HHS Public Access

Author manuscript

Drug Alcohol Depend. Author manuscript; available in PMC 2023 March 01.

Published in final edited form as:

Drug Alcohol Depend. 2022 March 01; 232: 109283. doi:10.1016/j.drugalcdep.2022.109283.

Heated tobacco product use, its correlates, and reasons for use among Mexican smokers

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Abstract

Background: Little is known about the use of novel heated tobacco products (HTPs) in low- and middle-income countries. We examined among smokers in Mexico the prevalence and correlates of HTP use, as well as reasons for using HTPs.

Methods: We analyzed data from five surveys (November 2019-March 2021) of an open cohort of adult smokers (n=6,500), including an oversample of those who also use e-cigarettes. Mixed-effects multinomial logistic models were used to estimate associations between study variables and current HTP use or prior HTP trial relative to never trying HTPs.

Results: The weighted prevalence of current HTP use was 1.1%. Independent correlates of current HTP use included greater smoking frequency, intention to quit, e-cigarette use, having partners/family-members who use e-cigarettes or HTPs, and exposure to HTP information inside/

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Contributors

Lizeth Cruz-Jimenez, and James F. Thrasher have contributed to all sections of manuscript, conceptualization, preparation, writing, review, and editing. Inti Barrientos-Gutiérrez, Edna Arillo-Santillán, Katia Gallegos-Carrillo, and Rosibel Rodríguez-Bolaños contributed to conceptualization, supervision, review, and editing. Luis Zavala-Arciniega and Shannon Gravely contributed to methodology, supervision, and writing – review. All authors have approved the final article for submission.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

outside tobacco shops. Having partners/family members who smoke and not knowing about the harm of HTPs relative to cigarettes were associated with lower likelihood of current HTP use. Having tried HTPs was more likely among smokers with partners/family who use e-cigarettes or HTPs and exposure to HTP information outside shops and on newspapers/magazines. Among current users, the top two reasons for using HTPs were greater social acceptability (50.2%) and lower perceived harm (40.0%) relative to cigarettes.

Conclusions: Uptake of HTPs appears relatively low among Mexican smokers, and correlates of use are similar to those for e-cigarette use. Further research is needed to determine if HTPs use promotes or impedes smoking cessation, given current HTP users are also likely to use various nicotine products.

Keywords

Heated tobacco products; new tobacco products; smokers; electronic cigarettes

1. Introduction

The tobacco industry increasingly markets a diverse array of nicotine products, including heated tobacco products (HTPs), which it claims will move smokers from cigarettes to these presumably less harmful products (Foundation for a Smoke-Free World, 2019). In 2014 Philip Morris International (PMI) launched its HTP “IQOS”, which instead of burning tobacco, heat a tobacco stick at a lower temperature (Philip Morris International, 2020a) to produce an aerosol that contains nicotine (Bitzer et al., 2020; Jackler et al., 2020). Their introduction to the market was followed by aggressive global expansion of IQOS marketing across Asia, Europe, Middle East, North America, and South America (Jackler et al., 2020; Philip Morris International, 2020b). In Japan, a high-income country (HIC) where IQOS was first introduced, it rapidly gained market share (Adamson et al., 2020; Liu et al., 2018; Sutanto et al., 2020; Tabuchi et al., 2019; Wu et al., 2019). As the industry has expanded HTP sales and marketing into low- and middle-income countries (LMICs) (Ochoa, 2020), no research of which we are aware has evaluated the profiles of LMIC consumers who have used HTPs. Mexico was one of the first LMICs in Latin America where IQOS was introduced, beginning at the end of 2019.

PMI claims that IQOS, the market leader for HTPs, aims “to replace cigarettes with the smoke-free products” (Philip Morris International, 2020c), but the data suggest this aim is not met. Recent studies in Japan and Korea (Hori et al., 2020; Jun et al., 2021), have found that HTPs are used more frequently by multiple tobacco product users (i.e. poly-tobacco users) than by exclusive smokers (Kang et al., 2020; Kuwabara et al., 2020; Sugiyama and Tabuchi, 2020; Sutanto et al., 2020). Research in the HIC countries of Canada, England, USA and Australia found that 89.8% of current HTP users were also concurrent smoker and vapers (Miller et al., 2020). The low level of exclusive HTP use suggests that complete switching to HTPs is unusual (Hwang et al., 2019; Jackler et al., 2020; Kang et al., 2020; Kim and Cho, 2020; Ratajczak et al., 2020). When smoking cessation attempts have been evaluated, smokers who use HTPs were no more likely than exclusive smokers to attempt to quit smoking (Hwang et al., 2019; Kang et al., 2020; Kim and Cho, 2020).

The introduction of HTPs appears to have increased the likelihood of poly-tobacco use, such that compared to exclusive smokers, dual and triple users of HTPs, e-cigarettes, or combustible cigarettes being more likely to have positive perceptions about HTPs (Fung et al., 2020; Kim and Cho, 2020; Sutanto et al., 2020).

Studies of HTP use among smokers are limited to HICs (Jankowski et al., 2019; Ratajczak et al., 2020). General population studies, most of them conducted in Asia, find that HTPs use is higher among males, young adults and those from higher socioeconomic status groups (Hwang et al., 2019; Kim and Cho, 2020; Marynak et al., 2018; Nyman et al., 2018; Sutanto et al., 2020). Futhermore, those who smoke more frequently appear more likely to use HTPs (Hwang et al., 2019). Also, awareness of tobacco company promotions for IQOS was positively associated with current HTP use in Japan (Tabuchi et al., 2018). It should be noted that while Japan bans e-cigarettes, HTPs can be marketed and sold, and its tobacco control regulations are relatively weak (Tanigaki and Poudyal, 2019), which may help explain the rapid growth in the HTPs market there. Korea has stronger tobacco control regulations than Japan, although HTPs and e-cigarettes can be marketed and sold (Jun et al., 2021).

1.1 Study context

Since 2008, Mexican legislation has prohibited the sale, distribution, and promotion of any product that looks like or mimics a cigarette, which has been interpreted to include e-cigarettes and HTPs (Cámara de Diputados del H. Congreso de la Unión, 2012). Nevertheless, since 2018 PMI has promoted IQOS through social media campaigns to anticipate and accompany the launch of product availability in retail stores at the end of 2019, when it became the first and only brand on the market. In early 2020, the importation of HTPs was banned by presidential decree (Diario Oficial de la Federación, 2020). Despite these regulations, HTP sales have continued as legal appeals have made their way through the court system. HTP advertising and promotions include implicit and explicit claims that IQOS are less risky than cigarettes (Philip Morris International, 2021), similar to those in other countries (i.e., “smoke free,” “doesn’t affect the people around you,” “reduces health risks”). These claims may increase HTP appeal and minimize potential health concerns (Gravely et al., 2020), including among Mexican smokers, who comprise about 17.5% of the 12- to 65-year old population (Reynales- Shigematsu et al., 2017). Therefore, the present study examines the prevalence, correlates and patterns of HTP use among Mexican smokers, including their reasons for using HTPs.

2. Methods

2.1 Data source

Data come from five surveys of an open cohort of Mexican smokers and e-cigarette users recruited through a non-probability sample of participants from online consumer panel and surveyed between November 2019 to March 2021. Participants had to be adults (≥18 years old) and have smoked or used e-cigarettes in the prior 30 days. At each survey, 1500 participants were recruited, with quotas used for last month e-cigarette use (n>500) and educational attainment (approximately 1/3=high school or less; 1/3=technical/trade school or community college/or some college; and 1/3=college degree or higher). We oversampled

e-cigarette users to evaluate dual users (33.9%). We excluded from the sample those who did not give information about household income (n=398), those who had quit smoking at the time of the survey (n=436), and exclusive e-cigarette users (n=172), who were excluded due to their small sample size across HTP use outcomes. Participants were followed to the extent possible, with the sample replenished with new participants to maintain the target sample size at each survey. The final analytic sample included 6,500 observations (Nov. 2019 n=1321, Mar. 2020 n=1282, Jul. 2020 n=1272, Nov. 2020 n=1309 and Mar 2021 n=1316), 3,108 unique participants who at the time of the survey were current cigarette smokers.

Surveys were administered in Spanish using standard questions on tobacco product use (International Agency for Research on Cancer, 2008) and questions on novel tobacco products from the International Tobacco Control (ITC) survey (Thompson et al., 2019). The survey took on average between 20–25 minutes to complete, and the panel provider gave standard compensation for participation (e.g., points-based or monetary rewards, chances to win prizes). All study procedures were approved by the Institutional Review Board and Ethics Committee of the National Institute of Public Health of Mexico (CI 1572).

2.2 Measures

2.2.1 HTP use variables—The survey section on HTPs began with a brief product description and image of IQOS, the only HTP available in Mexico. Product awareness was assessed (i.e., “Have you heard of heated tobacco products (outside of these surveys)?”) with responses dichotomized (yes vs. no or don’t know). Those who reported awareness were asked whether they had ever tried an HTP (yes vs. no or don’t know). Participants who reported HTP trial were queried about the frequency of current use (daily; less than daily, but at least once a week; less than weekly, but at least once a month; less than once a month, but occasionally; not at all). Responses to these questions were used to derive categories of use: never tried (i.e., unaware of HTPs or never tried HTPs); HTP trial (i.e., tried HTPs, but no use in the last month); and current HTP use (i.e., in the last month).

Current HTP users were asked about heatsticks/heets last used, showing images of each variety: Sienna Selection (intense tobacco), Amber Selection (toasted tobacco and nuts), Yellow Selection (smooth tobacco with citrus), Blue Selection (smooth menthol), Turquoise Selection (deep menthol), Purple Wave (fruit-flavored menthol), other type, and “don’t know”. HTP users also reported how they obtained the last IQOS device they used (i.e., bought; gifted; borrowed; free sample). Participants who reported buying it were asked where they bought it (online; vape shop or tobacconist; department store or supermarket; pharmacist; convenience store; temporary or mobile sales location, and gas station), the latter four categories were combined as “other” due to small sample sizes.

2.2.2 Smoking- and e-cigarette related variables—All participants reported smoking frequency and were categorized using cutpoints that generally reflect tertiles of consumption intensity in Mexico (non-daily; daily ≤5 cigarettes and daily >5 cigarettes) (Pan American Health Organization and National Institute of Public Health-Mexico, 2017). Participants also reported recent smoking cessation attempts (i.e., in the last four months;

yes vs. no) and intentions to quit smoking (i.e., in the next six months vs. not). Self-reported e-cigarette use frequency in the prior month was used to derive categories of exclusive cigarette smokers; sporadic dual user (i.e., e-cigarette use twice a week or less); and frequent dual user (i.e., e-cigarette use three times a week or more), with cutpoints based on the the median.

2.2.3 Descriptive norms of partner, family and friends—With two separate questions, we asked whether participants had a partner or spouse who smokes and whether a household family member smokes. Responses were combined to indicate smoking by partner or family (i.e., yes vs. no). For two parallel questions on e-cigarette use among partners/family, we used the same coding (yes vs. no). We also asked about HTP use among household family members (yes vs. no). Separate questions asked about current smoking, e-cigarette use, and HTP use among participants' five closest friends with whom they regularly spend time, with responses for each product dichotomized to reflect use by any of these friends (yes vs. no). For all these questions, those who responded "I don't know" or who indicated they were unaware of HTPs were classified as "no".

2.2.4 Relative risk perceptions and exposure to information about HTPs—Participants who reported awareness of HTPs were asked their perception of HTPs' harmfulness relative to cigarettes ("Compared to smoking cigarettes, how harmful do you think using a heated tobacco product is?"), with responses categorized to reflect lower perceived harm than cigarettes (i.e. much less harmful than smoking cigarettes, somewhat less harmful than smoking cigarettes), equally or more harmful than cigarettes (i.e. equally harmful to smoking cigarettes, somewhat more harmful than smoking cigarettes, much more harmful than smoking cigarettes) and I don't know/lack of awareness about HTPs. Additionally, we assessed potential marketing exposures about HTPs in the last 30 days via: the internet (yes vs. no); inside shops/stores that sell tobacco products (yes vs. no); outside shops/stores that sell tobacco products (yes vs. no); and in newspapers or magazines (yes vs. no). Those who reported being unaware of HTPs were classified as having "no" exposure.

2.2.6 Reasons for HTP and e-cigarette use—Participants who reported current use of HTPs and/or e-cigarettes answered product-specific but parallel questions about their reasons for using the product, with the option to check all that apply: is less harmful to people around me; is more acceptable than smoking ordinary cigarettes to people around me; helps me cut down on the number of ordinary cigarettes I smoke; I can use them in places where I can't smoke; and might help me stay quit from smoking ordinary cigarettes.

2.2.7 Sociodemographic variables—Sociodemographic measures included sex (male and female), age (18–29, 30–39, 40–49, and +50 years), educational attainment (middle school and less; high school, technical or some college; and university and more) and monthly household income in Mexican pesos (1 USD = 21 MXN: less than 8,000 MXN; 8,001 to 15,000 MXN; and 15,001 to >20,000MXN) responses of "refused" and "don't know" were coded as missing.

2.3 Analysis

We evaluated descriptive statistics using unweighted and weighted data, with inverse probability of selection weights based on the sex, age, and educational attainment profiles for exclusive smokers and, separately, for dual users according to nationally-representative data from 2018 (Shamah-Levy et al., 2020). Prevalences for HTP-related variables (awareness, ever tried and current use) were estimated as weighted proportions; and we compared prevalences by survey using weighted chi-square tests. Additionally, we assessed endorsement of different reasons for using HTPs and e-cigarettes among current users of each device, comparing them using weighted chi-square tests. Using mixed-effects multinomial logistic regression models to account for repeated measures among those who participated in multiple surveys, we estimated crude and adjusted relative risk ratios (RRRs & ARRRs, respectively) to estimate the likelihood of HTP use (current HTP use, prior HTP use, never tried HTPs=reference) by sociodemographics, smoking-related variables, descriptive social norms, perceived relative harmfulness of HTPs, and exposure to HTP information. As a sensitivity analysis, we re-estimated these models after excluding participants who were unaware of HTPs. Simiarly, we re-estimated the models for HTP use without weights. We do not report on the analytic sample (Supplement 1) or unweighted results (available upon request) since results were consistent with those from the full analytic sample using weighted data, and would not have changed our primary interpretations. Because of the purposive nature of our sample, especially the oversample of e-cigarette users, we believe the weighted estimates are of wider interest since they are more suitable for generalizing to the population of smokers in Mexico. Prevalence estimates, confidence intervals, and model inference were based on modified sandwich standard errors that adjusted for any form of within-participant correlation. All analyses were conducted using Stata v.14 (Stata Corp, TX, USA).

3. Results

Table 1 presents weighted characteristics of participants as well as the unweighted sample size for each subgroup of interest (N=6,500). About one-third (31.6%) reported being aware of HTPs, 5% reporting having tried them but not currently and 1.1% using them currently. The weighted prevalence of these variables did not significnatly differ across survey waves, except for HTP trial (p=0.0001), this difference appeared driven primarily by the highest estimate from the July 2020 survey (15.6%).

3.1 Factors associated with the use of HTPs among adult smokers

In adjusted models for HTP use (Table 2), likelihood of HTP trial (vs. never tried HTPs) was higher among those with partners/family who use e-cigarettes or HTPs (ARRR =3.89, 95% CI 1.79–8.44 and ARRR =5.32, 95% CI 1.88–15.08, respectively), as well as those exposed to HTPs information outsides shops/stores where tobacco is sold (ARRR =2.26, 95% CI 1.10–4.63) or through newspapers or magazines (ARRR =6.62, 95% CI 2.92–15.00). Not having an opinion about the harm of HTPs relative to cigarettes, were associated with less likely to current HTPs use ($ARRR_{\text{I don't know/ unaware vs. equally or more harmful}}$ =0.16, 95% CI 0.05–0.54). Other significant correlates of ever tried included: educational attainment

($ARRR_{\text{high school / technical/ some college vs. university+}}$ =2.78, 95% CI 1.34–5.78) and household income (i.e., 15,001 or more Mexican pesos a month) (ARRR=2.94, 95% CI 1.06–8.11).

Likelihood of current HTP use (vs. never tried HTPs) was higher among those who were light daily smokers ($ARRR_{\text{daily ≤5 cigarettes vs. non-daily}}$ =6.16, 95% CI 2.52–15.05), intend to quit (ARRR =2.57, 95% CI 1.34–4.92), and use e-cigarettes, whether sporadically ($ARRR_{\text{sporadic e-cigarette use vs. no use}}$ =6.35, 95% CI 2.46–16.37) or more frequently ($ARRR_{\text{frequent e-cigarette use vs. no use}}$ =11.26, 95% CI 3.85–32.90). Current HTP use was also higher among participants: with partners/family who use e-cigarettes (ARRR =10.04, 95% CI 3.03–33.22) or HTPs (ARRR =5.38, 95% CI 1.46–19.79); and those who reported having seen information about HTPs inside or outside shops where tobacco is sold (ARRR =2.43, 95% CI 1.06–5.61 and ARRR =3.54, 95% CI 1.67–7.50, respectively). Also, having partners/family members who smoke (ARRR =0.34, 95% CI 0.13–0.92) and not having an opinion about the harm of HTPs relative to cigarettes ($ARRR_{\text{I don't know/ unaware vs. equally or more harmful}}$ =0.03, 95% CI 0.01–0.08) were associated with lower likelihood of current HTPs use.

3.2 Use patterns and preferences among current HTP users

Among respondents who reported current HTP use (unweighted n=665), 13.5% reported daily use (Table 3). The most popular heatsticks/heets variety they used most recently were "Blue Selection" (31.8%), followed by "Amber Selection" (28.7%) and "Sienna Selection" (15.1%). Of the approximately 44.2% who bought their HTP device, 68.7% did so online and 18.5% from a vape shop or tobacconist.

3.3 Reasons for use HTPs and e-cigarette

Figure 1 shows the weighted percentages for each of the reasons for using HTPs and e-cigarettes, queried only among current users of HTPs (n=665) and e-cigarettes users (n=2,273). The most prevalent reason for using HTPs was their social acceptability relative to cigarettes (50.2%), followed by because HTPs are less harmful than cigarettes to people around them (40.0%) and because it helps to cut down on the number of combustible cigarettes they smoke (28.6%). Among e-cigarette users, the most frequently endorsed reason for use was lower harm to others (47.7%), followed by their social acceptability (39.7%) and because it helps stay quit from smoking cigarettes (28.1%). Use to cut down on cigarettes was the only reason that was statistically different when we compared HTPs users and e-cigarette users ($p<0.01$, 28.6% vs. 14.9%, respectively).

4. Discussion

This study among Mexican smokers found that the prevalence of current HTP use was approximately 1.1% and remained relatively stable over the year and a half period after their introduction into the market. This is similar to what has been found in European countries (Germany, Greece, Hungary, Poland, Romania and Spain) where 0.8% of adult smokers use HTPs (Lotrean et al., 2020), as well as in Canada, England, USA and Australia where this prevalence was 0.9% (Miller et al., 2020). Our results are also relatively consistent with a recent study across 28 European Union countries, including the United Kingdom, which

found 1.3% of the general population used HTPs, although current and former smokers were more likely to have ever or currently used HTPs (Laverty et al., 2021). Longitudinal research is needed to better understand who tries and goes on to use HTPs consistently, as, to our knowledge, all studies in this area are cross-sectional and do not ask about when consumers first tried HTPs.

In line with prior studies (Brose et al., 2018; Hwang et al., 2019; Kang et al., 2020; Kim and Cho, 2020), we found that most smokers who currently use HTPs also use e-cigarettes, making them poly-users of nicotine products. However, we did not find this association with HTP trial, suggesting that e-cigarette use promotes continued use HTPs. Longitudinal studies are needed to better evaluate the trajectories of HTP use, including assessment of quitting combustible cigarettes and the potential for impeding cessation, perhaps by providing a more socially acceptable and less detectable means of nicotine delivery than cigarettes for situations where one cannot smoke, as suggested in other studies (Hair et al., 2018; Tompkins et al., 2020).

Our focus on descriptive norms, or perceptions of actual behavior within a social group (Lapinski and Rimal, 2005), follows from diffusion of innovation theory's emphasis on social networks for explaining why innovations like HTPs are adopted (Rogers, 2003). We found strong associations between use of e-cigarettes and HTPs among partners/family and both trial and current use of HTPs. Furthermore, a substantial proportion of current HTP users obtained their devices as a gift from a relative or friend (34.0%). This follows a prior qualitative study among HTP users and ex-users who reported that family and friends who used HTPs promoted its use as an alternative to smoking and suggested they try it (Tompkins et al., 2020). Indeed, PMI marketing strategies in Mexico include a referral program where current users can get coupons for IQOS products if they promote IQOS use among their family and friends (Philip Morris International, 2020d). Notably, friend use of e-cigs or HTPs was strongly correlated with trial and use, but not in adjusted models, suggesting that familial influence matters more in the Mexican context given that family use was significant in both adjusted and unadjusted models.

Our findings contrast with prior studies that reported a high prevalence of believing HTPs were less harmful than smoking among current users of HTPs (Gravely et al., 2020; Laverty et al., 2021; Majek et al., 2021). A qualitative study of adult HTP users in the UK perceptions of lower harm were also prominent, although, as our results, there was a great uncertainty about risks from use (East et al., 2021). This could be due to the misperception promoted by the industry and the lack of scientific agreement on the risk of these products. Monitoring HTP marketing with implied and direct reduced risk claims, as well as evaluations of smokers' responses to this marketing, will be important in evaluating the uptake and consequences of HTP use going forward.

Consistent with the findings from a study of Japanese smokers, we found that the most prevalent exposure to HTP marketing among HTPs users was inside and outside stores (Craig et al., 2020). This engagement may happen after progression from trial to regular IQOS use. This is not entirely surprising, since smokers may be more likely to go to places where marketing activities are more intensive, such as tobacco shops. That exposure to

HTP information on the Internet was significant only in bivariate analyses – and only close to statistical significane in multivariate analyses – may be because online ad exposures are more prevalent among young adults (Jackler et al., 2020). Future research should focus on whether the effects of such exposures vary by age group. In Mexico, as in many other countries, the absence of a comprehensive tobacco product advertising ban and challenges around regulating internet content make it difficult to monitor and reduce marketing activities (Jankowski et al., 2019).

In the Metropolitan area of Mexico City, PMI promotes the IQOS through a fifteen day device loan program, with a discount voucher of 400 Mexican pesos (approximately $19 USD) if the person ultimately purchases the device for around $36 USD with the discount (Philip Morris International, 2020d). We are not aware of any free IQOS giveaway programs in Mexico, although a small percentage of users in our study reported getting their device as a free sample (12.3%), perhaps because they interpreted the loan program as a free sample. In a global market, making the device more accessible through discount packages gains new consumers who repeatedly buy products, like the tobacco sticks that are needed for HTPs (Jackler et al., 2020).

Consistent with the findings of a study among Japanese smokers (Sutanto et al., 2019), a large percentage of current users of HTPs prefer menthol flavor (41.5%). This is comparable to the prevalence of preference for cigarette varieties with flavor capsules in the filter in Mexico (43%) (Zavala-Arciniega et al., 2020), where mint/menthol flavor is common (Ogunnaike et al., 2020). Tobacco companies have long manipulated menthol content to promote smoking initiation, since menthol can mask the harshness of smoke among those who first experiment with the cigarettes (Kreslake et al., 2008). Indeed, this has driven some concerns about whether the appeal of HTPs for youth has been properly considered in evaluating their potential public health impact (Lempert and Glantz, 2020). Recent research among Guatemalan adolescents indicates that very few use HTPs (Gottschlich et al., 2020) and most perceive them as less appealing and more harmful than cigarettes (Monzón et al., 2021). Nevertheless, the great popularity of menthol flavor among HTP users, the inclusion of additional flavors like berry, and their potential uptake among youth should be further evaluated to clarify the role of HTPs in tobacco product initiation, relapse, or maintenance of nicotine dependence. Indeed, given the appeal of flavor capsules for youth, (Abad-Vivero et al., 2016; Barrientos-Gutierrez et al., 2021) efforts should be made to impede the introduction of HTP sticks that include capsules, as these have been introduced in other countries (Cho and Thrasher, 2019).

Our findings about the main reasons for using HTPs are consistent with previous qualitative and quantitative studies (Adamson et al., 2020; Hair et al., 2018; Queloz and Etter, 2019; Tompkins et al., 2020). The top reasons for using HTPs were social (can use around others and not harm them), similar to other studies (Adamson et al., 2020; Hair et al., 2018) and for the top reasons smokers in our sample used e-cigarettes. As suggested in other studies, smokers may use HTPs to experiencing relatively less stigma and negative judgments than when they smoke in public or around non-smokers (Hair et al., 2018; Tompkins et al., 2020). The use of HTPs because they are less harmful than cigarettes to people around them may be linked to reduced ash and odor from HTPs (Hair et al., 2018), which is a key message in

IQOS marketing materials and which, by extension, gives the appearance of lower toxicity than combustible cigarettes (Queloz and Etter, 2019). Given the relatively low percentage of smokers who use HTPs to cut down on cigarettes or help them quit, HTPs may mostly be used in social situations where this social use is a substitute for smoking (which may be preferred). Indeed, having recently tried to quit smoking was not associated with either trial or current use of HTPs, although quit intention was positively associated with current use. This finding contrasts with some studies where intention to quit smoking was relatively uncommon among HTP users (Park et al., 2021; Ryu et al., 2020). Given the relatively short period of time that HTPs have been on the Mexican market and the relatively low prevalence of use in Mexico compared to Asian countries, early adopters of novel HTP devices may be more to be interested in trying to quit compared to later adopters.

Our study has some limitations, including the use of a convenience sample from an online panel used for marketing research, where we over-sampled e-cigarette users and under-sampled smokers from lower socioeconomic status groups. Although our analyses integrated weighting to reflect sociodemographic profiles of exclusive smokers and dual users in the general population, our results may still be biased. Also, our analysis of HTP use includes those who were unaware of HTPs, so that the models would consider the characteristics of this subpopulation of smokers. These participants, however, were not queried about perceived harmfulness of HTPs, use of HTPs among family and friends, or exposure to HTP marketing, which is why we grouped them with those who reported not knowing the relative harms, no use of HTPs among network members, and no HTP marketing exposures. However, results from our sensitivity analyses that excluded participants who were unaware of HTPs indicated that the correlates of HTP use were consistent with those we found when analyzing the entire sample. Finally, our study was cross sectional, and so the temporal ordering of relationships is not clear. Longitudinal data are needed to better examine the incidence and correlates of tobacco product transitions related to HTP use.

5. Conclusion

In our sample of Mexican smokers, approximately 1.1% currently use HTPs, similar to findings in a variety of countries. Smokers who use e-cigarettes are particularly likely to use HTPs, leading to poly-product use as has also been found in other countries. Use of HTPs and e-cigarettes among social network members, particularly partners and family, appears to promote use, which industry explicitly encourages through its marketing. While HTP users are more likely to intend to quit smoking than those who have never tried HTPs, other data suggest that HTPs may be mostly used to deliver nicotine in settings where smoking is socially unacceptable, as is also found for e-cigarette use.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding

This research was funded by of the Fogarty International Center of the National Institutes of Health under award number R01 TW010652. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health

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Highlights

- Uptake of HTPs is low among Mexican smokers.
- Strong correlates of current HTPs use include frequent e-cigarette use and use of e-cigarettes and HTPs among close network members.
- Social acceptability and lower harm compared to cigarettes were the top reasons for use.

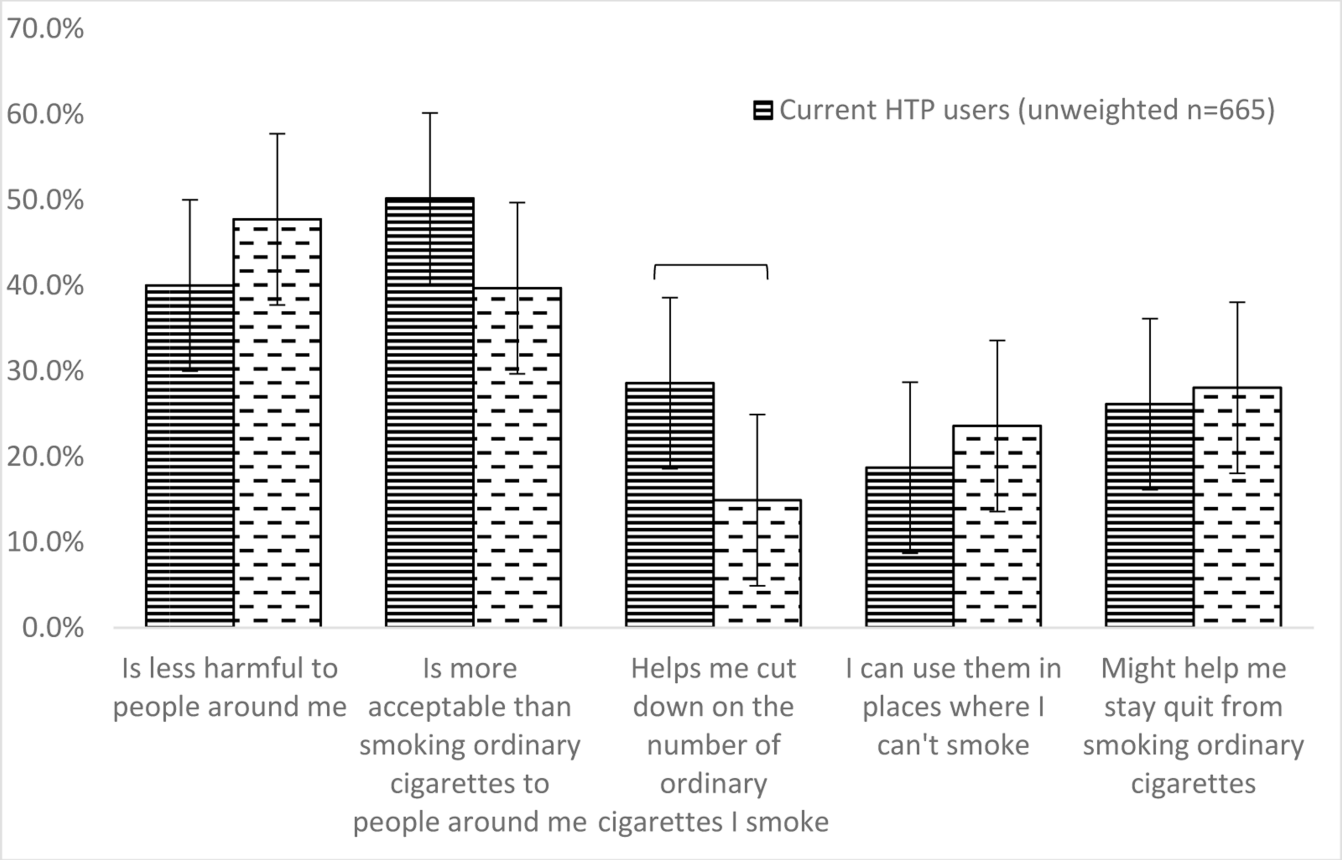

Figure 1.
Weighted percentages about the reasons for use HTPs and e-cigarettes among adult smokers. Histograms show percentage and 95% CIs *p-value: p<0.01

Table 1.

Analytic sample characteristics (n = 6500).

	n[§]	Unweighted % (95% CI)		Weighted % (95% CI)	
Survey					
November 2019	1321	20.3	(19.3–21.3)	20.7	(17.7–24.0)
March 2020	1282	19.7	(18.8–20.7)	19.6	(16.8–22.7)
July 2020	1272	19.6	(18.6–20.5)	19.3	(16.6–22.3)
November 2020	1309	20.1	(19.2–21.1)	20.1	(16.9–23.7)
March 2021	1316	20.2	(19.3–21.2)	20.4	(15.8–25.9)
Sex					
Male	3411	52.5	(51.3–53.7)	67.5	(64.1–70.7)
Female	3089	47.5	(46.3–48.7)	32.5	(29.3–35.9)
Age					
18–29	1759	27.1	(26.0–28.1)	43.7	(39.0–48.6)
30–39	1973	30.4	(29.2–31.5)	29.2	(25.9–32.7)
40–49	1277	19.6	(18.7–20.6)	14.1	(12.1–16.2)
> 50	1491	22.9	(21.9–24.0)	13.1	(11.5–14.8)
Education					
Middle school and less	622	9.6	(8.9–10.3)	57.5	(53.6–61.4)
High school / technical/ some college	3622	55.7	(54.5–56.9)	30.4	(27.6–33.3)
University and more	2256	34.7	(33.6–35.9)	12.1	(10.8–13.5)
Household income					
Less than 8000 MXN	1552	23.9	(22.8–24.9)	41.3	(36.8–45.9)
8001 to 15,000 MXN	2070	31.8	(30.7–33.0)	33.7	(29.4–38.2)
15,001 to > 20,000 MXN	2878	44.3	(43.1–45.5)	25.1	(22.2–28.2)
Smoking frequency					
Non-daily	3309	50.9	(49.7–52.1)	55.1	(50.6–59.5)
Daily < =5 cigarettes	1473	22.7	(21.6–23.7)	22.2	(18.2–26.7)
Daily > 5 cigarettes	1718	26.4	(25.4–27.5)	22.7	(19.8–26.0)
Recent quit attempt					
No	3879	59.7	(58.5–60.9)	62.4	(57.8–66.7)
Yes	2621	40.3	(39.1–41.5)	37.7	(33.3–42.2)
Intention to quit (next 6 months)					
No	4155	63.9	(62.8–65.1)	65.8	(61.3–70.1)
Yes	2345	36.1	(34.9–37.2)	34.2	(29.9–38.7)
E-cigarette use frequency					
Exclusive smoker	4227	65.0	(63.9–66.2)	97.1	(96.8–97.4)
Sporadic dual user	1365	21.0	(20.0–22.0)	1.7	(1.5–1.9)
Frequent dual user	908	14.0	(13.1–14.8)	1.2	(1.0–1.3)
Partners/family smoke					
No	2248	34.6	(33.4–35.7)	31.5	(28.0–35.2)

	n[§]	Unweighted % (95% CI)		Weighted % (95% CI)	
Yes	4252	65.4	(64.3–66.6)	68.5	(64.8–72.1)
Partners/family use e-cigarette					
No	4909	75.5	(74.5–76.6)	90.7	(88.1–92.7)
Yes	1591	24.5	(23.4–25.5)	9.3	(7.3–11.9)
Family use HTPs					
No	5629	86.6	(85.8–87.4)	96.6	(95.5–97.5)
Yes	871	13.4	(12.6–14.2)	3.4	(2.5–4.5)
Friends smoke					
No	1143	17.6	(16.7–18.5)	25.3	(21.1–29.9)
Yes	5357	82.4	(81.5–83.3)	74.7	(70.1–78.9)
Friends use e-cigarette					
No	4113	63.3	(62.1–64.4)	84.2	(79.8–87.7)
Yes	2387	36.7	(35.6–37.9)	15.9	(12.3–20.3)
Friends use HTPs					
No	5452	83.9	(83.0–84.8)	96.0	(94.8–97.0)
Yes	1048	16.1	(15.2–17.0)	4.0	(3.0–5.2)
Perceived harmfulness of HTPs relative to cigarettes					
HTPs are equally or more harmful than cigarettes	1397	21.5	(20.5–22.5)	11.8	(9.8–14.3)
HTPs are less harmful than cigarettes	1121	17.2	(16.3–18.2)	10.6	(7.2–15.3)
I don’t know	309	4.8	(4.2–5.3)	6.9	(3.9–12.1)
Unaware	3673	56.5	(55.3–57.7)	70.7	(65.5–75.4)
Information sources related to HTPS (in the past 30 days)					
On the Internet					
No	4567	70.3	(69.2–71.4)	83.3	(78.7–87.1)
Yes	1933	29.7	(28.6–30.8)	16.7	(12.9–21.4)
Inside shops/ stores					
No	5638	86.7	(85.9–87.6)	94.9	(93.5–96.0)
Yes	862	13.3	(12.4–14.1)	5.1	(4.0–6.5)
Outside shops/ stores					
No	5333	82.0	(81.1–83.0)	92.1	(90.3–93.6)
Yes	1167	18.0	(17.0–18.9)	7.9	(6.4–9.8)
In newspapers or magazines					
No	5423	83.4	(82.5–84.3)	91.4	(89.3–93.1)
Yes	1077	16.6	(15.7–17.5)	8.6	(6.9–10.7)
Aware of HTPs	2827	43.5	(42.3–44.7)	29.3	(24.7–34.5)
Ever tried HTPs	552	8.5	(7.8–9.2)	5.0	(3.7–6.6)
Current use of HTPs	665	10.2	(9.5–11.0)	1.1	(0.9–1.4)

[§]Unweighted data

Table 2

Weighted multinomial logistic regression of factors associated with the use of HTPs in adult smokers and vapers, keep those who never tried HTPs as the reference (N = 6500).

	Never tried HTPs	Ever tried HTPs							Current HTP use						
	%	%	RRR	(95% CI)	p-value	ARRR[§]	(95% CI)	p-value	%	RRR	(95% CI)	p-value	ARRR[§]	(95% CI)	p-value
Sex															
Male	94.1	4.7	Ref			Ref			1.2	Ref			Ref		
Female	93.5	5.4	1.16	(0.67–2.00)	0.592	1.07	(0.61–1.89)	0.809	1.1	0.92	(0.54–1.56)	0.760	1.78	(0.82−3.87)	0.144
Age															
18–29	94.3	4.4	Ref			Ref			1.3	Ref			Ref		
30–39	92.8	6.0	1.37	(0.65–2.92)	0.409	1.61	(0.76–3.40)	0.215	1.2	0.97	(0.59–1.61)	0.911	1.22	(0.53−2.80)	0.640
40–49	95.2	3.8	0.84	(0.39–1.81)	0.659	0.89	(0.37–2.14)	0.795	1.0	0.79	(0.35–1.77)	0.564	1.36	(0.39−4.74)	0.634
> 50	93.9	5.7	1.28	(0.54–3.02)	0.571	1.29	(0.54–3.09)	0.565	0.4	0.35	(0.19–0.62)	<0.001	0.90	(0.37−2.17)	0.808
Education															
Middle school and less	95.3	4.6	0.90	(0.48–1.69)	0.735	2.71	(0.96–7.68)	0.061	0.1	0.02	(0.01–0.07)	< 0.001	0.13	(0.03− 0.58)	0.008
High school / technical/ some college	92.9	5.7	1.13	(0.76–1.69)	0.547	2.19	(1.11–4.31)	0.024	1.4	0.27	(0.17–0.43)	< 0.001	0.61	(0.30− 1.25)	0.179
University and more	90.0	4.9	Ref			Ref			5.1	Ref			Ref		
Household income															
Less than 8,000MXN	95.4	4.0	Ref			Ref			0.7	Ref			Ref		
8001 to 15,000MXN	93.6	5.5	1.42	(0.69–2.93)	0.344	2.12	(0.93–4.82)	0.075	0.9	1.35	(0.68–2.70)	0.390	0.78	(0.31−1.97)	0.594
15,001 to > 20,000 MXN	92.0	5.8	1.53	(0.74–3.14)	0.252	3.20	(1.12–9.14)	0.030	2.2	3.37	(1.76–6.43)	<0.001	1.25	(0.48−3.21)	0.650
Smoking frequency															
Non-daily	94.7	4.6	Ref			Ref			0.8	Ref			Ref		
Daily < =5 cigarettes	92.9	5.7	1.27	(0.61–2.65)	0.518	2.23	(1.14–4.36)	0.019	1.5	1.88	(1.02–3.44)	0.041	3.15	(1.46−6.77)	0.003

	Never tried HTPs	Ever tried HTPs							Current HTP use						
	%	%	RRR	(95% CI)	p-value	ARRR[§]	(95% CI)	p-value	%	RRR	(95% CI)	p-value	ARRR[§]	(95% CI)	p-value
Daily > 5 cigarettes	93.3	5.2	1.15	(0.57–2.33)	0.694	1.25	(0.66–2.38)	0.492	1.6	2.03	(1.18–3.49)	0.011	1.57	(0.69−3.54)	0.279
Recent quit attempt															
No	94.3	4.8	Ref			Ref			0.9	Ref			Ref		
Yes	93.3	5.2	1.09	(0.60–1.96)	0.782	1.42	(0.74–2.70)	0.292	1.5	1.67	(1.09–2.57)	0.019	1.48	(0.84−2.62)	0.173
Intention to quit															
No	94.7	4.4	Ref			Ref			0.9	Ref			Ref		
In the next six months	92.4	6.0	1.41	(0.76–2.62)	0.276	1.19	(0.69–2.06)	0.525	1.5	1.72	(1.10–2.68)	0.017	1.78	(1.03−3.09)	0.039
E-cigarette use frequency															
Exclusive smoker	94.8	4.8	Ref			Ref			0.4	Ref			Ref		
Sporadic dual user	72.0	13.0	3.58	(2.43–5.25)	<0.001	1.44	(0.78–2.68)	0.247	15.0	47.06	(27.41–80.80)	< 0.001	6.99	(3.22−15.18)	< 0.001
Frequent dual user	53.2	8.5	3.17	(2.02–4.98)	< 0.001	0.45	(0.20–1.01)	0.053	38.4	162.75	(93.08-284.57)	< 0.001	7.27	(3.08−17.15)	< 0.001
Partners/family smokes															
No	94.8	4.3	Ref			Ref			0.9	Ref			Ref		
Yes	93.5	5.3	1.24	(0.65–2.38)	0.513	0.64	(0.36–1.13)	0.123	1.2	1.42	(0.80–2.53)	0.227	0.32	(0.12−0.83)	0.019
Partners/family use e-cigarette															
No	95.6	4.0	Ref			Ref			0.4	Ref			Ref		
Yes	77.8	14.0	4.29	(1.87–9.84)	< 0.001	1.88	(0.74–4.82)	0.187	8.2	25.60	(15.03−43.61)	< 0.001	7.96	(2.51−25.24)	< 0.001
Family use HTPs															
No	96.0	3.5	Ref			Ref			0.5	Ref			Ref		
Yes	34.8	46.1	36.14	(17.18−76.02)	< 0.001	5.76	(2.26–14.69)	<0.001	19.1	108.61	(60.97-193.49)	< 0.001	2.33	(0.92−5.92)	0.075
Friends smoke															
No	95.2	4.3	Ref			Ref			0.6	Ref			Ref		

	Never tried HTPs	Ever tried HTPs							Current HTP use						
	%	%	RRR	(95% CI)	p-value	ARRR[§]	(95% CI)	p-value	%	RRR	(95% CI)	p-value	ARRR[§]	(95% CI)	p-value
Yes	93.5	5.2	1.23	(0.60–2.49)	0.572	0.67	(0.33–1.38)	0.277	1.3	2.43	(1.16–5.09)	0.019	0.35	(0.12−1.07)	0.066
Friends use e-cigarette															
No	95.8	3.8	Ref			Ref			0.4	Ref			Ref		
Yes	83.9	11.1	3.32	(1.53–7.21)	0.002	1.42	(0.57–3.52)	0.449	5.0	15.26	(7.96–29.24)	< 0.001	1.37	(0.49−3.77)	0.549
Friends use HTPs															
No	96.0	3.7	Ref			Ref			0.3	Ref			Ref		
Yes	44.2	36.1	21.37	(9.99–45.72)	< 0.001	1.88	(0.80–4.47)	0.150	19.7	123.98	(66.32-231.76)	< 0.001	4.88	(2.50−9.52)	<0.001
Perceived harmfulness of HTPs relative to cigarettes															
HTPs are equally or more harmful than cigarettes	76.1	19.4	Ref			Ref			4.5	Ref			Ref		
HTPs are less harmful than cigarettes	80.0	14.6	0.72	(0.32–1.60)	0.413	0.74	(38–1.42)	0.360	5.4	1.14	(0.59–2.22)	0.701	1.13	(0.62–2.08)	0.690
I don’t know/ unaware	98.6	1.4	0.06	(0.02–0.13)	< 0.001	0.16	(0.06–0.45)	<0.001	0.02	0.004	(0.001–0.01)	< 0.001	0.03	(0.01–0.09)	< 0.001
Information on the Internet															
No	97.3	2.5	Ref			Ref			0.2	Ref			Ref		
Yes	76.9	17.2	8.66	(4.36–17.18)	< 0.001	0.77	(0.35–1.67)	0.503	5.9	49.47	(23.41–104.53)	< 0.001	1.61	(0.60–4.31)	0.340
Information inside (shops/ stores)															
No	95.6	3.9	Ref			Ref			0.5	Ref			Ref		
Yes	63.7	24.2	9.25	(4.76–17.97)	<0.001	1.87	(0.85–4.08)	0.118	12.2	35.15	(21.25–58.16)	< 0.001	3.42	(1.71–6.86)	0.001
Information outside (shops/ stores)															
No	96.7	2.8	Ref			Ref			0.5	Ref			Ref		
Yes	61.3	30.7	17.61	(9.30–33.35)	< 0.001	2.93	(1.57–5.46)	0.001	8.0	24.22	(14.83–39.56)	< 0.001	1.97	(1.07–3.62)	0.029

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	Never tried HTPs	Ever tried HTPs							Current HTP use						
	%	%	RRR	(95% CI)	p-value	ARRR[§]	(95% CI)	p-value	%	RRR	(95% CI)	p-value	ARRR[§]	(95% CI)	p-value
Information on newspapers or magazines															
No	96.7	2.7	Ref			Ref			0.6	Ref			Ref		
Yes	65.1	28.7	15.65	(8.29–29.52)	< 0.001	3.29	(1.32–8.18)	0.010	6.3	14.88	(9.13–24.24)	< 0.001	1.30	(0.68–2.46)	0.426

Unweighted: never tried HTPs (n = 5283); ever tried HTPs (n = 552); current HTP use (n = 665)

RRR (Relative Risk Ratios), ARRR (Adjusted Relative Risk Ratios)

[§]ARRR: Adjusted by all variables in the table and date of survey

Table 3.

Variables related to HTPs among current users (n=665)

	n[§]	Weighted % (95% CI)	
Frequency of use			
Daily	99	13.7	(10.0–18.6)
Not daily but at least once a week	334	40.7	(32.6–49.3)
Less than once a week, but at least once a month	232	45.6	(36.5–55.1)
Most recent variety of heatsticks/heets used			
Sienna Selection (intense tobacco)	139	24.6	(16.5–35.0)
Amber Selection (toasted tobacco and nuts)	117	22.3	(15.3–31.3)
Yellow Selection (smooth tobacco with citrus)	84	12.1	(7.1–19.9)
Blue Selection (smooth menthol)	161	22.0	(16.2–29.2)
Turquoise Selection (deep menthol)	70	8.0	(5.7–11.1)
Purple Wave (menthol with fruits)	84	9.2	(6.2–13.5)
Other and I dont' know	10	1.7	(0.8–3.8)
How did you obtain their HTPsdevice?			
I bought it	376	49.7	(40.8–58.7)
It was a gift from a relative or friend	211	35.1	(25.7–45.7)
It was a free sample	40	8.9	(4.7–16.2)
It was borrowed	38	6.3	(2.9–13.4)
Where did you buy their HTPsdevice?			
Online	213	63.2	(56.1–69.8)
Vape shop or tobacconist	83	18.7	(14.1–24.4)
Department store or supermarket	62	14.8	(10.6–20.3)
Other	18	3.3	(1.9–5.6)

[§]Unweighted data