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A 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 either in low- and middle-income countries (LMICs) or amongst adolescents. Guatemala is one of the few LMICs where HTPs are available. This study examined the 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 use included: use of other tobacco products (current smoking: AOR=10.53 & 34.93, respectively; current e-cigarette use: AOR=21.87 & 59.31, respectively), moderate alcohol consumption (AOR=1.49 & 5.99, respectively), marijuana use in the past 30 days (AOR=3.49 & 12.57, respectively), and having friends who use HTPs (AOR = 1.83 & 44.72, respectively).

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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. Prevention and intervention strategies could target adolescents who use other

substances, as well as those exposed to tobacco products through family and friends.

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Strengths and Limitations:

- Heated tobacco products (HTPs) are increasingly popular in the few countries where they have been introduced, but little is known about adolescent use or use in LMICs, making the topic of this research crucial to the development of control strategies.

- Guatemala, which has weak tobacco control policies, is one of the few LMICs where HTPs are now widely available, making it an ideal location to assess use and susceptibility to future use of these products.

- This study is one of the first to investigate current use of HTPs as well as susceptibility to future use among school-aged children in an LMIC and provides critical evidence which can be used to effectively implement intervention and prevention strategies to reduce the use of tobacco products among adolescents.

- The data is self-reported and participants were recruited from private schools, meaning there is a chance of misreporting and the sample is not representative of the country as a whole.

Introduction

The increase in popularity of non-conventional tobacco products has further 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 (e.g., increase price and legal age of purchase) and appeal (e.g., banning flavors 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, or 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.[4,5] HTPs appeal to some adult smokers and use has been rapidly increasing in some high-income countries where they have been introduced, suggesting a potential public health benefit, similar to that of e-cigarettes.[6–8] However, the appeal of HTPs among adolescents, particularly those who would otherwise not use tobacco, is relatively unknown.

Philip Morris´s HTP, IQOS, was introduced in some countries in 2014, and advertised as a less harmful alternative for smokers who want to reduce exposure to harmful chemicals produced by tobacco combustion.[9] By 2020 it was available in at least 52 countries worldwide, including Guatemala[4,5,10] 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, one study found that among young adults in South Korea, only 3 months after IQOS was introduce into the market, 38% were aware of the product and 3.5% were current users.[11] 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.[12] 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.[12]

To the best of our knowledge, only one study has reported rates of HTP use among adolescents: this study, from 2019, found that among 12- to 18-year-old South Koreans, ever use was 2.8%.[13] Studies among adults in high-income countries (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.[11,14,15] Although currently the correlates of HTP use among adolescents are relatively unknown, they may resemble those found for e-cigarette use: male, current or ever smoker, having peers or parents who smoke, sensation seeking, and technophilia.[16–19]

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.[20] In

2015, the prevalence of adolescent cigarette use in Guatemala was 12.9% and the

prevalence of adolescent e-cigarette use was 5.7% and 5.2% among males and females,

respectively.[21,22] However, there is no current data on HTP use among adolescents in

Latin America, or any other LMIC. Therefore, 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.

Methods

Survey design and data

Adolescents, grades 8-12, were recruited from private schools in Guatemala City

for this cross-sectional study. Of the 30 invited schools, six declined, 14 did not respond,

and 10 agreed to participate. While students in grades 8-11 were recruited from all

participating schools, students in the 12th grade were only recruited from five of the 10

participating schools. We obtained both passive consent from parents and assent from

participating students. Data were collected between May and September of 2019, using a

paper-based, self-administered, Spanish-language survey on socio-demographics and

tobacco product susceptibility, use, and risk factors. The survey was previously fielded

in Mexico and subsequently adapted for Guatemala and pre-tested to ensure

comprehension.[16] This protocol was approved by the Institutional Ethics Committee of

the Institute of Nutrition of Central America and Panama (INCAP), approval number 087/2019.

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.[23] The instrument was piloted among Guatemalan adolescents from schools not included in the study sample to ensure comprehension and edited by local researchers to fit the country-specific environment. Participating schools were first involved four months prior to data collection and were 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 with be granted to develop and tailor intervention strategies. Results will also be disseminated to authorities and stakeholders for policy development.

Outcome variables

We assessed HTP awareness (yes, no) by showing an image and description of IQOS, the only HTP available Guatemala. Susceptibility to future use of HTPs was assessed for all participants with a single question adapted from Pierce et al.'s validated scale.[24] 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.[25] 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 categorized as

unsusceptible, similar to prior studies.[16]   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 characterized 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 4-item Family Affluent Scale (FAS) (i.e., "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.[26]

Established risk factors for smoking and e-cigarette use were also considered,

including other substance use (e.g. tobacco products, alcohol, drugs). Use of cigarettes

and e-cigarettes were 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 (4 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 were

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 (i.e., never;

rarely/sometimes; often/very often) for both smoking and e-cigarettes, assessed

separately. Sensation seeking was evaluated with four items (i.e., "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

toward new technology adoption, using seven items that have been previously shown to

independently predict e-cigarette, but not smoking, initiation (i.e., 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).[27,28]

Statistical analysis

Binary logistic regression was used to estimate crude odds ratios (OR) 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 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 vs. current and alcohol was collapsed to non-recent-binge vs. 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. All analyses were conducted in R version 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 (75%).

Over half (52.4%) of students reported having heard of HTPs and 8.4% and 2.9%

reported ever- (but not current) and current use of HTPs, respectively. In the entire

sample, 52% were susceptible to future HTP use. Nearly two-thirds (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.

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 or e-cigarette 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- (AOR = 1.65, 95% CI = 1.23, 2.21) and current users of e-cigarettes

(AOR = 2.10, 95% CI = 1.47, 2.99), binge drinkers (AOR = 1.84, 95% CI = 1.28, 2.65)

and those exposed to medium (AOR = 1.39, 95% CI = 1.10, 1.75) and high levels of

online e-cigarette advertising (AOR = 1.76, 95% CI = 1.26, 2.46) (Table 2).

Additionally, family smoking (AOR = 1.31, 95% CI = 1.07, 1.60) and HTP use (AOR =

1.60, 95% CI = 1.22, 2.09), family affluence (AOR = 1.10, 95% CI = 1.04, 1.17), and

friend HTP use (AOR = 4.15, 95% CI = 3.11, 5.55) were positively associated with

participant HTP awareness.

In the entire sample, 52.4% were susceptible to continued or future HTP use.

Compared to unsusceptible never-smokers, higher susceptibility was found among

susceptible never- (AOR = 6.18, 95% CI = 4.72, 8.07), ever- (AOR = 6.93, 95% CI =

5.02, 9.57), and current smokers (AOR = 10.53, 95% CI = 5.92, 18.71), as well as

susceptible never- (AOR = 12.18, 95% CI = 7.79, 19.03), ever- (AOR = 11.08, 95% CI =

7.07, 17.37), and current e-cigarettes users (AOR = 21.87, 95% CI = 13.02, 36.71).

Similarly, ever- (AOR = 1.73, 95% CI = 1.25, 2.41), current (AOR = 1.49, 95% CI =

1.03, 2.17), and binge drinkers (AOR = 1.65, 95% CI = 1.04, 2.60), and current

marijuana users (AOR = 3.49, 95% CI = 1.40, 2.60) were more likely to be susceptible to

HTP use. Finally, having a friend who used HTPs (AOR = 1.83, 95% CI = 1.31, 2.57)

and higher sensation-seeking scores (AOR = 1.41, 95% CI = 1.19, 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-

(AOR = 3.73, 95% CI = 2.03, 6.82) or current smokers (AOR = 6.63, 95% CI = 3.20,

13.74), or ever- (AOR = 9.31, 95% CI = 2.61, 33.23) or current e-cigarette users (AOR =

10.40, 95% CI = 2.75, 39.17) were more likely to be ever HTP users (Table 3). Those

who reported binge drinking (AOR = 2.53, 95% CI = 1.08, 5.95) and marijuana use

(AOR = 2.29, 95% CI = 1.27, 4.13) were also more likely to be ever-HTP users. Family

smoking (AOR = 1.70, 95% CI = 1.19, 2.45) and friend HTP use (AOR = 7.28, 95% CI =

4.64, 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, 1.31).

In the overall population, 2.9% were current HTP users. The odds of current HTP

use was higher for both cigarette (AOR = 6.14, 95% CI = 2.71, 13.93) and e-cigarette

users (AOR = 84.90, 95% CI = 24.19, 298.22). Having family members who smoked

(AOR = 3.25, 95% CI = 1.51, 7.02) and friends who used HTPs (AOR = 44.72, 95% CI =

20.08, 99.58) were associated with higher odds current use of HTPs.

Discussion

We investigated HTP use among adolescents in private schools in Guatemala

City, where HTPs are readily available.[29] About half of the students were aware of

HTPs (54.2%) and susceptible to (54.2%) future use of HTPs, although ever use among

non-current users (8.4%) and current use (2.9%) were low compared to 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.[30–32] 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 is from HICs with stronger tobacco control policies, making cross-country comparisons challenging. One study of 16- to 19-year-old adolescents in Canada, the United States, and England, found lower levels of awareness (7% vs. 52.4%) and susceptibility (45.0% vs. 52.4%) compared to our sample. However, this study only included never-smokers and never-vapers. Likewise, we found that HTP susceptibility was associated with smoking and e-cigarette use. Additionally, use of alcohol, use of 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, but the associations we found are not unexpected given prior research on e-cigarettes susceptibility and use.[16–19] In the end, our results support Jessor's Problem Behavior Theory, which hypothesizes that substance use and other risk behaviors tend to cluster together.[33]

To our knowledge, the only other study of adolescents' current use of HTPs comes from South Korea.[13] This 2019 study among 12-18 year old Korean adolescents 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. [13] These results may reflect the fact that our sample over-represented higher socioeconomic status students, given that we only sampled private schools. However, according to the 2018 census, 37% of middle school students and 70% of high school students in Guatemala City attend private schools.[34] Our study goes beyond the Korean study by assessing correlates of use, which appear similar to those for e-cigarette use among adolescents.[16–18] For example, correlates of HTP use in our study are also as predictors of e-cigarette use in Mexico (use of cigarettes, alcohol, and marijuana, family use of cigarettes, and sensation-seeking behavior).[16] However, 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 amongst adolescents from LMICs. Furthermore, we did so 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 (e.g. 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, generalizability to the entire country is limited. Additionally, only four students

exclusively used HTPs (i.e., did not also smoke or use e-cigarettes), and thus is it hard to draw conclusions about this group. Because of this, model estimates include some large odds ratios (with similarly large confidence intervals) 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 is low in our study population, a large portion of the population is susceptible to continued or future use and rates of use may increase as IQOS and other HTP products become more widely available. This phenomenon could be seen across the world, where there may be a rapid increase in consumption as availability grows. Particularly concerning is the introduction of flavored HTPs in some countries, including sticks that include flavor capsules in the filter that the consumer can crush to make the aerosol taste like diverse flavors, ranging from mint to ginger and bubble gum.[35] Flavor capsules in cigarettes, which include an even broader range of flavors that are popular with youth (e.g., mango, mint, berry), are increasingly popular around the world, including in Guatemala, where they represented 32% of the cigarette market in 2017.[36] Currently, it does not seem like HTPs are gateway tobacco products for adolescents, as most current users in our sample report initially using e-cigarettes. However, as HTPs become more common and integrate new

flavors and flavor technologies, it is possible that this could change, particularly as the global e-cigarette market might become more regulated. It is critical to identify who is at risk for HTP uptake so that control and prevention strategies can be prioritized for this high-risk group. This study adds evidence to the literature to assist decision-makers in building a profile to identify the subset of adolescents who are most at risk for HTP use, allowing for the development of tailored prevention programs which could reduce current HTP use and deter future use among adolescents. 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 socio-economic groups as well as explore how adolescent e-cigarette users transition to HTP use.

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

	N / Mean	% / SD
Dependent variables		
Aware of HTP	1503	52.4
Susceptible to HTP	1500	52.4
HTP use		
Never (unsusceptible)[A]	1993	69.6
Never (susceptible)[B]	547	19.1
Ever (not current)	241	8.4
Current	84	2.9
Socio-demographic characteristics		
Sex		
Male	1438	50.3
Female	1420	49.7
Age	15.09	1.32
Grade - USA 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:		
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 smokes cigarettes	44	52.4
Also smokes 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)[C]	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)		
Sensation seeking (1-4)	2.77	0.7
Technophilia (0-7)	5.73	0.9
Family affluent scale (0-9)	7.27	1.57

[A] 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?"

[B] 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?"

[C] Binge drinking is defined as consuming 4 or more drinks on one occasion in the last month

Table 2. Crude and adjusted odds ratios for awareness and susceptibility of HTP among Guatemalan youth[A]

	HTP awareness N = 1503 (52.4%)					HTP susceptible N = 1500 (52.4%)				
	% / mean	OR	CI 95%	AOR[B]	CI 95%	% / mean	OR	CI 95%	AOR[B]	CI 95%
Socio-demographic characteristics										
Sex										
Female	54.94	Reference		Reference		52.33	Reference		Reference	
Male	49.72	0.86	(0.74, 1.01)	0.81*	(0.68, 0.97)	52.40	0.98	(0.84, 1.14)	0.83	(0.66, 1.04)
Age	15.29	1.25	(1.17, 1.32)	1.05	(0.93, 1.18)	15.26	1.29	(1.22, 1.37)	0.93	(0.79, 1.08)
Grade - USA categories										
Basico (grades 8-9)	43.77	Reference		Reference		44.04	Reference		Reference	
Bachillerato (grades 10-12)	58.95	1.73	(1.48, 2.02)	1.00	(0.74, 1.35)	58.64	1.92	(1.64, 2.24)	1.08	(0.73, 1.59)
School performance										
< 80%	53.26	Reference		Reference		60.92	Reference		Reference	
80-89%	54.62	1.02	(0.82, 1.27)	1.30*	(1.01, 1.67)	55.12	0.75	(0.61, 0.93)	0.88	(0.64, 1.20)
90-100%	48.61	0.72	(0.57, 0.92)	1.13	(0.85, 1.51)	44.58	0.49	(0.39, 0.62)	0.83	(0.58, 1.19)
Parents' highest educational attainment										
Secondary school or less	53.06	Reference		Reference		46.94	Reference		Reference	
High school or technical school	52.33	1	(0.55, 1.83)	0.75	(0.37, 1.51)	52.33	1.23	(0.69, 2.22)	1.07	(0.43, 2.67)
University or more	52.87	1.06	(0.60, 1.90)	0.80	(0.41, 1.59)	53.29	1.27	(0.72, 2.24)	1.34	(0.55, 3.27)
Missing	45.26	0.71	(0.37, 1.40)	0.91	(0.40, 2.05)	39.71	0.75	(0.39, 1.46)	1.11	(0.39, 3.16)
Substance use variables										
Cigarette smoker										
Never (unsusceptible)	41.59	Reference		Reference		17.00	Reference		Reference	
Never (susceptible)	51.39	1.54	(1.28, 1.86)	0.88	(0.69, 1.13)	75.90	15.68	(12.52, 19.65)	6.18*	(4.72, 8.07)
Ever (not current)	65.06	2.69	(2.19, 3.31)	1.19	(0.89, 1.59)	81.36	22.69	(17.53, 29.37)	6.93*	(5.02, 9.57)
Current	79.60	5.6	(4.01, 7.81)	1.58	(1.00, 2.49)	90.80	51.58	(32.64, 81.51)	10.53*	(5.92, 18.71)
E-cigarette user										
Never (unsusceptible)	33.43	Reference		Reference		4.64	Reference		Reference	
Never (susceptible)	43.12	1.6	(1.27, 2.03)	1.28	(0.95, 1.73)	63.42	36.41	(24.52, 54.07)	12.18*	(7.79, 19.03)
Ever (not current)	55.94	2.51	(2.03, 3.09)	1.65*	(1.23, 2.21)	61.34	38.66	(26.34, 57.75)	11.08*	(7.07, 17.37)
Current	72.41	4.67	(3.73, 5.86)	2.10*	(1.47, 2.99)	78.73	124.45	(82.40, 187.94)	21.87*	(13.02, 36.71)
Alcohol										
Never	35.34	Reference		Reference		20.56	Reference		Reference	
Ever (not current)	46.25	1.65	(1.34, 2.03)	1.25	(0.97, 1.60)	52.41	4.18	(3.33, 5.26)	1.73*	(1.25, 2.41)
Current (no binge)	57.84	2.44	(1.96, 3.05)	1.28	(0.95, 1.71)	65.68	8.78	(6.81, 11.32)	1.49*	(1.03, 2.17)
Current (binge)	76.83	5.27	(4.07, 6.82)	1.84*	(1.28, 2.65)	75.36	17.99	(13.41, 24.15)	1.65*	(1.04, 2.60)
Marijuana										
Never	49.43	Reference		Reference		48.40	Reference		Reference	
Ever (not current)	77.97	3.49	(2.42, 5.04)	1.50	(0.97, 2.32)	85.88	6.79	(4.40, 10.46)	1.61	(0.94, 2.75)
Current	81.55	4.03	(2.42, 6.71)	1.48	(0.82, 2.67)	93.20	16.78	(7.72, 36.49)	3.49*	(1.40, 8.72)
Internet cigarette ad exposure										
Never	44.74	Reference		Reference		38.78	Reference		Reference	
Rarely/sometimes	55.19	1.66	(1.40, 1.96)	1.07	(0.86, 1.34)	58.64	2.22	(1.88, 2.62)	1.40	(1.06, 1.84)
Mostly/always	63.01	2.44	(1.87, 3.19)	1.08	(0.75, 1.57)	64.78	2.87	(2.20, 3.73)	1.52	(0.97, 2.40)
Internet e-cigarette ad exposure										
Never	39.70	Reference		Reference		35.38	Reference		Reference	
Rarely/sometimes	55.47	2	(1.68, 2.38)	1.39*	(1.10, 1.75)	57.11	2.43	(2.05, 2.89)	1.05*	(0.78, 1.41)
Mostly/always	66.12	3.33	(2.62, 4.22)	1.76*	(1.26, 2.46)	69.12	4.05	(3.19, 5.13)	0.86	(0.57, 1.30)
Family member smokes cigarettes										
No	45.78	Reference		Reference		46.13	Reference		Reference	
Yes	64.36	2.14	(1.82, 2.51)	1.31*	(1.07, 1.60)	63.80	2.08	(1.78, 2.44)	1.17	(0.91, 1.50)
Family member smokes e-cigarettes										
No	47.96	Reference		Reference		48.76	Reference		Reference	
Yes	69.28	2.17	(1.78, 2.64)	1.25	(0.98, 1.59)	66.39	2.25	(1.85, 2.73)	1.08	(0.81, 1.45)
Family member uses HTP										

	% / mean	OR	CI 95%	AOR	CI 95%	% / mean	OR	CI 95%	AOR	CI 95%
No	49.98	Reference		Reference		51.18	Reference		Reference	
Yes	67.85	2.08	(1.65, 2.62)	1.60*	(1.22, 2.09)	60.51	1.48	(1.19, 1.84)	0.98	(0.71, 1.36)
Friend smokes cigarettes										
No	43.72	Reference		Reference		40.50	Reference		Reference	
Yes	59.81	1.89	(1.62, 2.20)	1.03	(0.83, 1.29)	62.56	2.5	(2.14, 2.91)	0.91	(0.70, 1.19)
Friend uses e-cigarettes										
No	39.71	Reference		Reference		38.98	Reference		Reference	
Yes	59.80	1.96	(1.67, 2.31)	0.72*	(0.57, 0.91)	60.17	2.75	(2.33, 3.25)	0.70*	(0.51, 0.95)
Friend uses HTP										
No	48.05	Reference		Reference		49.90	Reference		Reference	
Yes	77.73	4.19	(3.27, 5.38)	4.15*	(3.11, 5.55)	66.43	1.98	(1.59, 2.47)	1.83*	(1.31, 2.57)
Constructed scales (score range)										
Sensation seeking (1-4)	2.87	1.61	(1.44, 1.80)	1.08	(0.95, 1.24)	2.97	2.47	(2.20, 2.78)	1.41*	(1.19, 1.68)
Technophilia (0-7)	5.85	1.29	(1.19, 1.41)	1.07	(0.97, 1.19)	5.82	1.29	(1.18, 1.40)	1.04	(0.91, 1.20)
Family affluent scale (0-9)	7.46	1.15	(1.09, 1.21)	1.10*	(1.04, 1.17)	7.29	1.04	(0.99, 1.09)	0.94	(0.88, 1.02)

[A] All models include a random intercept for each participant to account for school-clustering

[B] Adjusted models are adjusted for all independent variables

* Significant at $\alpha = 0.05$

Table 3. Crude and adjusted odds ratios for ever and current HTP use among Guatemalan youth[A]

	Ever HTP use (not current) N = 241 (8.6%)					Current HTP use N = 84 (2.9%)				
	% / mean	OR	CI 95%	AOR[B]	CI 95%	% / mean	OR	CI 95%	AOR[B]	CI 95%
Socio-demographic characteristics										
Sex										
Female	7.56	Reference		Reference		2.63	Reference		Reference	
Male	9.75	1.4	(1.07, 1.84)	1.22	(0.86, 1.72)	3.42	1.31	(0.84, 2.06)	1.1	(0.55, 2.20)
Age	15.87	1.72	(1.53, 1.94)	1.2	(0.97, 1.50)	15.65	1.49	(1.25, 1.80)	0.96	(0.62, 1.50)
Grade - USA categories										
Basico (grades 8-9)	3.77	Reference		Reference		1.43	Reference		Reference	
Bachillerato (grades 10-12)	12.44	3.45	(2.47, 4.82)	0.92	(0.49, 1.71)	4.45	3.22	(1.88, 5.53)	2.69	(0.72, 10.06)
School performance										
< 80%	11.78	Reference		Reference		4.54	Reference		Reference	
80-89%	10.07	0.71	(0.50, 1.01)	1.04	(0.67, 1.63)	3.36	0.73	(0.43, 1.25)	0.89	(0.38, 2.08)
90-100%	5.24	0.29	(0.19, 0.45)	0.69	(0.38, 1.25)	1.81	0.39	(0.20, 0.75)	1.15	(0.43, 3.11)
Parents' highest educational attainment										
Secondary school or less	16.67	Reference		Reference		2.44	Reference		Reference	
High school or technical school	10.90	0.63	(0.28, 1.43)	0.5	(0.18, 1.69)	2.92	1.2	(0.15, 9.41)	0.26	(0.02, 3.14)
University or more	8.12	0.48	(0.22, 1.04)	0.36	(0.12, 1.07)	3.29	1.36	(0.18, 10.08)	0.2	(0.02, 2.29)
Missing	5.15	0.27	(0.09, 0.80)	0.28	(0.06, 1.37)	0.77	0.31	(0.02, 5.09)	0	NA
Substance use variables										
Cigarette smoker[C]										
Never (unsusceptible)	1.75	Reference		Reference						
Never (susceptible)	4.59	2.76	(1.60, 4.76)	1.34	(0.69, 2.61)					
Ever (not current)	18.37	12.7	(7.92, 20.36)	3.73*	(2.03, 6.82)	1.59	Reference		Reference	
Current	37.98	34.93	(21.01, 58.08)	6.63*	(3.20, 13.74)	24.56	20.15	(12.59, 32.26)	6.14*	(2.71, 13.93)
E-cigarette user[C]										
Never (unsusceptible)	0.42	Reference		Reference						
Never (susceptible)	0.55	1.31	(0.26, 6.49)	0.71	(0.13, 3.92)					
Ever (not current)	11.19	29.66	(9.37, 93.89)	9.31*	(2.61, 33.23)	0.25	Reference		Reference	
Current	20.00	59.31	(18.84, 186.69)	10.4*	(2.75, 39.17)	11.73	61.32	(24.38, 154.20)	84.9*	(24.19, 298.22)
Alcohol[D]										
Never	1.47	Reference		Reference						

	%	OR	CI	aOR	CI	%	OR	CI	aOR	CI
Ever (not current)	4.22	2.96	(1.47, 5.97)	1.14	(0.50, 2.60)					
Current (no binge)	8.18	5.99	(3.02, 11.87)	1.19	(0.52, 2.75)	1.73	Reference		Reference	
Current (binge)	26.25	23.92	(12.43, 46.03)	2.53*	(1.08, 5.95)	10.12	6.39	(3.89, 10.50)	0.59	(0.27, 1.30)
Marijuana										
Never	6.07	Reference		Reference		1.74	Reference		Reference	
Ever (not current)	29.03	6.18	(4.20, 9.09)	1.37	(0.84, 2.22)	16.67	11.27	(6.50, 19.54)	2.34	(0.96, 5.68)
Current	45.98	12.57	(7.93, 19.93)	2.29*	(1.27, 4.13)	25.40	19.19	(10.07, 36.54)	2.27	(0.72, 7.10)
Internet cigarette ad exposure										
Never	6.54	Reference		Reference		1.85	Reference		Reference	
Rarely/sometimes	8.88	1.46	(1.07, 2.00)	1.13	(0.74, 1.75)	3.12	1.71	(0.97, 3.01)	1.32	(0.52, 3.36)
Mostly/always	14.33	2.56	(1.69, 3.88)	1.5	(0.81, 2.77)	6.88	3.91	(2.01, 7.64)	3.12	(0.99, 9.90)
Internet e-cigarette ad exposure										
Never	5.45	Reference		Reference		2.04	Reference		Reference	
Rarely/sometimes	8.09	1.54	(1.08, 2.18)	0.67	(0.41, 1.09)	2.73	1.35	(0.75, 2.41)	0.33*	(0.12, 0.91)
Mostly/always	16.41	3.61	(2.45, 5.31)	0.98	(0.54, 1.77)	6.52	3.35	(1.80, 6.22)	0.32	(0.10, 1.01)
Family member smokes cigarettes										
No	5.28	Reference		Reference		2.07	Reference		Reference	
Yes	14.88	3.1	(2.36, 4.07)	1.7*	(1.19, 2.45)	5.01	2.49	(1.60, 3.90)	3.25*	(1.51 7.02)
Family member smokes e-cigarettes										
No	6.58	Reference		Reference		2.42	Reference		Reference	
Yes	16.49	2.64	(1.98, 3.51)	1.37	(0.94, 2.01)	5.74	2.46	(1.54, 3.92)	0.64	(0.30, 1.37)
Family member uses HTP										
No	8.09	Reference		Reference		2.86	Reference		Reference	
Yes	12.40	1.58	(1.13, 2.23)	0.9	(0.58, 1.42)	4.60	1.63	(0.93, 2.86)	1.15	(0.48, 2.76)
Friend smokes cigarettes										
No	4.77	Reference		Reference		1.12	Reference		Reference	
Yes	12.07	2.71	(2.01, 3.66)	0.77	0.50, 1.18	4.89	4.54	(2.54, 8.12)	0.74	(0.30, 1.83)
Friend uses e-cigarettes										
No	3.97	Reference		Reference		0.60	Reference		Reference	
Yes	10.22	2.93	(2.06, 4.18)	0.51*	(0.30, 0.86)	4.63	8.04	(3.49, 18.53)	0.62	(0.19, 2.01)
Friend uses HTP										
No	6.72	Reference		Reference		1.19	Reference		Reference	
Yes	21.14	3.98	(2.94, 5.39)	7.28*	(4.64, 11.43)	15.65	15.46	(9.58, 24.94)	44.72*	(20.08, 99.58)
Constructed scales (score range)										
Sensation seeking (1-4)	3.10	2.46	(1.97, 3.07)	1.27	(0.96, 1.68)	3.25	3.75	(2.51, 5.60)	1.44	(0.79, 2.63)
Technophilia (0-7)	5.96	1.4	(1.18, 1.67)	1.12	(0.89, 1.40)	6.11	1.91	(1.39, 2.65)	1.54	(0.99, 2.41)
Family affluent scale (0-9)	7.64	1.18	(1.07, 1.30)	1.15*	(1.02, 1.31)	7.63	1.21	(1.03, 1.42)	1.16	(0.90, 1.48)

[A] All models include a random intercept for each participant to account for school-clustering

[B] Adjusted models are adjusted for all independent variables

[C] Due to low counts, for current use models, cigarette and e-cigarette use was combined to current user versus non-current user

[D] Due to low counts, alcohol use was combined to non-binge versus binge in last month

* Significant at $\alpha = 0.05$

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	10
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10

		(*b*) Report category boundaries when continuous variables were categorized	10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A cross-sectional study on the awareness, susceptibility, and use of heated tobacco products among adolescents in Guatemala City, Guatemala

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A cross-sectional study on the awareness, susceptibility, and use of heated tobacco products among adolescents in Guatemala City, Guatemala

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Abstract: 299; Words: 4077; Tables: 3; Figures: 0; References: 41

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 amongst 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 13-17 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 use included: use of other tobacco products (current smoking: AOR=10.53 & 34.93, respectively; current e-cigarette use: AOR=21.87 & 59.31, respectively), moderate alcohol consumption (AOR=1.49 & 5.99, respectively), marijuana use in the past 30 days (AOR=3.49 & 12.57, respectively), and having friends who use HTPs (AOR = 1.83 & 44.72, 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 (i.e. those who use other substances or are exposed to tobacco through family and friends).

Strengths and Limitations:

- HTPs are increasingly popular in countries where available, but little is known about adolescent use in LMICs 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 generalizable 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 is self-reported, thus there is a chance of misreporting, particularly underreporting due to social desirability bias.

Introduction

The increase in popularity of non-conventional tobacco products has further 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 (e.g., increase price and legal age of purchase) and appeal (e.g., banning flavors 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.[4,5] However, current evidence on the harmful effects of HTPs compared to conventional cigarettes are yet to be determined as most of the available evidence is in vitro and comes from tobacco industry funded research.[6–9] HTPs appeal to some adult smokers and use has been rapidly increasing in some high-income countries where they have been introduced, suggesting a potential public health benefit, similar to that of e-cigarettes.[10–12] However, the appeal of HTPs among adolescents, particularly those who would otherwise not use tobacco, is relatively unknown.

Philip Morris´s HTP, IQOS, was introduced in some countries in 2014, and advertised as a less harmful alternative for smokers who want to reduce exposure to

harmful chemicals produced by tobacco combustion.[13] By 2020 it was available in at

least 52 countries worldwide, including Guatemala[4,5,14] 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, one study found that among young adults in South Korea, only 3 months after

IQOS was introduce into the market, 38% were aware of the product and 3.5% were

current users.[15] 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.[16]

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.[16]

 To the best of our knowledge, only one study has reported rates of HTP use

among adolescents: this study, from 2019, found that among 12- to 18-year-old South

Koreans, ever use was 2.8%.[17] Studies among adults in high-income countries (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.[15,18,19] 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 hypothesized to be related to e-cigarette use due

to Jessor's Problem Behavior Theory, which hypothesizes that engaging in one risky

behavior increases the likelihood of engagement in other risky behaviors.[20–24]

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.[25] In

2015, the prevalence of adolescent cigarette use in Guatemala was 12.9% and the

prevalence of adolescent e-cigarette use was 5.7% and 5.2% among males and females,

respectively.[26,27] There is no current data on HTP use among adolescents in Latin

America, or any other 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 HTPs.

Methods

Survey design and data

Adolescents, grades 8-12, were recruited for this cross-sectional study. Based on

the official list of private and public schools in Guatemala City, 30 private 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, four 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 five of the 10 participating schools. We obtained both

passive consent from parents (i.e. 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 of 2019, using a paper-based, self-

administered, Spanish-language survey on socio-demographics and tobacco product

susceptibility, use, and risk factors. The survey was previously fielded in Mexico and

subsequently adapted for Guatemala and pre-tested to ensure comprehension.[20] This

protocol was approved by the Institutional Ethics Committee of the Institute of Nutrition

of Central America and Panama (INCAP) (approval number 087/2019).

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.[28] 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 Guatemala, and asking if they 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.[29] 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.[30] 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 categorized as unsusceptible, similar to prior

studies.[20]   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 characterized 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 4-item Family Affluent Scale (FAS) (i.e., "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.[31]

Established risk factors for smoking and e-cigarette use were also considered,

including other substance use (e.g. tobacco products, alcohol, drugs). Use of cigarettes

and e-cigarettes were 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 (4 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 were

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 (i.e., never;

rarely/sometimes; often/very often) for both smoking and e-cigarettes, assessed

separately. Sensation seeking (in accordance with Jessor's Problem Behavior Theory)

was evaluated with four items (i.e., "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 toward new technology adoption, using

seven items that have been previously shown to independently predict e-cigarette, but not

smoking, initiation (i.e., 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).[32,33]

Statistical analysis

Binary logistic regression was used to estimate crude odds ratios (OR) 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

vs. current and alcohol was collapsed to non-recent-binge vs. 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. All analyses were conducted in R version 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 (75%).

Over half (52.4%) of students reported having heard of HTPs and 8.4% and 2.9% reported ever- (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.

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- (AOR = 1.65, 95% CI = 1.23, 2.21) and current users of e-cigarettes (AOR = 2.10, 95% CI = 1.47, 2.99), binge drinkers (AOR = 1.84, 95% CI = 1.28, 2.65)

and those exposed to medium (AOR = 1.39, 95% CI = 1.10, 1.75) and high levels of online e-cigarette advertising (AOR = 1.76, 95% CI = 1.26, 2.46) (Table 2). Additionally, family smoking (AOR = 1.31, 95% CI = 1.07, 1.60) and HTP use (AOR = 1.60, 95% CI = 1.22, 2.09), family affluence (AOR = 1.10, 95% CI = 1.04, 1.17), and friend HTP use (AOR = 4.15, 95% CI = 3.11, 5.55) were positively associated with participant HTP awareness.

In the entire sample, 52.4% were susceptible to continued or future HTP use. Compared to unsusceptible never-smokers, higher susceptibility was found among susceptible never- (AOR = 6.18, 95% CI = 4.72, 8.07), ever- (AOR = 6.93, 95% CI = 5.02, 9.57), and current smokers (AOR = 10.53, 95% CI = 5.92, 18.71), as well as susceptible never- (AOR = 12.18, 95% CI = 7.79, 19.03), ever- (AOR = 11.08, 95% CI = 7.07, 17.37), and current e-cigarettes users (AOR = 21.87, 95% CI = 13.02, 36.71). Similarly, ever- (AOR = 1.73, 95% CI = 1.25, 2.41), current (AOR = 1.49, 95% CI = 1.03, 2.17), and binge drinkers (AOR = 1.65, 95% CI = 1.04, 2.60), and current marijuana users (AOR = 3.49, 95% CI = 1.40, 2.60) were more likely to be susceptible to HTP use. Finally, having a friend who used HTPs (AOR = 1.83, 95% CI = 1.31, 2.57) and higher sensation-seeking scores (AOR = 1.41, 95% CI = 1.19, 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- (AOR = 3.73, 95% CI = 2.03, 6.82) or current smokers (AOR = 6.63, 95% CI = 3.20, 13.74), or ever- (AOR = 9.31, 95% CI = 2.61, 33.23) or current e-cigarette users (AOR =

10.40, 95% CI = 2.75, 39.17) were more likely to be ever HTP users (Table 3). Those

who reported binge drinking (AOR = 2.53, 95% CI = 1.08, 5.95) and marijuana use

(AOR = 2.29, 95% CI = 1.27, 4.13) were also more likely to be ever-HTP users. Family

smoking (AOR = 1.70, 95% CI = 1.19, 2.45) and friend HTP use (AOR = 7.28, 95% CI =

4.64, 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, 1.31).

In the overall population, 2.9% were current HTP users. The odds of current HTP

use was higher for both cigarette (AOR = 6.14, 95% CI = 2.71, 13.93) and e-cigarette

users (AOR = 84.90, 95% CI = 24.19, 298.22). Having family members who smoked

(AOR = 3.25, 95% CI = 1.51, 7.02) and friends who used HTPs (AOR = 44.72, 95% CI =

20.08, 99.58) were associated with higher odds current use of HTPs.

Discussion

We investigated HTP use among adolescents in private schools in Guatemala

City, where HTPs are readily available.[34] 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 to 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.[35–37] 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 is from HICs with stronger tobacco control policies, making cross-country comparisons challenging. One study of 16- to 19-year-old adolescents in Canada, the United States, and England[16], found lower levels of awareness (7%) and susceptibility (45.0%) compared to 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 reported use of tobacco. 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, but the associations we found are not unexpected given prior research on e-cigarettes susceptibility and use.[20–23] In the end, our results support Jessor's Problem Behavior Theory, which hypothesizes that substance use and other risk behaviors tend to cluster together.[24]

To our knowledge, the only other study of adolescents' current use of HTPs comes from South Korea.[17] This 2019 study among 12-18 year old Korean adolescents 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. [17] While South Korea has a much higher GDP per capita than Guatemala, our study population was selected from private schools in middle and high SES neighborhoods in Guatemala City,

which are predominantly attended by students of significant higher socioeconomic status, 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 $388-420USD plus an annual enrollment fee of on average $550USD, and a 2020 report from the World Bank[38] found that about 50% of Guatemalans live below the upper-middle income poverty line of about $165USD 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, so our results may be more generalizable to the rest of Guatemala City, but not the entire country.[39] Our study goes beyond the Korean study by assessing correlates of use, which appear similar to those for e-cigarette use among adolescents.[20–22] For example, correlates of HTP use in our study are also as predictors of e-cigarette use in Mexico (use of cigarettes, alcohol, and marijuana, family use of cigarettes, and sensation-seeking behavior).[20] 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 amongst adolescents from LMICs. Furthermore, we did so 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 (e.g. 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, generalizability to the entire country is limited. Additionally, only four students

exclusively used HTPs (i.e., did not also smoke or use e-cigarettes), and thus is it hard to

draw conclusions about this group. Because of this, model estimates include some large

odds ratios (with similarly large confidence intervals) 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 is low in our study

population, a large portion of the population is susceptible to continued or future use and

rates of use may increase as IQOS and other HTP products become more widely

available. This phenomenon could be seen across the world, where there may be a rapid

increase in consumption as availability grows. Particularly concerning is the introduction

of flavored HTPs in some countries, including sticks that contain flavor capsules in the

filter that the consumer can crush to make the aerosol taste like diverse flavors, ranging

from mint to ginger and bubble gum.[40] Flavor capsules in cigarettes, which include an

even broader range of flavors (e.g., mango, mint, berry) that are popular with youth, are

increasingly popular around the world, including in Guatemala, where they represented

32% of the cigarette market in 2017.[41] Currently, it does not seem like HTPs are

gateway tobacco products for adolescents, as most current users in our sample report

initially using e-cigarettes. However, as HTPs become more common and integrate new

flavors and flavor technologies, it is possible that this could change, particularly as the global e-cigarette market might become more regulated. It is critical to identify who is at risk for tobacco product uptake, including HTP use, so that control and prevention strategies can be prioritized for this high-risk group. This study adds evidence to the literature to assist decision-makers in building a profile to identify the subset of adolescents who are most at risk for tobacco use in the form of HTPs, allowing for the development of tailored prevention programs which could reduce current HTP use and potentially use of other tobacco products as well as deter future use among adolescents. 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 socio-economic groups as well as explore how adolescent e-cigarette users transition to HTP use.

Competing Interests: None declared.

Author Contributions: AG – analysis design and execution, drafted manuscript; SM – study design, questionnaire design, data collection, manuscript review and approval; JM – study design, questionnaire design, data collection, manuscript review and approval; JT – study design, questionnaire design, analysis design, manuscript review and approval; JB – study design, questionnaire design, data collection, manuscript review and approval, stakeholder engagement

Data Availability Statement: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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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)[A]	1993	69.6
Never (susceptible)[B]	547	19.1
Ever (not current)	241	8.4
Current	84	2.9
Socio-demographic characteristics	N	%
Sex		
Male	1438	50.3
Female	1420	49.7
Age (Mean, SD)*	15.09*	1.32*
Grade - USA 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	N	%
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:		
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 smokes cigarettes	44	52.4
Also smokes 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)[C]	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 affluent scale (0-9)	7.27	1.57

[A] 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?"

[B] 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?"

[C] Binge drinking is defined as consuming 4 or more drinks on one occasion in the last month

Table 2. Crude and adjusted odds ratios for awareness and susceptibility of HTP among Guatemalan youth[A]

	HTP awareness N = 1503 (52.4%)					HTP susceptible N = 1500 (52.4%)				
	%	OR	CI 95%	AOR[B]	CI 95%	%	OR	CI 95%	AOR[B]	CI 95%
Socio-demographic characteristics										
Sex										
Female	54.94	Reference		Reference		52.33	Reference		Reference	
Male	49.72	0.86	(0.74, 1.01)	0.81*	(0.68, 0.97)	52.40	0.98	(0.84, 1.14)	0.83	(0.66, 1.04)
Age (Mean)[A]	15.29[A]	1.25*	(1.17, 1.32)	1.05	(0.93, 1.18)	15.26[A]	1.29*	(1.22, 1.37)	0.93	(0.79, 1.08)
Grade - USA categories										
Basico (grades 8-9)	43.77	Reference		Reference		44.04	Reference		Reference	
Bachillerato (grades 10-12)	58.95	1.73*	(1.48, 2.02)	1.00	(0.74, 1.35)	58.64	1.92*	(1.64, 2.24)	1.08	(0.73, 1.59)
School performance										
< 80%	53.26	Reference		Reference		60.92	Reference		Reference	
80-89%	54.62	1.02	(0.82, 1.27)	1.30*	(1.01, 1.67)	55.12	0.75*	(0.61, 0.93)	0.88	(0.64, 1.20)
90-100%	48.61	0.72*	(0.57, 0.92)	1.13	(0.85, 1.51)	44.58	0.49*	(0.39, 0.62)	0.83	(0.58, 1.19)
Parents' highest educational attainment										
Secondary school or less	53.06	Reference		Reference		46.94	Reference		Reference	
High school or technical school	52.33	1.00	(0.55, 1.83)	0.75	(0.37, 1.51)	52.33	1.23	(0.69, 2.22)	1.07	(0.43, 2.67)
University or more	52.87	1.06	(0.60, 1.90)	0.80	(0.41, 1.59)	53.29	1.27	(0.72, 2.24)	1.34	(0.55, 3.27)
Missing	45.26	0.71	(0.37, 1.40)	0.91	(0.40, 2.05)	39.71	0.75	(0.39, 1.46)	1.11	(0.39, 3.16)
Substance use variables	%	OR	CI 95%	AOR[B]	CI 95%	%	OR	CI 95%	AOR[B]	CI 95%
Cigarette smoker										
Never (unsusceptible)	41.59	Reference		Reference		17.00	Reference		Reference	
Never (susceptible)	51.39	1.54*	(1.28, 1.86)	0.88	(0.69, 1.13)	75.90	15.68*	(12.52, 19.65)	6.18*	(4.72, 8.07)
Ever (not current)	65.06	2.69*	(2.19, 3.31)	1.19	(0.89, 1.59)	81.36	22.69*	(17.53, 29.37)	6.93*	(5.02, 9.57)
Current	79.60	5.60*	(4.01, 7.81)	1.58	(1.00, 2.49)	90.80	51.58*	(32.64, 81.51)	10.53*	(5.92, 18.71)
E-cigarette user										
Never (unsusceptible)	33.43	Reference		Reference		4.64	Reference		Reference	
Never (susceptible)	43.12	1.60*	(1.27, 2.03)	1.28	(0.95, 1.73)	63.42	36.41*	(24.52, 54.07)	12.18*	(7.79, 19.03)
Ever (not current)	55.94	2.51*	(2.03, 3.09)	1.65*	(1.23, 2.21)	61.34	38.66*	(26.34, 57.75)	11.08*	(7.07, 17.37)
Current	72.41	4.67*	(3.73, 5.86)	2.10*	(1.47, 2.99)	78.73	124.45*	(82.40, 187.94)	21.87*	(13.02, 36.71)
Alcohol										
Never	35.34	Reference		Reference		20.56	Reference		Reference	
Ever (not current)	46.25	1.65*	(1.34, 2.03)	1.25	(0.97, 1.60)	52.41	4.18*	(3.33, 5.26)	1.73*	(1.25, 2.41)
Current (no binge)	57.84	2.44*	(1.96, 3.05)	1.28	(0.95, 1.71)	65.68	8.78*	(6.81, 11.32)	1.49*	(1.03, 2.17)
Current (binge)	76.83	5.27*	(4.07, 6.82)	1.84*	(1.28, 2.65)	75.36	17.99*	(13.41, 24.15)	1.65*	(1.04, 2.60)
Marijuana										
Never	49.43	Reference		Reference		48.40	Reference		Reference	
Ever (not current)	77.97	3.49*	(2.42, 5.04)	1.50	(0.97, 2.32)	85.88	6.79*	(4.40, 10.46)	1.61	(0.94, 2.75)
Current	81.55	4.03*	(2.42, 6.71)	1.48	(0.82, 2.67)	93.20	16.78*	(7.72, 36.49)	3.49*	(1.40, 8.72)
Internet cigarette ad exposure										
Never	44.74	Reference		Reference		38.78	Reference		Reference	
Rarely/sometimes	55.19	1.66*	(1.40, 1.96)	1.07	(0.86, 1.34)	58.64	2.22*	(1.88, 2.62)	1.40*	(1.06, 1.84)
Mostly/always	63.01	2.44*	(1.87, 3.19)	1.08	(0.75, 1.57)	64.78	2.87*	(2.20, 3.73)	1.52	(0.97, 2.40)
Internet e-cigarette ad exposure										
Never	39.70	Reference		Reference		35.38	Reference		Reference	
Rarely/sometimes	55.47	2.00*	(1.68, 2.38)	1.39*	(1.10, 1.75)	57.11	2.43*	(2.05, 2.89)	1.05	(0.78, 1.41)
Mostly/always	66.12	3.33*	(2.62, 4.22)	1.76*	(1.26, 2.46)	69.12	4.05*	(3.19, 5.13)	0.86	(0.57, 1.30)
Family member smokes cigarettes										
No	45.78	Reference		Reference		46.13	Reference		Reference	
Yes	64.36	2.14*	(1.82, 2.51)	1.31*	(1.07, 1.60)	63.80	2.08*	(1.78, 2.44)	1.17	(0.91, 1.50)
Family member smokes e-cigarettes										
No	47.96	Reference		Reference		48.76	Reference		Reference	
Yes	69.28	2.17*	(1.78, 2.64)	1.25	(0.98, 1.59)	66.39	2.25*	(1.85, 2.73)	1.08	(0.81, 1.45)
Family member uses HTP										

	Mean/%	OR	CI 95%	AOR	CI 95%	Mean/%	OR	CI 95%	AOR	CI 95%
No	49.98	Reference		Reference		51.18	Reference		Reference	
Yes	67.85	2.08*	(1.65, 2.62)	1.60*	(1.22, 2.09)	60.51	1.48*	(1.19, 1.84)	0.98	(0.71, 1.36)
Friend smokes cigarettes										
No	43.72	Reference		Reference		40.50	Reference		Reference	
Yes	59.81	1.89*	(1.62, 2.20)	1.03	(0.83, 1.29)	62.56	2.50*	(2.14, 2.91)	0.91	(0.70, 1.19)
Friend uses e-cigarettes										
No	39.71	Reference		Reference		38.98	Reference		Reference	
Yes	59.80	1.96*	(1.67, 2.31)	0.72*	(0.57, 0.91)	60.17	2.75*	(2.33, 3.25)	0.70*	(0.51, 0.95)
Friend uses HTP										
No	48.05	Reference		Reference		49.90	Reference		Reference	
Yes	77.73	4.19*	(3.27, 5.38)	4.15*	(3.11, 5.55)	66.43	1.98*	(1.59, 2.47)	1.83*	(1.31, 2.57)
Constructed scales (score range)	Mean	OR	CI 95%	AOR[B]	CI 95%	Mean	OR	CI 95%	AOR[B]	CI 95%
Sensation seeking (1-4)	2.87	1.61*	(1.44, 1.80)	1.08	(0.95, 1.24)	2.97	2.47*	(2.20, 2.78)	1.41*	(1.19, 1.68)
Technophilia (0-7)	5.85	1.29*	(1.19, 1.41)	1.07	(0.97, 1.19)	5.82	1.29*	(1.18, 1.40)	1.04	(0.91, 1.20)
Family affluent scale (0-9)	7.46	1.15*	(1.09, 1.21)	1.10*	(1.04, 1.17)	7.29	1.04	(0.99, 1.09)	0.94	(0.88, 1.02)

[A] All models include a random intercept for each participant to account for school-clustering

[B] Adjusted models are adjusted for all independent variables

* Significant at $\alpha = 0.05$

Table 3. Crude and adjusted odds ratios for ever and current HTP use among Guatemalan youth[A]

	Ever HTP use (not current) N = 241 (8.6%)					Current HTP use N = 84 (2.9%)				
	%	OR	CI 95%	AOR[B]	CI 95%	%	OR	CI 95%	AOR[B]	CI 95%
Socio-demographic characteristics										
Sex										
Female	7.56	Reference		Reference		2.63	Reference		Reference	
Male	9.75	1.40*	(1.07, 1.84)	1.22	(0.86, 1.72)	3.42	1.31	(0.84, 2.06)	1.03	(0.56, 1.89)
Age (Mean)[A]	15.87[A]	1.72*	(1.53, 1.94)	1.20	(0.97, 1.50)	15.65[A]	1.39	(1.16, 1.65)	0.85	(0.58, 1.25)
Grade - USA categories										
Basico (grades 8-9)	3.77	Reference		Reference		1.43	Reference		Reference	
Bachillerato (grades 10-12)	12.44	3.45*	(2.47, 4.82)	0.92	(0.49, 1.71)	4.45	2.86*	(1.69, 4.83)	2.18	(0.68, 6.96)
School performance										
< 80%	11.78	Reference		Reference		4.54	Reference		Reference	
80-89%	10.07	0.71	(0.50, 1.01)	1.04	(0.67, 1.63)	3.36	0.69	(0.41, 1.17)	0.74	(0.36, 1.52)
90-100%	5.24	0.29*	(0.19, 0.45)	0.69	(0.38, 1.25)	1.81	0.38*	(0.20, 0.72)	0.84	(0.35, 2.00)
Parents' highest educational attainment										
Secondary school or less	16.67	Reference		Reference		2.44	Reference		Reference	
High school or technical school	10.90	0.63	(0.28, 1.43)	0.50	(0.18, 1.69)	2.92	1.37	(0.18, 10.70)	0.62	(0.07, 5.60)
University or more	8.12	0.48	(0.22, 1.04)	0.36	(0.12, 1.07)	3.29	1.52	(0.21, 11.25)	0.63	(0.07, 5.51)
Missing	5.15	0.27*	(0.09, 0.80)	0.28	(0.06, 1.37)	0.77	0.72	(0.06, 8.11)	0.00	NA
Substance use variables	%	OR	CI 95%	AOR[B]	CI 95%	%	OR	CI 95%	AOR[B]	CI 95%
Cigarette smoker[C]										
Never (unsusceptible)	1.75	Reference		Reference						
Never (susceptible)	4.59	2.76*	(1.60, 4.76)	1.34	(0.69, 2.61)					
Ever (not current)	18.37	12.70*	(7.92, 20.36)	3.73*	(2.03, 6.82)	1.59	Reference		Reference	
Current	37.98	34.93*	(21.01, 58.08)	6.63*	(3.20, 13.74)	24.56	13.81*	(8.79, 21.68)	3.90*	(1.90, 8.02)
E-cigarette user[C]										
Never (unsusceptible)	0.42	Reference		Reference						
Never (susceptible)	0.55	1.31	(0.26, 6.49)	0.71	(0.13, 3.92)					
Ever (not current)	11.19	29.66*	(9.37, 93.89)	9.31*	(2.61, 33.23)	0.25	Reference		Reference	
Current	20.00	59.31*	(18.84, 186.69)	10.40*	(2.75, 39.17)	11.73	45.24*	(19.32, 105.94)	46.12*	(16.15, 131.74)
Alcohol[D]										
Never	1.47	Reference		Reference						

	Mean	OR	CI 95%	AOR	CI 95%	Mean	OR	CI 95%	AOR	CI 95%
Ever (not current)	4.22	2.96*	(1.47, 5.97)	1.14	(0.50, 2.60)					
Current (no binge)	8.18	5.99*	(3.02, 11.87)	1.19	(0.52, 2.75)	1.73	Reference		Reference	
Current (binge)	26.25	23.92*	(12.43, 46.03)	2.53*	(1.08, 5.95)	10.12	4.55*	(2.94, 7.06)	0.53	(0.27, 1.06)
Marijuana										
Never	6.07	Reference		Reference		1.74	Reference		Reference	
Ever (not current)	29.03	6.18*	(4.20, 9.09)	1.37	(0.84, 2.22)	16.67	8.54*	(5.03, 14.51)	1.91	(0.87, 4.18)
Current	45.98	12.57*	(7.93, 19.93)	2.29*	(1.27, 4.13)	25.40	10.64*	(5.77, 19.60)	1.32	(0.50, 3.45)
Internet cigarette ad exposure										
Never	6.54	Reference		Reference		1.85	Reference		Reference	
Rarely/sometimes	8.88	1.46*	(1.07, 2.00)	1.13	(0.74, 1.75)	3.12	1.60	(0.92, 2.78)	1.27	(0.55, 2.90)
Mostly/always	14.33	2.56*	(1.69, 3.88)	1.50	(0.81, 2.77)	6.88	3.37*	(1.75, 6.51)	2.65	(0.91, 7.71)
Internet e-cigarette ad exposure										
Never	5.45	Reference		Reference		2.04	Reference		Reference	
Rarely/sometimes	8.09	1.54*	(1.08, 2.18)	0.67	(0.41, 1.09)	2.73	1.37	(0.77, 2.45)	0.49	(0.20, 1.18)
Mostly/always	16.41	3.61*	(2.45, 5.31)	0.98	(0.54, 1.77)	6.52	2.95*	(1.59, 5.47)	0.40	(0.14, 1.13)
Family member smokes cigarettes										
No	5.28	Reference		Reference		2.07	Reference		Reference	
Yes	14.88	3.10*	(2.36, 4.07)	1.70*	(1.19, 2.45)	5.01	2.28*	(1.47, 3.54)	2.00*	(1.03, 3.88)
Family member smokes e-cigarettes										
No	6.58	Reference		Reference		2.42	Reference		Reference	
Yes	16.49	2.64*	(1.98, 3.51)	1.37	(0.94, 2.01)	5.74	2.19*	(1.39, 3.46)	0.74	(0.38, 1.46)
Family member uses HTP										
No	8.09	Reference		Reference		2.86	Reference		Reference	
Yes	12.40	1.58*	(1.13, 2.23)	0.90	(0.58, 1.42)	4.60	1.49	(0.86, 2.60)	1.08	(0.50, 2.33)
Friend smokes cigarettes										
No	4.77	Reference		Reference		1.12	Reference		Reference	
Yes	12.07	2.71*	(2.01, 3.66)	0.77	(0.50, 1.18)	4.89	4.03*	(2.29, 7.07)	0.83	(0.38, 1.82)
Friend uses e-cigarettes										
No	3.97	Reference		Reference		0.60	Reference		Reference	
Yes	10.22	2.93*	(2.06, 4.18)	0.51*	(0.30, 0.86)	4.63	6.52*	(3.00, 14.19)	0.61	(0.21, 1.77)
Friend uses HTP										
No	6.72	Reference		Reference		1.19	Reference		Reference	
Yes	21.14	3.98*	(2.94, 5.39)	7.28*	(4.64, 11.43)	15.65	12.40*	(7.81, 19.71)	21.06*	(11.13, 39.85)
Constructed scales (score range)	Mean	OR	CI 95%	AOR[B]	CI 95%	Mean	OR	CI 95%	AOR[B]	CI 95%
Sensation seeking (1-4)	3.10	2.46*	(1.97, 3.07)	1.27	(0.96, 1.68)	3.25	3.34*	(2.26, 4.92)	1.34	(0.80, 2.27)
Technophilia (0-7)	5.96	1.40*	(1.18, 1.67)	1.12	(0.89, 1.40)	6.11	1.81*	(1.32, 2.48)	1.34	(0.90, 2.00)
Family affluent scale (0-9)	7.64	1.18*	(1.07, 1.30)	1.15*	(1.02, 1.31)	7.63	1.18*	(1.01, 1.38)	1.04	(0.84, 1.29)

[A] All models include a random intercept for each participant to account for school-clustering

[B] Adjusted models are adjusted for all independent variables

[C] Due to low counts, for current use models, cigarette and e-cigarette use was combined to current user versus non-current user

[D] Due to low counts, alcohol use was combined to non-binge versus binge in last month

* Significant at $\alpha = 0.05$

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	10
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10

		(*b*) Report category boundaries when continuous variables were categorized	10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A cross-sectional study on the awareness, susceptibility, and use of heated tobacco products among adolescents in Guatemala City, Guatemala

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A 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 amongst 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 13-17 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 use included: use of other tobacco products (current smoking: AOR=10.53 & 34.93, respectively; current e-cigarette use: AOR=21.87 & 59.31, respectively), moderate alcohol consumption (AOR=1.49 & 5.99, respectively), marijuana use in the past 30 days (AOR=3.49 & 12.57, respectively), and having friends who use HTPs (AOR = 1.83 & 44.72, respectively).

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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

(i.e. those who use other substances or are exposed to tobacco through family and

friends).

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Strengths and Limitations:

- HTPs are increasingly popular in countries where available, but little is known about adolescent use in LMICs 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 generalizable 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 is self-reported, thus there is a chance of misreporting, particularly underreporting due to social desirability bias.

Introduction

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

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

(e.g., increase price and legal age of purchase) and appeal (e.g., banning flavors 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.[4,5] However, current

evidence on the harmful effects of HTPs compared to conventional cigarettes are yet to

be determined as most of the available evidence is in vitro and comes from tobacco

industry funded research.[6–9] In July of 2020, the FDA authorized Philip Morris to

make claims in its HTP (IQOS) marketing about reduced exposure to harmful

constituents compared to 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 risk[12], and HTPs

appeal to adult smokers and use has been rapidly increasing in some high-income

countries 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, one study found

that among young adults in South Korea, only 3 months after IQOS was introduce 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 12- to 18-year-old South

Koreans, ever use was 2.8%.[20] Studies among adults in high-income countries (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 hypothesized to be related to e-cigarette use due to Jessor's Problem Behavior Theory, which hypothesizes that engaging in one risky behavior increases the likelihood of engagement in other risky behaviors.[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 is no current data on HTP use among adolescents in Latin America, or any other 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 and public schools in Guatemala City, 30 private 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, four 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 five of the 10 participating schools. We obtained both

passive consent from parents (i.e. 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 of 2019, using a paper-based, self-

administered, Spanish-language survey on socio-demographics and tobacco product

susceptibility, use, and risk factors. The survey was previously fielded in Mexico and

subsequently adapted for Guatemala and pre-tested to ensure comprehension.[23] This

protocol was approved by the Institutional Ethics Committee of the Institute of Nutrition

of Central America and Panama (INCAP) (approval number 087/2019).

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.[31] 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 Guatemala, and asking if they 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.[32] 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.[33] 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 categorized as unsusceptible, similar to prior

studies.[23] 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 characterized 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 4-item Family Affluent Scale (FAS) (i.e., "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.[34]

Established risk factors for smoking and e-cigarette use were also considered,

including other substance use (e.g. tobacco products, alcohol, drugs). Use of cigarettes

and e-cigarettes were 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 (4 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 were

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 (i.e., never;

rarely/sometimes; often/very often) for both smoking and e-cigarettes, assessed

separately. Sensation seeking (in accordance with Jessor's Problem Behavior Theory)

was evaluated with four items (i.e., "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 toward new technology adoption, using

seven items that have been previously shown to independently predict e-cigarette, but not

smoking, initiation (i.e., 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).[35,36]

Statistical analysis

Binary logistic regression was used to estimate crude odds ratios (OR) 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

vs. current and alcohol was collapsed to non-recent-binge vs. 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 re-ran 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 version

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 (75%).

Over half (52.4%) of students reported having heard of HTPs and 8.4% and 2.9% reported ever- (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.

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

In the entire sample, 52.4% were susceptible to continued or future HTP use. Compared to unsusceptible never-smokers, higher susceptibility was found among susceptible never- (AOR = 6.18, 95% CI = 4.72, 8.07), ever- (AOR = 6.93, 95% CI = 5.02, 9.57), and current smokers (AOR = 10.53, 95% CI = 5.92, 18.71), as well as susceptible never- (AOR = 12.18, 95% CI = 7.79, 19.03), ever- (AOR = 11.08, 95% CI =

7.07, 17.37), and current e-cigarettes users (AOR = 21.87, 95% CI = 13.02, 36.71).

Similarly, ever- (AOR = 1.73, 95% CI = 1.25, 2.41), current (AOR = 1.49, 95% CI = 1.03, 2.17), and binge drinkers (AOR = 1.65, 95% CI = 1.04, 2.60), and current marijuana users (AOR = 3.49, 95% CI = 1.40, 2.60) were more likely to be susceptible to HTP use. Finally, having a friend who used HTPs (AOR = 1.83, 95% CI = 1.31, 2.57) and higher sensation-seeking scores (AOR = 1.41, 95% CI = 1.19, 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- (AOR = 3.73, 95% CI = 2.03, 6.82) or current smokers (AOR = 6.63, 95% CI = 3.20, 13.74), or ever- (AOR = 9.31, 95% CI = 2.61, 33.23) or current e-cigarette users (AOR = 10.40, 95% CI = 2.75, 39.17) were more likely to be ever HTP users (Table 3). Those who reported binge drinking (AOR = 2.53, 95% CI = 1.08, 5.95) and marijuana use (AOR = 2.29, 95% CI = 1.27, 4.13) were also more likely to be ever-HTP users. Family smoking (AOR = 1.70, 95% CI = 1.19, 2.45) and friend HTP use (AOR = 7.28, 95% CI = 4.64, 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, 1.31).

In the overall population, 2.9% were current HTP users. The odds of current HTP use was higher for both cigarette (AOR = 6.14, 95% CI = 2.71, 13.93) and e-cigarette users (AOR = 84.90, 95% CI = 24.19, 298.22). Having family members who smoked (AOR = 3.25, 95% CI = 1.51, 7.02) and friends who used HTPs (AOR = 44.72, 95% CI = 20.08, 99.58) were associated with higher odds current use of HTPs.

Discussion

We investigated HTP use among adolescents in private schools in Guatemala City, where HTPs are becoming readily available.[37] 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 to 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.[38–40] 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 is from HICs, which have stronger tobacco control policies, making cross-country comparisons challenging. One study of 16- to 19-year-old adolescents in Canada, the United States, and England[19], found lower levels of awareness (7.0%) and susceptibility (45.0%) compared to 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-cigarettes susceptibility and use.[23–26] In the end, our results support Jessor's Problem Behavior Theory, which hypothesizes that substance use and other risk behaviors 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 12-18 year old Korean adolescents 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 GDP per capita than Guatemala, our study population was selected from private schools in middle and high SES neighborhoods in Guatemala City, which are predominantly attended by students of significant higher socioeconomic status, 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 $388-420USD plus an annual enrollment fee of on average $550USD, and a 2020 report from the World Bank[41] found that about 50% of Guatemalans live below the upper-middle income poverty line of about $165USD 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 generalizable to Guatemala City, but not the entire country.[42] 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 behavior).[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 amongst adolescents from LMICs. Furthermore, we did so 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 (e.g. 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, generalizability to the entire country is limited. Additionally, only four students exclusively used HTPs (i.e., did not also smoke or use e-cigarettes), and thus is it hard to draw conclusions about this group. Because of this, model estimates include some large odds ratios (with similarly large confidence intervals) 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 flavored HTPs in some countries, which contain sticks with flavor capsules in the filter that the consumer can crush to make the aerosol taste like diverse flavors, ranging from mint to ginger to bubble gum.[43] Flavor capsules in cigarettes, which include an even broader range of flavors (e.g., 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.[44] 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 flavors and flavor 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, etc) so that FCTC policies can be adequately designed and implemented to in a manner prioritized 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 socio-economic groups as well as explore how adolescent e-cigarette users transition to HTP use.

Competing Interests: None declared.

Author Contributions: AG – analysis design and execution, drafted manuscript; SM – study design, questionnaire design, data collection, manuscript review and approval; JM – study design, questionnaire design, data collection, manuscript review and approval; JT – study design, questionnaire design, analysis design, manuscript review and approval; JB – study design, questionnaire design, data collection, manuscript review and approval, stakeholder engagement

Data Availability Statement: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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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)[A]	1993	69.6
Never (susceptible)[B]	547	19.1
Ever (not current)	241	8.4
Current	84	2.9
Socio-demographic characteristics	N	%
Sex		
Male	1438	50.3
Female	1420	49.7
Age (Mean, SD)*	15.09*	1.32*
Grade - USA 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	N	%
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:		
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 smokes cigarettes	44	52.4
Also smokes 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)[C]	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 affluent scale (0-9)	7.27	1.57

[A] 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?"

[B] 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?"

[C] Binge drinking is defined as consuming 4 or more drinks on one occasion in the last month

Table 2. Crude and adjusted odds ratios for awareness and susceptibility of HTP among Guatemalan youth[A]

	HTP awareness N = 1503 (52.4%)					HTP susceptible N = 1500 (52.4%)				
	%	OR	CI 95%	AOR[B]	CI 95%	%	OR	CI 95%	AOR[B]	CI 95%
Socio-demographic characteristics										
Sex										
Female	54.94	Reference		Reference		52.33	Reference		Reference	
Male	49.72	0.86	(0.74, 1.01)	0.81*	(0.68, 0.97)	52.40	0.98	(0.84, 1.14)	0.83	(0.66, 1.04)
Age (Mean)[A]	15.29[A]	1.25*	(1.17, 1.32)	1.05	(0.93, 1.18)	15.26[A]	1.29*	(1.22, 1.37)	0.93	(0.79, 1.08)
Grade - USA categories										
Basico (grades 8-9)	43.77	Reference		Reference		44.04	Reference		Reference	
Bachillerato (grades 10-12)	58.95	1.73*	(1.48, 2.02)	1.00	(0.74, 1.35)	58.64	1.92*	(1.64, 2.24)	1.08	(0.73, 1.59)
School performance										
< 80%	53.26	Reference		Reference		60.92	Reference		Reference	
80-89%	54.62	1.02	(0.82, 1.27)	1.30*	(1.01, 1.67)	55.12	0.75*	(0.61, 0.93)	0.88	(0.64, 1.20)
90-100%	48.61	0.72*	(0.57, 0.92)	1.13	(0.85, 1.51)	44.58	0.49*	(0.39, 0.62)	0.83	(0.58, 1.19)
Parents' highest educational attainment										
Secondary school or less	53.06	Reference		Reference		46.94	Reference		Reference	
High school or technical school	52.33	1.00	(0.55, 1.83)	0.75	(0.37, 1.51)	52.33	1.23	(0.69, 2.22)	1.07	(0.43, 2.67)
University or more	52.87	1.06	(0.60, 1.90)	0.80	(0.41, 1.59)	53.29	1.27	(0.72, 2.24)	1.34	(0.55, 3.27)
Missing	45.26	0.71	(0.37, 1.40)	0.91	(0.40, 2.05)	39.71	0.75	(0.39, 1.46)	1.11	(0.39, 3.16)
Substance use variables	%	OR	CI 95%	AOR[B]	CI 95%	%	OR	CI 95%	AOR[B]	CI 95%
Cigarette smoker										
Never (unsusceptible)	41.59	Reference		Reference		17.00	Reference		Reference	
Never (susceptible)	51.39	1.54*	(1.28, 1.86)	0.88	(0.69, 1.13)	75.90	15.68*	(12.52, 19.65)	6.18*	(4.72, 8.07)
Ever (not current)	65.06	2.69*	(2.19, 3.31)	1.19	(0.89, 1.59)	81.36	22.69*	(17.53, 29.37)	6.93*	(5.02, 9.57)
Current	79.60	5.60*	(4.01, 7.81)	1.58	(1.00, 2.49)	90.80	51.58*	(32.64, 81.51)	10.53*	(5.92, 18.71)
E-cigarette user										
Never (unsusceptible)	33.43	Reference		Reference		4.64	Reference		Reference	
Never (susceptible)	43.12	1.60*	(1.27, 2.03)	1.28	(0.95, 1.73)	63.42	36.41*	(24.52, 54.07)	12.18*	(7.79, 19.03)
Ever (not current)	55.94	2.51*	(2.03, 3.09)	1.65*	(1.23, 2.21)	61.34	38.66*	(26.34, 57.75)	11.08*	(7.07, 17.37)
Current	72.41	4.67*	(3.73, 5.86)	2.10*	(1.47, 2.99)	78.73	124.45*	(82.40, 187.94)	21.87*	(13.02, 36.71)
Alcohol										
Never	35.34	Reference		Reference		20.56	Reference		Reference	
Ever (not current)	46.25	1.65*	(1.34, 2.03)	1.25	(0.97, 1.60)	52.41	4.18*	(3.33, 5.26)	1.73*	(1.25, 2.41)
Current (no binge)	57.84	2.44*	(1.96, 3.05)	1.28	(0.95, 1.71)	65.68	8.78*	(6.81, 11.32)	1.49*	(1.03, 2.17)
Current (binge)	76.83	5.27*	(4.07, 6.82)	1.84*	(1.28, 2.65)	75.36	17.99*	(13.41, 24.15)	1.65*	(1.04, 2.60)
Marijuana										
Never	49.43	Reference		Reference		48.40	Reference		Reference	
Ever (not current)	77.97	3.49*	(2.42, 5.04)	1.50	(0.97, 2.32)	85.88	6.79*	(4.40, 10.46)	1.61	(0.94, 2.75)
Current	81.55	4.03*	(2.42, 6.71)	1.48	(0.82, 2.67)	93.20	16.78*	(7.72, 36.49)	3.49*	(1.40, 8.72)
Internet cigarette ad exposure										
Never	44.74	Reference		Reference		38.78	Reference		Reference	
Rarely/sometimes	55.19	1.66*	(1.40, 1.96)	1.07	(0.86, 1.34)	58.64	2.22*	(1.88, 2.62)	1.40*	(1.06, 1.84)
Mostly/always	63.01	2.44*	(1.87, 3.19)	1.08	(0.75, 1.57)	64.78	2.87*	(2.20, 3.73)	1.52	(0.97, 2.40)
Internet e-cigarette ad exposure										
Never	39.70	Reference		Reference		35.38	Reference		Reference	
Rarely/sometimes	55.47	2.00*	(1.68, 2.38)	1.39*	(1.10, 1.75)	57.11	2.43*	(2.05, 2.89)	1.05	(0.78, 1.41)
Mostly/always	66.12	3.33*	(2.62, 4.22)	1.76*	(1.26, 2.46)	69.12	4.05*	(3.19, 5.13)	0.86	(0.57, 1.30)
Family member smokes cigarettes										
No	45.78	Reference		Reference		46.13	Reference		Reference	
Yes	64.36	2.14*	(1.82, 2.51)	1.31*	(1.07, 1.60)	63.80	2.08*	(1.78, 2.44)	1.17	(0.91, 1.50)
Family member smokes e-cigarettes										
No	47.96	Reference		Reference		48.76	Reference		Reference	
Yes	69.28	2.17*	(1.78, 2.64)	1.25	(0.98, 1.59)	66.39	2.25*	(1.85, 2.73)	1.08	(0.81, 1.45)
Family member uses HTP										

	% / Mean	OR	CI 95%	AOR[B]	CI 95%	% / Mean	OR	CI 95%	AOR[B]	CI 95%
No	49.98	Reference		Reference		51.18	Reference		Reference	
Yes	67.85	2.08*	(1.65, 2.62)	1.60*	(1.22, 2.09)	60.51	1.48*	(1.19, 1.84)	0.98	(0.71, 1.36)
Friend smokes cigarettes										
No	43.72	Reference		Reference		40.50	Reference		Reference	
Yes	59.81	1.89*	(1.62, 2.20)	1.03	(0.83, 1.29)	62.56	2.50*	(2.14, 2.91)	0.91	(0.70, 1.19)
Friend uses e-cigarettes										
No	39.71	Reference		Reference		38.98	Reference		Reference	
Yes	59.80	1.96*	(1.67, 2.31)	0.72*	(0.57, 0.91)	60.17	2.75*	(2.33, 3.25)	0.70*	(0.51, 0.95)
Friend uses HTP										
No	48.05	Reference		Reference		49.90	Reference		Reference	
Yes	77.73	4.19*	(3.27, 5.38)	4.15*	(3.11, 5.55)	66.43	1.98*	(1.59, 2.47)	1.83*	(1.31, 2.57)
Constructed scales (score range)	Mean	OR	CI 95%	AOR[B]	CI 95%	Mean	OR	CI 95%	AOR[B]	CI 95%
Sensation seeking (1-4)	2.87	1.61*	(1.44, 1.80)	1.08	(0.95, 1.24)	2.97	2.47*	(2.20, 2.78)	1.41*	(1.19, 1.68)
Technophilia (0-7)	5.85	1.29*	(1.19, 1.41)	1.07	(0.97, 1.19)	5.82	1.29*	(1.18, 1.40)	1.04	(0.91, 1.20)
Family affluent scale (0-9)	7.46	1.15*	(1.09, 1.21)	1.10*	(1.04, 1.17)	7.29	1.04	(0.99, 1.09)	0.94	(0.88, 1.02)

[A] All models include a random intercept for each participant to account for school-clustering

[B] Adjusted models are adjusted for all independent variables

* Significant at $\alpha = 0.05$

Table 3. Crude and adjusted odds ratios for ever and current HTP use among Guatemalan youth[A]

	Ever HTP use (not current) N = 241 (8.6%)					Current HTP use N = 84 (2.9%)				
	%	OR	CI 95%	AOR[B]	CI 95%	%	OR	CI 95%	AOR[B]	CI 95%
Socio-demographic characteristics										
Sex										
Female	7.56	Reference		Reference		2.63	Reference		Reference	
Male	9.75	1.40*	(1.07, 1.84)	1.22	(0.86, 1.72)	3.42	1.31	(0.84, 2.06)	1.03	(0.56, 1.89)
Age (Mean)[A]	15.87[A]	1.72*	(1.53, 1.94)	1.20	(0.97, 1.50)	15.65[A]	1.39	(1.16, 1.65)	0.85	(0.58, 1.25)
Grade - USA categories										
Basico (grades 8-9)	3.77	Reference		Reference		1.43	Reference		Reference	
Bachillerato (grades 10-12)	12.44	3.45*	(2.47, 4.82)	0.92	(0.49, 1.71)	4.45	2.86*	(1.69, 4.83)	2.18	(0.68, 6.96)
School performance										
< 80%	11.78	Reference		Reference		4.54	Reference		Reference	
80-89%	10.07	0.71	(0.50, 1.01)	1.04	(0.67, 1.63)	3.36	0.69	(0.41, 1.17)	0.74	(0.36, 1.52)
90-100%	5.24	0.29*	(0.19, 0.45)	0.69	(0.38, 1.25)	1.81	0.38*	(0.20, 0.72)	0.84	(0.35, 2.00)
Parents' highest educational attainment										
Secondary school or less	16.67	Reference		Reference		2.44	Reference		Reference	
High school or technical school	10.90	0.63	(0.28, 1.43)	0.50	(0.18, 1.69)	2.92	1.37	(0.18, 10.70)	0.62	(0.07, 5.60)
University or more	8.12	0.48	(0.22, 1.04)	0.36	(0.12, 1.07)	3.29	1.52	(0.21, 11.25)	0.63	(0.07, 5.51)
Missing	5.15	0.27*	(0.09, 0.80)	0.28	(0.09, 1.37)	0.77	0.72	(0.06, 8.11)	0.00	NA
Substance use variables	%	OR	CI 95%	AOR[B]	CI 95%	%	OR	CI 95%	AOR[B]	CI 95%
Cigarette smoker[C]										
Never (unsusceptible)	1.75	Reference		Reference						
Never (susceptible)	4.59	2.76*	(1.60, 4.76)	1.34	(0.69, 2.61)					
Ever (not current)	18.37	12.70*	(7.92, 20.36)	3.73*	(2.03, 6.82)	1.59	Reference		Reference	
Current	37.98	34.93*	(21.01, 58.08)	6.63*	(3.20, 13.74)	24.56	13.81*	(8.79, 21.68)	3.90*	(1.90, 8.02)
E-cigarette user[C]										
Never (unsusceptible)	0.42	Reference		Reference						
Never (susceptible)	0.55	1.31	(0.26, 6.49)	0.71	(0.13, 3.92)					
Ever (not current)	11.19	29.66*	(9.37, 93.89)	9.31*	(2.61, 33.23)	0.25	Reference		Reference	
Current	20.00	59.31*	(18.84, 186.69)	10.40*	(2.75, 39.17)	11.73	45.24*	(19.32, 105.94)	46.12*	(16.15, 131.74)
Alcohol[D]										
Never	1.47	Reference		Reference						

	Mean	OR	CI 95%	AOR	CI 95%	Mean	OR	CI 95%	AOR	CI 95%
Ever (not current)	4.22	2.96*	(1.47, 5.97)	1.14	(0.50, 2.60)					
Current (no binge)	8.18	5.99*	(3.02, 11.87)	1.19	(0.52, 2.75)	1.73	Reference		Reference	
Current (binge)	26.25	23.92*	(12.43, 46.03)	2.53*	(1.08, 5.95)	10.12	4.55*	(2.94, 7.06)	0.53	(0.27, 1.06)
Marijuana										
Never	6.07	Reference		Reference		1.74	Reference		Reference	
Ever (not current)	29.03	6.18*	(4.20, 9.09)	1.37	(0.84, 2.22)	16.67	8.54*	(5.03, 14.51)	1.91	(0.87, 4.18)
Current	45.98	12.57*	(7.93, 19.93)	2.29*	(1.27, 4.13)	25.40	10.64*	(5.77, 19.60)	1.32	(0.50, 3.45)
Internet cigarette ad exposure										
Never	6.54	Reference		Reference		1.85	Reference		Reference	
Rarely/sometimes	8.88	1.46*	(1.07, 2.00)	1.13	(0.74, 1.75)	3.12	1.60	(0.92, 2.78)	1.27	(0.55, 2.90)
Mostly/always	14.33	2.56*	(1.69, 3.88)	1.50	(0.81, 2.77)	6.88	3.37*	(1.75, 6.51)	2.65	(0.91, 7.71)
Internet e-cigarette ad exposure										
Never	5.45	Reference		Reference		2.04	Reference		Reference	
Rarely/sometimes	8.09	1.54*	(1.08, 2.18)	0.67	(0.41, 1.09)	2.73	1.37	(0.77, 2.45)	0.49	(0.20, 1.18)
Mostly/always	16.41	3.61*	(2.45, 5.31)	0.98	(0.54, 1.77)	6.52	2.95*	(1.59, 5.47)	0.40	(0.14, 1.13)
Family member smokes cigarettes										
No	5.28	Reference		Reference		2.07	Reference		Reference	
Yes	14.88	3.10*	(2.36, 4.07)	1.70*	(1.19, 2.45)	5.01	2.28*	(1.47, 3.54)	2.00*	(1.03, 3.88)
Family member smokes e-cigarettes										
No	6.58	Reference		Reference		2.42	Reference		Reference	
Yes	16.49	2.64*	(1.98, 3.51)	1.37	(0.94, 2.01)	5.74	2.19*	(1.39, 3.46)	0.74	(0.38, 1.46)
Family member uses HTP										
No	8.09	Reference		Reference		2.86	Reference		Reference	
Yes	12.40	1.58*	(1.13, 2.23)	0.90	(0.58, 1.42)	4.60	1.49	(0.86, 2.60)	1.08	(0.50, 2.33)
Friend smokes cigarettes										
No	4.77	Reference		Reference		1.12	Reference		Reference	
Yes	12.07	2.71*	(2.01, 3.66)	0.77	(0.50, 1.18)	4.89	4.03*	(2.29, 7.07)	0.83	(0.38, 1.82)
Friend uses e-cigarettes										
No	3.97	Reference		Reference		0.60	Reference		Reference	
Yes	10.22	2.93*	(2.06, 4.18)	0.51*	(0.30, 0.86)	4.63	6.52*	(3.00, 14.19)	0.61	(0.21, 1.77)
Friend uses HTP										
No	6.72	Reference		Reference		1.19	Reference		Reference	
Yes	21.14	3.98*	(2.94, 5.39)	7.28*	(4.64, 11.43)	15.65	12.40*	(7.81, 19.71)	21.06*	(11.13, 39.85)
Constructed scales (score range)	Mean	OR	CI 95%	AOR[B]	CI 95%	Mean	OR	CI 95%	AOR[B]	CI 95%
Sensation seeking (1-4)	3.10	2.46*	(1.97, 3.07)	1.27	(0.96, 1.68)	3.25	3.34*	(2.26, 4.92)	1.34	(0.80, 2.27)
Technophilia (0-7)	5.96	1.40*	(1.18, 1.67)	1.12	(0.89, 1.40)	6.11	1.81*	(1.32, 2.48)	1.34	(0.90, 2.00)
Family affluent scale (0-9)	7.64	1.18*	(1.07, 1.30)	1.15*	(1.02, 1.31)	7.63	1.18*	(1.01, 1.38)	1.04	(0.84, 1.29)

[A] All models include a random intercept for each participant to account for school-clustering

[B] Adjusted models are adjusted for all independent variables

[C] Due to low counts, for current use models, cigarette and e-cigarette use was combined to current user versus non-current user

[D] Due to low counts, alcohol use was combined to non-binge versus binge in last month

* Significant at $\alpha = 0.05$

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	10
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10

		(*b*) Report category boundaries when continuous variables were categorized	10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.