



BMJ Open Cross-sectional study on the awareness, susceptibility and use of heated tobacco products among adolescents in Guatemala City, Guatemala

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ABSTRACT

Objectives Heated tobacco products (HTPs) are increasingly marketed worldwide, yet limited research on HTPs has been conducted in low and middle-income countries (LMICs) or among adolescents. Guatemala is one of the few LMICs where HTPs are available. This study examined prevalence and correlates of HTP awareness, susceptibility and use among adolescents in Guatemala.

Design, setting and participants A cross-sectional survey on HTP awareness, susceptibility and use was conducted among 2870 students between the ages of 13 and 17 in private schools in Guatemala City, Guatemala.

Primary and secondary outcome measures The primary outcome was susceptibility to future use of HTP among school-aged current and never smokers in Guatemala. We also explored awareness and use of HTPs. Multivariate binomial regression models were used to explore associations between these outcomes and both sociodemographic factors and established smoking correlates.

Results Of all students (n=2870), about half were aware of HTPs (52.4%) and susceptible to future or continued use (52.4%). Whereas 8.4% of students had tried HTPs in the lifetime (but not in the last month), only 2.9% used HTPs in the past month. Independent correlates of HTP susceptibility and ever-use included: use of other tobacco products (current smoking: adjusted OR (AOR)=10.53 and 6.63, respectively; current e-cigarette use: AOR=21.87 and 10.40, respectively), moderate alcohol consumption (AOR=1.49 and 1.19, respectively), marijuana use in the past 30 days (AOR=3.49 and 2.29, respectively) and having friends who use HTPs (AOR=1.83 and 7.28, respectively).

Conclusions Among this sample of adolescents in Guatemala City, where tobacco control is weak, the prevalence of HTP use was low but susceptibility to future use was high. Tobacco prevention and intervention strategies for cigarettes and e-cigarettes should now also include HTPs, which tend to be used by similar adolescent populations (ie, those who use other substances or are exposed to tobacco through family and friends).

INTRODUCTION

The increase in popularity of non-conventional tobacco products has further

Strengths and limitations of this study

- Heated tobacco products (HTPs) are increasingly popular in countries where available, but little is known about adolescent use in low and middle-income countries with weak tobacco control policies like Guatemala.
- The study sample was selected from private high school students in Guatemala City, specifically to oversample potential HTP users but also resulted in a population not generalisable nationwide.
- This study used a previously fielded questionnaire adapted to Guatemala, and research questions, outcomes and analysis were based on prior local work.
- Both the population of interest and public were involved in study design and implementation: a subset of students were asked to pilot and comment on the survey before implementation, participating schools were asked to review the protocol and the Ministry of Health gave support of this study with the understanding that results will be shared and used to support tobacco control strategies.
- The data are self-reported, thus there is a chance of misreporting, particularly under-reporting due to social desirability bias.

complicated an already challenging tobacco control landscape. For example, electronic cigarettes (e-cigarettes) increasingly appear more appealing to adolescents than conventional cigarettes; a considerable proportion of adolescent e-cigarette users have never smoked conventional cigarettes.^{1 2} The appeal of e-cigarettes in younger populations is a key argument for strong regulations that would decrease youth access (eg, increase price and legal age of purchase) and appeal (eg, banning flavours and marketing), often outweighing arguments that policies should promote e-cigarette use among established smokers who may benefit from consumption of a less harmful product.³ Recently, tobacco product regulation in some countries has

been additionally complicated by the introduction of novel heated tobacco products (HTPs). HTPs heat but do not burn tobacco, producing an aerosol with nicotine that does not contain or has lower levels of many of the harmful chemicals in cigarette smoke.⁴⁵ However, current evidence on the harmful effects of HTPs compared with conventional cigarettes is yet to be determined as most of the available evidence is *in vitro* and comes from tobacco industry-funded research.^{6–9} In July 2020, the Food and Drug Administration (FDA) authorised Philip Morris to make claims in its HTP (IQOS) marketing about reduced exposure to harmful constituents compared with cigarettes; however, the FDA prohibited marketing claims about reduced risks from IQOS use, citing the lack of evidence for this claim.^{10–11} Nevertheless, consumers equate reduced exposure with reduced risk¹²: HTPs appeal to adult smokers and use of HTPs has been rapidly increasing in some high-income countries (HIC) where they have been introduced, suggesting a potential public health benefit, similar to that of e-cigarettes.^{13–15} Nonetheless, the appeal of HTPs among adolescents, particularly those who would otherwise not use tobacco, is relatively unknown.

IQOS was introduced in some countries in 2014, and is advertised as a less harmful alternative for smokers who want to reduce exposure to harmful chemicals produced by tobacco combustion.¹⁶ By 2020, it was available in at least 52 countries worldwide, including Guatemala,^{4 5 17} but due to the fairly recent introduction to the market, little is known about its awareness and use, particularly among adolescents. Nonetheless, HTPs appear to quickly penetrate markets: for example, among young adults in South Korea, only 3 months after IQOS was introduced into the market, 38% were aware of the product and 3.5% were current users.¹⁸ Additionally, in 2018, a study of older adolescents (16–19 years old) in England, Canada and the USA (where HTPs were either only available in limited areas or not available at the time of the study) reported that among all participants, 7% were aware of IQOS, 45% susceptible to future use and 38% interested in trying IQOS; these percentages were higher in the current smoker and e-cigarette user subpopulation.¹⁹ Notably, susceptibility to IQOS use (25%) was higher than susceptibility to conventional cigarette use (19%) among never smokers or e-cigarette users, suggesting its potential appeal among adolescents who otherwise would not use tobacco products.¹⁹

To the best of our knowledge, only one study has reported rates of HTP use among adolescents: this study, from 2019, found that among South Koreans aged 12–18 years, ever use was 2.8%.²⁰ Studies among adults in HICs have shown that HTP awareness and use tends to be higher among males, young adults, cigarette and e-cigarette smokers, and smokers with intentions to quit—all consistent risk factors for e-cigarette use.^{18 21 22} Although currently the correlates of HTP use among adolescents are relatively unknown, they may resemble those for e-cigarette use: male, current or ever smoker, having peers or

parents who smoke, sensation seeking and technophilia. Some of these factors are hypothesised to be related to e-cigarette use due to Jessor's problem-behaviour theory, which hypothesises that engaging in one risky behaviour increases the likelihood of engagement in other risky behaviours.^{23–27}

Study context

Guatemala is a middle-income country in Central America that signed and ratified the WHO's Framework Convention on Tobacco Control (FCTC) in 2005. However, as of 2020, the only FCTC-recommended policy that has been implemented is smoke-free environments (Article 8), and this has been executed with poor enforcement.²⁸ In 2015, the prevalence of adolescent cigarette and e-cigarette use in Guatemala was approximately 13% and 5.5%, respectively.^{29 30} There are no current data on HTP use among adolescents in Latin America, or any other low and middle-income countries (LMIC). This study aims to address this gap by evaluating the prevalence and correlates of HTP awareness, susceptibility and use among adolescents in Guatemala to inform prevention and intervention strategies to target those at highest risk for tobacco use, including use of cigarettes, e-cigarettes and HTPs.

METHODS

Survey design and data

Adolescents, grades 8–12, were recruited for this cross-sectional study. Based on the official list of private in Guatemala City, 30 schools were conveniently selected from middle to high socioeconomic urban areas and sent invitation letters to participate in the study. Six of these schools declined, 4 of which enrolled only boys or girls and 14 did not respond, leaving 10 participating schools. While students in grades 8–11 were recruited from all participating schools, students in the 12th grade were only recruited from 5 of the 10 participating schools. We obtained both passive consent from parents (ie, a consent letter was sent home with students and parents were able to opt their child out of the study by signing and returning the letter) and assent from participating students. All students in participating grades were invited to complete the survey and no incentive was given to the participants or schools. Data were collected between May and September 2019 using a paper-based, self-administered, Spanish-language survey on sociodemographics and tobacco product susceptibility, use and risk factors. The survey was previously fielded in Mexico and subsequently adapted for Guatemala and pretested to ensure comprehension.²⁴

Patient and public involvement

The research questions and outcome measures, including the study questionnaire, were based on our previous research on e-cigarettes in Guatemala and Mexico.¹³ The instrument was piloted among Guatemalan adolescents

from schools not included in the study sample to ensure comprehension, and further edited by local researchers to fit the country-specific environment. Participating schools were involved prior to data collection and asked to review the study protocol. Certain schools requested that the study team include 12th graders along with the proposed younger grades in the study sample, and this was accommodated by the study team. Schools were aware of the time required to complete the survey and surveys were only conducted in the time and place allocated by each school. Additionally, a letter of support from the Ministry of Health National Commission for the Prevention and Control of Chronic Disease was obtained prior to the start of the study. Results of this study will be shared with enrolled schools and support will be granted to develop and tailor tobacco use control strategies. Results will also be disseminated to authorities and stakeholders for policy development.

Outcome variables

We first assessed HTP awareness (yes, no) by showing an image and description of an IQOS, the only HTP available in Guatemala, and asking if participants had previously heard of them. Susceptibility to future HTP use was then assessed for all participants with a single question adapted from Pierce *et al's* validated scale.³¹ This question (prompt: 'If one of your friends offered you a heated tobacco product like IQOS, would you use it?'; possible responses: 'Definitely yes', 'Probably yes', 'Probably no', 'Definitely no') has been shown to predict smoking initiation with the same accuracy as the full scale among Latin American youth.³² Those who answered 'Definitely yes', 'Probably yes' or 'Probably no' were considered susceptible to continued or future use, while those who reported 'Definitely no' were categorised as unsusceptible, similar to prior studies.²⁴ Students did not need to be previously aware of HTPs to be susceptible to future use. Students were also asked if they had ever tried HTPs (yes, no) and, to assess current use, if they had used HTPs in the prior 30 days. Using the above described definitions, HTP use was characterised as the following four exclusive categories: never used and unsusceptible to future use; never used but susceptible to future use; ever used, but not currently; and current use.

Independent variables

Sociodemographic variables that were assessed included sex (male, female), age (continuous), grade (8th–9th vs 10th–12th), school performance (averaging <80%, 80%–89% or >90%), highest educational attainment by either parent (primary school or less, high school or technical school, university or more) and family affluence. To assess family affluence, we used the four-item Family Affluence Scale (ie, 'How many cars does your family have?', 'Do you have your own bedroom?', 'How many times did your family go on vacation last year?' and 'How many computers are in your house?'), which is a

summative measure validated among other adolescent populations.³³

Established risk factors for smoking and e-cigarette use were also considered, including other substance use (eg, tobacco products, alcohol, drugs). Use of cigarettes and e-cigarettes was queried and derived consistent with our definition for HTP use (never used and unsusceptible to future use; never used but susceptible to future use; ever used, but not currently; and current use). Additionally, we assessed ever use of any tobacco product (yes/no), first product used among ever users (cigarette, e-cigarette, HTP, other) and dual use of products (yes/no; if yes, which products). Ever use of alcohol, current use (last 30 days) and recent binge drinking (four or more drinks in one sitting in the last 30 days) were assessed and used to derive exclusive categories. We also considered ever and current marijuana use. Smoking, e-cigarette and HTP use was measured separately for both family members (yes, no) and friends (yes, no among five closest friends).

Other common risk factors for smoking and vaping that were considered in this study included frequency of exposure to internet advertising (ie, never; rarely/sometimes; often/very often) for both smoking and e-cigarettes, assessed separately. Sensation seeking (in accordance with Jessor's problem-behaviour theory) was evaluated with four items (ie, 'I would like to explore strange places', 'I like to do things that scare me', 'I like new and exciting experiences, even when I am breaking the rules' and 'Sometimes I do crazy things just for fun') with Likert responses (1=strongly disagree; 5=strongly agree) and averaged together ($\alpha=0.77$). We also measured 'technophilia', which is a positive orientation towards new technology adoption, using seven items that have been previously shown to independently predict e-cigarette, but not smoking, initiation (ie, having internet access in their room; having a laptop in their room; owning a tablet; having a cellphone with internet access; frequency of using social media; enjoyment from using the internet; level of interest in new technologies).^{34 35}

Statistical analysis

Binary logistic regression was used to estimate crude ORs for the association between each independent variable and key outcomes: (1) HTP awareness (yes, no) among all participants; (2) susceptibility to future HTP use (yes, no) among all participants; (3) ever HTP use (yes, no) among non-current users; and (4) current HTP use (yes, no) among all participants. A cut-off of less than 5% missing was a necessary criterion for inclusion of each variable in the models. However, no variables had more than 5% missing data, and thus all were included in the final analyses. Parent educational attainment was borderline (4.8%) so a 'missing' category was included for this variable. Due to the low prevalence of HTP use, particularly current use, categories of cigarette, e-cigarette and alcohol use were collapsed in some models to increase small cell counts. In the current HTP use model, cigarette and e-cigarette use was collapsed to non-current versus

current and alcohol was collapsed to non-recent binge versus recent binge. Next, for each outcome, multivariate logistic regression models were calculated to estimate the adjusted ORs (AORs) associated with each independent variable, adjusting for all other independent variables. Crude and adjusted models included a random intercept to adjust for non-independence of observations within schools. In all models, we evaluated collinearity among independent variables by examining the variance inflation factor, and results indicated no collinearity concerns. Also, due to concern regarding the strong influence of friend use of e-cigarettes, we reran the full models after removing this variable and compared results with the original model. There were minimal differences in the coefficients across models, and the direction, statistical significance and interpretation are the same across model specifications. Because of the importance of peer influence for youth tobacco use, we report on the results from the original model that includes the friend use of e-cigarettes variable. All analyses were conducted in R V.3.4.4.

RESULTS

Participants

At the 10 schools, 3311 students were invited to participate and 2870 (87%) completed the survey: 271 (8%) were absent, 135 (4%) did not have permission from their parents, 28 (<1%) refused and 2 (<1%) did not speak Spanish. Five (<1%) students who did not complete the survey gave no reason as to why they did not wish to participate.

About half of participants were male and the mean age was slightly over 15 years (table 1). Most respondents were in the higher grades (grades 10, 11 and 12) (56.9%), had an average grade of 80% or higher (81.2%) and had at least one parent with a university degree or higher (74.8%).

Over half (52.4%) of students reported having heard of HTPs and 8.4% and 2.9% reported ever use (but not current) and current use of HTPs, respectively. In the entire sample, 52% were susceptible to future HTP use. In this sample, 939 (32.7%) students were both previously aware of HTPs and susceptible to future use, while 802 (27.9%) were neither previously aware nor susceptible to future use. Furthermore, 563 (19.6%) were previously aware but not susceptible, and 560 (19.5%) were not previously aware but were susceptible. Over half (58.4%) had used a tobacco product at some point in their life; most ever tobacco users first used e-cigarettes (54.0%) or cigarettes (43.2%). Only 1.5% of ever tobacco users first used an HTP. Nearly half (44%) of students had never smoked conventional cigarettes and were unsusceptible to future cigarette use, 30% had tried smoking and 9% were current smokers. Regarding e-cigarettes, 56% reported ever use and 28% currently use e-cigarettes. Of current tobacco users, the majority only used e-cigarettes (65.9%) and only 0.5% currently used HTP but not cigarettes or e-cigarettes.

Table 1 Characteristics of secondary school student participants in Guatemala, 2019 (n=2870)

	n	%
Dependent variables		
Aware of HTP	1503	52.4
Susceptible to HTP	1500	52.4
HTP use		
Never (unsusceptible)*	1993	69.6
Never (susceptible)†	547	19.1
Ever (not current)	241	8.4
Current	84	2.9
Sociodemographic characteristics		
Sex		
Male	1438	50.3
Female	1420	49.7
Age (mean, SD)		
	15.09	1.32
Grade—US categories		
Basico (grades 8–9)	1238	43.1
Bachillerato (grades 10–12)	1632	56.9
School performance		
<80%	523	18.8
80%–89%	1321	47.6
90%–100%	932	33.6
Parents' highest educational attainment		
Secondary school or less	49	1.7
High school or technical school	537	18.7
University or more	2146	74.8
Missing	138	4.8
Substance use variables		
Ever use of any tobacco product		
	1675	58.4
Of ever users, first tobacco product used		
Cigarette	456	43.2
E-cigarette	570	54.0
HTP	16	1.5
Other	13	1.2
Cigarette smoker		
Never (unsusceptible)*	1261	44.0
Never (susceptible)†	754	26.3
Ever (not current)	601	21.0
Current	250	8.7
E-cigarette user		
Never (unsusceptible)*	713	25.0
Never (susceptible)†	545	19.1
Ever (not current)	808	28.3
Current	791	27.7
Of current smokers, which product used		

Continued

Table 1 Continued

	n	%
Only cigarettes	48	5.7
Only e-cigarettes	556	65.9
Only HTPs	4	0.5
More than one product	236	30.0
Of current HTP users		
Also smoke cigarettes	44	52.4
Also smoke e-cigarettes	78	92.9
Alcohol user		
Never	683	23.9
Ever (not current)	935	32.7
Current (no binge)	676	23.7
Current (binge)‡	561	19.6
Marijuana user		
Never	2563	90.2
Ever (not current)	177	6.2
Current	103	3.6
Internet cigarette ad exposure		
Never	980	34.5
Rarely/sometimes	1543	54.3
Mostly/always	319	11.2
Internet e-cigarette ad exposure		
Never	881	31.0
Rarely/sometimes	1471	51.8
Mostly/always	490	17.2
Family member smokes cigarettes	1025	35.8
Family member uses e-cigarettes	599	21.0
Family member uses HTP	395	13.8
Friend smokes cigarettes	1551	54.1
Friend smokes e-cigarettes	1817	63.6
Friend uses HTP	423	14.8
Constructed scales (score range)	Mean	SD
Sensation seeking (1–4)	2.77	0.7
Technophilia (0–7)	5.73	0.9
Family Affluence Scale (0–9)	7.27	1.57

*Unsusceptible is defined as answering definitely no to both ‘Do you think you will smoke in the next 12 months?’ and ‘If one of your best friends offered you a cigarette, would you smoke it?’

†Susceptible is defined as answering probably no, probably yes or definitely yes to either ‘Do you think you will smoke in the next 12 months?’ or ‘If one of your best friends offered you a cigarette, would you smoke it?’

‡Binge drinking is defined as consuming four or more drinks on one occasion in the last month
HTP, heated tobacco product.

Considering other substances, one-quarter (24%) reported never consuming alcohol and 20% reported at least one instance of binge drinking in the past 30 days. Most (90.2%) had never used marijuana. About

50% of students report seeing online cigarette or e-cigarette advertising rarely or sometimes when they use the internet. Family use of cigarettes, e-cigarettes or HTPs was 35.8%, 21.0% and 13.8%, respectively. Concerning friend cigarette, e-cigarette or HTP use, the corresponding percentages were 54.1%, 63.6% and 14.8%, respectively.

Factors associated with HTP awareness and susceptibility

About half (52.4%) of students reported awareness of HTPs. HTP awareness was higher for ever users (AOR=1.65, 95% CI 1.23 to 2.21) and current users of e-cigarettes (AOR=2.10, 95% CI 1.47 to 2.99), binge drinkers (AOR=1.84, 95% CI 1.28 to 2.65) and those exposed to medium (AOR=1.39, 95% CI 1.10 to 1.75) and high levels of online e-cigarette advertising (AOR=1.76, 95% CI 1.26 to 2.46) (table 2). Additionally, family smoking (AOR=1.31, 95% CI 1.07 to 1.60) and HTP use (AOR=1.60, 95% CI 1.22 to 2.09), family affluence (AOR=1.10, 95% CI 1.04 to 1.17) and friend HTP use (AOR=4.15, 95% CI 3.11 to 5.55) were positively associated with participant HTP awareness.

In the entire sample, 52.4% were susceptible to continued or future HTP use. Compared with unsusceptible never smokers, higher susceptibility was found among susceptible never smokers (AOR=6.18, 95% CI 4.72 to 8.07), ever smokers (AOR=6.93, 95% CI 5.02 to 9.57) and current smokers (AOR=10.53, 95% CI 5.92 to 18.71), as well as susceptible never (AOR=12.18, 95% CI 7.79 to 19.03), ever (AOR=11.08, 95% CI 7.07 to 17.37) and current e-cigarette users (AOR=21.87, 95% CI 13.02 to 36.71), compared to unsusceptible never e-cigarette users. Similarly, ever (AOR=1.73, 95% CI 1.25 to 2.41), current (AOR=1.49, 95% CI 1.03 to 2.17) and binge drinkers (AOR=1.65, 95% CI 1.04 to 2.60), and current marijuana users (AOR=3.49, 95% CI 1.40 to 2.60) were more likely to be susceptible to HTP use, compared to never-drinkers/users. Finally, having a friend who used HTPs (AOR=1.83, 95% CI 1.31 to 2.57) and higher sensation-seeking scores (AOR=1.41, 95% CI 1.19 to 1.68) were positively associated with HTP susceptibility.

Factors associated with HTP use (ever and current)

Among non-current HTP users, 8.6% had tried HTPs. Students who were ever smokers (AOR=3.73, 95% CI 2.03 to 6.82) or current smokers (AOR=6.63, 95% CI 3.20 to 13.74), or ever (AOR=9.31, 95% CI 2.61 to 33.23) or current e-cigarette users (AOR=10.40, 95% CI 2.75 to 39.17) were more likely to be ever HTP users than corresponding unsusceptible non-users (table 3). Those who reported binge drinking (AOR=2.53, 95% CI 1.08 to 5.95) and marijuana use (AOR=2.29, 95% CI 1.27 to 4.13) were also more likely to be ever HTP users than non-users. Family smoking (AOR=1.70, 95% CI 1.19 to 2.45) and friend HTP use (AOR=7.28, 95% CI 4.64 to 11.43) were associated with higher odds of ever use of HTPs. Higher family affluence was also associated with ever use (AOR=1.15, 95% CI 1.02 to 1.31).

Table 2 Crude and adjusted ORs for awareness and susceptibility of HTP among Guatemalan youth*

HTP awareness n=1503 (52.4%)		HTP susceptible n=1500 (52.4%)									
	%	OR	95%CI	AOR†	95%CI	%	OR	95%CI	AOR†	95%CI	
Sociodemographic characteristics											
Sex											
Female	54.94	Reference	Reference	Reference	Reference	52.33	Reference	Reference	Reference	Reference	
Male	49.72	0.86	(0.74 to 1.01)	0.81‡	(0.68 to 0.97)	52.40	0.98	(0.84 to 1.14)	0.83	(0.66 to 1.04)	
Age (mean)	15.29	1.25‡	(1.17 to 1.32)	1.05	(0.93 to 1.18)	15.26	1.29‡	(1.22 to 1.37)	0.93	(0.79 to 1.08)	
Grade—US categories											
Basico (grades 8–9)	43.77	Reference	Reference	Reference	Reference	44.04	Reference	Reference	Reference	Reference	
Bachillerato (grades 10–12)	58.95	1.73‡	(1.48 to 2.02)	1.00	(0.74 to 1.35)	58.64	1.92‡	(1.64 to 2.24)	1.08	(0.73 to 1.59)	
School performance											
<80%	53.26	Reference	Reference	Reference	Reference	60.92	Reference	Reference	Reference	Reference	
80%–89%	54.62	1.02	(0.82 to 1.27)	1.30‡	(1.01 to 1.67)	55.12	0.75‡	(0.61 to 0.93)	0.88	(0.64 to 1.20)	
90%–100%	48.61	0.72‡	(0.57 to 0.92)	1.13	(0.85 to 1.51)	44.58	0.49‡	(0.39 to 0.62)	0.83	(0.58 to 1.19)	
Parents' highest educational attainment											
Secondary school or less	53.06	Reference	Reference	Reference	Reference	46.94	Reference	Reference	Reference	Reference	
High school or technical school	52.33	1.00	(0.55 to 1.83)	0.75	(0.37 to 1.51)	52.33	1.23	(0.69 to 2.22)	1.07	(0.43 to 2.67)	
University or more	52.87	1.06	(0.60 to 1.90)	0.80	(0.41 to 1.59)	53.29	1.27	(0.72 to 2.24)	1.34	(0.55 to 3.27)	
Missing	45.26	0.71	(0.37 to 1.40)	0.91	(0.40 to 2.05)	39.71	0.75	(0.39 to 1.46)	1.11	(0.39 to 3.16)	
Substance use variables											
Cigarette smoker											
Never (unsusceptible)	41.59	Reference	Reference	Reference	Reference	17.00	Reference	Reference	Reference	Reference	
Never (susceptible)	51.39	1.54‡	(1.28 to 1.86)	0.88	(0.69 to 1.13)	75.90	15.68‡	(12.52 to 19.65)	6.18‡	(4.72 to 8.07)	
Ever (not current)	65.06	2.69‡	(2.19 to 3.31)	1.19	(0.89 to 1.59)	81.36	22.69‡	(17.53 to 29.37)	6.93‡	(5.02 to 9.57)	
Current	79.60	5.60‡	(4.01 to 7.81)	1.58	(1.00 to 2.49)	90.80	51.58‡	(32.64 to 81.51)	10.53‡	(5.92 to 18.71)	
E-cigarette user											
Never (unsusceptible)	33.43	Reference	Reference	Reference	Reference	4.64	Reference	Reference	Reference	Reference	
Never (susceptible)	43.12	1.60‡	(1.27 to 2.03)	1.28	(0.95 to 1.73)	63.42	36.41‡	(24.52 to 54.07)	12.18‡	(7.79 to 19.03)	
Ever (not current)	55.94	2.51‡	(2.03 to 3.09)	1.65‡	(1.23 to 2.21)	61.34	38.66‡	(26.34 to 57.75)	11.08‡	(7.07 to 17.37)	
Current	72.41	4.67‡	(3.73 to 5.86)	2.10‡	(1.47 to 2.99)	78.73	124.45‡	(82.40 to 187.94)	21.87‡	(13.02 to 36.71)	
Alcohol											
Never	35.34	Reference	Reference	Reference	Reference	20.56	Reference	Reference	Reference	Reference	

Continued

Table 2 Continued

	HTP awareness n=1503 (52.4%)		HTP susceptible n=1500 (52.4%)				
Ever (not current)	46.25	1.65‡ (1.34 to 2.03)	1.25	4.18‡ (0.97 to 1.60)	52.41	4.18‡ (3.33 to 5.26)	1.73‡ (1.25 to 2.41)
Current (no binge)	57.84	2.44‡ (1.96 to 3.05)	1.28	8.78‡ (0.95 to 1.71)	65.68	8.78‡ (6.81 to 11.32)	1.49‡ (1.03 to 2.17)
Current (binge)	76.83	5.27‡ (4.07 to 6.82)	1.84‡	17.99‡ (1.28 to 2.65)	75.36	17.99‡ (13.41 to 24.15)	1.65‡ (1.04 to 2.60)
Marijuana							
Never	49.43	Reference	Reference	48.40	Reference	Reference	Reference
Ever (not current)	77.97	3.49‡ (2.42 to 5.04)	1.50	6.79‡ (0.97 to 2.32)	85.88	6.79‡ (4.40 to 10.46)	1.61 (0.94 to 2.75)
Current	81.55	4.03‡ (2.42 to 6.71)	1.48	16.78‡ (0.82 to 2.67)	93.20	16.78‡ (7.72 to 36.49)	3.49‡ (1.40 to 8.72)
Internet cigarette ad exposure							
Never	44.74	Reference	Reference	38.78	Reference	Reference	Reference
Rarely/sometimes	55.19	1.66‡ (1.40 to 1.96)	1.07	2.22‡ (0.86 to 1.34)	58.64	2.22‡ (1.88 to 2.62)	1.40‡ (1.06 to 1.84)
Mostly/always	63.01	2.44‡ (1.87 to 3.19)	1.08	2.87‡ (0.75 to 1.57)	64.78	2.87‡ (2.20 to 3.73)	1.52 (0.97 to 2.40)
Internet e-cigarette ad exposure							
Never	39.70	Reference	Reference	35.38	Reference	Reference	Reference
Rarely/sometimes	55.47	2.00‡ (1.68 to 2.38)	1.39‡	2.43‡ (1.10 to 1.75)	57.11	2.43‡ (2.05 to 2.89)	1.05 (0.78 to 1.41)
Mostly/always	66.12	3.33‡ (2.62 to 4.22)	1.76‡	4.05‡ (1.26 to 2.46)	69.12	4.05‡ (3.19 to 5.13)	0.86 (0.57 to 1.30)
Family member smokes cigarettes							
No	45.78	Reference	Reference	46.13	Reference	Reference	Reference
Yes	64.36	2.14‡ (1.82 to 2.51)	1.31‡	2.08‡ (1.07 to 1.60)	63.80	2.08‡ (1.78 to 2.44)	1.17 (0.91 to 1.50)
Family member smokes e-cigarettes							
No	47.96	Reference	Reference	48.76	Reference	Reference	Reference
Yes	69.28	2.17‡ (1.78 to 2.64)	1.25	2.25‡ (0.98 to 1.59)	66.39	2.25‡ (1.85 to 2.73)	1.08 (0.81 to 1.45)
Family member uses HTP							
No	49.98	Reference	Reference	51.18	Reference	Reference	Reference
Yes	67.85	2.08‡ (1.65 to 2.62)	1.60‡	1.48‡ (1.22 to 2.09)	60.51	1.48‡ (1.19 to 1.84)	0.98 (0.71 to 1.36)
Friend smokes cigarettes							
No	43.72	Reference	Reference	40.50	Reference	Reference	Reference
Yes	59.81	1.89‡ (1.62 to 2.20)	1.03	2.50‡ (0.83 to 1.29)	62.56	2.50‡ (2.14 to 2.91)	0.91 (0.70 to 1.19)
Friend uses e-cigarettes							
No	39.71	Reference	Reference	38.98	Reference	Reference	Reference
Yes	59.80	1.96‡ (1.67 to 2.31)	0.72‡	2.75‡ (0.57 to 0.91)	60.17	2.75‡ (2.33 to 3.25)	0.70‡ (0.51 to 0.95)
Friend uses HTP							

Continued

Table 2 Continued

	HTP awareness n=1503 (52.4%)			HTP susceptible n=1500 (52.4%)		
	Mean OR	95%CI	AOR†	Mean OR	95%CI	AOR†
No	48.05	Reference	Reference	49.90	Reference	Reference
Yes	77.73	4.19‡ (3.27 to 5.38)	4.15‡ (3.27 to 5.38)	66.43	1.98‡ (1.59 to 2.47)	1.83‡ (1.31 to 2.57)
Constructed scales (score range)	Mean OR	95%CI	AOR†	Mean OR	95%CI	AOR†
Sensation seeking (1–4)	2.87	1.61‡ (1.44 to 1.80)	1.08 (1.44 to 1.80)	2.97	2.47‡ (0.95 to 1.24)	1.41‡ (2.20 to 2.78)
Technophilia (0–7)	5.85	1.29‡ (1.19 to 1.41)	1.07 (1.19 to 1.41)	5.82	1.29‡ (0.97 to 1.19)	1.04 (1.18 to 1.40)
Family Affluence Scale (0–9)	7.46	1.15‡ (1.09 to 1.21)	1.10‡ (1.09 to 1.21)	7.29	1.04 (1.04 to 1.17)	0.94 (0.99 to 1.09)

*All models include a random intercept for each participant to account for school clustering.

†Adjusted models are adjusted for all independent variables.

‡Significant at $\alpha=0.05$.

AOR, adjusted OR; HTP, heated tobacco product.

In the overall population, 2.9% were current HTP users. The odds of current HTP use was higher for both cigarette (AOR=3.90, 95% CI 1.90 to 8.02) and e-cigarette users (AOR=46.12, 95% CI 16.15 to 131.74). Having family members who smoked (AOR=2.00, 95% CI 1.03 to 3.88) and friends who used HTPs (AOR=21.06, 95% CI 11.13 to 39.85) was associated with higher odds of current use of HTPs.

DISCUSSION

We investigated HTP use among adolescents in private schools in Guatemala City, where HTPs are becoming readily available.³⁶ About half of the students were aware of HTPs (54.2%) and susceptible to future use of HTPs (54.2%), although ever (but not current) HTP use (8.4%) and current HTP use (2.9%) were low compared with smoking (21.0% and 8.7%, respectively) and e-cigarette use (28.3% and 27.7%, respectively). Furthermore, almost none of the students who had ever used any tobacco product reported using HTPs as their first tobacco product (1.5%), and nearly all current HTP users also either smoked cigarettes (52.4%) or used e-cigarettes (92.9%). These results suggest that in this population HTPs are not a gateway tobacco product, as has been reported for e-cigarettes in many locations, including in Latin America, even though there is evidence against this claim.^{37–39} However, the high prevalence of susceptibility to future use that we found suggests that this may change if HTPs become more popular or accessible.

Currently, the available data on HTP awareness and use are from HICs, which have stronger tobacco control policies, making cross-country comparisons challenging. One study of adolescents aged 16–19 years in Canada, the USA and England¹⁹ found lower levels of awareness (7.0%) and susceptibility (45.0%) compared with our sample (52.4% and 52.4%, respectively). However, this study only included never smokers and never vapers. As we found that HTP susceptibility was associated with smoking and e-cigarette use, it is unsurprising that rates are higher in our study population, which included participants who reported tobacco use. Additionally, use of alcohol or marijuana, family and friend use of tobacco products and higher sensation seeking were all positively associated with susceptibility to continued and future use of HTPs in adolescents; these variables have not been previously studied among HTP users, but the associations we found are not unexpected given prior research on e-cigarette susceptibility and use.^{23–26} In the end, our results support Jessor's problem-behaviour theory, which hypothesises that substance use and other risk behaviours tend to cluster together.²⁷

To our knowledge, the only other study of adolescents' current use of HTPs comes from South Korea.²⁰ This 2019 study among Korean adolescents aged 12–18 years found lower ever-use HTP rates than in our sample (2.8% vs 8.4%), despite the fact that HTPs have been on the market for longer in Korea than Guatemala.²⁰ While South Korea has a much higher gross domestic product per capita

Table 3 Crude and adjusted ORs for ever and current HTP use among Guatemalan youth*

		Ever HTP use (not current) n=241 (8.6%)			Current HTP use n=84 (2.9%)					
	%	OR	95%CI	AOR†	95%CI	%	OR	95%CI	AOR†	95%CI
Sociodemographic characteristics										
Sex										
Female	7.56	Reference	Reference	Reference	Reference	2.63	Reference	Reference	Reference	Reference
Male	9.75	1.40‡	(1.07 to 1.84)	1.22	(0.86 to 1.72)	3.42	1.31	(0.84 to 2.06)	1.03	(0.56 to 1.89)
Age (mean)	15.87	1.72‡	(1.53 to 1.94)	1.20	(0.97 to 1.50)	15.65	1.39‡	(1.16 to 1.65)	0.85	(0.58 to 1.25)
Grade—US categories										
Basico (grades 8–9)	3.77	Reference	Reference	Reference	Reference	1.43	Reference	Reference	Reference	Reference
Bachillerato (grades 10–12)	12.44	3.45‡	(2.47 to 4.82)	0.92	(0.49 to 1.71)	4.45	2.86‡	(1.69 to 4.83)	2.18	(0.68 to 6.96)
School performance										
<80%	11.78	Reference	Reference	Reference	Reference	4.54	Reference	Reference	Reference	Reference
80%–89%	10.07	0.71	(0.50 to 1.01)	1.04	(0.67 to 1.63)	3.36	0.69	(0.41 to 1.17)	0.74	(0.36 to 1.52)
90%–100%	5.24	0.29‡	(0.19 to 0.45)	0.69	(0.38 to 1.25)	1.81	0.38‡	(0.20 to 0.72)	0.84	(0.35 to 2.00)
Parents' highest educational attainment										
Secondary school or less	16.67	Reference	Reference	Reference	Reference	2.44	Reference	Reference	Reference	Reference
High school or technical school	10.90	0.63	(0.28 to 1.43)	0.50	(0.18 to 1.69)	2.92	1.37	(0.18 to 10.70)	0.62	(0.07 to 5.60)
University or more	8.12	0.48	(0.22 to 1.04)	0.36	(0.12 to 1.07)	3.29	1.52	(0.21 to 11.25)	0.63	(0.07 to 5.51)
Missing	5.15	0.27‡	(0.09 to 0.80)	0.28	(0.06 to 1.37)	0.77	0.72	(0.06 to 8.11)	0.00	NA
Substance use variables										
Cigarette smokers§										
Never (unsusceptible)	1.75	Reference	Reference	Reference	Reference					
Never (susceptible)	4.59	2.76‡	(1.60 to 4.76)	1.34	(0.69 to 2.61)					
Ever (not current)	18.37	12.70‡	(7.92 to 20.36)	3.73‡	(2.03 to 6.82)	1.59	Reference	Reference	Reference	Reference
Current	37.98	34.93‡	(21.01 to 58.08)	6.63‡	(3.20 to 13.74)	24.56	13.81‡	(8.79 to 21.68)	3.90‡	(1.90 to 8.02)
E-cigarette users§										
Never (unsusceptible)	0.42	Reference	Reference	Reference	Reference					
Never (susceptible)	0.55	1.31	(0.26 to 6.49)	0.71	(0.13 to 3.92)					
Ever (not current)	11.19	29.66‡	(9.37 to 93.89)	9.31‡	(2.61 to 33.23)	0.25	Reference	Reference	Reference	Reference
Current	20.00	59.31‡	(18.84 to 186.69)	10.40‡	(2.75 to 39.17)	11.73	45.24‡	(19.32 to 105.94)	46.12‡	(16.15 to 131.74)
Alcohol¶										
Never	1.47	Reference	Reference	Reference	Reference					
Ever (not current)	4.22	2.96‡	(1.47 to 5.97)	1.14	(0.50 to 2.60)					
Current (no binge)	8.18	5.99‡	(3.02 to 11.87)	1.19	(0.52 to 2.75)	1.73	Reference	Reference	Reference	Reference

Continued

Table 3 Continued

	Ever HTP use (not current) n=241 (8.6%)		Current HTP use n=84 (2.9%)							
Current (binge)	26.25	23.92‡ (12.43 to 46.03)	2.53‡	(1.08 to 5.95)	10.12	4.55‡ (2.94 to 7.06)	0.53	(0.27 to 1.06)		
Marijuana										
Never	6.07	Reference	Reference	Reference	1.74	Reference	Reference	Reference		
Ever (not current)	29.03	6.18‡ (4.20 to 9.09)	1.37	(0.84 to 2.22)	16.67	8.54‡ (5.03 to 14.51)	1.91	(0.87 to 4.18)		
Current	45.98	12.57‡ (7.93 to 19.93)	2.29‡	(1.27 to 4.13)	25.40	10.64‡ (5.77 to 19.60)	1.32	(0.50 to 3.45)		
Internet cigarette ad exposure										
Never	6.54	Reference	Reference	Reference	1.85	Reference	Reference	Reference		
Rarely/sometimes	8.88	1.46‡ (1.07 to 2.00)	1.13	(0.74 to 1.75)	3.12	1.60 (0.92 to 2.78)	1.27	(0.55 to 2.90)		
Mostly/always	14.33	2.56‡ (1.69 to 3.88)	1.50	(0.81 to 2.77)	6.88	3.37‡ (1.75 to 6.51)	2.65	(0.91 to 7.71)		
Internet e-cigarette ad exposure										
Never	5.45	Reference	Reference	Reference	2.04	Reference	Reference	Reference		
Rarely/sometimes	8.09	1.54‡ (1.08 to 2.18)	0.67	(0.41 to 1.09)	2.73	1.37 (0.77 to 2.45)	0.49	(0.20 to 1.18)		
Mostly/always	16.41	3.61‡ (2.45 to 5.31)	0.98	(0.54 to 1.77)	6.52	2.95‡ (1.59 to 5.47)	0.40	(0.14 to 1.13)		
Family member smokes cigarettes										
No	5.28	Reference	Reference	Reference	2.07	Reference	Reference	Reference		
Yes	14.88	3.10‡ (2.36 to 4.07)	1.70‡	(1.19 to 2.45)	5.01	2.28‡ (1.47 to 3.54)	2.00‡	(1.03 to 3.88)		
Family member smokes e-cigarettes										
No	6.58	Reference	Reference	Reference	2.42	Reference	Reference	Reference		
Yes	16.49	2.64‡ (1.98 to 3.51)	1.37	(0.94 to 2.01)	5.74	2.19‡ (1.39 to 3.46)	0.74	(0.38 to 1.46)		
Family member uses HTP										
No	8.09	Reference	Reference	Reference	2.86	Reference	Reference	Reference		
Yes	12.40	1.58‡ (1.13 to 2.23)	0.90	(0.58 to 1.42)	4.60	1.49 (0.86 to 2.60)	1.08	(0.50 to 2.33)		
Friend smokes cigarettes										
No	4.77	Reference	Reference	Reference	1.12	Reference	Reference	Reference		
Yes	12.07	2.71‡ (2.01 to 3.66)	0.77	(0.50 to 1.18)	4.89	4.03‡ (2.29 to 7.07)	0.83	(0.38 to 1.82)		
Friend uses e-cigarettes										
No	3.97	Reference	Reference	Reference	0.60	Reference	Reference	Reference		
Yes	10.22	2.93‡ (2.06 to 4.18)	0.51‡	(0.30 to 0.86)	4.63	6.52‡ (3.00 to 14.19)	0.61	(0.21 to 1.77)		
Friend uses HTP										
No	6.72	Reference	Reference	Reference	1.19	Reference	Reference	Reference		
Yes	21.14	3.98‡ (2.94 to 5.39)	7.28‡	(4.64 to 11.43)	15.65	12.40‡ (7.81 to 19.71)	21.06‡	(11.13 to 39.85)		
Constructed scales (score range)	Mean	OR	95%CI	AOR†	95%CI	Mean	OR	95%CI	AOR†	95%CI
Sensation seeking (1–4)	3.10	2.46‡	(1.97 to 3.07)	1.27	(0.96 to 1.68)	3.25	3.34‡	(2.26 to 4.92)	1.34	(0.80 to 2.27)

Continued

Table 3 Continued

	Ever HTP use (not current) n=241 (8.6%)		Current HTP use n=84 (2.9%)	
Technophilia (0–7)	5.96	1.40‡	6.11	1.81‡
Family Affluence Scale (0–9)	7.64	1.18‡	7.63	1.18‡
		(1.18 to 1.67)	(0.89 to 1.40)	(1.32 to 2.48)
		(1.07 to 1.30)	(1.02 to 1.31)	(1.01 to 1.38)
		1.12	1.34	1.04
		1.15‡	1.04	1.04

*All models include a random intercept for each participant to account for school clustering.

†Adjusted models are adjusted for all independent variables.

‡Significant at $\alpha=0.05$.

§Due to low counts, for current use models, cigarette and e-cigarette use was combined to current user versus non-current user.

¶Due to low counts, alcohol use was combined to non-binge versus binge in the last month.

AOR, adjusted OR; HTP, heated tobacco product; NA, not applicable.

than Guatemala, our study population was selected from private schools in middle and high socioeconomic status (SES) neighbourhoods in Guatemala City, which are predominantly attended by students of significant higher SES, and this could be the cause of the discrepancy. For example, the average monthly cost to attend one of the schools in our study is US\$388–US\$420 plus an annual enrolment fee of an average US\$550, and a 2020 report from the World Bank⁴⁰ found that about 50% of Guatemalans live below the upper middle-income poverty line of about US\$165 per month. However, according to the 2018 census, 37% of middle school students and 70% of high school students in Guatemala City attend private schools. Therefore, our results may be generalisable to Guatemala City, but not the entire country.⁴¹ Our study goes beyond the study from Korea by assessing correlates of use, which appear similar to those for e-cigarette use among adolescents.^{23–25} For example, correlates of HTP use in our study are also predictors of e-cigarette use in Mexico (use of cigarettes, alcohol and marijuana, family use of cigarettes and sensation-seeking behaviour).²³ We also found that e-cigarette use was a correlate of HTP use.

To the best of our knowledge, our study is the first to assess HTP awareness or use among adolescents from LMICs. Furthermore, we conducted a study in a country with weak FCTC implementation where HTPs, e-cigarettes and cigarettes are all readily available. In addition, we used a previously implemented survey that includes novel predictors (eg, technophilia, sensation seeking) of non-conventional tobacco product use. However, our results must be interpreted in the context of the study's limitations. All data were self-reported, although the directionality of any biases is not clear. This resulted in an expected amount of uncertainty due to misreporting. The sample was recruited from private schools, which predominantly serve middle and high-income students. Therefore, generalisability to the entire country is limited. Additionally, only four students exclusively used HTPs (ie, did not also smoke or use e-cigarettes), and thus it is hard to draw conclusions about this group. Because of this, model estimates include some large ORs (with similarly large CIs) when examining associations between HTP use and other tobacco product use. These estimates could be made more precise with larger sample sizes, but they may also reflect the fact that HTP use typically follows use of other tobacco products and substances—in other words, at this time HTPs do not appear to be a 'gateway' product for Guatemalan youth. Finally, the data are cross-sectional and so preclude causal inference for some time-varying variables in the analyses.

Despite its limitations, this study is the first of its kind to examine HTP use and its correlates among adolescents in an LMIC. While current HTP use was low in our study, awareness and susceptibility were high and therefore use of IQOS and other HTP products might increase as they become more widely available. Particularly concerning is the introduction of flavoured HTPs in some countries, which involves the addition of sticks with flavour capsules



in the filter that the consumer can crush to make the aerosol taste like diverse flavours, ranging from mint to ginger to bubble gum.⁴² Flavour capsules in cigarettes, which include an even broader range of flavours (eg, mango, mint, berry) that are popular with youth, are increasingly popular worldwide, including in Guatemala, where they represented 32% of the cigarette market in 2017.⁴³ While it does not seem like HTPs are gateway tobacco products for adolescents, as most current users in our sample report initially using e-cigarettes, as HTPs become more common and integrate new flavours and flavour technologies, it is possible that this could change, particularly among adolescents. It is critical to identify adolescents at risk for tobacco product uptake (cigarette, e-cigarette, HTPs, and so on) so that FCTC policies can be adequately designed and implemented in a manner prioritised for this high-risk group. Future studies should investigate whether rates of HTP use and predictors for HTP use are similar among other populations in Guatemala, including adults and other socioeconomic groups, as well as explore how adolescent e-cigarette users transition to HTP use.

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