Use patterns of cigarettes and alternative tobacco products and socioeconomic correlates in Hong Kong adolescents

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Abstract

Smoking is a major cause of health inequities. However, sociodemographic differences in adolescent tobacco use are unclear, especially for new tobacco products. We investigated tobacco use patterns and sociodemographic correlates in Hong Kong adolescents. In a territory-wide school-based survey, 33 991 students (US grade 7–12) completed an anonymous questionnaire. Tobacco use prevalences and current-ever use ratios by sociodemographic factors were calculated. Generalised linear mixed models were used in association analyses. Current use was highest for cigarettes (3.19%), closely followed by alternative tobacco products (2.96%). Current-ever use ratios were highest for heated tobacco products (HTPs, 0.60), followed by nicotine-containing e-cigarettes (0.52), waterpipe (0.51) and cigarettes (0.35). Student use prevalences and current-ever use ratios of all products showed J-shaped relations with family affluence, being highest in the richest families. Tobacco use was also associated with higher grades, the lowest parental education and boys, but current-ever use ratios of HTP and waterpipe were higher in girls. The results suggested that adolescent ever users of nicotine-containing alternative products were more likely to keep using them than cigarettes, and the richest adolescents were at the highest risks of tobacco use. Diverse tobacco control measures are needed to improve health equity, especially on alternative products.

Introduction

Smoking is a major cause of health inequities. Over 80% of smokers live in low- and middle-income countries (LMIC), where over 80% of smoking-related deaths were predicted by 2030.[1] The inequities were also evident within countries and regions, with smoking inversely associated with socioeconomic status (SES) in developed countries.[2,3] Disadvantaged people tend to initiate smoking at younger ages, smoke heavier, and are less successful in quitting.[3] Diverting their limited disposable income to tobacco means lower expenditures on food, shelter, education and healthcare,[4,5] aggravating socioeconomic inequities.

However, studies have shown inconsistent associations between family SES and adolescent cigarette smoking. In the US and UK, lower family SES strongly predicted adolescent smoking initiation and escalation.[6-8] The World Health Organisation Health Behaviour in School-aged Children (HBSC) study in 35 Western countries showed that each standard deviation lower family affluence was only associated with a modest (9%) increase in the odds of adolescent weekly smoking; the associations were generally stronger in more affluent countries, and non-significant in over half the countries.[9] Studies, though limited in developing countries and regions at relatively early stages of the smoking epidemic, showed that the patterns in mainland China were similar to those in the US and UK,[10] but no association was found in Ghana.[11]

The associations between SES and use of alternative tobacco products remain unclear in adolescents. Studies in the US and New Zealand have found higher EC use in adolescents from low-SES families and communities.[12,13] However, other studies showed that SES was unassociated,[14-16] or even positively associated with adolescent EC use or use susceptibility.[17,18] We found only one study, the Korea Youth Risk Behavior Web-based Survey, on the correlates of HTP use, which showed that compared with the highest-SES group, ever HTP use was 27% lower in the middle-SES group but showed no difference in the lowest-SES group.[19] Student use of waterpipe was more common in those who received the largest amount of spending money in most of the 60 countries in a secondary analysis based on the Global Youth Tobacco Survey.[20]

The current-ever use ratio (the proportion of current users among ever users) of a tobacco product is a useful indicator of how likely the product is used beyond experimentation among adolescents and can be assessed using cross-sectional data. However, we found no such reports after searching PubMed and Web of Science using the terms of "(current ever ratio OR current ever use ratio OR current users among ever users OR current use among ever users) AND (tobacco) AND (child OR adolescent)" up to 5 February 2020.

Hong Kong has implemented comprehensive tobacco control measures and achieved a daily smoking prevalence (10.2% in persons aged over 15 in 2019) that was among the lowest in the world.[21] However, the emergence of alternative tobacco products threatens to renormalise tobacco use and reverse its secular declining trend. Although the sale and import of nicotine-EC and HTPs have not been approved as of 5 February 2021,[22] they are available in online and physical stores.[23,24] The objectives of this study were to compare the use patterns of cigarettes, e-cigarettes, HTPs, and waterpipe, and examine their associations with SES in Hong Kong adolescents, to inform future tobacco control policies and practices.

Methods

Study design. The School-based Smoking Survey is the largest territory-wide biennial smoking survey in secondary school students (US grade 7-12) in Hong Kong. The present study was based on the latest round of survey conducted from October 2018 to July 2019. Details of the survey methods have been reported.[24-26] Briefly, a stratified random sample of schools in all 18 districts of Hong Kong were invited in proportion to the total number of schools in each district. Parental consent was sought before the survey. All parents in recruited schools received an invitation letter via students, and declining parents were to ask students to return a blank answer sheet during the survey. At the beginning of the survey, class teachers explained the voluntary participation to students that they could decline even with parental consent. Ethics approval was obtained from the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster.

We invited all students in participated schools to complete a self-administered standardised structured questionnaire by writing the answers on an anonymous separate answer sheet in classrooms. Class teachers distributed questionnaires and answer sheets and maintained the order, following the standard procedures on a prepared instruction sheet. We assigned at least one trained research assistant per grade to help coordinate and answer students' queries during the survey. To encourage candid reporting, teachers avoided patrolling near students. Completed answer sheets were immediately sealed in front of students and collected by research staff. Students who were absent received a questionnaire and answer sheet pack from teachers to be returned

directly to us in a prepaid envelope. The questionnaire took 20 minutes to complete, covering sociodemographic characteristics, tobacco-related knowledge, attitudes, susceptibility and behaviours, secondhand smoke exposure, and other health-related items.

In total, 34 063 students in 88 schools participated, with student- and school-level response rates of 94% and 23%, respectively. Non-participation of schools was usually due to administrative reasons, e.g. tight schedule, rather than smoking-related issues. We used Remark Office OMR 8.0 software to capture data on the answer sheets, with a low error rate of 0.3% tested by a 5% double entry. Responses with over 50% missing data were excluded (0.2%), leaving 33 991 for analysis.

Measures. We separately assessed ever use of various tobacco products by "Please choose one sentence which suits you most regarding each of the following products (cigarette/electronic cigarette/heated tobacco product/waterpipe/other tobacco products, e.g. cigar and snus)", with the same options for various products. Students were classified as never users for choosing "I have never used it", and ever users for choosing other options ("I have used it once or a few times (for fun or to try a puff)", "I used to use it occasionally (not every day), but have quit now", "I used to use it every day, but have quit now", "I use it occasionally (not every day)", and "I use it every day"). Current use of each tobacco product was assessed similarly by "On how many of the past 30 days did you use the following products (cigarette/electronic cigarette/heated tobacco product/waterpipe/other tobacco products, e.g. cigar and snus)", with the options of "0/1-2/3-5/6-9/10-19/20-29/30 days". Current use of a product was defined as having used it for at least 1 day in the past 30 days.[27]

We also asked "Do you use electronic cigarettes containing nicotine?" Students who chose "Some contain nicotine" or "All contain nicotine" were classified as having used nicotine ECs, and those who chose "None of them contain nicotine" were classified as never used nicotine ECs.

We assessed two dimensions of family SES—perceived family affluence and parental education (options: "primary or below", "secondary", "post-secondary" and "don't know"). As income inequality in Hong Kong is among the highest in the world[28] and easily perceivable (e.g. by type, size and location of housing), we assessed student perceived family affluence by "You consider your family's economic status" (options: "relatively poor", "poor to average", "average", "average to rich" and "relatively rich").[29,30] We also collected student sociodemographic characteristics including sex, age and school grade.

Statistical analysis. We analysed 8 categories of tobacco products, i.e. any (one or more) tobacco products, alternative tobacco products (any products other than cigarettes), cigarettes, ECs, nicotine ECs, non-nicotine ECs, HTPs, and waterpipe. The use prevalence and current-ever use ratio of each category of tobacco product by sociodemographic characteristic were calculated. Current-ever use ratio was the proportion of current users among ever users. All the proportions were weighted by sex, age and grade distribution of the underlying population provided by the Education Bureau of the Hong Kong SAR Government.

For each tobacco product, we calculated adjusted odds ratios (AORs) of ever (versus never) use and current (versus non-current) use in all students, and current (versus non-current) use in ever users by sociodemographic factors, using generalised linear mixed models (GLMM) with a "logit" link function and random intercept accounting for school clustering effects, with R (version 4.0.0) package "lme4" (version 1.1-21). In regression analyses, we adjusted for grade together with sex, perceived family affluence and parental education since age and grade were highly correlated. We only included the four specific products without separating nicotine and non-nicotine ECs, because of insufficient users in some subgroups. We also tested the trends (linear or quadratic if the trend appeared to be curvilinear) of tobacco use by these sociodemographic factors. A P value less than 0.05 was considered statistically significant. We assessed interactions between sex and other sociodemographic factors. We found sex interactions and reported stratified results for boys and girls (in Supplementary Table S1). We conducted sensitivity analyses with students who had never used any tobacco products as the reference group.

Results

The sample had a mean age (±SD) of 14.8 (±1.9) years. Table 1 shows that 51.5% students were boys, and 13.1% had ever used any tobacco products, with cigarettes (9.1%) being the most common, followed by ECs (7.9%), waterpipe (3.6%) and HTPs (2.6%). Only 4.1% were current users of any tobacco products. Both ever and current use were higher in boys than girls, and increased with age and grade. The current-ever use ratios were higher for HTPs (0.60), nicotine ECs (0.52) and waterpipe (0.51), but lower for cigarettes (0.35) and non-nicotine ECs (0.22). Current-ever use ratios were highest for HTP in girls (0.68).

Fig. 1 (a3 and b3) shows that the most commonly used category was cigarettes in the poorest families, but alternative tobacco products in the richest families (the prevalences were also shown in Table 1). Ever use prevalences, current use prevalences and current-ever use ratios (Fig. 1 a3, b3 and c3) of all categories showed J-shaped patterns by perceived family affluence that the highest prevalences and ratios were in students from the richest families, followed by the poorest families and the middle groups. Similar V-shaped patterns were observed for ever and current use prevalences and current-ever use ratios by parental education (Fig. 1 a4, b4 and c4), except that ever use prevalences of cigarettes and ECs decreased with parental education (Fig. 1 a4).

In Table 2, we mutually adjusted for sociodemographic factors in regression models. More boys than girls had ever used the 4 products and currently used cigarettes (non-significant for ECs, HTPs and waterpipe), but AORs of current use in ever users of HTPs (1.44, 95% CI 1.04–1.97) and waterpipe (1.50, 1.14–1.96) were higher in girls than boys. Ever use and current use of the 4 products were associated with higher grades, but no clear trends by grades were observed for current use in ever users of ECs and HTPs.

The AORs of ever and current use in all students and current use in ever users of the 4 products showed curvilinear trends (P values < 0.01) by perceived family affluence. Compared with the poorest families, AORs of ever use of the 4 products were lower in the middle groups, but were higher (cigarettes: AOR 1.67, 95% confidence interval [CI] 1.30–2.14; ECs: 2.26, 1.74–2.92; HTPs: 2.59, 1.87–3.58; waterpipe: 2.65, 1.95–3.61) in the richest. Similarly, the AORs of current use of the 4 products were also lowest in the middle groups, and highest in the richest families. Compared with those from the poorest families, AORs of current use in ever users were lower in the middle groups, but higher in the richest for cigarettes (4.40, 2.70–7.16) and ECs (1.99, 1.21–3.26), and marginally-significantly higher for HTPs (1.82, 0.89–3.73, P = 0.10) and waterpipe (1.80, 0.96–3.38, P = 0.07).

The AORs of ever and current use in all students and current use in ever users of the 4 products showed curvilinear trends (P values < 0.05) by parental education, except for ever use of cigarettes and ECs for which linear trends (P values < 0.01) were observed. The AORs of ever and current tobacco use were highest in students whose parents received primary school education and below (the lowest category). Compared with the lowest parental education, the AORs of current use in ever users of the 4 products were lower in the middle group, but not different from the highest parental education. Only a few levels of the sociodemographic factors had interaction effects with sex (Table 2), with no marked differences in the patterns of AORs by sex (Supplementary Table S1). Sensitivity analyses with students who had never used any tobacco products as the reference group showed similar AORs (Supplementary Table S2).

Discussion

We first used the current-ever use ratio as an indicator of how likely a tobacco product is used beyond experimentation among adolescents using cross-sectional data, and showed that adolescent ever users of nicotine-containing alternative tobacco products were more likely to keep using them than users of cigarettes and non-nicotine products, and more girls than boys in ever users of waterpipe and HTPs kept using them despite the lower use prevalences in girls. In addition, we showed the socioeconomic gradient in adolescent users of various tobacco products, and found J-shaped relations that adolescents from the richest families had the highest use prevalences and the middle groups had the lowest use prevalences. Moreover, the most commonly used category was cigarettes in the poorest families, but alternative tobacco products in the richest families.

We found J-shaped relations between family affluence and adolescent tobacco use. The poorest families had higher risks of child tobacco use than the middle-SES families, which could be due to parental smoking, peer influence, single parents, stress, and poor school performance.[3,6-10,31] However, compared with those from the poorest families, higher proportions of adolescents from the richest families used the 4 tobacco products, especially alternative products, which were more expensive (a pack of cigarettes cost US$7.1–9.0 including US$4.9 of tax; ECs and HTPs cost US$25–130 per reusable device set in Hong Kong). Our previous study also showed that waterpipe use was more common in Hong Kong adolescents from rich families.[32] The affordability of the products could modify the associations between family affluence and tobacco use in adolescents, which was also showed in overseas studies. Adolescents from poor families had higher smoking prevalences in countries and regions where cigarettes were more affordable, such as mainland China (as low as US$0.5/pack)[10] and developed countries,[6-8] but the differences were smaller in lower-income countries.[9,11] In Ghana, smokeless tobacco (tawa) that is cheaper and more readily available than cigarettes, was more commonly used by adolescents from poor families, but cigarette use did not vary by family affluence.[11] EC using adolescents in Korea usually had more spending money.[33] High-SES adolescents usually used JUUL rather than cheaper EC devices in the US.[34]

Apart from affordability, several reasons could help explain why alternative tobacco products were more commonly used in the most well-off adolescents. First, new and alternative tobacco products have targeted the middle and upper classes, touting the so-called "premium" and "high-end" lifestyle,[35] and this global marketing strongly influences consumers in Hong Kong especially through the internet. Second, privileged social groups are usually exposed to more advertising and they try new products earlier. In England, ECs were first used by high-SES groups before spreading to low-SES groups from 2014 to 2017.[36] Third, adolescents and parents from the most affluent families would also be more health conscious and ready to pay a premium for alternative tobacco products that are claimed to be less harmful than cigarettes,[23,37-39] especially in Hong Kong, where three-quarters of people were considered to be health conscious.[40]

We found lower current-ever use ratios for cigarettes (35%) and non-nicotine ECs (22%), and higher current-ever use ratios for nicotine-containing alternative products—HTPs (60%), nicotine ECs (52%) and waterpipe (51%). Based on the results of the National Youth Tobacco Survey (NYTS) 2019 in US students (grade 7–12),[41] the current-ever use ratio calculated by us was 57.1% for ECs and 26.1% for cigarettes. The current-ever use ratio of nicotine ECs in Hong Kong appeared to be similar to that of ECs in the US where almost all ECs (99%) contain nicotine.[42] High nicotine concentrations in products including JUUL and IQOS expose youth to high risk of addiction,[43] and an adult study also shows that HTPs could reinforce nicotine dependence, rather than serving as a cessation aid.[44] In addition, alternative tobacco products with kid-friendly flavours are less irritant than cigarettes,[45] which may encourage regular use. We found higher current-ever use ratios of nicotine-containing alternative tobacco products in girls than boys, despite their lower prevalences of use. Prior studies also showed that women and teenage girls were more prone to nicotine addiction after smoking initiation,[46] and had more difficulties in quitting.[47] Researchers and tobacco control advocates should pay close attention to use progressions and nicotine dependence in adolescent users of alternative tobacco products, especially in girls. On the other hand, persistent use in experimenters of non-nicotine EC products should also be monitored.

Given the J-shaped relations between family affluence and various tobacco use, we propose to adopt diverse tobacco control measures to improve health equity. Raising tobacco taxes and prices is regarded as the most effective in curbing tobacco use in adolescents and disadvantaged groups.[48] However, it may be less effective in reducing alternative tobacco product use, especially in high-income families. Total bans on advertising and sponsorship of new and alternative tobacco products should be strictly enforced. Hong Kong SAR Government has proposed a total ban of ECs and HTPs in February 2019, but it encounters strong resistance from the tobacco industry and some pro-industry legislators. The bills are still under debate as of 5 February 2021. As our results have shown that adolescent experimenters of alternative tobacco products were more prone to persistent use than cigarette experimenters, this total ban would greatly prevent the epidemic of adolescent tobacco use.

This study had some limitations. First, because our study was cross-sectional, the temporal sequence was uncertain. However, the risk factors (family SES) were unlikely to have been influenced by the outcomes (adolescent tobacco use). Second, the higher current-ever use ratios of new tobacco products might be partly due to their shorter history so that recent use would be more likely. The latest product included in this study was HTP, which became available and popular in Hong Kong only 1–2 years before this survey. Further studies are needed to confirm the findings.

Alternative tobacco product use has become as common as cigarette use. We have first shown by using the current-ever use ratio that, higher proportions (over half) of the ever users of nicotine-containing alternative tobacco products kept using them than users of cigarettes and non-nicotine products. Ever and current use prevalences and current-ever use ratios of cigarettes, e-cigarettes, HTPs and waterpipe showed J-shaped relations with family affluence, being highest in the richest families and lowest in the middle groups. High use prevalences of all products were associated with higher grades, the lowest parental education and boys, but current-ever use ratios of HTP and waterpipe were higher in girls. Such alarming situation needs urgent and strong regulations on tobacco products, especially in regions where new products are emerging.

Abbreviations

TP = tobacco product; Alt TP = alternative tobacco product; Cig = cigarette; EC = e-cigarette; N-Nct = non-nicotine; Nct = nicotine; HTP = heated tobacco product; WP = waterpipe.

Declarations

Funding

Competing interests

The authors declare no competing interests.

Author contributions

L.W., J.C., L.T.L., S.Y.H., M.P.W., and T.H.L. conceptualised and designed the study. L.W., J.C. and L.T.L. collected the data. L.W. and S.Y.H. analysed the data. L.W. wrote the first draft of the manuscript. All authors reviewed the manuscript and approved the submitted version of the manuscript.

Data Availability

Dataset can be requested with appropriate reasons and permission from The Food and Health Bureau, the Government of Hong Kong Special Administrative Region. For requests, please contact the corresponding author.

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Tables

Table 1. Use of various tobacco products in Hong Kong secondary school students by sociodemographic factors

	All (%),	Ever use (%)								Current use (%)								Current-ever use ratio					
	n=33 991	Any TPs	Alt TPs	Cig	EC	N-Nct EC	Nct EC	HTP	WP	Any TPs	Alt TPs	Cig	EC	N-Nct EC	Nct EC	HTP	WP	Any TPs	Alt TPs	Cig	EC	N-Nct EC	Nct EC
Overall	-	13.1	9.2	9.1	7.9	5.6	2.3	2.6	3.6	4.1	3.0	3.2	2.5	1.3	1.2	1.6	1.8	0.31	0.32	0.35	0.31	0.22	0.52
Sex																							
Boys	51.5	14.9	10.3	10.6	8.9	6.3	2.6	3.1	4.1	4.6	3.3	3.6	2.8	1.5	1.3	1.7	2.0	0.31	0.31	0.33	0.31	0.23	0.50
Girls	48.6	11.2	8.0	7.6	6.9	4.8	2.0	2.0	3.0	3.6	2.6	2.8	2.2	1.1	1.1	1.4	1.7	0.32	0.33	0.37	0.32	0.22	0.54
Age																							
≤12	13.4	6.0	3.7	4.2	3.1	2.2	0.9	1.5	1.6	2.3	2.0	1.8	1.7	1.0	0.7	1.2	1.2	0.37	0.51	0.41	0.53	0.43	0.73
13	16.2	7.5	4.9	5.2	4.2	3.0	1.2	1.5	1.5	2.4	1.8	1.7	1.5	0.9	0.6	0.9	0.9	0.32	0.37	0.33	0.35	0.30	0.49
14	16.3	10.7	6.7	7.5	5.7	4.1	1.7	1.4	1.6	2.9	1.9	2.2	1.7	1.0	0.7	0.8	0.9	0.27	0.28	0.29	0.29	0.23	0.41
15	15.2	13.3	9.9	8.5	8.8	6.2	2.7	2.3	2.9	4.3	3.3	3.2	2.8	1.2	1.6	1.8	2.0	0.32	0.33	0.38	0.32	0.20	0.60
16	16.3	15.1	10.6	10.3	9.1	6.4	2.6	2.8	3.7	4.4	3.1	3.5	2.6	1.3	1.3	1.8	2.0	0.29	0.29	0.34	0.29	0.20	0.50
17	15.9	18.7	14.2	12.6	12.2	8.8	3.4	3.6	6.4	5.5	3.8	4.3	3.1	1.5	1.7	1.8	2.6	0.29	0.26	0.34	0.25	0.16	0.48
≥18	6.8	27.9	19.7	22.6	16.5	11.0	5.5	7.6	11.4	10.6	7.7	8.5	5.9	3.1	2.9	4.1	5.0	0.38	0.39	0.37	0.36	0.28	0.52
Grade																							
7	18.0	6.6	3.9	4.6	3.2	2.2	0.9	1.1	1.1	1.9	1.5	1.3	1.2	0.7	0.5	0.8	0.8	0.29	0.38	0.27	0.38	0.32	0.51
8	17.2	9.3	5.9	6.6	5.1	3.5	1.6	1.6	1.8	2.9	1.9	2.3	1.7	1.1	0.6	1.0	1.0	0.31	0.33	0.35	0.33	0.29	0.40
9	16.6	11.6	7.7	8.1	6.7	4.8	2.0	1.8	2.1	3.6	2.5	2.8	2.0	1.1	0.9	0.9	1.1	0.31	0.32	0.35	0.30	0.23	0.46
10	16.3	15.6	11.4	10.6	10.0	7.1	2.9	2.9	3.9	5.1	3.6	4.0	3.2	1.5	1.7	2.0	2.3	0.33	0.32	0.38	0.32	0.21	0.59
11	16.0	16.5	11.9	11.2	10.1	7.3	2.9	3.5	4.8	4.9	3.6	3.7	3.1	1.6	1.5	2.1	2.6	0.30	0.31	0.33	0.30	0.22	0.51
12	15.9	20.1	15.4	14.4	13.2	9.1	4.1	4.6	8.1	6.6	4.9	5.3	4.0	1.8	2.2	2.6	3.4	0.33	0.32	0.36	0.30	0.19	0.55
Perceived family affluence																							
Relatively poor	5.7	19.4	12.9	15.5	11.7	8.2	3.5	5.6	6.6	7.1	5.3	5.7	4.6	2.6	2.1	3.8	3.8	0.36	0.40	0.36	0.39	0.30	0.60
Poor to average	21.4	16.2	10.4	11.6	9.0	6.7	2.3	2.4	3.2	3.5	2.3	2.8	1.9	1.0	0.9	1.2	1.4	0.21	0.22	0.24	0.21	0.15	0.40
Average	58.7	11.2	8.0	7.6	6.9	4.8	2.0	1.9	2.8	3.5	2.4	2.7	2.0	1.0	1.0	1.1	1.4	0.31	0.30	0.35	0.29	0.20	0.49
Average to rich	12.4	12.0	9.3	7.9	7.6	4.9	2.7	3.1	4.6	5.2	4.1	3.5	3.3	1.7	1.7	1.9	2.4	0.43	0.44	0.45	0.44	0.34	0.62
Relatively rich	1.8	23.4	21.0	18.4	19.3	11.9	7.4	12.8	14.6	15.8	14.4	13.3	12.4	6.5	5.9	9.1	10.2	0.67	0.68	0.72	0.64	0.54	0.80
Parental education																							
Primary or below	5.0	20.5	14.1	15.2	12.6	9.3	3.4	4.5	5.3	6.2	4.7	4.9	3.9	2.4	1.5	2.8	3.0	0.30	0.32	0.31	0.30	0.23	0.46
Secondary	50.4	14.2	9.4	10.0	8.2	6.0	2.2	2.0	3.0	3.6	2.3	2.9	1.9	1.0	0.8	1.1	1.4	0.25	0.24	0.28	0.23	0.17	0.38
Tertiary	26.7	10.2	8.2	6.7	6.8	4.2	2.6	2.9	4.1	4.5	3.9	3.1	3.3	1.4	1.9	2.0	2.3	0.44	0.47	0.47	0.49	0.34	0.72
Unknown	17.9	12.0	8.5	8.4	7.4	5.4	2.1	2.9	3.5	4.5	3.0	3.7	2.5	1.4	1.2	1.8	2.0	0.37	0.35	0.44	0.34	0.25	0.55

Abbreviations: TP = tobacco product; Alt TP = alternative tobacco product; Cig = cigarette; EC = e-cigarette; N-Nct = non-nicotine; Nct = nicotine; HTP = heated tobacco produc WP = waterpipe.

Notes: All percentages were weighted by age, sex, and grade distribution of the target population provided by the Education Bureau of the Hong Kong SAR Government.

Table 2. Associations between sociodemographic factors and tobacco use in Hong Kong secondary school students

	OR (95% CI)[a]				OR (95% CI)[b]			
	Cigarette	EC	HTP	Waterpipe	Cigarette	EC	HTP	Waterpipe
a) Ever (vs never) use in all students								
Sex								
Boys	1	1	1	1	1	1	1	1
Girls	0.77 (0.71, 0.84)***	0.86 (0.79, 0.94)***	0.74 (0.64, 0.85)***	0.80 (0.70, 0.91)***	0.78 (0.71, 0.84)***	0.86 (0.79, 0.94)***	0.75 (0.65, 0.87)***	0.80 (0.70, 0.92)**
Grade								
7	1	1	1	1	1	1	1	1
8	1.45 (1.24, 1.68)***	1.52 (1.27, 1.81)***	1.27 (0.96, 1.70)	1.46 (1.10, 1.93)***	1.47 (1.26, 1.71)***	1.55 (1.30, 1.85)***	1.37 (1.02, 1.83)*	1.53 (1.15, 2.04)**
9	1.81 (1.56, 2.09)***	1.99 (1.69, 2.36)***	1.47 (1.11, 1.94)**	1.79 (1.37, 2.35)***	1.79 (1.54, 2.07)***	2.04 (1.72, 2.42)***	1.60 (1.20, 2.12)**	1.92 (1.46, 2.53)***
10	2.30 (1.99, 2.66)***	2.91 (2.48, 3.43)***	1.98 (1.52, 2.58)***	2.80 (2.16, 3.62)***	2.26 (1.95, 2.61)***	2.99 (2.54, 3.53)***	2.23 (1.70, 2.93)***	3.11 (2.39, 4.05)***
11	2.39 (2.06, 2.76)***	2.93 (2.48, 3.45)***§	2.41 (1.85, 3.13)***	3.47 (2.69, 4.48)***	2.28 (1.96, 2.65)***	2.96 (2.50, 3.51)***	2.68 (2.04, 3.52)***	3.79 (2.91, 4.93)***
12	3.14 (2.64, 3.74)***	3.81 (3.15, 4.61)***	3.21 (2.38, 4.33)***	6.15 (4.65, 8.13)***	2.93 (2.46, 3.50)***	3.81 (3.14, 4.62)***	3.47 (2.54, 4.74)***	6.60 (4.95, 8.80)***
P for trend	<0.001[†]	<0.001[†]	<0.001[†]	<0.001[†]	<0.001[†]	<0.001[†]	<0.001[†]	<0.001[†]
Perceived family affluence								
Relatively poor	1	1	1	1	1	1	1	1
Poor to average	0.73 (0.64, 0.85)***	0.73 (0.62, 0.85)***	0.36 (0.29, 0.46)***	0.40 (0.32, 0.49)***	0.77 (0.67, 0.89)***	0.77 (0.66, 0.91)**	0.41 (0.32, 0.52)***	0.44 (0.35, 0.55)***
Average	0.52 (0.45, 0.59)***	0.60 (0.52, 0.70)***	0.33 (0.27, 0.41)***	0.36 (0.30, 0.44)***	0.60 (0.52, 0.69)***	0.72 (0.61, 0.83)***	0.40 (0.32, 0.49)***	0.45 (0.37, 0.55)**
Average to rich	0.59 (0.50, 0.71)***	0.71 (0.59, 0.85)***	0.57 (0.44, 0.74)***	0.58 (0.46, 0.73)***	0.76 (0.63, 0.90)**	0.91 (0.75, 1.10)	0.69 (0.52, 0.90)**	0.77 (0.60, 0.98)*
Relatively rich	1.24 (0.97, 1.58)	1.66 (1.29, 2.13)***	2.13 (1.57, 2.9)***§	1.93 (1.44, 2.59)***§	1.67 (1.30, 2.14)***	2.26 (1.74, 2.92)***	2.59 (1.87, 3.58)***§	2.65 (1.95, 3.61)***
P for trend	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]
Parental education								
Primary or below	1	1	1	1	1	1	1	1
Secondary	0.71 (0.62, 0.82)***	0.72 (0.61, 0.84)***	0.50 (0.39, 0.63)***	0.57 (0.46, 0.72)***	0.82 (0.71, 0.95)**	0.80 (0.68, 0.94)**	0.61 (0.47, 0.78)*	0.70 (0.55, 0.88)**
Tertiary	0.56 (0.48, 0.66)***	0.65 (0.54, 0.77)***	0.76 (0.58, 0.98)*§	0.71 (0.56, 0.91)**§	0.64 (0.54, 0.75)***	0.70 (0.58, 0.84)***	0.80 (0.61, 1.06)	0.77 (0.60, 1.00)*
P for trend	<0.001[†]	<0.001[†]	<0.001[‡]	<0.001[‡]	<0.001[†]	<0.01[†]	<0.001[‡]	<0.001[‡]

	OR (95% CI)[a]				OR (95% CI)[b]			
	Cigarette	EC	HTP	Waterpipe	Cigarette	EC	HTP	Waterpipe
b) Current (vs non-current) use in all students								
Sex								
Boys	1	1	1	1	1	1	1	1
Girls	0.85 (0.74, 0.96)*	0.86 (0.74, 1.00)*	0.89 (0.74, 1.07)	0.94 (0.79, 1.11)	0.86 (0.75, 0.98)*	0.88 (0.76, 1.02)	0.92 (0.77, 1.11)	0.97 (0.82, 1.16)
Grade								
7	1	1	1	1	1	1	1	1
8	1.70 (1.32, 2.21)***	1.25 (0.94, 1.66)	1.07 (0.76, 1.52)	1.12 (0.79, 1.60)	1.80 (1.38, 2.33)***	1.32 (0.99, 1.76)	1.18 (0.83, 1.68)	1.24 (0.87, 1.77)
9	2.08 (1.62, 2.67)***	1.47 (1.12, 1.93)**	1.18 (0.84, 1.65)	1.40 (1.00, 1.96)*	2.19 (1.70, 2.83)***	1.58 (1.19, 2.08)**	1.30 (0.92, 1.83)	1.54 (1.10, 2.17)*
10	2.60 (2.04, 3.32)***§	1.94 (1.49, 2.53)***	1.83 (1.34, 2.50)***	2.14 (1.57, 2.93)***	2.85 (2.23, 3.66)***§	2.14 (1.64, 2.81)***	2.12 (1.54, 2.93)***	2.49 (1.81, 3.44)***
11	2.32 (1.80, 2.98)***	1.89 (1.45, 2.48)***	1.98 (1.45, 2.71)***	2.53 (1.85, 3.46)***	2.50 (1.93, 3.23)***	2.05 (1.55, 2.70)***	2.22 (1.60, 3.09)***	2.86 (2.07, 3.95)***
12	3.06 (2.30, 4.08)***	2.36 (1.73, 3.22)***	2.36 (1.63, 3.41)***§	3.38 (2.37, 4.83)***§	3.22 (2.40, 4.31)***	2.44 (1.77, 3.36)***	2.50 (1.70, 3.67)***§	3.68 (2.54, 5.33)***§
P for trend	<0.001[†]	<0.001[†]	<0.001[†]	<0.001[†]	<0.001[†]	<0.001[†]	<0.001[†]	<0.001[†]
Perceived family affluence								
Relatively poor	1	1	1	1	1	1	1	1
Poor to average	0.48 (0.38, 0.60)***	0.36 (0.28, 0.46)***	0.26 (0.20, 0.35)***	0.31 (0.23, 0.41)***	0.53 (0.42, 0.67)***	0.40 (0.31, 0.52)***	0.31 (0.23, 0.41)***	0.35 (0.26, 0.47)***
Average	0.49 (0.40, 0.61)***	0.38 (0.31, 0.48)***	0.27 (0.21, 0.34)***	0.29 (0.23, 0.37)***	0.58 (0.47, 0.72)***	0.45 (0.36, 0.57)***	0.33 (0.25, 0.43)***	0.36 (0.28, 0.46)***
Average to rich	0.71 (0.56, 0.92)**	0.64 (0.49, 0.84)**	0.51 (0.37, 0.69)***	0.53 (0.40, 0.72)***	0.89 (0.69, 1.16)	0.76 (0.58, 1.01)	0.63 (0.45, 0.87)**	0.67 (0.49, 0.93)*
Relatively rich	2.44 (1.81, 3.31)***	2.35 (1.71, 3.24)***§	2.44 (1.74, 3.43)***§	2.55 (1.83, 3.56)***§	3.09 (2.25, 4.24)***	2.75 (1.97, 3.85)***§	2.91 (2.02, 4.19)***§	3.16 (2.21, 4.52)***§
P for trend	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]
Parental education								
Primary or below	1	1	1	1	1	1	1	1
Secondary	0.59 (0.47, 0.74)***	0.46 (0.36, 0.59)***	0.34 (0.26, 0.45)***	0.39 (0.30, 0.52)***	0.66 (0.53, 0.83)***	0.53 (0.41, 0.69)***	0.43 (0.32, 0.57)***	0.49 (0.37, 0.65)***
Tertiary	0.72 (0.56, 0.92)**§	0.71 (0.55, 0.93)*	0.62 (0.46, 0.84)**§	0.66 (0.49, 0.89)**§	0.69 (0.54, 0.90)**	0.70 (0.53, 0.94)*	0.63 (0.46, 0.88)**§	0.68 (0.49, 0.93)*§
P for trend	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]	<0.01[‡]	<0.001[‡]	<0.001[‡]	<0.001[‡]

	OR (95% CI)[a]				OR (95% CI)[b]			
	Cigarette	EC	HTP	Waterpipe	Cigarette	EC	HTP	Waterpipe
c) Current (vs non-current) use in ever users								
Sex								
Boys	1	1	1	1	1	1	1	1
Girls	1.04 (0.88, 1.24)	0.94 (0.78, 1.13)	1.50 (1.11, 2.04)**	1.46 (1.13, 1.90)**	1.00 (0.84, 1.19)	0.91 (0.75, 1.10)	1.44 (1.04, 1.97)*	1.50 (1.14, 1.96)**
Grade								
7	1	1	1	1	1	1	1	1
8	1.13 (0.79, 1.60)	0.75 (0.51, 1.11)	0.67 (0.36, 1.24)	0.56 (0.31, 1.02)	1.19 (0.82, 1.71)	0.77 (0.52, 1.14)	0.69 (0.36, 1.32)	0.58 (0.31, 1.08)
9	1.38 (0.99, 1.94)	0.79 (0.55, 1.14)	0.70 (0.39, 1.27)	0.71 (0.40, 1.25)	1.47 (1.04, 2.09)*	0.81 (0.56, 1.19)	0.71 (0.38, 1.32)	0.70 (0.38, 1.26)
10	1.51 (1.09, 2.09)*	0.68 (0.48, 0.96)*	1.00 (0.57, 1.76)	0.74 (0.43, 1.27)	1.81 (1.29, 2.54)***	0.78 (0.54, 1.12)	1.12 (0.62, 2.02)	0.77 (0.44, 1.35)
11	1.28 (0.92, 1.79)	0.71 (0.50, 1.01)	0.79 (0.45, 1.39)	0.68 (0.40, 1.16)	1.50 (1.06, 2.13)*	0.81 (0.56, 1.18)	0.85 (0.47, 1.53)	0.71 (0.41, 1.25)
12	1.51 (1.04, 2.20)*	0.71 (0.48, 1.06)	0.68 (0.37, 1.26)§	0.50 (0.28, 0.89)*	1.71 (1.15, 2.52)**	0.73 (0.48, 1.11)	0.63 (0.33, 1.20)§	0.51 (0.28, 0.92)*§
P for trend	0.04†	0.10†	0.66†	0.12†	0.04†	0.41†	0.18†	0.05†
Perceived family affluence								
Relatively poor	1	1	1	1	1	1	1	1
Poor to average	0.54 (0.40, 0.73)***	0.35 (0.25, 0.49)***	0.39 (0.24, 0.65)***	0.48 (0.30, 0.75)**	0.59 (0.44, 0.80)***	0.39 (0.27, 0.55)***	0.44 (0.26, 0.74)**	0.55 (0.34, 0.88)*
Average	0.84 (0.64, 1.10)	0.51 (0.38, 0.68)***	0.55 (0.35, 0.86)**	0.59 (0.40, 0.88)**	0.90 (0.68, 1.19)	0.54 (0.39, 0.73)***	0.60 (0.37, 0.97)*	0.65 (0.43, 0.99)*
Average to rich	1.37 (0.98, 1.92)	0.99 (0.69, 1.43)	0.84 (0.49, 1.45)	0.79 (0.49, 1.28)	1.44 (1.02, 2.05)*	0.97 (0.67, 1.42)	0.88 (0.50, 1.57)	0.85 (0.51, 1.40)
Relatively rich	4.78 (2.97, 7.69)***	2.30 (1.42, 3.73)***§	1.84 (0.92, 3.66)	1.95 (1.07, 3.56)*§	4.40 (2.70, 7.16)***	1.99 (1.21, 3.26)**§	1.82 (0.89, 3.73)§	1.80 (0.96, 3.38)
P for trend	<0.001‡	<0.001‡	<0.001‡	<0.001‡	<0.001‡	<0.001‡	<0.001‡	<0.01‡
Parental education								
Primary or below	1	1	1	1	1	1	1	1
Secondary	0.62 (0.47, 0.83)**	0.53 (0.38, 0.73)***	0.46 (0.27, 0.78)**	0.48 (0.30, 0.76)**	0.64 (0.48, 0.86)**	0.59 (0.42, 0.83)**	0.56 (0.31, 0.98)*	0.55 (0.33, 0.89)*
Tertiary	1.34 (0.97, 1.84)§	1.20 (0.85, 1.70)	0.75 (0.43, 1.30)	0.82 (0.50, 1.34)	1.13 (0.81, 1.59)§	1.10 (0.76, 1.59)§	0.74 (0.40, 1.35)	0.83 (0.49, 1.40)
P for trend	<0.001‡	<0.001‡	<0.001‡	<0.001‡	<0.001‡	<0.001‡	0.04‡	<0.01‡

* P < 0.05, ** P < 0.01, ** P < 0.001. † Linear trend. ‡ Curvilinear (quadratic) trend. § Interaction with sex. Abbreviations: EC = e-cigarette; HTP = heated tobacco product; OR = adjusted odds ratio; CI = confidence interval.

[a] Odds ratios with adjustment for school clustering effects.

[b] Odds ratios with adjustment for sex, grade, perceived family affluence, parental education and school clustering effects.
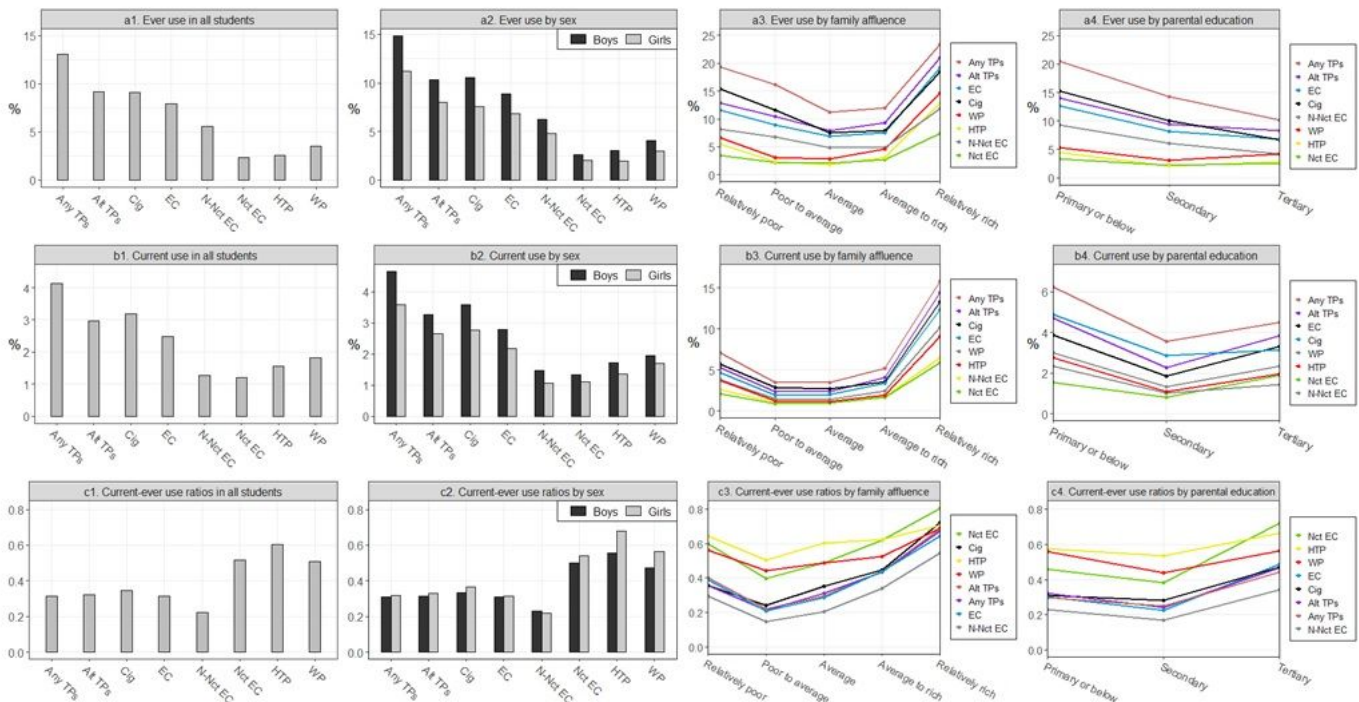
Figures

Figure 1

Use of various tobacco products in Hong Kong secondary school students by sociodemographic factors Abbreviations: TP = tobacco product; Alt TP = alternative tobacco product; Cig = cigarette; EC = e-cigarette; N-Nct = non-nicotine; Nct = nicotine; HTP = heated tobacco product; WP = waterpipe. Note: In line graphs, the position of legends was aligned with the rank of the last value on each line. All percentages were weighted by sex, age, and grade distribution of the target population provided by the Education Bureau of the Hong Kong SAR Government.

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