been reported elsewhere.²⁰ The Tobacco Control Policy-related Survey (TCPS) was a cross-sectional regular survey from commissioned by the Hong Kong Council on Smoking and Health (COSH). The telephone-based survey was conducted by the Public Opinion Program (POP), the University of Hong Kong. This study was an analysis of 2015-17 telephone-based survey, which used two-stage random sampling method. Residential telephone numbers were drawn randomly from residential telephone directories to become seed numbers, another set of numbers were generated using “plus/minus one/two” approach to capture unlisted numbers. One eligible person was selected among the eligible family members using the “next birthday” approach, whose birthday nearest to the survey date was selected at the time of interview. The whole sample of 15534 Cantonese-speaking respondents of the 3 surveys included (1) current cigarette smokers, who smoked at least one cigarette in the past 7-day (N= 5113); (2) ex-smokers, who had abstained and reported no cigarette smoking in the past 7 days (N=5141) and (3) never smokers (N=5280). The questionnaire comprised core and random questions. Sociodemographic characteristics, nicotine dependence, and intention to quit were core questions for all current cigarette smokers. Questions related to PTU were random questions and used for randomly selected subsets of current cigarette smokers. All respondents in the same subset answered the same sets of random questions and core questions. A randomly selected representative sample of 1139 current cigarette users was analyzed. Inverse probability (of being sampled from the population) weighting based on the sex and age distribution of the Hong Kong adult current cigarette users in 2017 (from census) was conducted to make the sample more representative to Hong Kong population.¹⁶ All respondents provided oral consent before the telephone interview. Ethical approval was granted by from the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster.

Measurements

Baseline socio-demographic characteristics were collected, including sex, age, educational attainment, marital status, employment status (economically active and non-active) and monthly household income. Nicotine dependence was measured by Heaviness of Smoking Index (HSI), it comprised of two questions: “How soon after wake up do you smoke your first cigarette?” and “How many cigarettes do you smoke per day?” Score 0-1 indicated as light smoker, 2-3 as moderate smoker and 4-6 as heavy smoker.²¹ Current cigarette smokers were asked about their intention to quit smoking, It was measured by asking “Do you plan to quit smoking? If yes, what is your planned quit day?” Those reported quit intention within 30-day were defined as ready to quit and beyond 30-day were defined as no intention to quit.²² Current cigarette smokers were asked if they used other tobacco products (cigars, self-rolling cigarette, waterpipe and electronic cigarette) within 30-day, those responded “Yes” were categorized as current poly-users and “No” as exclusive cigarette smokers. PTU was categorized by number of tobacco products use (one tobacco product and two or more tobacco products use in addition to cigarette).

Statistical analysis

Socio-demographic characteristics and overall prevalence of PTU were weighted by sex and age distribution of 2017 Hong Kong adult current cigarette users. The associations of socio-demographic characteristics with current PTU were analyzed using multivariable logistic regression. We further examined the associations of HSI and intention to quit with PTU controlling for sex, age, educational attainment and monthly household income. Results were reported as adjusted odds ratio (AOR). All the analyses were performed using STATA (V. 13.0). Two-tailed p-value less than 5 % is considered as statistically significant. Listwise deletion was used to handle missing value due to a small proportion of data was missing (< 3%).

Results

Table 1 shows most of the current smokers were male (84.1%), aged ≥ 40 (71.2%), had secondary education (59.5%), were economically active (69.6%) and had a monthly household income greater than HK \$30000 (48.0%). 84.1% (95% CI 81.4-86.6%) of current cigarette smokers were exclusive cigarette users. The overall prevalence of current PTU was 15.9% (13.4-18.6%), 12.3% for 2 products (10.2-14.8%), and 2.52% for 3 products (1.59-3.97%). Current PTU increased slightly by year from 15.5%-16.3%, 2015-17. (figure 1) The overall prevalence of one tobacco product use with cigarette was 6.28% for cigar (4.75-8.27%), 5.52% for self-rolling cigarette (4.15-7.30%), 3.77% for waterpipe (2.55-5.56%), and 1.05% for EC (0.44-2.50%) (table 2) The trends of overall prevalence of number of tobacco product use with cigarette varied in three years (2015-17). For one tobacco product use with cigarette, the prevalence decreased from 14.1% (10.2-19.1%) to 10.4% (6.42-16.5%), then increased to 12.4% (9.53-16.0%). (figure 2) For two or more tobacco products use with cigarette, the prevalence increased from 1.33% (0.54-3.25%) to 5.05% (2.35-10.5%), then decreased to 3.90% (2.37-6.34%). (figure 3)

Table 1. Socio-demographic characteristics of 1139 current cigarette smokers ^a

	Overall sample	Exclusive cigarette smoker
	n=1139 n (%)	n= 987 (84.2%, 81.4-86.6%) n (%)
Sex		
Male	932 (84.1)	805 (83.7)
Female	207 (15.9)	182 (16.3)
Age		
15-29	88 (10.4)	60 (8.60)
30-39	107 (18.4)	80 (16.0)
40-49	166 (24.6)	143 (25.3)
50-59	250 (22.2)	221 (23.3)
≥60	443 (24.4)	408 (26.8)
Educational attainment ^b		
Primary or below	241 (15.1)	223 (16.3)
Secondary	660 (59.5)	580 (61.7)
Tertiary or above	231 (25.4)	178 (22.0)
Marital status		
Single	204 (24.5)	155 (21.5)
Married/cohabited	785 (64.9)	699 (67.6)
Divorced/widowed	143 (10.6)	127 (10.9)
Employment		
Economically active	641 (69.6)	540 (68.5)
Economically non-active	492 (30.4)	441 (31.5)
Monthly income ^c		
≥ 30000	407 (48.0)	337 (46.4)
20000-29999	171 (18.5)	148 (18.3)
≤ 19999	397 (33.5)	356 (35.3)

^a The proportions were weighted by age and sex distribution of adult current cigarette users in Hong Kong 2017, the observations (n) were unweighted.

^b Proportion add up is not 100% due to rounding.

^c US\$ 1= HK\$ 7.8.

Table 2. Overall prevalence of one tobacco product use with cigarette of 1139 current cigarette smokers

Tobacco products	n	% ^a (95% CI)
Cigar + cigarette	57	6.28 (4.75-8.27)
Self-rolling cigarette + cigarette	57	5.52 (4.15-7.30)
Waterpipe + cigarette	33	3.77 (2.55-5.56)
Electronic cigarette + cigarette	7	1.05 (0.44-2.50)

a. Prevalence was weighted by age and sex distribution of adult current cigarette users in Hong Kong 2017, the observations (n) were unweighted.

For socio-demographic characteristics variables, being male was associated with current use of poly-tobacco product (AOR 2.01, 95% CI 1.12-3.61). Inverse association was found between age and current PTU; the AOR increased with younger age and the association remains strongly significant after adjustment. (AORs range from 1.34-4.65, P for trend less than 0.001). (table 3) No intention to quit cigarette smoking was associated with current PTU (AOR 2.08, 95% CI 1.09-3.97). HSI was not associated with current PTU before and after adjustment. (table 4)

Table 3. Associations of socio-demographic characteristics with current use of poly-tobacco products in 1139 current smokers

	Current use of poly-tobacco products		
	n (%)	Crude OR (95% CI)	AOR (95% CI) ^a (n= 905)
Sex			
Female	207 (18.2)	1	1
Male	932 (81.8)	1.15 (0.73-1.82)	2.01 (1.12-3.61)*
Age (years)			
≥60	443 (42.0)	1	1
50-59	250 (23.7)	1.53 (0.91-2.57)	1.34 (0.69-2.58)
40-49	166 (15.8)	1.87 (1.07-3.28) *	1.95 (0.94-4.06)
30-39	107 (10.2)	3.93 (2.26-6.86) ***	4.15 (1.90-9.07) ***
15-29	88 (8.30)	5.44 (3.09-9.58) ***	4.65 (1.87-11.6) ***
P for trend		<0.001	<0.001
Educational attainment			
Primary or below	241 (21.3)	1	1
Secondary	660 (58.3)	1.71 (1.01-2.92) *	1.10 (0.59-2.05)
Tertiary or above	231 (20.4)	3.69 (2.09-6.52) ***	1.32 (0.64-2.72)
P for trend		<0.001	0.30
Marriage			
Married/cohabited	785 (69.4)	1	1
Divorced/widowed	143 (12.6)	1.02 (0.58-1.80)	1.18 (0.62-2.24)
Single	204 (18.0)	2.57 (1.74-3.80) ***	1.06 (0.59-1.89)
Employment			
Economically non-active	492 (43.4)	1	1
Economically active	641 (56.6)	1.62 (1.13-2.32) **	0.82 (0.47-1.44)
Monthly household income (HK\$)^b			
≤ 19999	397 (40.7)	1	1
20000-29999	171 (17.5)	1.35 (0.78-2.33)	0.87 (0.46-1.65)
≥ 30000	407 (41.7)	1.80 (1.19-2.73) **	1.30 (0.78-2.16)
P for trend		<0.01	0.21

^a All variables were mutually adjusted.

^b US\$ 1= HK\$ 7.8.

* P<0.05; ** P<0.01; *** P<0.0

Table 4. Associations of smoking and quitting behaviors with current use of poly-tobacco products in 1139 current smokers

	Current use of poly-tobacco products		
	n (%)	Crude OR (95% CI)	AOR (95% CI) ^a (n=902)
Heaviness of Smoking Index			
0-2 (light)	538 (54.4)	1	1
3-4 (medium)	384 (38.8)	1.16 (0.79-1.69)	1.35 (0.87-2.08)
5-6 (high)	67 (6.77)	0.94 (0.43-2.05)	0.90 (0.36-2.24)
Intention to quit			
Within 30 days	170 (15.1)	1	1
No intention to quit	957 (84.9)	1.73 (0.99-3.02)	2.08 (1.09-3.97)*

^a Adjusting for sex, age, educational attainment and income.

* P<0.05; ** P<0.01; *** P<0.001.

Discussion

We identified the prevalence, trends, and risk factors associated with PTU. We found the prevalence of PTU had been slowly increasing in three years, one tobacco product use with cigarette was more common, and which cigar and cigarette has the highest prevalence compared with other patterns of PTU. The trend changes in overall prevalence of number of tobacco product use with cigarette varied in three years. Being male and less ready to quit were associated with current PTU. Strong association of being younger age with current PTU was also observed.

This is the first large scale study to examine the prevalence, trends, and risk factors associated with PTU from a large representative sample of Chinese general population. We observed that the prevalence of current PTU (15.9%) was lower than the U.S. (38.7%),²³ but was higher than that in some large European countries, such as Russian (15.6%), Ukraine (12.0%) and Turkey (12.3%).²⁴ Studies from other countries (e.g. U.S., Canada and Egypt) also showed consistent findings of increasing prevalence of PTU.²⁴⁻²⁵ The slow increasing PTU may be driven by relatively strict regulation of cigarettes sales compared with alternative tobacco products. Small geographical area (e.g. Hong Kong) along with high penetration of smartphone also contributes to increasing PTU via frequent expose to social media promotion on alternative tobacco products.²⁶ Estimates indicated using one tobacco product was more common than using two tobacco products in addition to cigarette (12.3% vs. 2.52%). Among this, cigar was the most used tobacco product (6.28%) compared with EC (1.05%). This suggested EC was less popular for PTU and those who used EC were more likely to be exclusive EC users. Dual use of cigar and cigarette was associated with less negative perception toward cigarette use and quit attempts,²⁷ tobacco intervention program specific to this subgroup of smokers is warranted to prevent the growth of this type of PTU. The trend changes in overall prevalence of number of tobacco product use with cigarette varied in three years, this suggested these smoking behaviors had not been routinized. PTU is in the early stage of

epidemic in Hong Kong, continuous monitoring and early intervention are warranted to prevent progression of long-term PTU.

Although studies on social norm and risk perception of PTU are limited, some studies had examined the socio-demographic characteristics associated with PTU.^{11 28-29} Consistent with previous studies in other countries,^{2 9 30-31} our findings showed that being male and younger age were positively associated with current PTU. Men were reported with higher risk-taking and sensation-seeking behaviors, such as drug or alcohol abuse and smoking experimentation.³²⁻³³ Dose-response relationship was observed between age and current PTU; being younger was significantly more likely to use multiple tobacco products in addition to cigarette. The association remains significant and robust after accounting for confounders. Tobacco industries mainly target young population by introducing these products (e.g. waterpipe) in different flavors and promoting the products as less harmful than cigarette on social media.³⁴ This age group of current smokers perceived PTU as less harmful, less addictive and more fashionable than smoking cigarettes.³⁵⁻³⁶ Many of cigar and waterpipe lounges were also densely located in nightlife district, where the modern and luxurious environments attracted large amount of young smokers.¹⁸ Our findings highlighted that younger age was a significant risk factor for current PTU, further studies are needed to explore their knowledge and perception about PTU.

We extend the understanding of smoking and quitting behaviors with current PTU. Current smokers with no intention to quit cigarette had higher odds of PTU. Other studies found positive association between higher quit attempts and PTU.^{11 37} The results were explained by the finding that poly-users had lower intention to quit smoking cigarette because they experienced less cessation success despite with higher quit attempts.²² Most of the poly-users were young and young smokers were associated with lower intention to quit smoking cigarette compared with other age groups.^{12 38} Instead of complete abstinence from smoking cigarettes, young smokers switched from exclusive cigarette users to poly-users for smoking experimentation.^{11 39 40} Some studies showed positive association between nicotine dependence and PTU,^{8 12-14} this was inconsistent with our finding. Heaviness of Smoking Index only measured the degree of nicotine dependence from smoking cigarette, it is possible that current smokers who concomitantly used cigarette with other tobacco products did not solely rely on cigarette to acquire nicotine and therefore smoked less compared with exclusive cigarette smokers. Such behavior is a barrier for smoking cessation treatment, as this specific group of smokers rarely seek cessation services and make them harder to quit.³⁷ Future longitudinal studies are needed to specifically follow poly-users to investigate their smoking behaviors and cessation outcomes.

This study has some limitations. As the analysis was based on repeated cross-sectional data, a longitudinal study is needed to further explore the detailed trend changes of PTU and the temporal relations of smoking and quitting behaviors with PTU. As smoking is generally considered unacceptable in Chinese culture, respondents may subject to social desirability bias due to nature of the survey. Socially desirable responses were likely to occur in response to sensitive questions, such as number of cigarette smoked and tobacco products used,⁴¹⁻⁴² therefore the prevalence may be underestimated.

Confidentiality was assured before the interview began, but data collected from the lane line surveys were self-reported and answers might still be subject to measurement and reporting bias due to underreporting, attenuation of associations were possible.⁴³

Abbreviation

EC, electronic cigarette; PTU, poly-tobacco product use; TCPS, Tobacco Control Policy-related Survey; COSH, the Hong Kong Council on Smoking and Health; POP, the Public Opinion Program; HSI, Heaviness of Smoking Index; AOR, adjusted odds ratio

Declarations

Ethics approval and consent to participate

Ethical approval has been granted by Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (Ref: UW15-108). Participants provided oral consent before being able to take part in this study. We only obtained oral consents from parent or guardian of participants under 16 years old due to nature of lane-line telephone survey.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interest

MPW is one of the associate editors of health behavior, health promotion and society of BMC Public Health journal.

Funding

The Tobacco Control Policy-related Surveys 2015-17 were funded by the Hong Kong Council on Smoking and Health. We received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Author's contribution

MPW, DYT and THL designed the study. MPW, DYT and YW collected the data. YW, SLC and MPW analyzed the data. SLC and MPW drafted the manuscript. All authors critically revised and approved the final version of the manuscript.

Acknowledgements

The authors wish to acknowledge those who contributed significantly to the work and respondents who participated in the surveys.

Author information

¹School of Nursing, University of Hong Kong, 21 Sassoon Road, Pokfulam, Hong Kong

²School of Public Health, University of Hong Kong, 7 Sassoon Road, Pokfulam, Hong Kong

³Hong Kong Council on Smoking and Health, 183 Queen's Road East, Wanchai, Hong Kong

References

- 1 Kowitt SD, Patel T, Ranney LM, *et al.* Poly-tobacco use among high school students. *J Environ Public Health.* 2015; 12:14477-89.2
- 2 Sung HY, Wang Y, Yao T, *et al.* Poly tobacco use of cigarettes, cigars, chewing tobacco, and snuff among US adults. *Nicotine Tob Res.* 2016; 1; 18:817-26.
- 3 Merianos, A. L., Mancuso, T. F., Gordon, J. S., *et al.* Dual- and Poly tobacco/Nicotine Product Use Trends in a National Sample of High School Students. *Am J Health Promot.* 2018; 32: 1280-1290.
- 4 Kang H, Cho SI. Heated tobacco product use among Korean adolescents. *Tob control.* 2019; 0:1-3
- 5 World Health Organization. 90% of smokeless tobacco users live in South-East Asia. World Health Organ. 2013.
- 6 Sinha D, Gupta PC, Parascondola M, *et al.* Global burden of smokeless tobacco (SLT) use. *Tob Induc Dis.* 2018; 16: 215.
- 7 Caputi TL, Leas E, Dredze M, *et al.* They're heating up: Internet search query trends reveal significant public interest in heat-not-burn tobacco products. *PLoS One.* 2017;12: 10.
- 8 King JL, Reboussin D, Ross JC, *et al.* Poly tobacco use among a nationally representative sample of adolescent and young adult e-cigarette users. *J Adolescent Health.* 2018; 63: 407-12.
- 9 Petersen A, Myers MG, Tully L, *et al.* Poly tobacco use among young adult smokers: prospective association with cigarette consumption. *Tob Control.* 2020; 29: 43-8.
- 10 Chaffee BW, Couch ET, Gansky SA. Trends in characteristics and multi-product use among adolescents who use electronic cigarettes, United States 2011-2015. *PLoS One.* 2017; 12: 5.

- 11 Lee YO, Hebert CJ, Nonnemaker JM, *et al.* Multiple tobacco product use among adults in the United States: cigarettes, cigars, electronic cigarettes, hookah, smokeless tobacco, and snus. *Prev Med.* 2014; 62:14-9.
- 12 Corral I, Landrine H, Simms DA, *et al.* Polytabacco use and multiple-product smoking among a random community sample of African-American adults. *BMJ Open.* 2013; 3:e003606.
- 13 Ali M, Gray TR, Martinez DJ, *et al.* Risk profiles of youth single, dual, and poly tobacco users. *Nicotine Tob Res.* 2016; 18:1614-21.
- 14 Little MA, Bursac Z, Derefinko KJ, *et al.* Types of dual and poly-tobacco users in the US military. *Am J Epidemiol.* 2016; 184:211-8.
- 15 Yang G, Wang Y, Wu Y, *et al.* The road to effective tobacco control in China. *The Lancet.* 2015; 385:1019-28.
- 16 Census and Statistic Department. Thematic household survey report no. 64: Pattern of smoking. In. Hong Kong. 2018
- 17 Wang MP, Li WH, Jiang N, *et al.* E-cigarette awareness, perceptions and use among community-recruited smokers in Hong Kong. *PLoS One.* 2015;10.
- 18 Jiang N, Ho SY, Wang MP, *et al.* The relationship of waterpipe use with cigarette smoking susceptibility and nicotine dependence: A cross-sectional study among Hong Kong adolescents. *Addict Behav.* 2017;64:123-8.
- 19 Lee JP. Tobacco control policy in Hong Kong. *Hong Kong Med J.* 2016; 22:96-7.
- 20 Cheung YT, Wang MP, Ho SY, *et al.* Public support for electronic cigarette regulation in Hong Kong: a population-based cross-sectional study. *J Environ Public Health.* 2017;14:709.
- 21 Borland R, Yong HH, O'connor RJ, *et al.* The reliability and predictive validity of the Heaviness of Smoking Index and its two components: findings from the International Tobacco Control Four Country study. *Nicotine Tob Res.* 2010;12:45-50.
- 22 Tworek C, Schauer GL, Wu CC, *et al.* Youth tobacco cessation: quitting intentions and past-year quit attempts. *Am J Prev Med.* 2014; 47:15-27.
- 23 Sung HY, Wang Y, Yao T, *et al.* Polytabacco use and nicotine dependence symptoms among US adults, 2012–2014. *Nicotine Tob Res.* 2018; 20:88-98.
- 24 Agaku IT, Filippidis FT, Vardavas CI, *et al.* Poly-tobacco use among adults in 44 countries during 2008–2012: evidence for an integrative and comprehensive approach in tobacco control. *Drug Alcohol Depend.* 2014;139:60-70.

- 25 Mostafa A, El Houssinie M, Fotouh AA. Multiple tobacco use among young adult waterpipe smokers in Egypt. *World Health Organ.* 2018; 24:7-17.
- 26 Link AR, Cawkwell PB, Shelley DR, *et al.* An exploration of online behaviors and social media use among hookah and electronic-cigarette users. *Addict Behav.* 2015; 2:37-40.
- 27 Pickworth WB, Rosenberry ZR, O'Grady KE, *et al.* Dual use of cigarettes, little cigars, cigarillos, and large cigars: smoking topography and toxicant exposure. *Tob Regul Sci.* 2017; 3:72-83.
- 28 Backinger CL, Fagan P, O'Connell ME, *et al.* Use of other tobacco products among US adult cigarette smokers: prevalence, trends and correlates. *Addict Behav.* 2008; 33:472-89.
- 29 Mushtaq N, Williams MB, Beebe LA. Concurrent use of cigarettes and smokeless tobacco among US males and females. *J Environ Public Health.* 2012.
- 30 Stanton CA, Halenar MJ. Patterns and correlates of multiple tobacco product use in the United States. *Nicotine Tob Res.* 2018; 20:1-4.
- 31 Osibogun O, Taleb ZB, Bahelah R, *et al.* Correlates of poly-tobacco use among youth and young adults: Findings from the Population Assessment of Tobacco and Health study, 2013–2014. *Drug Alcohol Depend.* 2018; 187:160-4.
- 32 Bombard JM, Pederson LL, Nelson DE, *et al.* Are smokers only using cigarettes? Exploring current polytobacco use among an adult population. *Addict Behav.* 2007; 32:2411-9.
- 33 Rigotti NA, Lee JE, Wechsler H. US college students' use of tobacco products: results of a national survey. *JAMA.* 2000; 284:699-705.
- 34 Harrell MB, Weaver SR, Loukas A, *et al.* Flavored e-cigarette use: Characterizing youth, young adult, and adult users. *Prev Med Rep.* 2017; 5:33-40.
- 35 Cooper M, Creamer MR, Ly C, *et al.* Social norms, perceptions and dual/poly tobacco use among Texas youth. *Am J Health Behav.* 2016 Nov 1;40:761-70.
- 36 Roditis M, Delucchi K, Cash D, *et al.* Adolescents' perceptions of health risks, social risks, and benefits differ across tobacco products. *J Adolesc Health.* 2016; 58:558-66.
- 37 Pulvers K, Hayes RB, Scheuermann TS, *et al.* Tobacco use, quitting behavior, and health characteristics among current electronic cigarette users in a national tri-ethnic adult stable smoker sample. *Nicotine Tob Res.* 2014;17:1085-95.
- 38 Tomar SL, Alpert HR, Connolly GN. Patterns of dual use of cigarettes and smokeless tobacco among US males: findings from national surveys. *Tob Control.* 2010;19:104-9.

39 McClave-Regan AK, Berkowitz J. Smokers who are also using smokeless tobacco products in the US: a national assessment of characteristics, behaviours and beliefs of 'dual users'. *Tob Control*. 2011;20:239-42.

40 Siahpush M, McNeill A, Borland R, *et al*. Socioeconomic variations in nicotine dependence, self-efficacy, and intention to quit across four countries: findings from the International Tobacco Control (ITC) Four Country Survey. *Tob Control*. 2006;15:71-5.

41 Wang MP, Ho SY, Lam TH. Parental smoking, exposure to secondhand smoke at home, and smoking initiation among young children. *Nicotine Tob Res*. 2011;13:827-32.

42 Van de Mortel TF. Faking it: social desirability response bias in self-report research. *Aust J Adv Nurs*, The. 2008;25:40.

43 Luk TT, Wang MP, Leung LT, *et al*. Perceived family relationship quality and use of poly-tobacco products during early and late adolescence. *Addict Behav*. 2018;85:38-42.

Figures

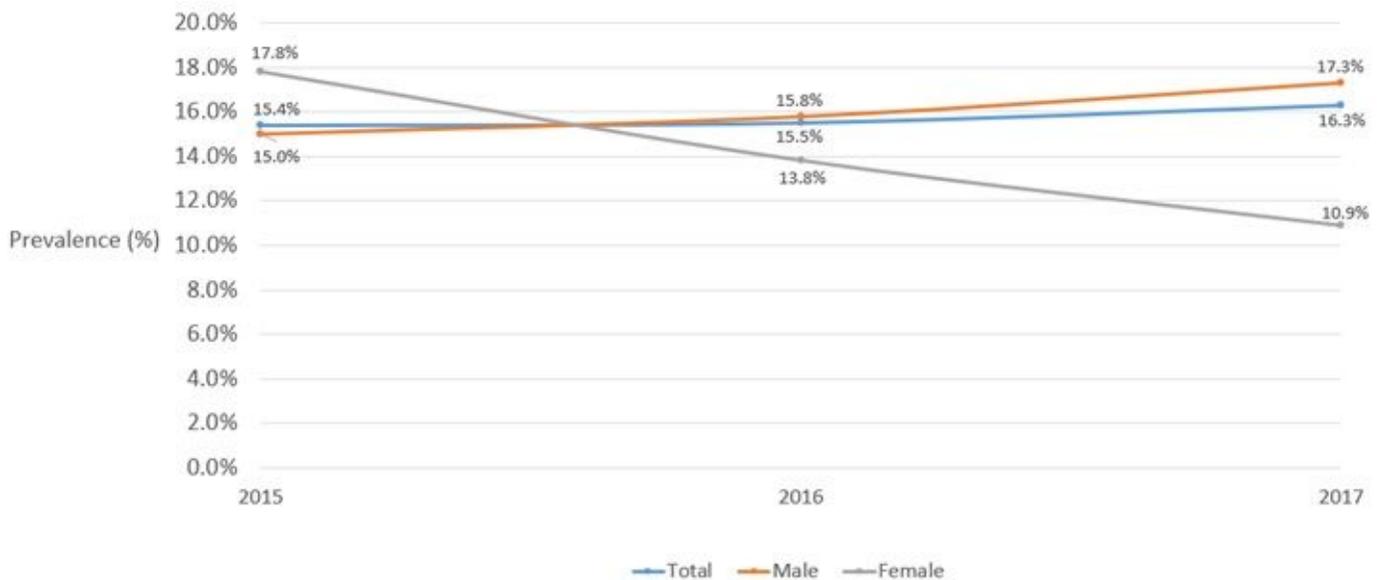


Figure 1

Prevalence of current poly-tobacco product use by sex, 2015-17 (n=1139)

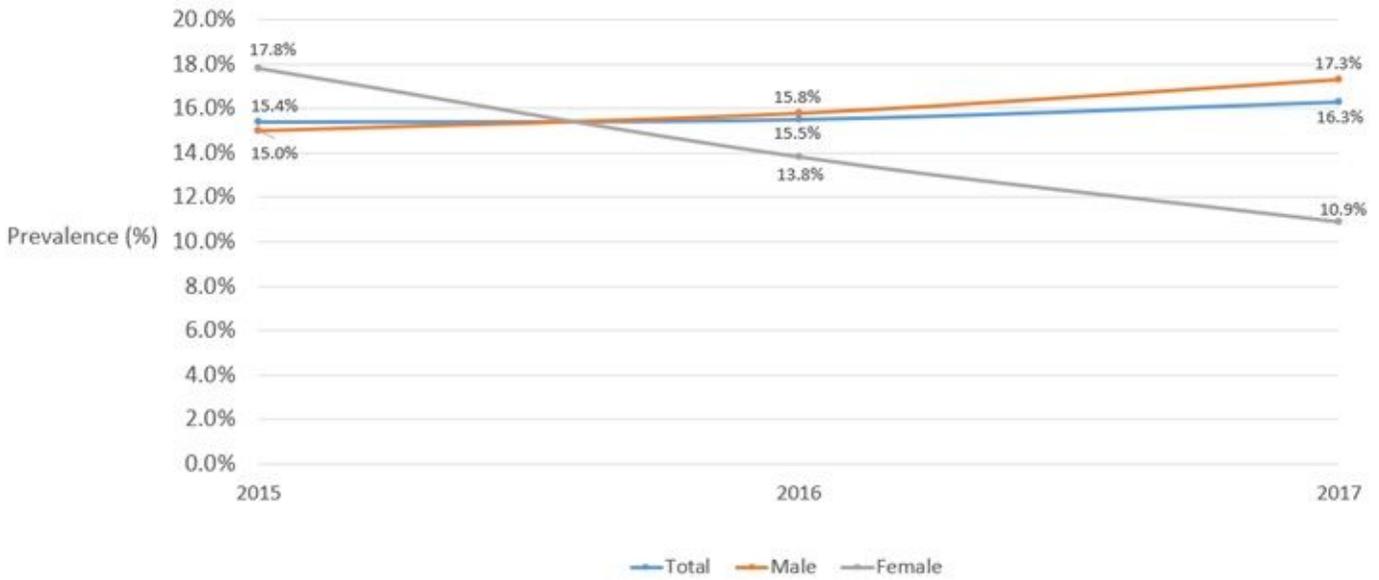


Figure 1

Prevalence of current poly-tobacco product use by sex, 2015-17 (n=1139)

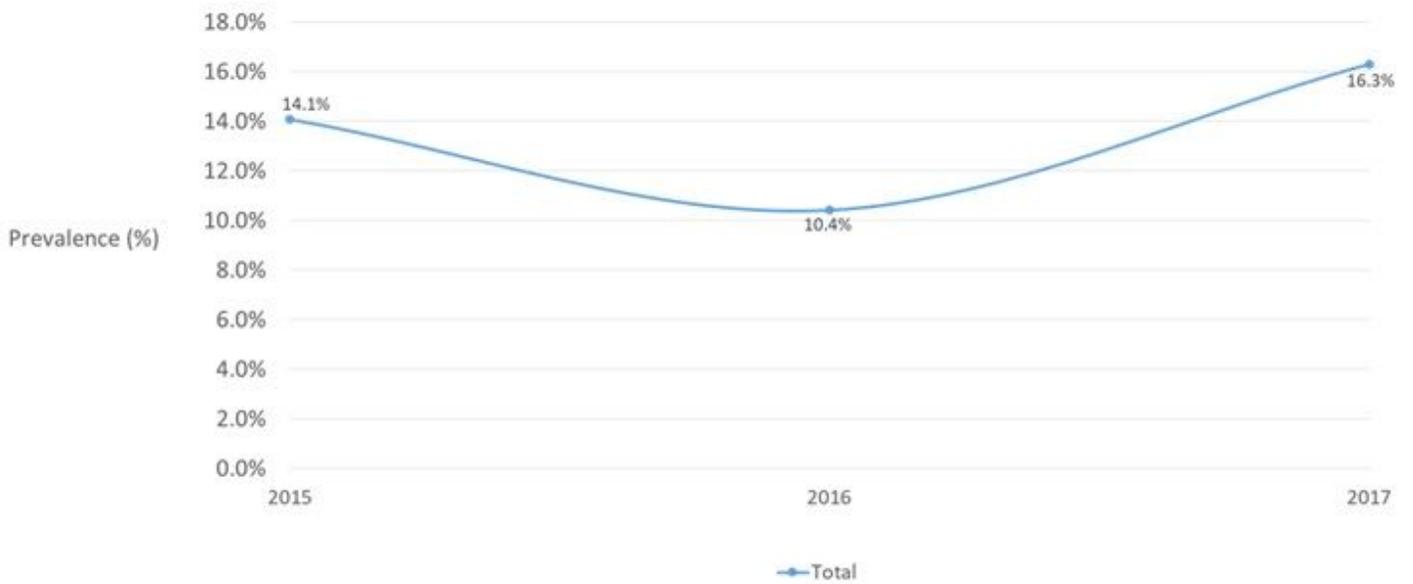


Figure 2

Overall prevalence of one tobacco product use with cigarette, 2015-17 (n=1139)

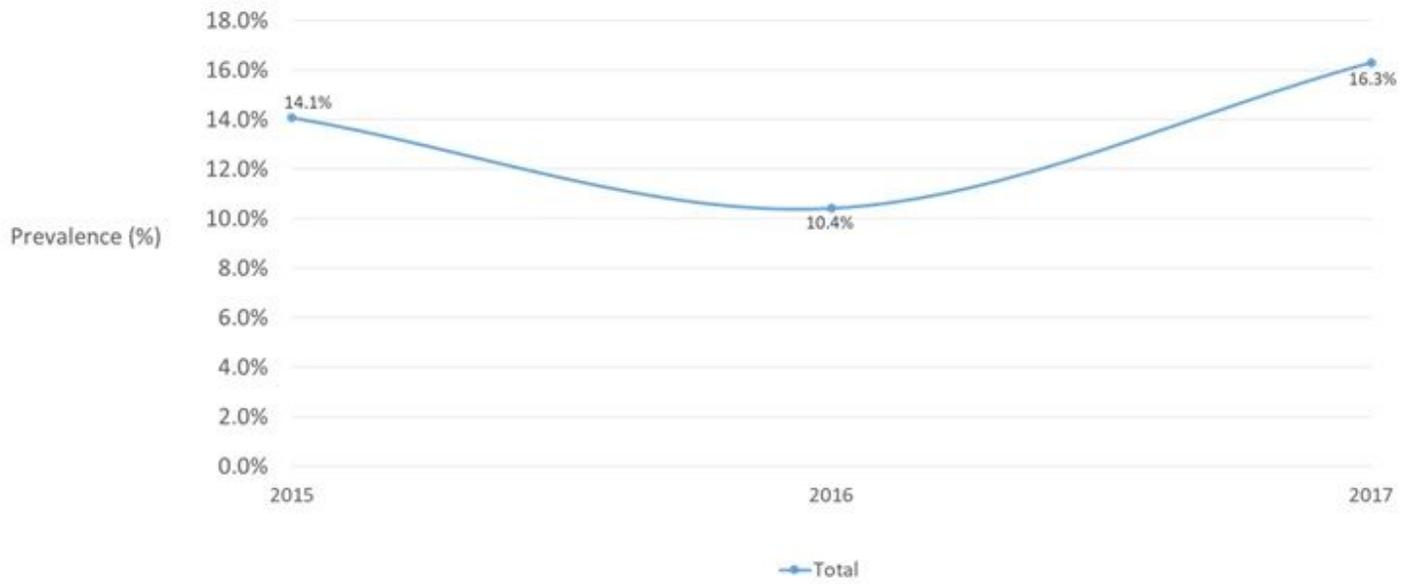


Figure 2

Overall prevalence of one tobacco product use with cigarette, 2015-17 (n=1139)

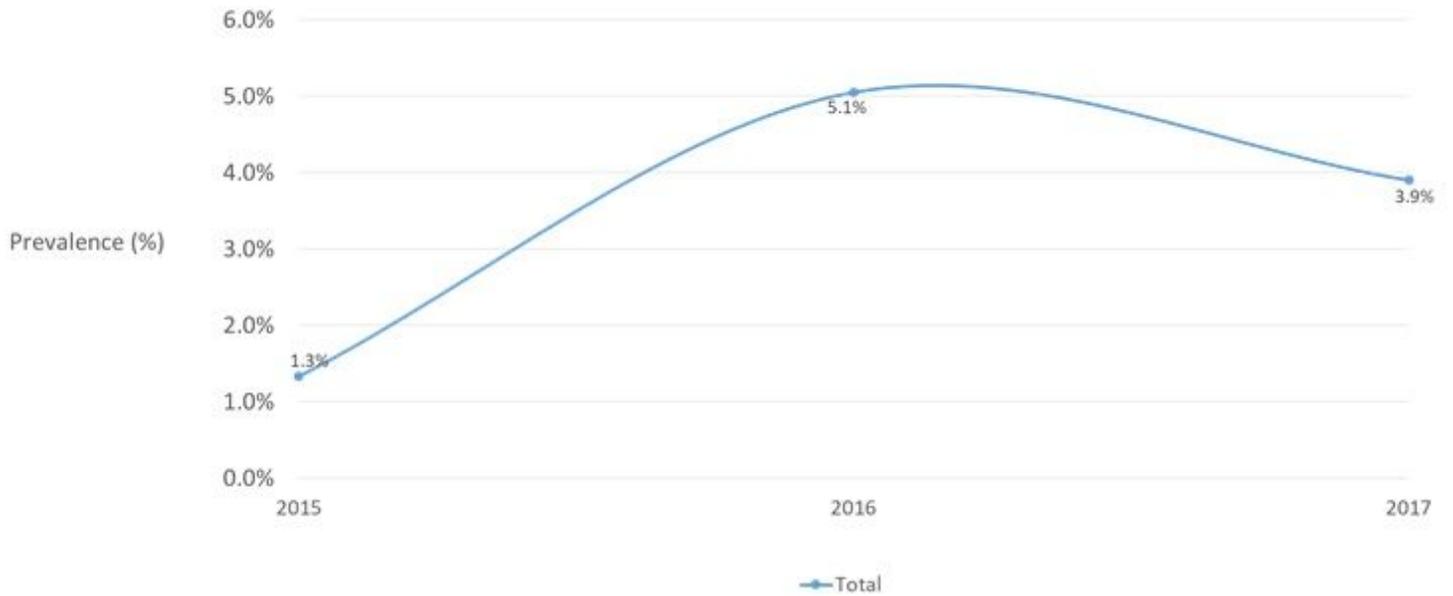


Figure 3

Overall prevalence of two or more tobacco products use with cigarette, 2015-17 (n=1139)

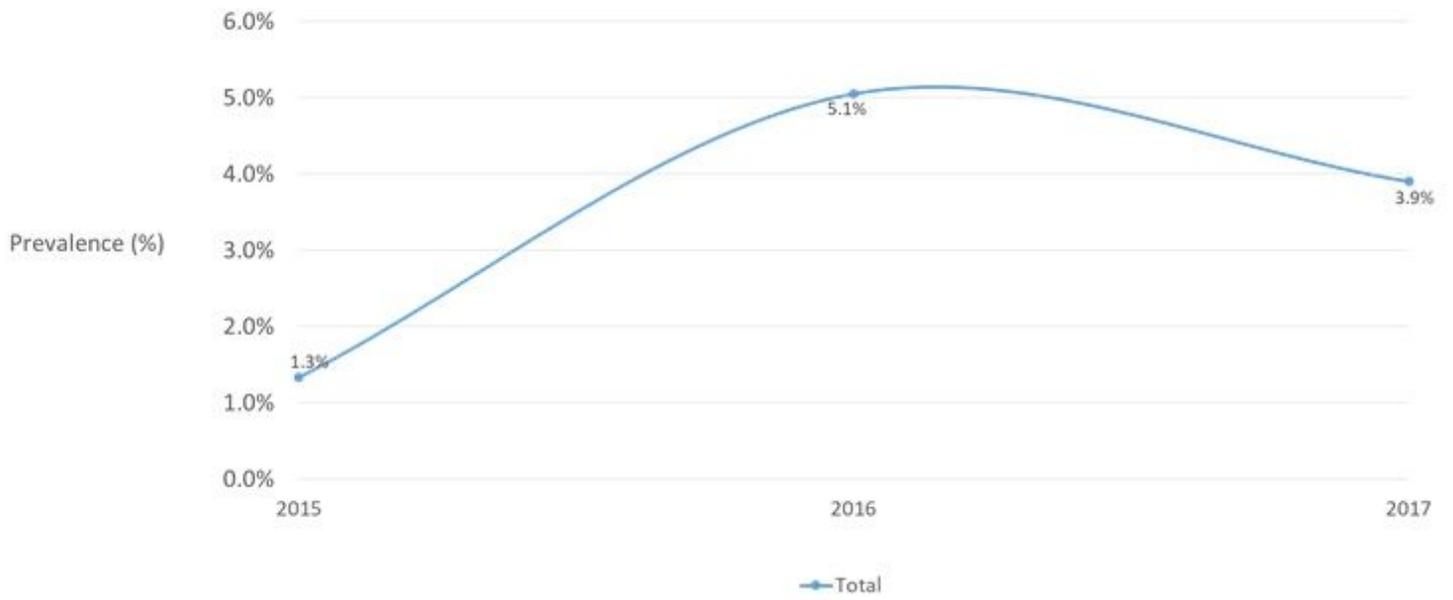


Figure 3

Overall prevalence of two or more tobacco products use with cigarette, 2015-17 (n=1139)