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ORIGINAL ARTICLE

# Waterpipe smoking among secondary school students in Hong Kong

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**Abstract**
*Objectives* To examine the prevalence of waterpipe smoking and its associated factors among adolescents in Hong Kong.
*Methods* We analyzed data of the School-based Survey on Smoking among Students 2012/2013 from a representative sample of 45,857 secondary school students in Hong Kong (mean age 14.8, SD 1.9). We conducted Chi-square tests and *t* test to compare current (past 30 days) waterpipe users and nonusers by sociodemographic variables and other covariates. Univariate and multivariable logistic regression models were used to examine the factors associated with current waterpipe smoking.
*Results* Overall, 1.2 % of students reported current waterpipe smoking, of whom 43 % reported concurrent use of cigarettes. Waterpipe was the most popular alternative tobacco product (non-cigarette) used by students. Current waterpipe smoking was associated with older age, male sex, higher self-perceived family financial status, poor knowledge about the harm of cigarette smoking, positive attitudes toward smoking, current cigarette smoking, other tobacco use, and alcohol consumption.
*Conclusions* Waterpipe smoking was the most popular alternative tobacco product among Hong Kong adolescents. Despite the low prevalence, it should be routinely monitored. Education programs and cessation interventions need to address waterpipe smoking in addition to cigarette smoking.

**Keywords** Waterpipe smoking · Tobacco · Adolescent · Hong Kong

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## Introduction

The waterpipe is a device used to smoke charcoal-heated tobacco where smoke is passed through water prior to inhalation (Grekin and Ayna 2012). Waterpipe smoking has traditionally been popular in Eastern Mediterranean and Southeast Asia (Aboaziza and Eissenberg 2015), but now it has become a potential global health threat and is gaining popularity among adolescents worldwide (Maziak 2015; Maziak et al. 2015). In the US, the prevalence of current waterpipe smoking (past 30 days) increased among middle (1.0–2.5 %) and high school (4.1–9.4 %) students from 2011 to 2014, and waterpipe use has become as common as cigarette smoking among students (Arrazola et al. 2015). In Canada, current waterpipe smoking increased from 4.0 % in 2010 to 5.4 % in 2012/2013 among high school students (grade 9–12) (Czoli et al. 2013; Minaker et al. 2015). Waterpipe smoking is particularly popular in Eastern Mediterranean countries, such as Lebanon (36.9 %), West Bank (32.7 %), Latvia (22.7 %), the Czech Republic (22.1 %), Estonia (21.9 %), Syria (20.1 %), and Jordan (18.9 %) (Jawad et al. 2015a).

A common misconception about waterpipe smoking is the addictive property. Young people underestimate the addictiveness of waterpipe smoking (Alvur et al. 2014; Daniels and Roman 2013; Grekin and Ayna 2012; Heinz et al. 2013; Smith et al. 2011), and this misconception is a significant predictor of waterpipe smoking (Eissenberg

et al. 2008; Heinz et al. 2013; Smith-Simone et al. 2008; Smith et al. 2011). Another misconception is about the harms of waterpipe smoking. A great proportion of adolescents and young adults, including both waterpipe users and nonusers, misconceive that waterpipe is less harmful than regular cigarettes (Alvur et al. 2014; Daniels and Roman 2013; Heinz et al. 2013; Jawad et al. 2013; Smith et al. 2011, 2007; Villanti et al. 2015). This false perception also predicts waterpipe smoking (Heinz et al. 2013; Minaker et al. 2015; Villanti et al. 2015).

Most research on waterpipe smoking have been focused on college students or adults. Of the few studies on adolescents, most, if not all, have been based on Western (e.g., Canada, the US and UK) or Middle East populations (Akl et al. 2015; Zyoud et al. 2014). Cigarette smoking is the most important predictor of waterpipe use among adolescents (Barnett et al. 2009; Jawad et al. 2015a, b; Minaker et al. 2015; Palamar et al. 2014; Smith et al. 2011; Weglicki et al. 2008). Other factors include male sex (Barnett et al. 2009; Jawad et al. 2015a; Minaker et al. 2015; Palamar et al. 2014), older age or higher grade level (Barnett et al. 2009; Jawad et al. 2015b; Smith et al. 2011; Weglicki et al. 2008), peer smoking (Jawad et al. 2013, 2015a, b; Roohafza et al. 2011), parental smoking (Jawad et al. 2013, 2015a, b), alcohol consumption (Chan et al. 2011; Czoli et al. 2013; Palamar et al. 2014), marijuana use (Chan et al. 2011; Czoli et al. 2013; Palamar et al. 2014), other tobacco product use (Amrock et al. 2014; Jawad et al. 2013), and positive attitudes toward smoking (Barnett et al. 2009).

Little is known about adolescent waterpipe smoking in other regions of the world, including Hong Kong, the most westernized city of China with the lowest smoking prevalence in the world. The Hong Kong Smoking (Public Health) Ordinance treats waterpipe as a type of pipe and prohibits waterpipe smoking in statutory smoke-free areas, such as the indoor areas of restaurants and bars (The Government of the Hong Kong Special Administrative Region 2007). However, many restaurants and bars serve waterpipe in outdoor spaces. In recent years, waterpipe lounges are popping up widely in Hong Kong, and the lounges offer a variety of flavors for consumers to choose from (e.g., apple, cherry, mint, etc.).

From 2002/2003 to 2012/2013, current cigarette smoking rate has decreased among secondary school students (9.6–3.3 %) and among adults (15.3–11.8 %) in Hong Kong (The Government of the Hong Kong Special Administrative Region 2003, 2013). But no study has examined the use of waterpipe among adolescents. Whether the predictors of waterpipe use identified elsewhere are applicable to adolescents in Hong Kong is unknown. Identifying the correlates of waterpipe smoking is critical to inform the development of targeted interventions. We addressed the research gap and examined the prevalence of current waterpipe smoking and its associated factors in a large representative sample of secondary school students in Hong Kong.

## Methods

### Data source

We analyzed the data from the School-based Survey on Smoking among Students 2012/2013 (hereafter referred to as "the Survey"). This biennial Survey monitors the patterns of tobacco use among primary (US grade 4–6) and secondary school students (US grade 7–12) in Hong Kong (Lo et al. 2013). The 2012/2013 data were collected from October 2012 to April 2013. The Survey was commissioned by the Food and Health Bureau of the Government of the Hong Kong Special Administrative Region and was approved by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster. The Survey used proportionate stratified sampling strategy to obtain a representative sample of schools. Special schools (for adolescents with visual, hearing and other physical impairments or disabilities) were excluded. Schools were randomly selected from each of the 18 districts in Hong Kong, and in each district, the number of selected schools was proportional to the total number of schools in that district.

All students in participating schools were invited to complete a voluntary anonymous self-administered questionnaire which was developed based on the Chinese version of Global Youth Tobacco Survey. The questionnaire was printed in Chinese (for local schools) and English (for international schools). Waterpipe smoking was assessed among secondary school students only. Thus our study was limited to students from secondary schools ($N = 45{,}857$). The response rate was 19 % at school level and 96 % at student level. School refusals were mainly due to administrative reasons (e.g., busy class schedule). We compared the student sample characteristics (sex, grade and age distribution) with 2012/2013 Hong Kong school student enrollment data, and found that our sample well represented the overall secondary school student population as indicated by small Cohen's effect size (range from 0.05 to 0.21) (Lo et al. 2013).

### Main measures

Current waterpipe use was measured by one question, "In the past 30 days, which of the following products have you used: cigarettes; electronic cigarettes; waterpipe; chewing tobacco; cigars; snus; smoking pipe or nasal snuff; other

tobacco product?" Respondents who checked "waterpipe" were defined as current waterpipe smokers.

Independent variables included students' age, sex, self-perceived family financial status, peer smoking, living with a smoker, knowledge about cigarette smoking, attitudes toward cigarette smoking, current cigarette smoking, other tobacco use, and alcohol consumption. Perceived family financial status was assessed by a question "In your opinion, your family financial status is ____" with 5 response options from "relatively poor" to "relatively rich". Responses were re-categorized into 3 groups (i.e., average, poor, and rich). Peer smoking was measured by asking "How many of your close friends smoke?" with 5 response options from "none" to "all". We re-classified the responses into 3 groups (i.e., none, less than half, and half or more). Living with a smoker was measured by one question, "Do you live with anyone who smokes cigarettes?" Responses were dichotomized as "yes" and "no".

Knowledge about the harm of cigarette smoking was assessed by a question, "Do you think smoking is harmful?" with 4 response options from "definitely no" to "definitely yes". We dichotomously coded the responses as "good" if students checked "definitely yes", and "poor" if other options were checked. Students were also asked "Your attitudes toward cigarette smoking is ____" with a 5-point Likert scale ranging from "very negative" to "very positive". Responses were re-classified as neutral, negative, and positive.

Current cigarette smoking was measured by asking "In the past 30 days, on how many days did you smoke?" The response options included "0 days", "1–2 days", "3–5 days", "6–9 days", "10–19 days", "20–29 days" and "30 days". Respondents who smoked cigarettes on at least one of the past 30 days were defined as current cigarette smokers. Other tobacco product use included electronic cigarettes, chewing tobacco, cigars, snus, smoking pipe/nasal snuff, and any other forms of tobacco (other than cigarettes and waterpipe). Alcohol consumption was assessed by a question, "How frequently do you drink alcohol or alcoholic beverage?" to which students could respond "I do not drink", "less than 1 day per month", "1–3 days per month", "1–3 days per week", "4–6 days per week", and "I drink every day". Subjects were re-categorized into 3 groups, including non-drinkers, <1 day/month, and ≥1 day/month.

### Statistical analysis

Data were weighted using the 2012/2013 Hong Kong student enrolment statistics to match the sample with the overall secondary school student population. We used descriptive statistics to summarize the characteristics of the student sample, current waterpipe users, and nonusers. Chi-square tests (for categorical variables) and *t* test (for continuous variable) were conducted to compare waterpipe users and nonusers by sociodemographic variables and other covariates. Univariate and multivariable logistic regression models were used to examine the association of current waterpipe smoking with sociodemographic factors, peer smoking, living with a smoker, knowledge about the harm of cigarette smoking, attitudes toward cigarette smoking, current cigarette smoking, other tobacco use, and alcohol consumption. Stata version 13.1 was used for data analysis.

## Results

Table 1 shows the sample characteristics. Overall, 1.2 % of the students reported waterpipe smoking during the past 30 days. Waterpipe was the most common form of alternative tobacco product (non-cigarette) used by students, followed by electronic cigarettes (1.1 %), cigars (1.1 %), chewing tobacco (0.8 %), snus (0.6 %), and nasal snuff (0.5 %; data not shown in tables). Of the waterpipe users, 43.0 % were current cigarette smokers. Bivariate comparison shows that waterpipe smoking was more common in older students ($p < 0.001$), boys ($p < 0.001$), students who perceived their family as rich ($p < 0.001$), those who had smoking peers ($p < 0.001$) or lived with a smoker ($p < 0.001$), students with poor knowledge about the harm of cigarette smoking ($p < 0.001$) or positive attitudes toward smoking ($p < 0.001$), current cigarette smokers ($p < 0.001$), other tobacco product users ($p < 0.001$), and alcohol users who drank on ≥1 day/month ($p < 0.001$).

The univariate logistic regression model showed that older age, male sex, higher self-perceived family financial status, peer smoking, living with a smoker, poor knowledge about the harm of cigarette smoking, positive attitudes toward smoking, current cigarette smoking, use of other tobacco products, and alcohol use were associated with elevated odds of current waterpipe smoking (Table 2). The multivariable analysis showed that current waterpipe smoking was associated with older age [adjusted odds ratio (AOR) = 1.17 per year, 95 % confidence interval (CI) 1.06–1.28], male sex (AOR = 1.52, 95 % CI 1.09–2.11), higher self-perceived family financial status (AOR = 1.55, 95 % CI 1.04–2.32), poor knowledge about the harm of smoking (AOR = 1.97, 95 % CI 1.30–2.98), positive attitudes toward smoking (AOR = 2.71, 95 % CI 1.66–4.44), current cigarette smoking (AOR = 2.64, 95 % CI 1.66–4.19), other tobacco use (AOR = 4.12, 95 % CI 2.66–6.38), and alcohol consumption (AOR = 1.92, 95 % CI 1.17–3.15 for <1 day/month; AOR = 5.25, 95 % CI 3.43–8.01 for ≥1 day/month).

**Table 1** Characteristics of student sample in Hong Kong (2012/2013), and bivariate comparisons between current waterpipe users and nonusers

| | Full sample ($N = 45,857$; 100 %) | | Current waterpipe users ($n = 581$; 1.2 %) | | Nonusers ($n = 45,276$; 98.8 %) | | *P* |
|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | |
| Age, year (SD) | 14.8 | (1.9) | 15.6 | (2.0) | 14.8 | (1.9) | <0.001 |
| Sex | | | | | | | <0.001 |
| Girls | 21,117 | (48.6) | 178 | (33.4) | 20,939 | (48.8) | |
| Boys | 24,740 | (51.4) | 403 | (66.6) | 24,337 | (51.3) | |
| Self-perceived family financial status | | | | | | | <0.001 |
| Average | 25,480 | (55.6) | 279 | (45.1) | 25,201 | (55.7) | |
| Poor | 13,921 | (29.4) | 161 | (27.0) | 13,760 | (29.4) | |
| Rich | 6315 | (15.0) | 136 | (27.8) | 6179 | (14.9) | |
| Peer smoking | | | | | | | <0.001 |
| No | 27,149 | (60.9) | 116 | (20.4) | 27,033 | (61.4) | |
| Less than half | 14,568 | (30.8) | 163 | (28.8) | 14,405 | (30.8) | |
| Half or more | 4068 | (8.3) | 296 | (50.8) | 3772 | (7.8) | |
| Living with a smoker | | | | | | | <0.001 |
| No | 24,717 | (55.8) | 183 | (33.9) | 24,534 | (56.0) | |
| Yes | 21,140 | (44.2) | 398 | (66.1) | 20,742 | (44.0) | |
| Knowledge about cigarette smoking | | | | | | | <0.001 |
| Good | 40,604 | (89.1) | 327 | (56.4) | 40,277 | (89.6) | |
| Poor | 5235 | (10.9) | 254 | (43.6) | 4981 | (10.4) | |
| Attitudes toward cigarette smoking | | | | | | | <0.001 |
| Neutral | 10,454 | (21.4) | 237 | (37.1) | 10,217 | (21.2) | |
| Negative | 33,878 | (75.8) | 178 | (32.8) | 33,700 | (76.4) | |
| Positive | 1304 | (2.8) | 162 | (30.1) | 1142 | (24.4) | |
| Current cigarette smoking[a] | | | | | | | <0.001 |
| No | 43,434 | (96.7) | 262 | (57.0) | 43,172 | (97.1) | |
| Yes | 1694 | (3.3) | 217 | (43.0) | 1477 | (2.9) | |
| Other tobacco use[b] | | | | | | | <0.001 |
| No | 44,453 | (97.1) | 317 | (59.9) | 44,136 | (97.5) | |
| Yes | 1404 | (2.9) | 264 | (40.1) | 1140 | (2.5) | |
| Alcohol consumption | | | | | | | <0.001 |
| Non-drinker | 29,633 | (66.8) | 111 | (18.7) | 29,522 | (67.4) | |
| <1 day/month | 8221 | (18.4) | 67 | (12.3) | 8154 | (18.5) | |
| ≥1 day/month | 6846 | (14.8) | 388 | (69.0) | 6458 | (14.1) | |

[a] Current cigarette smokers smoked cigarettes on at least 1 day in the past 30 days

[b] Other tobacco use includes using any of the following during the past 30 days: electronic cigarettes, chewing tobacco, cigars, snus, smoking pipe/nasal snuff, or any other form of tobacco (other than cigarettes and waterpipe)

## Discussion

This is the first study to examine the factors associated with waterpipe smoking in a large representative sample of adolescents in Hong Kong. The current waterpipe smoking rate was low among students in Hong Kong. However, studies from other countries (e.g., the US, Canada and Jordan) suggest that waterpipe smoking may increase rapidly in a short time (Arrazola et al. 2015; Czoli et al. 2013; McKelvey et al. 2014; Minaker et al. 2015). Thus waterpipe smoking in Hong Kong might be in the early stage of epidemic, and its potential growth should not be underestimated. It is necessary to continuously monitor waterpipe smoking.

Waterpipe was the most popular alternative tobacco product used by students. Most (57 %) waterpipe users were non-cigarette smokers. The spread of waterpipe may be fueled by the misconceptions about the harmful and

**Table 2** Factors associated with current waterpipe smoking among adolescents in Hong Kong (2012/2013)

| | % | (95 % CI) | Crude OR (95 % CI) | AOR[a] (95 % CI) |
|---|---|---|---|---|
| Age, year (SD) | 15.6 | (2.0) | 1.22 (1.14, 1.31)*** | 1.17 (1.06, 1.28) ** |
| Sex | | | | |
| Girls | 0.8 | (0.7, 1.1) | 1 | 1 |
| Boys | 1.6 | (1.4, 1.8) | 1.90 (1.43, 2.52)*** | 1.52 (1.09, 2.11)* |
| Self-perceived family financial status | | | | |
| Average | 1.0 | (0.8, 1.2) | 1 | 1 |
| Poor | 1.1 | (0.9, 1.4) | 1.14 (0.85, 1.52) | 0.88 (0.59, 1.32) |
| Rich | 2.2 | (1.7, 2.9) | 2.31 (1.67, 3.19)*** | 1.55 (1.04, 2.32)* |
| Peer smoking | | | | |
| No | 0.4 | (0.3, 0.5) | 1 | 1 |
| Less than half | 1.1 | (0.9, 1.4) | 2.81 (1.98, 4.00)*** | 1.19 (0.71, 1.98) |
| Half or more | 7.3 | (6.2, 8.7) | 19.63 (14.29, 26.98)*** | 1.55 (0.86, 2.77) |
| Living with a smoker | | | | |
| No | 0.8 | (0.6, 0.9) | 1 | 1 |
| Yes | 1.8 | (1.6, 2.1) | 2.48 (1.90, 3.24)*** | 1.19 (0.87, 1.62) |
| Knowledge about cigarette smoking | | | | |
| Good | 0.8 | (0.7, 0.9) | 1 | 1 |
| Poor | 4.9 | (4.0, 6.0) | 6.61 (5.09, 8.58)*** | 1.97 (1.30, 2.98)** |
| Attitudes toward cigarette smoking | | | | |
| Neutral | 2.1 | (1.8, 2.5) | 1 | 1 |
| Negative | 0.5 | (0.4, 0.7) | 0.24 (0.18, 0.33)*** | 0.82 (0.53, 1.27) |
| Positive | 13.3 | (10.5, 16.7) | 7.06 (5.11, 9.76)*** | 2.71 (1.66, 4.44)*** |
| Current cigarette smoking[b] | | | | |
| No | 0.6 | (0.5, 0.7) | 1 | 1 |
| Yes | 12.8 | (10.6, 15.3) | 25.08 (18.95, 33.21)*** | 2.64 (1.66, 4.19)*** |
| Other tobacco use[c] | | | | |
| No | 0.8 | (0.6, 0.9) | 1 | 1 |
| Yes | 16.7 | (14.2, 19.7) | 26.34 (20.24, 34.29)*** | 4.12 (2.66, 6.38)*** |
| Alcohol consumption | | | | |
| Non-drinker | 0.3 | (0.2, 0.5) | 1 | 1 |
| <1 day/month | 0.8 | (0.6, 1.2) | 2.39 (1.51, 3.79)*** | 1.92 (1.17, 3.15)* |
| ≥1 day/month | 5.7 | (4.9, 6.7) | 17.61 (12.79, 24.24)*** | 5.25 (3.43, 8.01)*** |

*OR* odds ratio, *AOR* adjusted odds ratio, *CI* confidence interval

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[a] Multivariable logistic regression model adjusted for all variables listed in the table

[b] Current cigarette smokers smoked cigarettes on at least 1 day in the past 30 days

[c] Other tobacco use includes using any of the following during the past 30 days: electronic cigarettes, chewing tobacco, cigars, snus, smoking pipe/nasal snuff, or any other form of tobacco (other than cigarettes and waterpipe)

addictive effects of waterpipe smoking. The influence of waterpipe use on subsequent cigarette smoking has been confirmed by several longitudinal studies. Two studies of Jordanian adolescents found that waterpipe smokers were more likely to initiate cigarette smoking (Jaber et al. 2015) and become current cigarette smokers (Mzayek et al. 2012). A US study reported that waterpipe use predicted cigarette smoking initiation, current cigarette smoking, and higher smoking intensity among young people (Soneji et al. 2015).

About 43 % of waterpipe users reported current cigarette smoking. Previous research has investigated how dual use (cigarette and waterpipe) would affect cigarette smoking progression. In a study of US college students,

Doran et al. (2015) compared cigarette smoking intensity between cigarette-only smokers and the dual users of cigarette and waterpipe, and found that cigarette consumption decreased among cigarette-only smokers but increased among dual users over a 6-month follow-up period, and the decrease in cigarette smoking days was more evident among cigarette-only smokers. A longitudinal study of Danish adolescents found that the dual use was associated with increased smoking frequency in boys (Jensen et al. 2010). Future tobacco control programs for youth must address the use of multiple forms of tobacco products in addition to cigarette smoking. Interventions should clarify the substantial risks of waterpipe smoking and the harm of using multiple tobacco products. Waterpipe-only smokers should be clearly informed about the potential pathway from waterpipe use to cigarette smoking and the addictive potential of waterpipe smoking. Further research is warranted to better understand the features of waterpipe smoking and the characteristics related to the waterpipe users. Studies need to explore what motivate adolescents to use waterpipe, their knowledge and perceptions about waterpipe smoking, usage patterns, and waterpipe marketing strategies and their influence on youth tobacco use. Prospective longitudinal studies are needed to investigate the trajectory of tobacco use to understand how waterpipe use affects cigarette smoking progression among adolescents.

Consistent with existing studies (Alzyoud et al. 2013; Barnett et al. 2009; Chan et al. 2011; Jawad et al. 2013, 2015a, b; Minaker et al. 2015; Palamar et al. 2014; Smith et al. 2011; Weglicki et al. 2008), our results indicated that current waterpipe smoking was associated with male sex, older age, current cigarette smoking, other tobacco product use, and alcohol consumption. As high-risk behaviors (e.g., smoking, alcohol consumption, and drug use) tend to cluster in adolescents (Baskin-Sommers and Sommers 2006; Chen et al. 2001; Faeh et al. 2006), smoking cessation treatment and prevention programs for young people should address alcohol consumption and the use of multiple tobacco products rather than focusing on cigarette smoking only.

Self-perceived high family financial status was associated with waterpipe smoking among adolescents. This finding is different from a previous study which found no relationship between waterpipe smoking and self-perceived family financial status among Lebanese school students (Jawad et al. 2015b). A potential explanation might be that the waterpipe marketing in Hong Kong (e.g., lounges and retailers) mainly target people with high socioeconomic status. Many waterpipe restaurants and bars in Lan Kwai Fong, a district best known for nightlife in Hong Kong, are famous for their modern decorations and luxurious environment. As waterpipe use costs much more than cigarette smoking, waterpipe use may be perceived as an upper social class activity. Counter-marketing interventions that deglamorize waterpipe smoking may help reduce the incidence.

Poor knowledge about the harm of cigarette smoking and positive attitudes toward smoking were associated with waterpipe smoking among school students. School-based anti-tobacco education has been an important element of the comprehensive tobacco control program in Hong Kong since early 1980s. The education program aims to enhance schoolchildren's knowledge about cigarette smoking, deter youth from trying the first cigarette, and motivate them to encourage friends and family members to quit smoking (Hong Kong Council on Smoking and Health 2014). But there is a lack of such education targeting waterpipe. Future school-based programs should educate students about the detrimental health effects of using alternative tobacco products. Students should be informed that waterpipe smoke contains nicotine, carbon monoxide, and carcinogens (Aboaziza and Eissenberg 2015; Aslam et al. 2014), and that waterpipe smoking is associated with lung cancer, respiratory illness, and cardiovascular disease (Aslam et al. 2014; El-Zaatari et al. 2015; Hakim et al. 2011; Kadhum et al. 2015). Messages denormalizing waterpipe smoking may potentially discourage students from using waterpipe.

This study had several limitations. First, the cross-sectional study design prohibited causality inference on the relationship between independent variables and waterpipe smoking. Second, the response rate at school level was 19 % which might reduce the representativeness of our sample and could lead to some nonresponse bias. However, the school refusals were mainly related to administrative reasons, and the small Cohen's effect size indicated that our results were unlikely to be biased. Third, special schools for adolescents with visual, hearing or other physical impairments or disabilities were not included in the Survey. The findings may not be generalized to all secondary school students in Hong Kong. Finally, the study was based on self-reports, and therefore was subject to recall and reporting errors.

## Conclusion

The current waterpipe smoking rate was low among school students in Hong Kong. However, it is the most popular alternative tobacco product used by students. Thus it is necessary to continuously monitor waterpipe smoking. Public health professionals should better understand the waterpipe marketing strategies, user characteristics, the influence of waterpipe use on cigarette smoking initiation and progression, and the trend of waterpipe use in Hong Kong. This study identified important factors associated with waterpipe smoking (e.g., cigarette smoking, other

tobacco product use, alcohol consumption, smoking knowledge and attitudes, and higher perceived family financial status). Smoking cessation services and school education programs must be better equipped to address waterpipe smoking and the use of other tobacco products, and educate youth about the health hazards and addictive property of waterpipe smoking. Counter-marketing campaigns deglamorizing waterpipe smoking may help reduce the incidence and prevent uptake.

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**Compliances with ethical standards**

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**Conflict of interest** The authors declare no conflict of interest.

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