

Poly-tobacco product use among a representative sample of Chinese current smokers: a population survey

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Abstract

Background

Poly-tobacco product use is increasingly popular, but little is known about the patterns, trends of concomitant use, and risk factors 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

15.9% (95% CI 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. The co-use of cigarette with cigar was more common and the least co-use product was e-cigarette with cigarette. By age group, proportion of co-use of cigarette with waterpipe was highest in young poly-users, older age used more cigar and self-rolling cigarette in addition to cigarette. Prevalence of two products use with cigarette was low. Trends of concomitant use were varied. 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, co-use of one tobacco product with cigarette was more common. Being male, younger and less ready to quit were associated with current PTU.

[236/250 words]

Background

Poly-tobacco product use (PTU) refers to concomitantly using two or more tobacco products, such as 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 conventional cigarette decreased by 18% in 2000–2007, but cigar sales surged by 37%.² Concomitant use of EC and waterpipe also increased dramatically from 1.5–16% and 4.1–7.2% in 2011–2015, respectively.³ Asian countries reported with 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 conventional cigarette.⁷ Youth were more likely to explore different tobacco products.^{8–9} Over 80% of poly-tobacco product users reported starting concomitant use 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 concomitant use.

We investigated the overall prevalence of PTU, patterns of concomitant use among current smokers, and examined the trends of PTU stratified by patterns of concomitant use. 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 (Wu et al., 2019; Cheung et al., 2017). The Tobacco Control Policy-related Survey (TCPS) was a cross-sectional regular survey from 2015-17 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. 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 respondents of the 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 whole sample of 15534 Cantonese-speaking participants was weighted by sex, age and smoking status using inverse probability weighting to make the sample

more representative to Hong Kong population.¹⁶ A representative sample of 1139 current cigarette users was analyzed. All respondents provided oral consent before the telephone interview. Ethical approval was sought 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).²¹ Respondents were asked about their intention to quit smoking (quit in 30-day vs quit after 30-day).²² Current cigarette smokers reported using other tobacco products (cigars, self-rolling cigarette, waterpipe and electronic cigarette) within 30-day were categorized as current poly-users. PTU was categorized by number of tobacco products use (one tobacco product or two tobacco products use in addition to cigarette) and patterns of concomitant use.

Statistical analysis

Socio-demographic characteristics, prevalence of PTU and concomitant use were weighted by sex and age distribution of 2017 Hong Kong adult current cigarette users. The associations of socio-demographic characteristics, HSI and intention to quit with current PTU were analyzed using multivariable logistic regression, 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.

Results

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%). The overall prevalence of current PTU was 15.9% (12.3% for 2 products, 2.52% for 3 products and 1.01% for 4 or more products, including cigarette) and its use increased slightly by year from 15.5%-16.3%, 2015-17. (Fig. 1 and Fig. 2) The overall prevalence of one tobacco product use with cigarette was 6.28% for cigar, 5.52% for self-rolling cigarette, 3.77% for waterpipe and 1.05% for EC (Table 1). For two tobacco products use with cigarette, the overall prevalence was 1.08% for cigar with self-rolling cigarette, 1.00% for waterpipe with self-rolling cigarette, 0.98% for waterpipe with cigar, 0.74% for EC with waterpipe, 0.52% for EC with cigar, and 0.43% for EC with self-rolling cigarette. (Fig. 3) Fig. 4 shows the trend of PTU stratified by patterns of concomitant use, the most used tobacco product with cigarette in 2015 was cigar (6.40%), waterpipe (6.11%) in 2016, and cigar (7.26%) in 2017. The most used two tobacco products with cigarette in 2015 was cigar with EC (0.33%), EC with waterpipe (2.28%) in 2016, and self-rolling cigarette

with waterpipe (1.36%) in 2017. (Fig. 5) Among current poly-users, aged 15–29 respondents used more waterpipe with conventional cigarette (41.92%). Older age group (30–59 years) used more cigar with cigarette and aged ≥ 60 poly-users used more self-rolling cigarette with cigarette (51.95%). (Fig. 6).

Table 1

Socio-demographic characteristics of 1139 current cigarette smokers ^a

	Overall sample n = 1139 n (%)	Cigar + cigarette smokers n = 57 (6.28%) n (%)	Self-rolling cig. + cigarette smokers n = 57 (5.52%) n (%)	Waterpipe + cigarette smokers n = 33 (3.77%) n (%)	E-cig + cigarette smokers n = 7 (1.05%) n (%)
Sex					
Male	932 (84.1)	53 (93.1)	49 (87.4)	26 (86.1)	5 (90.9)
Female	207 (15.9)	4 (6.90)	8 (12.6)	7 (13.9)	2 (9.10)
Age					
15–29	88 (10.4)	7 (12.8)	11 (22.7)	11 (32.4)	4 (46.4)
30–39	107 (18.4)	10 (34.0)	11 (31.1)	8 (38.6)	2 (41.4)
40–49	166 (24.6)	8 (20.3)	5 (14.1)	2 (7.60)	1 (12.2)
50–59	250 (22.2)	15 (23.3)	9 (14.9)	5 (12.1)	0
≥ 60	443 (24.4)	10 (9.60)	18 (17.2)	7 (9.30)	0
Educational attainment ^b					
Primary or below	241 (15.1)	7 (7.20)	9 (9.50)	6 (11.5)	0
Secondary	660 (59.5)	28 (46.5)	29 (46.3)	14 (39.8)	2 (19.9)
Tertiary or above	231 (25.4)	22 (46.3)	19 (44.2)	12 (48.7)	5 (80.1)
Marital status					
Single	204 (24.5)	20 (47.6)	20 (44.6)	14 (53.1)	4 (68.0)
Married/cohabited	785 (64.9)	32 (45.4)	31 (46.2)	13 (36.2)	3 (32.0)
Divorced/widowed	143 (10.6)	5 (7.00)	6 (9.20)	5 (10.7)	0
Employment					

^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.

	Overall sample n = 1139 n (%)	Cigar + cigarette smokers n = 57 (6.28%) n (%)	Self-rolling cig. + cigarette smokers n = 57 (5.52%) n (%)	Waterpipe + cigarette smokers n = 33 (3.77%) n (%)	E-cig + cigarette smokers n = 7 (1.05%) n (%)
Economically active	641 (69.6)	45 (83.1)	34 (72.8)	17 (58.0)	4 (51.1)
Economically non-active	492 (30.4)	12 (16.9)	23 (27.2)	16 (42.0)	3 (48.9)
Monthly income ^c					
≥ 30000	407 (48.0)	31 (65.7)	26 (58.7)	14 (56.7)	4 (100)
20000–29999	171 (18.5)	9 (19.5)	7 (17.3)	4 (14.9)	0
≤ 19999	397 (33.5)	10 (14.8)	18 (24.0)	11 (28.4)	0
^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
Associations of socio-demographic characteristics with current use of poly-tobacco products in 1139 current smokers

	Current use of poly-tobacco products	
	Crude OR (95% CI)	AOR (95% CI) ^a
Sex		
Female	1	1
Male	1.15 (0.73–1.82)	2.01 (1.12–3.61)*
Age (years)		
≥ 60	1	1
50–59	1.53 (0.91–2.57)	1.34 (0.69–2.58)
40–49	1.87 (1.07–3.28) *	1.95 (0.94–4.06)
30–39	3.93 (2.26–6.86) ***	4.15 (1.90–9.07) ***
15–29	5.44 (3.09–9.58) ***	4.65 (1.87–11.6) ***
P for trend	< 0.001	< 0.001
Educational attainment		
Primary or below	1	1
Secondary	1.71 (1.01–2.92) *	1.10 (0.59–2.05)
Tertiary or above	3.69 (2.09–6.52) ***	1.32 (0.64–2.72)
P for trend	< 0.001	0.30
Marriage		
Married/cohabited	1	1
Divorced/widowed	1.02 (0.58–1.80)	1.18 (0.62–2.24)
Single	2.57 (1.74–3.80) ***	1.06 (0.59–1.89)
Employment		
Economically non-active	1	1

^a All variables were mutually adjusted.

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

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

	Current use of poly-tobacco products	
Economically active	1.62 (1.13–2.32) **	0.82 (0.47–1.44)
Monthly household income (HK\$) ^b		
≤ 19999	1	1
20000–29999	1.35 (0.78–2.33)	0.87 (0.46–1.65)
≥ 30000	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 < 0.001		

Table 3
Associations of smoking and quitting behaviors with current use of poly-tobacco products in 1139 current smokers

	Current use of poly-tobacco products	
	Crude OR (95% CI)	AOR (95% CI) ^a
Heaviness of Smoking Index		
0–2 (light)	1	1
3–4 (medium)	1.16 (0.79–1.69)	1.35 (0.87–2.08)
5–6 (high)	0.94 (0.43–2.05)	0.90 (0.36–2.24)
Intention to quit		
Within 30 days	1	1
No intention to quit	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.		

For socio-demographic characteristics variables, only sex and age were associated with current use of poly-tobacco product. Inverse association was found between age and current PTU; the AOR increased with younger age and the association remains strongly significant after adjustment. (P for trend less than 0.001). 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.

Discussion

This is the first large scale study to examine the prevalence of PTU, patterns and trends of concomitant use, 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 increasing concomitant use 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 the increasing concomitant use 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 concomitant use 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 co-use. We examined the patterns of concomitant use with cigarette over three years. Compared with dual use of waterpipe and cigarette, the prevalence of cigar or self-rolling cigarette with cigarette use dropped slightly in 2016, then raised in the next year. For two tobacco products use in addition to cigarette, only self-rolling cigarette with waterpipe use had steady increase by year. The varied patterns of concomitant use 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 concomitant use.

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 conventional 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 concomitant use.

We extend the understanding of smoking and quitting behaviors with current PTU. Current smokers with no intention to quit conventional 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. We were unable to determine the temporal relationships given the cross-sectional design. Although reverse causation between socio-demographic characteristics (sex and age) and PTU are unlikely, longitudinal study is needed to further explore 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 subject to measurement and reporting bias due to underreporting, attenuation of associations were possible.⁴³

Conclusions

We identified the prevalence of PTU, patterns and trends of concomitant use, and risk factors associated with such use. We found the prevalence of PTU had been slowly increasing in three years, co-use of one tobacco product with cigarette was more common, and which cigar and cigarette has the highest prevalence compared with other patterns of concomitant use. Among poly-users, young adults preferred co-use of waterpipe and cigarette, cigar and self-rolling cigarette were more common for co-use in older age group in addition to cigarette. Being male and less ready to quit were associated with current PTU. Strong association of being younger age with current PTU was also observed. These important risk factors can be the indicators to identify specific vulnerable groups for designing public health campaigns and control multiple tobacco products use in future.

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.

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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.

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Figures

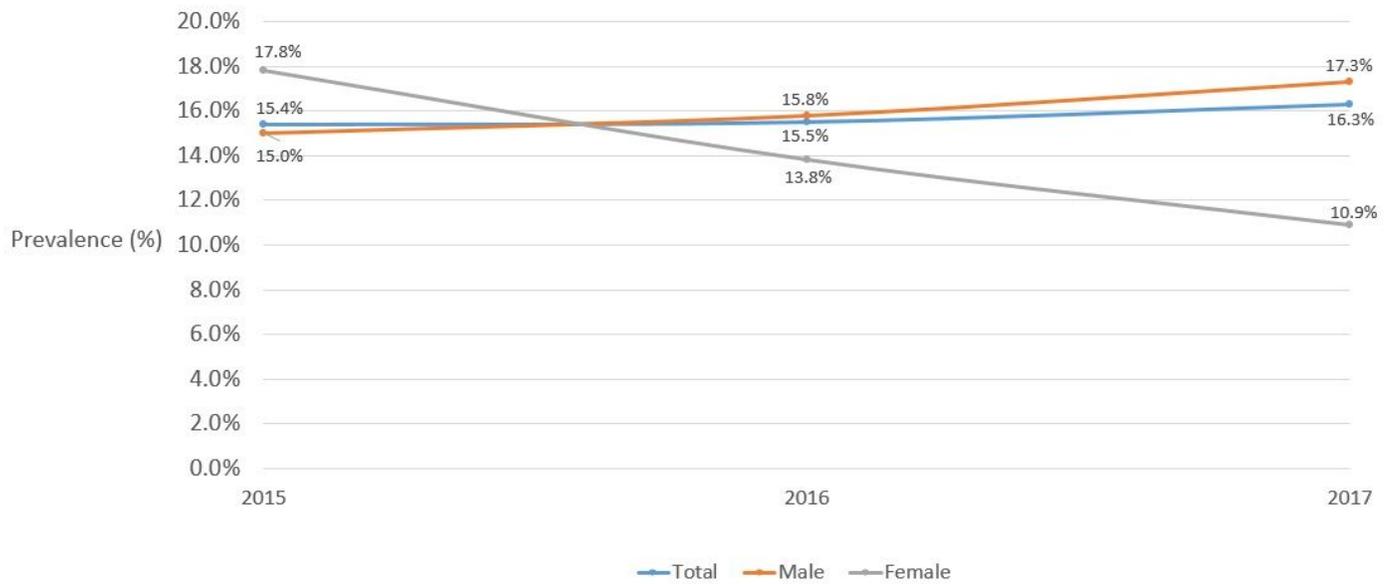


Figure 1: Prevalence of current poly-tobacco product use by sex, 2015-17 (n=1139)

Figure 1

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

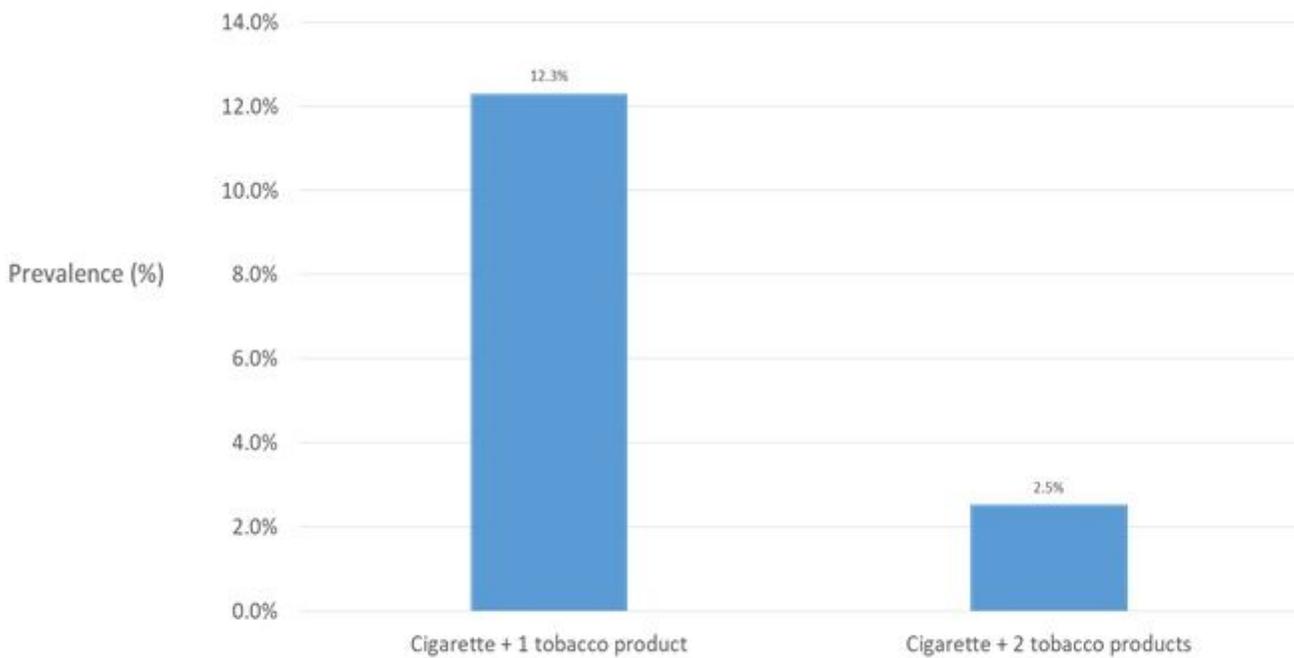


Figure 2: Overall prevalence of current poly-tobacco product use by number of tobacco product use, 2015-17 (n=1139)

Figure 2

Overall prevalence of current poly-tobacco product use by number of tobacco product use, 2015-17 (n=1139)

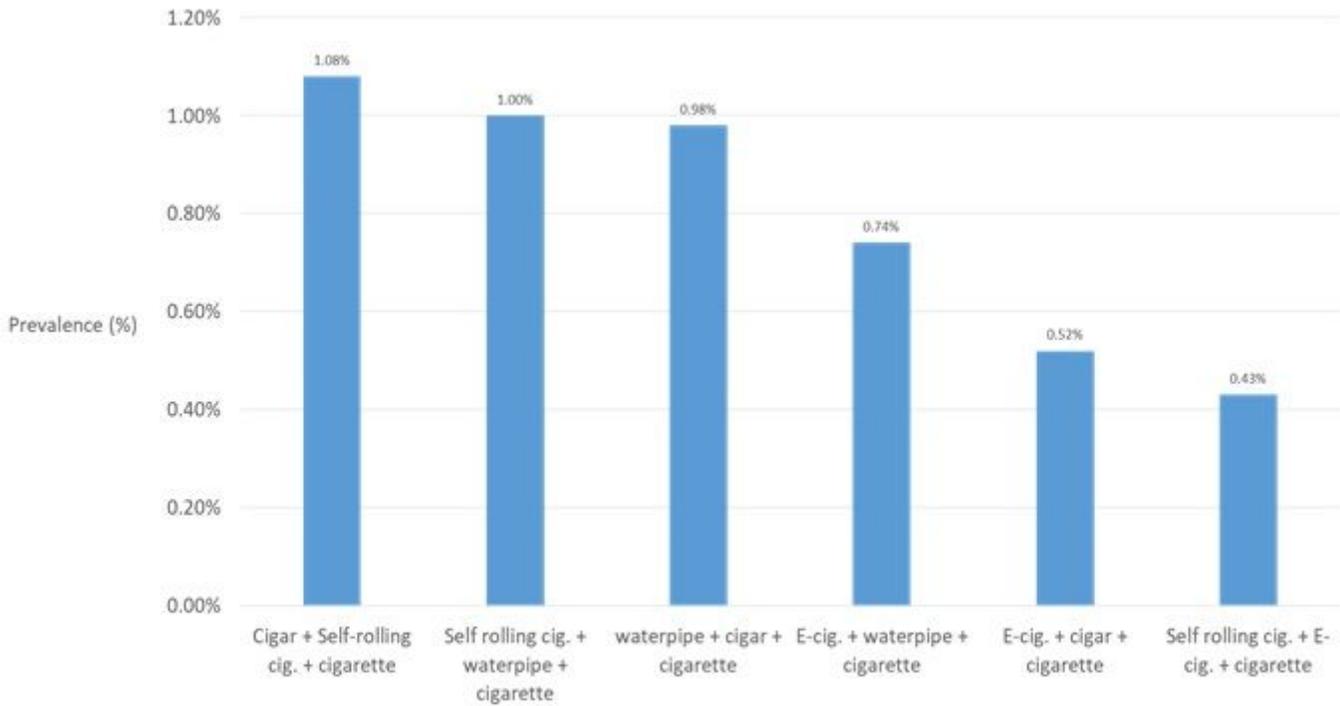


Figure 3: Overall prevalence of current poly-tobacco product use by pattern of concomitant use (cigarette + 2 tobacco products), 2015-17 (n=1139)
Cig= cigarette

Figure 3

Overall prevalence of current poly-tobacco product use by pattern of concomitant use (cigarette + 2 tobacco products), 2015-17 (n=1139)

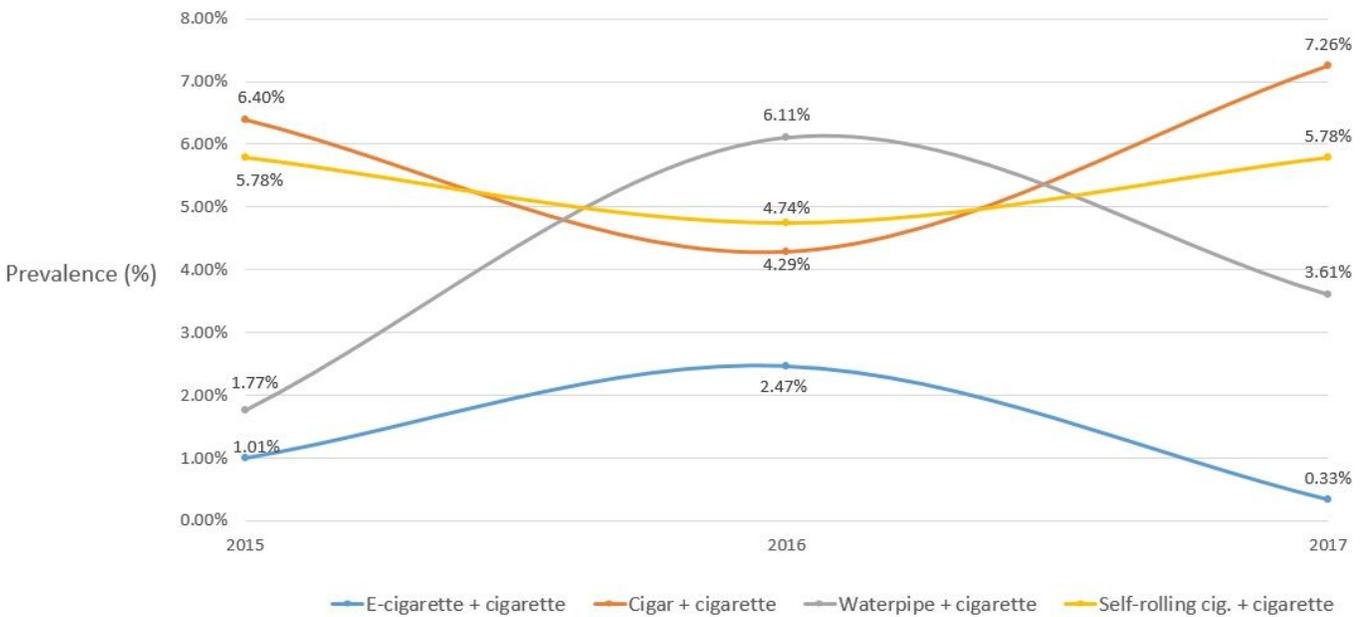


Figure 4: Trend of poly-tobacco product use (cigarette + 1 tobacco product) by patterns of concomitant use, 2015-17 (n=1139)
Cig= cigarette

Figure 4

Trend of poly-tobacco product use (cigarette + 1 tobacco product) by patterns of concomitant use, 2015-17 (n=1139)

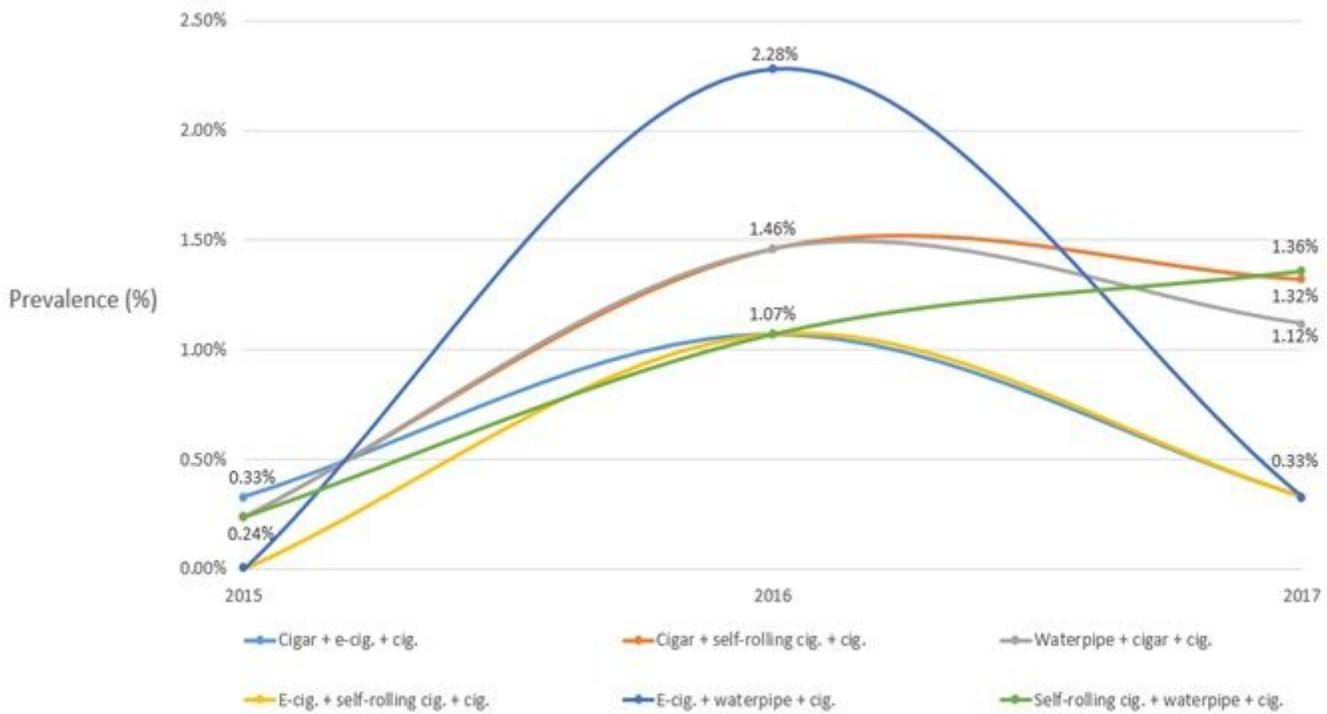


Figure 5: Trend of poly-tobacco product use (cigarette + 2 tobacco products) by pattern of concomitant use, 2015-17 (n=1139)
Cig= cigarette

Figure 5

Trend of poly-tobacco product use (cigarette + 2 tobacco products) by pattern of concomitant use, 2015-17 (n=1139)

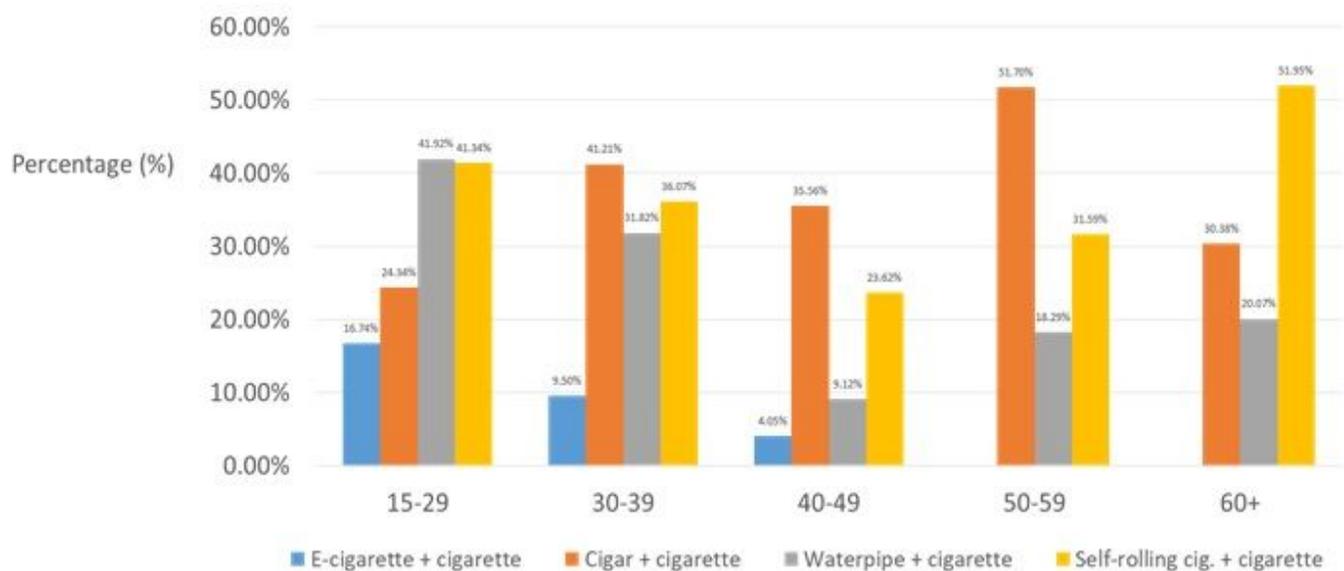


Figure 6: Proportion of concomitant use among poly-users by age group (cigarette + 1 tobacco product), 2015-17 (n=152)
Cig=cigarette

Figure 6

Proportion of concomitant use among poly-users by age group (cigarette + 1 tobacco product), 2015-17 (n=152)