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Correlates of Awareness and Use of Heated Tobacco Products in a Sample of US Young Adults in 2018–2019

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Abstract

Introduction: Tobacco companies have devoted increased resources in recent years to developing and marketing heated tobacco products (HTPs) as alternatives to combustible products like cigarettes. However, little is known about correlates of awareness and use of these products in American young adults.

Methods: Two thousand four hundred ninety-seven young adults (mean age = 21.6) completed survey items on HTP awareness and lifetime use in 2018–2019. Logistic regression models compared young adults who were (1) unaware of HTPs (reference group) with those who were, (2) aware of HTPs, and (3) had ever used HTPs on demographic, tobacco, and other substance use characteristics. Among current smokers, these groups were compared on cigarette use, dependence, and readiness to quit.

Results: Approximately 12% of respondents (n = 293) were aware of HTPs, and 5% (n = 134) reported lifetime HTP use. Controlling for demographics, HTP awareness and use were both associated with greater use of all types of tobacco products, number of different tobacco products, and use of marijuana and other drugs. Among current smokers, HTP awareness and use correlated with heavier cigarette consumption, greater dependence, and past-month marijuana use, but not with recent quit attempts or thinking about quitting cigarettes.

Conclusions: Awareness and use of HTPs among young adults were associated with greater use of tobacco products and other substances and, among current smokers, with greater cigarette dependence (but not cessation-related factors). As these products become increasingly available in the United States, additional surveillance and monitoring activities are needed to better understand use patterns, consequences, and reasons for using HTPs.

Implications: Few studies have examined factors associated with awareness and use of heated tobacco products (HTPs) among US young adults. HTP awareness and lifetime use correlated with a range of factors, including male gender, white race/ethnicity, and tobacco and other substance use. Lifetime use of HTPs was low (5%); most lifetime HTP users reported history of other tobacco use, but a sizeable minority (14%) reported no other tobacco product use history. Among current cigarette smokers, cigarette dependence, poly-tobacco use, and marijuana use—but not cigarette cessation attempts or contemplation—were associated with greater likelihood of awareness and use of HTPs.

Introduction

Heated tobacco products (HTPs), also known as "heat-not-burn" tobacco, are a diverse group of devices that heat tobacco (eg, loose tobacco or solid processed tobacco "plugs" or "sticks") to temperatures below combustion to produce an aerosol instead of smoke.[1] Similar to electronic nicotine delivery systems (ENDS), emerging data suggests that HTPs may lead to reduced exposure to some toxins compared to combustible products like cigarettes.[1–6] Although versions of these products have been commercially available for decades, in recent years tobacco companies have begun to market new-generation HTPs as alternatives to combustible tobacco products.[6–9] For example, in 2014, Philip Morris International began marketing its HTP system, IQOS, in a handful of regions. Now sold in over 40 countries, IQOS sales have increased exponentially with expectations for continued growth,[10] particularly following its entrance into the US market. In April 2019, Altria received authorization from the US Food and Drug Administration to market IQOS in the United States. As of October 2019, IQOS entered the US market with a handful of stores selling the products in Atlanta, GA.

Although they do not burn tobacco, and therefore may not expose consumers to the same levels of toxic chemicals as cigarettes,[2–4,6] health effects associated with HTPs and their potential to impact public health are unknown. Understanding factors associated with use of HTPs has important implications for gauging the public health effects of these products, and for preventing potential harms associated with increasing availability of HTPs. To date, only a handful of studies address awareness or use of HTPs. A national probability sample of US adults reported that awareness of HTPs increased from 9.3% to 12.4% between 2016 and 2017, with lifetime use of HTPs also increasing (1.4% to 2.2%) during this period.[11] In addition, among a sample of US adolescents (ages 16–19) from the International Tobacco Control Youth Tobacco and E-cigarette Survey study, approximately 9.1% of US respondents reported being aware of HTPs (specifically, IQOS) in 2017.[12] However, no studies to date have focused on samples of US young adults, who may be at particularly high risk for use.[13] Similarly, few studies have examined HTP use or awareness in relation to risk factors such as cigarette dependence or cessation intentions, which is a crucial oversight given HTPs stated potential for facilitating cessation of "ordinary" cigarettes.[6,7] A handful of studies have identified a few demographic and tobacco use characteristics (eg, male gender, cigarette smoking, and ENDS use) as correlates of greater HTP awareness/use[11,12,14,15]; however, the existing literature on this topic is extremely sparse, particularly with respect to studies that assess US samples. Given the high likelihood of widespread marketing and expanded access to these products in the United States in the imminent future, as well as potential regulatory and policy shifts surrounding ENDS that may affect tobacco product use trends, additional work examining a wide range of potential risk and protective factors associated with HTP awareness and use in US samples is urgently needed. Such data can help to clarify, for example, which groups of individuals may be most likely to adopt these new products.

Historically, young adults have been a key target of tobacco marketing campaigns,[16] and recent analyses of HTP marketing strategies suggest that marketing of new-generation HTPs like IQOS may specifically appeal to youth and young adults.[13] Young adulthood is a key transitional period whereby individuals may experiment with using different types of tobacco and other substances; it is also a critical window for tobacco use escalation and progression to regular use,[17] partly due to individuals ages 21 and older being able to legally purchase tobacco products. Furthermore, young adults use other novel noncombustible products like ENDS at significantly higher rates than their older counterparts.[18–20] Thus, young adults may be more likely than other subgroups to be "early adopters" of HTPs.

In addition, certain characteristics may contribute to greater awareness/use of HTPs. For example, use of multiple types of tobacco products (ie, poly-tobacco use), common among young adults,[21,22] may increase familiarity with "alternative" products like HTPs. Similarly, other substance use (particularly marijuana) is strongly correlated with greater likelihood of cigarette smoking, ENDS use, and poly-tobacco use.[21,23–25] Moreover, some HTPs (eg, "dry herb vaporizers," like Pax) can be used to consume both tobacco and marijuana. Thus, young adults who use marijuana may have greater exposure to HTPs. Finally, little is known about how cigarette dependence or cessation intentions relate to HTP awareness/use. Because HTPs are increasingly advertised as cigarette alternatives,[7–9,26] current smokers who want to quit or reduce combustible cigarette use (ostensibly, target HTP consumers) may be more likely to know about or use HTPs. Examining such factors may yield important insights into whether young cigarette smokers who may benefit most from increased access to these products from a harm-reduction standpoint (ie, by switching from combustible tobacco to HTPs) are aware of or using these products.

The current study takes a critical first step in addressing these important questions using survey data collected in 2018–2019 from a large, racially/ethnically diverse sample of US young adults (average age 22 years). We examined factors associated with awareness and lifetime use of HTPs among the full sample, as well as among young adults who currently smoke cigarettes. We hypothesized that all types of tobacco use, using more different types of tobacco products, and other substance use (specifically, marijuana use) would be correlated with greater likelihood of HTP awareness and use. Among current cigarette smokers, we also hypothesized that cigarette consumption, dependence, quitting attempts, and motivation/readiness to quit would be greater among young adults who were aware of or had ever used HTPs compared to those who were unaware of HTPs.

Methods

Procedures

This study utilizes cross-sectional data from the most recent wave of the longitudinal CHOICE-STRATA cohort study, which originated from two cohorts of 6th and 7th grade students recruited in 2008 (wave 1) from 16 middle schools in Southern California, United States as part of a voluntary school-based drug prevention program, CHOICE. Adolescents who participated in the CHOICE study were representative of students in their middle schools in Southern California with respect to demographic and substance use risk.[27] The CHOICE program, conducted over 10 years ago, showed effects on youths' alcohol and other drug use at one year after the program; however, no effects were observed beyond one year for any substance use outcomes, and intervention status at wave 1 is unrelated to substance use or retention across study waves.[27,28] Participants completed waves 1–5 during middle school physical education classes; follow-up rates during this period ranged from 74% to 90%. After wave 5 (2011), participants transitioned from middle school to over 200 high schools and were subsequently re-contacted and re-consented to complete annual Web-based surveys. At wave 6 (2013–2014), 61% of the wave 5 sample participated. We retained

80% of the sample from waves 6–7, 91% of the sample from waves 7–8, 89% of the sample from waves 8–9, 90% of the sample from waves 9–10, and 92% of the sample from waves 10–11. Sample retention from wave to wave is unrelated to demographics or substance use (eg, tobacco, alcohol, marijuana).[29] The present analyses utilize cross-sectional data from the wave 11 survey, fielded online between August 2018 and July 2019, which included items assessing awareness and use of HTPs for the first time. The analytic sample consists of 2497 respondents, the majority of whom (78%) currently reside in California.

Measures

Awareness and Lifetime Use of HTPs

We assessed participants' awareness and use of HTPs using an item modified from Brose et al.[14]: "Heat-not-burn tobacco products (eg, Ploom, IQOS) use a technology whereby tobacco is being heated as opposed to being burned. Thinking about heat-not-burn tobacco products, which of the following statements best applies to you?" Response options were: (1) *I have never heard of heat-not-burn tobacco products and have never tried them*; (2) *I have heard of heat-not-burn tobacco products but have never tried them*; (3) *I have tried heat-not-burn tobacco products but do not use them anymore*; (4) *I have tried heat-not-burn tobacco products and still use them*. Based on responses, we created three HTP awareness/use groups for analysis as follows: *Not aware of HTPs* (response 1 only); *Aware of HTPs* (responses 2, 3, and 4); and *Ever used HTPs* (responses 3 and 4; response 4, current use ["still use them"], was not assessed as a separate category due to extremely small cell sizes, particularly when sub-setting to current cigarette smokers).

Demographic Characteristics

Respondents reported on age, gender, race/ethnicity, sexual orientation, and college/university student status. They also provided information on proxy variables for acculturation status (language spoken at home [English vs. other] and parents' birth country [United States vs. other]) and socioeconomic status (mother's educational attainment).

Tobacco Product Use

Using separate items modified from Monitoring the Future (MTF),[30] participants reported on frequency of lifetime (0 = *none*, 1 = *1 time*, 2 = *2 times*, 3 = *3 times*, 4 = *4–6 times*, *5 = 7 or more times*), past-year (0 = *none*, 1 = *1 time*, 2 = *2 times*, 3 = *3 to 10 times*, 4 = *11 to 20 times*, *5 = more than 20 times*), and past-month (*0 to 30 days*) use of the following tobacco products: cigarettes, ENDS (assessed using two separate items: "Electronic or e-cigarette" and "Personal vaporizer"; items were combined to create a single ENDS use indicator variable),[31] smokeless tobacco, hookah, pipe tobacco, and cigars/cigarillos. Responses were dichotomized to create indicators (*yes/no*) for lifetime, past-year, and past-month use for each tobacco product. In addition, within each reference period, we created variables to indicate use of *any type of tobacco* (1 = yes; 0 = no) and *number of different types of tobacco products used* (range 0–6).

Other Substance Use

We assessed frequency of using alcohol, marijuana, and other drugs (inhalants, cocaine, heroin, hallucinogens, methamphetamine, prescription medications to get high, and over-the-counter medications to get high) with MTF items,[30] using the same reference periods and response options as for tobacco products. We derived dichotomous indicators for any use of alcohol, marijuana, and other drugs for each reference period.

Heaviness of Cigarette Consumption, Dependence, and Cessation-Related Factors

Past-month cigarette users reported average number of cigarettes smoked per day on smoking days. Cigarette dependence was assessed using the 4-item PROMIS Nicotine (Cigarette) Dependence short form[32] and time to first cigarette on smoking days (dichotomized as less than 30 minutes or not). Quitting contemplation was assessed using a modified Contemplation Ladder,[33] which asked: "Which of the following best describes you?" with response options ("rungs") ranging from 1 ("*I enjoy using cigarettes and have decided never to change it. I have no interest in changing the way that I use cigarettes*") to 10 ("*I have quit using cigarettes and will never go back*"). Quitting contemplation was assessed as a continuous variable (1–10). We also created a dichotomized variable to distinguish individuals who indicated readiness to quit/ reduce smoking (rungs 7–10) from those who did not (rungs 1–6). Additionally, current smokers reported the number of times that they attempted to quit or reduce smoking in the past 3 months (0 times; 1 time; 2 times; 3–4 times; 5–10 times; 10 or more times)[34]; responses were dichotomized (0 vs. 1 or more times) to assess differences between those reporting any attempts versus no attempts. Separate items assessed future intentions to smoke cigarettes[35] and to use tobacco products other than cigarettes or ENDS in the next 6 months (*definitely no; probably no; probably yes; and definitely yes*), dichotomized (yes/no) for analyses.

Analyses

First, among the full sample, we used bivariate logistic regression analyses to examine differences in demographic characteristics across individuals who reported that they were (1) not aware of HTPs (reference group) versus those who were, (2) aware of HTPs, and (3) had ever used HTPs (a subset of the individuals who were aware of HTPs). Adjusting for demographic characteristics and CHOICE intervention group at wave 1, we used separate multivariable logistic regression models to examine associations between tobacco and substance use indicators and likelihood of HTP awareness and lifetime use. Among individuals who reported past-month cigarette smoking, separate multivariable logistic regression models examined associations of HTP awareness/use with frequency and quantity of cigarette consumption, dependence, poly-tobacco use, and cessation-related variables. All analyses were conducted in SAS version 9.4.

Results

Sample

Participants (N = 2497) averaged 21.60 years (SD = 0.78), and 63.97% were currently enrolled in college or university. The sample was 44.81% male, 85.09% heterosexual/straight-identifying, 20.63% non-Hispanic White, 45.31% Hispanic, 20.39% non-Hispanic Asian, 2.32% non-Hispanic black, and 11.34% Other races/ethnicities.

Correlates of HTP Awareness and Use in the Full Sample

Table 1 shows demographic characteristics for the full sample and separately for each HTP awareness/use group. Overall,

Table 1. Demographic Characteristics of HTP Awareness and Use Groups

					Comparison with unaware group[a]			
	Overall (*N* = 2497)[b]	Unaware of HTPs (*N* = 2188)	Aware of HTPs (*N* = 293)	Ever used HTPs (*N*= *134*)	Aware of HTPs		Ever used HTPs	
Participant characteristics	*M* (*SD*) /%	*M* (*SD*) /%	*M* (*SD*) /%	*M* (*SD*)/%	*OR* (95% CI)	*p*	*OR* (95% CI)	*p*
Age	21.60 (0.78)	21.59 (0.76)	21.67 (0.88)	21.70 (0.89)	1.14 (0.98, 1.34)	.09	1.21 (0.97, 1.51)	.10
Gender								
Man	44.81%	42.59%	61.43%	59.70%	(ref)	(ref)	(ref)	(ref)
Woman	53.95%	56.27%	36.52%	38.81%	**0.45 (0.35, 0.58)**	**<.0001**	**0.49 (0.34, 0.71)**	**.0001**
Other gender	1.24%	1.14%	2.05%	1.49%	1.24 (0.50, 3.07)	.64	0.93 (0.22, 4.00)	.92
Sexual orientation								
Heterosexual	85.09%	85.59%	81.57%	83.58%	(ref)	(ref)	(ref)	(ref)
Lesbian, gay, bisexual, or other	14.91%	14.41%	18.43%	16.42%	1.34 (0.98, 1.85)	.07	1.17 (0.73, 1.87)	.52
Race/ethnicity								
Non-Hispanic white	20.63%	19.56%	28.77%	20.15%	(ref)	(ref)	(ref)	(ref)
Hispanic	45.31%	46.21%	39.38%	53.73%	**0.58 (0.43, 0.79)**	**.0004**	1.13 (0.72, 1.78)	.60
Non-Hispanic Asian	20.39%	20.70%	17.12%	14.18%	**0.56 (0.39, 0.82)**	**.003**	0.67 (0.36, 1.21)	.18
Non-Hispanic black	2.32%	2.42%	1.71%	1.49%	0.48 (0.19, 1.24)	.13	0.60 (0.14, 2.59)	.49
Other	11.34%	11.11%	13.01%	10.45%	0.80 (0.53, 1.21)	.28	0.91 (0.47, 1.78)	.79
Current college/university student (% Yes)	63.97%	64.84%	57.53%	52.99%	**0.74 (0.57, 0.94)**	**.015**	**0.61 (0.43, 0.87)**	**.006**
Mother's education								
<High School or don't know	20.11%	20.57%	17.12%	20.90%	(ref)	(ref)	(ref)	(ref)
High school	15.71%	15.77%	15.41%	19.40%	1.17 (0.77, 1.80)	.46	1.21 (0.70, 2.10)	.50
>High school	64.18%	63.67%	67.47%	59.70%	1.27 (0.92, 1.77)	.15	0.92 (0.59, 1.44)	.72
Mother born in United States (%Yes)	44.72%	43.95%	51.12%	50.00%	**1.33 (1.03, 1.72)**	**.03**	1.28 (0.88, 1.84)	.20
Only speak English at home (%Yes)	46.05%	45.12%	53.36%	48.33%	**1.39 (1.08, 1.80)**	**.01**	1.14 (0.79, 1.65)	.49

HTP = heated tobacco product; *OR* = odds ratio. Bolded values are intended to indicate significance at $p < .05$.

[a]Separate bivariate logistic regression models were used to assess associations between each factor and likelihood of HTP awareness and lifetime use.

[b]*n* = 16 individuals in the full sample had missing data on HTP awareness/use.

approximately 5% of the sample reported lifetime use of HTPs (with approximately 3% reporting current use) and approximately 12% of the sample was aware of HTPs. Men were more likely to report awareness and use of HTPs compared to women. Compared to non-Hispanic whites, non-Hispanic Asian and Hispanic young people were less likely to report awareness of HTPs. In addition, college/university students were less likely to report awareness and use of HTPs compared to those who were not in college/university. Individuals who reported US-born mothers were more likely to report awareness of HTPs; similarly, those who reported only speaking English at home were more likely to report awareness of HTPs.

Table 2 shows associations between tobacco and other substance use and HTP awareness/use, adjusting for demographic characteristics. Approximately 85% of individuals who reported being aware of HTPs, and 86% of those who ever used HTPs reported using some other type of tobacco product in their lifetime. Over 40% of individuals reporting awareness or lifetime use of HTPs reported past month tobacco use. Only 6% (*n* = 43) of individuals with no lifetime history of other tobacco product use (*n* = 680) reported awareness of HTPs, and only 3% (*n* = 19) reported ever trying HTPs. All tobacco use indicators (any tobacco use; use of specific products; number of different tobacco products used) across all reference time periods (lifetime, past-year, past-month) were positively associated with HTP awareness. A similar pattern was observed for likelihood of ever using HTPs. In addition, marijuana use for all reference periods was positively associated with HTP awareness; lifetime and past-month marijuana use was associated with greater likelihood of lifetime HTP use. Similarly, other drug use across all reference time periods was associated with greater likelihood of awareness and use of HTPs. In contrast, past year alcohol use was correlated with lower likelihood of awareness and use of HTPs, and past-month alcohol use correlated with lower likelihood of use of HTPs.

Tobacco Use, Dependence, and Cessation-Related Correlates of HTP Awareness and Lifetime Use Among Current Cigarette Smokers

Among current cigarette smokers (*n* = 296), approximately 23% (*n* = 68) reported awareness of HTPs and nearly 10% (*n* = 29) reported lifetime use (Table 3). Adjusting for demographic characteristics, smoking more cigarettes per day on smoking days and higher cigarette dependence scores were associated with greater likelihood of HTP awareness and use (although note: time to first cigarette was not correlated with likelihood of lifetime use) (Table 3). Nearly three quarters (72%) of current smokers reported using at least one other tobacco product in the past month, and 23% used two or more other tobacco products in addition to cigarettes; ENDS was the most common "other" type of tobacco product used by current smokers (64% of all current smokers), followed by cigars/cigarillos (19%) and hookah (16%). Using two or more other tobacco products in the past month (compared to using no other products) was associated with greater likelihood

Table 2. Tobacco, Marijuana, and Other Substance Use Characteristics Associated With HTP Awareness and Use

					Comparison with unaware group, adjusting for demographic characteristics[a]			
	Overall (*N* = 2497)	Unaware of HTPs (*N* = 2188)	Aware of HTPs (*N*= 293)	Ever used HTPs (*N* = 134)	Aware of HTPs		Ever used HTPs	
Tobacco product use	*M(SD)*/%	*M(SD)*/%	*M(SD)*/%	*M(SD)*/%	*aOR* (95% CI)	*p*	*aOR* (95% CI)	*p*
Any tobacco use (% Yes)[b]								
Lifetime	72.58%	70.80%	85.32%	85.82%	**2.18 (1.54, 3.08)**	**<.0001**	**2.21 (1.34, 3.64)**	**.002**
Past-year	43.15%	41.09%	57.88%	53.73%	**1.68 (1.30, 2.17)**	**<.0001**	**1.49 (1.04, 2.13)**	**.03**
Past-month	25.83%	23.05%	45.86%	42.86%	**2.41 (1.86, 3.12)**	**<.0001**	**2.27 (1.57, 3.28)**	**<.0001**
# types of different tobacco products used[c]								
Lifetime	2.24 (1.94)	2.09 (1.86)	3.33 (2.12)	3.35 (2.16)	**1.33 (1.24, 1.42)**	**<.0001**	**1.35 (1.23, 1.49)**	**<.0001**
Past-year	0.95 (1.40)	0.84 (1.27)	1.74 (1.96)	1.56 (1.89)	**1.35 (1.26, 1.46)**	**<.0001**	**1.31 (1.18, 1.46)**	**<.0001**
Past-month	0.43(0.90)	0.35 (0.75)	1.01 (1.50)	0.89 (1.44)	**1.62 (1.45, 1.81)**	**<.0001**	**1.55 (1.34, 1.80)**	**<.0001**
ENDS (% Yes)								
Lifetime	58.67%	56.60%	74.57%	72.39%	**2.02 (1.52, 2.68)**	**<.0001**	**1.82 (1.23, 2.70)**	**.0029**
Past-year	31.78%	29.38%	49.48%	47.01%	**2.06 (1.59, 2.66)**	**<.0001**	**2.04 (1.42, 2.92)**	**.0001**
Past-month	18.42%	16.12%	36.08%	32.33%	**2.54 (1.93, 3.35)**	**<.0001**	**2.40 (1.62, 3.57)**	**<.0001**
Cigarette smoking (% Yes)								
Lifetime	55.76%	53.52%	72.26%	71.64%	**2.03 (1.54, 2.68)**	**<.0001**	**1.93 (1.30, 2.86)**	**.0010**
Past-year	25.96%	23.70%	43.15%	37.31%	**2.09 (1.61, 2.71)**	**<.0001**	**1.70 (1.17, 2.47)**	**.005**
Past-month	11.89%	10.33%	23.45%	21.97%	**2.24 (1.64, 3.06)**	**<.0001**	**2.11 (1.35, 3.30)**	**.001**
Smokeless tobacco (% Yes)								
Lifetime	23.13%	20.56%	41.58%	46.27%	**2.33 (1.78, 3.04)**	**<.0001**	**2.91 (2.02, 4.21)**	**<.0001**
Past-year	5.26%	3.75%	16.44%	17.16%	**3.65 (2.45, 5.44)**	**<.0001**	**4.36 (2.58, 7.38)**	**<.0001**
Past-month	1.93%	1.05%	8.62%	8.33%	**6.36 (3.50, 11.53)**	**<.0001**	**6.31 (2.94, 13.57)**	**<.0001**
Hookah (% Yes)								
Lifetime	45.94%	43.76%	61.86%	60.45%	**1.98 (1.52, 2.56)**	**<.0001**	**1.86 (1.29, 2.68)**	**.0008**
Past-year	16.00%	15.12%	22.60%	19.40%	**1.49 (1.10, 2.02)**	**.01**	1.26 (0.80, 1.98)	.32
Past-month	4.83%	4.03%	10.69%	8.27%	**2.48 (1.58, 3.87)**	**<.0001**	**2.04 (1.05, 3.98)**	**.04**
Cigar/cigarillo (% Yes)								
Lifetime	28.31%	24.95%	52.58%	50.75%	**2.75 (2.11, 3.59)**	**<.0001**	**2.67 (1.84, 3.88)**	**<.0001**
Past-year	11.67%	9.40%	28.08%	23.13%	**2.92 (2.15, 3.97)**	**<.0001**	**2.32 (1.49, 3.62)**	**.0002**
Past-month	4.55%	3.12%	14.88%	11.36%	**3.99 (2.62, 6.07)**	**<.0001**	**2.98 (1.63, 5.47)**	**.0004**
Hand pipe (% Yes)								
Lifetime	13.31%	10.69%	32.41%	33.58%	**3.31 (2.47, 4.43)**	**<.0001**	**3.88 (2.61, 5.76)**	**<.0001**
Past-year	4.26%	2.75%	15.07%	11.94%	**4.90 (3.21, 7.50)**	**<.0001**	**4.22 (2.32, 7.65)**	**<.0001**
Past-month	1.45%	0.55%	7.88%	7.46%	**12.80 (6.14, 26.66)**	**<.0001**	**12.57 (5.13, 30.80)**	**<.0001**
Marijuana use (% Yes)								
Lifetime	73.06%	71.30%	85.57%	85.07%	**2.24 (1.58, 3.19)**	**<.0001**	**2.11 (1.29, 3.46)**	**.003**
Past-year	49.86%	48.65%	57.88%	50.75%	**1.31 (1.02, 1.70)**	**.04**	1.03 (0.72, 1.47)	.88
Past-month	32.11%	30.39%	44.83%	42.86%	**1.63 (1.26, 2.10)**	**.0002**	**1.57 (1.09, 2.27)**	**.02**
Alcohol use (% Yes)								
Lifetime	91.04%	90.62%	94.18%	91.04%	1.65 (0.97, 2.81)	.06	1.00 (0.54, 1.86)	.99
Past-year	78.67%	79.23%	73.88%	63.91%	**0.70 (0.52, 0.94)**	**.02**	**0.45 (0.31, 0.65)**	**<.0001**
Past-month	67.55%	67.72%	65.86%	57.89%	0.87 (0.66, 1.13)	.30	**0.62 (0.43, 0.90)**	**.01**
Other drug use[d] (% Yes)								
Lifetime	50.00%	47.02%	72.35%	72.39%	**2.71 (2.05, 3.56)**	**<.0001**	**2.78 (1.88, 4.13)**	**<.0001**
Past-year	20.48%	17.94%	38.57%	33.58%	**2.45 (1.87, 3.22)**	**<.0001**	**2.24 (1.52, 3.32)**	**<.0001**
Past-month	9.70%	8.18%	20.76%	19.55%	**2.52 (1.80, 3.52)**	**<.0001**	**2.60 (1.62, 4.15)**	**<.0001**

aOR = adjusted odds ratio; ENDS = electronic nicotine delivery systems; HTP = heated tobacco product. Bolded values are intended to indicate significance at $p < .05$.

[a]Separate logistic regression models assessed associations between each factor and likelihood of HTP awareness or lifetime use. All models controlled for age, race/ethnicity, gender, sexual orientation, college status, mother's education, and CHOICE wave 1 intervention group.

[b]Any use of: cigarettes, ENDS, smokeless tobacco, hookah, cigars/cigarillos, or pipe tobacco.

[c]Sum of number of different types of tobacco products used (cigarettes, ENDS, smokeless tobacco, hookah, cigars/cigarillos, or pipe tobacco), range 0–6.

[d]Other drug use included inhalants, cocaine, heroin, hallucinogens, methamphetamine, prescription medications to get high, and over-the-counter medications to get high.

of HTP awareness and use. In addition, smokeless tobacco, cigar/cigarillo, and pipe tobacco use were associated with greater likelihood of HTP awareness and use. HTP awareness and use were unrelated to number of smoking days in the past month, cigarette contemplation/quit stage, number of attempts to quit or cut down in recent months, or future intentions to smoke cigarettes or use other tobacco products. Finally, past-month marijuana use among current smokers was also associated with greater awareness of HTPs; alcohol and other drug use were not correlated with HTP awareness or lifetime use.

Table 3. Factors Associated With HTP Awareness Among Current Smokers

					Comparison with unaware group, adjusting for demographic characteristics[a]			
	Overall (*N* = 296)	Unaware of HTPs (*N* = 226)	Aware of HTPs (*N* = 68)	Ever used HTPs (*N* = 29)	Aware of HTPs		Ever used HTPs	
	M (SD) /%	*M (SD)* /%	*M (SD)* /%	*M (SD)*/%	*aOR* (95% CI)	*p*	*aOR* (95% CI)	*p*
Cigarette consumption								
Smoking days in past month	7.79 (9.78)	7.58 (9.56)	8.40 (10.63)	8.59 (10.86)	1.00 (0.97, 1.03)	.91	1.01 (0.97, 1.05)	.78
Cigarettes per day	2.23 (3.30)	1.80 (2.49)	3.37 (4.51)	4.47 (5.52)	**1.15 (1.05, 1.26)**	**.003**	**1.25 (1.11, 1.41)**	**.0003**
Dependence								
Cigarette dependence score[a]	0.55 (0.86)	0.46 (0.76)	0.85 (1.09)	1.15 (1.38)	**1.55 (1.14, 2.12)**	**.006**	**2.02 (1.37, 3.00)**	**.0004**
Time to first cigarette on smoking days								
Less than 30 minutes	13.54%	10.78%	21.67%	23.08%	**2.38 (1.02, 5.55)**	**.045**	2.53 (0.81, 7.94)	.11
30 minutes or more	86.46%	89.22%	78.33%	76.92%	(ref)	(ref)	(ref)	(ref)
Poly-tobacco use								
Number of additional tobacco products used in the past month								
0	27.70%	29.65%	19.12%	24.14%	(ref)	(ref)	(ref)	(ref)
1	49.66%	52.21%	42.65%	37.93%	1.33 (0.63, 2.84)	.46	1.12 (0.39, 3.26)	.83
≥2	22.64%	18.14%	38.24%	37.93%	**3.26 (1.44, 7.40)**	**.005**	**3.12 (1.00, 9.71)**	**.0497**
Concurrent use of specific tobacco products in the past month (% Yes)								
ENDS	64.29%	62.05%	73.53%	58.62%	1.91 (0.98, 3.72)	.06	1.27 (0.52, 3.11)	.60
Smokeless tobacco	9.80%	5.75%	23.53%	31.03%	**4.46 (1.91, 10.44)**	**.0006**	**6.16 (2.10, 18.13)**	**.001**
Hookah	16.27%	13.78%	25.00%	27.59%	2.00 (0.96, 4.17)	.06	2.53 (0.91, 7.05)	.08
Cigar/cigarillo	19.05%	14.22%	35.82%	41.38%	**3.11 (1.58, 6.11)**	**.001**	**3.65 (1.48, 8.99)**	**.005**
Pipe tobacco	7.09%	2.65%	22.06%	24.14%	**10.36 (3.53, 30.36)**	**<.0001**	**12.11 (3.13, 46.89)**	**.0003**
Cigarette cessation-related factors								
Cigarette contemplation ladder[b]	7.00 (2.87)	6.85 (2.95)	7.50 (2.57)	7.00 (3.21)	1.07 (0.97, 1.19)	.19	0.95 (0.83, 1.10)	.50
Not ready to quit or reduce (rungs 1–6)	36.61%	39.82%	26.47%	34.48%	(ref)	(ref)	(ref)	(ref)
Ready to quit or reduce (rungs 7–10)	63.39%	60.18%	73.53%	65.52%	1.75 (0.93, 3.28)	.08	0.90 (0.38, 2.14)	.81
Number of attempts to cut down or stop cigarette smoking in past 3 months	1.64 (2.61)	1.51 (2.54)	1.82 (2.61)	2.19 (2.87)	1.03 (0.91, 1.16)	.67	1.06 (0.90, 1.24)	.48
Any attempt to cut down or stop cigarette smoking in past 3 months? (%Yes)	47.64%	43.86%	56.67%	57.69%	1.40 (0.74, 2.67)	.30	1.31 (0.52, 3.31)	.57
Future use intentions								
Future intentions to smoke cigarettes (next 6 months)								
Definitely/Probably No	34.58%	34.07%	35.29%	41.38%	(ref)	(ref)	(ref)	(ref)
Definitely/Probably Yes	65.42%	65.93%	64.71%	58.62%	0.90 (0.49, 1.64)	.72	0.77 (0.33, 1.79)	.54
Future intentions to use other tobacco products (next 6 months)								
Definitely/Probably No	58.64%	59.29%	55.88%	65.52%	(ref)	(ref)	(ref)	(ref)
Definitely/Probably Yes	41.36%	40.71%	44.12%	34.48%	1.11 (0.62, 1.98)	.74	0.71 (0.30, 1.72)	.45

Table 3. Continued

	Overall (*N* = 296)	Unaware of HTPs (*N* = 226)	Aware of HTPs (*N* = 68)	Ever used HTPs (*N* = 29)	Comparison with unaware group, adjusting for demographic characteristics[a]			
					Aware of HTPs		Ever used HTPs	
	M (SD) /%	*M (SD)* /%	*M (SD)* /%	*M (SD)*/%	*aOR* (95% CI)	*p*	*aOR* (95% CI)	*p*
Other substance use[c]								
Past-month marijuana use	64.63%	60.89%	77.61%	79.31%	**2.23 (1.15, 4.33)**	**.02**	2.54 (0.93, 6.96)	.07
Past-month alcohol use	90.51%	92.04%	85.07%	79.31%	0.52 (0.22, 1.26)	.15	0.37 (0.12, 1.17)	.09
Past-month other drug use	36.39%	34.96%	40.30%	44.83%	1.12 (0.62, 2.02)	.71	1.47 (0.63, 3.40)	.37

aOR = adjusted odds ratio; ENDS = electronic nicotine delivery systems; HTP = heated tobacco product. Separate logistic regression models assessed associations between each factor and likelihood of HTP awareness or lifetime use. All models controlled for age, race/ethnicity, gender, sexual orientation, college status, mother's education, and CHOICE wave 1 intervention group. Bolded values are intended to indicate significance at $p < .05$.

[a]PROMIS Nicotine (Cigarette) Dependence Short Form summary score, range 0–4.

[b]Cigarette Contemplation Ladder scores ranged 1–10, and response options were: 1 = I enjoy using cigarettes and have decided never to change it. I have no interest in changing the way that I use cigarettes; 2 = I never think about changing the way that I use cigarettes, and I have no plans to change; 3 = I rarely think about changing the way that I use cigarettes, and I have no plans to change; 4 = I sometimes think about changing the way that I use cigarettes, but I have not planned to change it yet; 5 = I often think about changing the way that I use cigarettes, but I have not planned to change it yet; 6 = I definitely plan to change my cigarettes use, but I am not ready to make any plans about how to change; 7 = I definitely plan to change my cigarettes use, and I am ready to make some plans about how to change; 8 = I still use cigarettes, but I will begin to change, like cutting back on the amount of cigarettes that I use; 9 = I have cut down on or quit my cigarette use, but I still worry about slipping back, so I need to keep working on the changes I have made; 10 = I have quit using cigarettes and will never go back.

[c]Other drug use included inhalants, cocaine, heroin, hallucinogens, methamphetamine, prescription medications to get high, and over-the-counter medications to get high.

Discussion

This is one of the first studies to examine correlates of HTP awareness and lifetime use among young adults in the US. Findings add to the HTP literature by describing correlations between HTP awareness/use and multiple types of tobacco product and other substance use, as well as associations between tobacco dependence and cessation-related factors and HTP awareness/use among current smokers. Overall, rates of HTP awareness/use in this sample were similar to those observed in recent US studies,[11,12] with over 1 in 10 (12%) young adults reporting awareness of HTPs, and approximately 5% reporting lifetime use.

As anticipated, use of any type of tobacco product during any time frame (lifetime, past-year, past-month) was positively associated with HTP awareness and use in the full sample. Additionally, using more types of tobacco products during any reference period was associated with greater awareness and use of HTPs. Similarly, consistent with our hypotheses, marijuana and other drug use correlated with greater likelihood of HTP awareness and use in the full sample; among current smokers, past-month marijuana use was also associated with greater awareness of HTPs. Young people who engage in poly-tobacco and/or poly-substance use may be more inclined to experiment with a multitude of different tobacco products, perhaps due to some common underlying propensity to use substances.[36] Additionally, young adults who use drugs such as marijuana may be exposed to situations that increase exposure and/or access to different types of tobacco products,[37] which may put them at greater risk for experimenting with HTPs. Furthermore, some types of devices (eg, dry herb vaporizers) can be used to consume both tobacco and other drugs like marijuana (ie, using one type of substance independently or co-administering [mixing together] in the same use episode),[31] which could facilitate greater awareness and use of HTPs among individuals who use similar products to consume marijuana. Future studies examining specific types of products/brands associated with HTP and marijuana use patterns, as well as co-administration of tobacco and marijuana, could help clarify correlations between HTP and marijuana use observed in this study.

Rates of awareness and use of HTPs among tobacco-naïve individuals were low; however, a sizeable minority (approximately 14%) of individuals who endorsed ever using HTPs had no lifetime history of other tobacco use. This suggests that HTPs may not exclusively appeal to current or even former tobacco users. As HTPs become increasingly available in the United States, monitoring use of these products among tobacco-naïve individuals may be critical for informing prevention efforts and reducing potential public health harms associated with the introduction of these novel products.

Among current smokers, nicotine dependence was associated with greater likelihood of awareness and use of HTPs. Further, use of multiple tobacco products correlated with HTP awareness and use: roughly half of the smokers reporting lifetime use of HTPs endorsed using two or more tobacco products in addition to cigarettes within the past month. However, contrary to our hypotheses, factors related to smoking cessation were unrelated to HTP awareness or use. Although the current study did not assess attitudes toward or reasons for using HTPs, this pattern of findings may suggest that young adult cigarette smokers—especially those who already use other tobacco products—may view HTPs as simply another method of consuming nicotine/tobacco, rather than a means of transitioning off of combustible tobacco. This is consistent with past reports of young adults' attitudes toward ENDS, which indicate that some individuals view ENDS as simply another method or "toy" for using tobacco.[38] Of note, use of multiple tobacco products may lead to greater dependence,[21,22,39] which could make cessation more difficult for young people who wish to quit smoking in the future.[22] Future longitudinal work is needed to better understand patterns and motivations for using HTPs, particularly among individuals who use multiple tobacco products.

Similar to ENDS,[40] available evidence suggests that HTP use may lead to less exposure to some—but not all—types of harmful compounds compared to combustible tobacco.[2–4,6] However, actual health effects associated with long-term HTP use are yet unknown, and net benefits to public health will likely depend in part upon whether smokers –who otherwise would not have quit with or without the use of approved, efficacious methods such as nicotine replacement therapy—are able to switch entirely from using combustible cigarettes to HTPs.[1,6,7,9] Although recent data suggest that some smokers may completely "replace" smoking with HTPs,[26] more research is needed to determine which types of individuals can successfully make this switch and whether such changes are temporary or long-term. In the context of an increasingly diverse tobacco product landscape and continued widespread availability of combustible products, clear messaging surrounding relative health risks and policy measures aimed at limiting appeal to non-smokers (eg, surrounding flavors, marketing, and youth access to HTPs) may be needed to determine whether HTPs achieve their promise of reducing harms compared to "ordinary smoking." Given the changing tobacco landscape, ongoing surveillance is needed to understand patterns of utilization, consumer perceptions (eg, of health risks[41]), and potential net harms and benefits associated with HTPs.

Findings must be considered in the context of limitations. First, we used a single item to assess HTP awareness and lifetime use. Based on this item, we were unable to distinguish between experimentation versus more frequent use of these products. Similarly, we could not distinguish between specific types of HTPs, including products that might support use of both marijuana and tobacco. Although we referenced specific brands of newer-generation HTPs that hold the greatest market share globally (eg, IQOS), these products were not yet marketed in the United States during the period in which data collection occurred. However, as noted above, rates of HTP awareness/use were consistent with those observed in other recent US samples. In addition, this sample is not nationally representative; participants are based predominantly in California, which differs in important ways with respect to tobacco policies compared to other parts of the United States. However, rates of substance use (eg, ENDS, alcohol, marijuana) are largely consistent with those from national samples of youth, such as MTF,[30] and the racial/ethnic diversity of the sample is a considerable strength. Future studies with large, representative samples spanning different policy environments are needed to determine whether and how HTP use may differ in relation to variable tobacco policy settings.

The current study adds to the small but growing literature on HTP awareness and use among young adults. We found that awareness and use of HTPs strongly correlated with other tobacco product use, marijuana use, and other drug use in the full sample, and with greater cigarette dependence—but not cessation-related factors—among current cigarette smokers. However, a sizeable minority of individuals reporting lifetime HTP use had never used another tobacco product, which suggests that HTPs may not exclusively appeal to tobacco users. As new HTPs become increasingly accessible in the United States, work must continue to address the use patterns and

potential public health consequences of these products in an increasingly diverse tobacco product landscape.

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Declaration of Interests

None declared.

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