Variations in Electronic Nicotine Delivery System (ENDS) Device Types and Association with Cigarette Quit Attempts

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Abstract

This study examined Electronic nicotine delivery systems (ENDS) devices classified as disposable, non-refillable cartridge, refillable cartridge, refillable tank, and refillable mod systems and examined if cigarette quit attempts varied by device type among daily and non-daily ENDS users. Data from Wave 3 (2015–16) of the Population Assessment of Tobacco and Health Study, a nationally representative study in the U.S. was used to explore ENDS device types among past 12 month adult cigarette and ENDS users (n=4,952). Multivariate models were fitted to predict cigarette quit attempts among daily (n=474) and nondaily (n=1,074) ENDS users by ENDS device types. Analyses were conducted in April 2020.

Refillable tank system (38.5%) was the most prevalent and refillable cartridge was the least prevalent (3.3%) device type among past 12 month cigarette and ENDS users. Adults who used disposable ENDS were least likely to use ENDS as an alternative to quitting (p< 0.001) or as a way of cutting down on smoking (p< 0.001). The odds of attempting to quit smoking were higher among daily ENDS users who used non-refillable cartridge (AOR=7.3, 95% CI: 1.5 – 34.9), refillable tank (AOR=5.3, 95% CI: 1.5 – 19.3) or refillable mod systems (AOR=5.9, 95% CI: 1.2 – 30.1) compared to those who used disposables adjusting for age group, gender, race, ethnicity, and nicotine dependence. The likelihood of quit attempt among non-daily ENDS users did not differ by device type. Better understanding of ENDS device types and their use in smoking cessation is needed to inform health interventions.

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Introduction

Electronic nicotine delivery systems (ENDS) are a diverse group of battery-operated devices that produce an aerosol containing nicotine and other additives that are inhaled by a user.[1] Use of ENDS has grown tremendously in the past few years especially among youth and young adults.[2,3] The product was first introduced in the market in 2007 as first generation device that looked like cigarettes, hence referred to as "cigalikes."[4] As the market has grown, several device types that are more sophisticated and customizable have been introduced. Of the few studies on ENDS device types, most have classified the devices as open/closed systems or by generations.[5,6,7] Open systems include reloadable devices with cartridges or second and third generation customizable devices commonly referred to as "tanks" and "mods" which allow a user to refill the chamber with customizable nicotine level flavor(s), and humectants such as propylene glycol (PG) and glycerol.[8] Closed systems, on the other hand, are not customizable and consist of prefilled cartridges.[5]

Using Wave 3 of the Population Assessment of Tobacco and Health (PATH) Study data, we had the unique opportunity to extend previous analyses and examine ENDS device types as disposable, non-refillable cartridge products, refillable cartridge product, refillable tank system and refillable mod system products. Aims of the study were (1) to describe user characteristics by ENDS device types and (2) to explore whether ENDS device types were associated with quit attempts among cigarette smokers in a nationally representative sample of adult ENDS users. Previous studies have shown inconsistent results in terms of associations between ENDS use with cigarette quit attempts and successful quits. To our knowledge, however, no study has examined quit outcomes by ENDS device types.[9,10,11]

Methods

Data Source

The PATH Study is an ongoing, nationally representative, longitudinal cohort study of youth (ages 12–17) and adults (18 or older) in the United States. Self-reported data were collected using audio computer-assisted self-interviews (ACASI) administered in English and Spanish. The PATH Study recruitment employed a stratified address-based, area-probability sampling design at W1 that oversampled adult tobacco users, young adults (ages 18–24), and African American adults. An in-person screener was used at Wave 1 to randomly select youth and adults from households for participation in the study. At Wave 1, the weighted response rate for the household screener was 54.0%. Among screened households, the overall weighted response rate was 78.4% for adults at Wave 3. Further details are published elsewhere.[12] The study was approved by the Westat Institutional Review Board. All respondents ages 18 and older provided informed consent. This analysis used Wave 3 adult data (n=28,148) that were collected between October 2015 to October 2016 and all analyses were conducted in April 2020. First, the analytic sample was restricted

to past 12 month cigarette smokers and ENDS users (n=4,952) to describe past 12-month dual users by ENDS device types (Table 1). Further, to examine cigarette quit attempts by ENDS device types, analysis was conducted separately among daily ENDS users (n=474) and someday or non-daily ENDS users (n=1,040) (Table 2).

Measures

Demographic characteristics of respondents included age groups (18–24, 25 or older), gender (male/female), race (White alone, Black alone or Other race), ethnicity (Hispanic/Non-Hispanic), and household income (less than $10,000, $10,000 to $24,999, $25,000 to $49,999, $50,000 to $99,999, $100,000 or more).

Participants responded to questions about use of tobacco products. Past 12-month cigarette and ENDS users included those who used the products in the past 12 months, irrespective of use of any other tobacco product. At Wave 3, ENDS were described as "electronic nicotine products such as e-cigarettes, e-cigars, e-pipes, e-hookahs, and personal vaporizers, as well as vape pens and hookah pens that are battery-powered, use nicotine fluid rather than tobacco leaves, and produce vapor instead of smoke. Some ENDS can be bought as one-time, disposable products, while others can be bought as re-usable kits with a cartridge or tank system. Some people refill their own ENDS with nicotine fluid, sometimes called "e-liquid" or "e-juice". Disposable ENDS cartridges and e-liquid come in many different flavors and nicotine concentrations. Some common brands include Vuse, Blu, Logic, MarkTen, NJOY, and eGo". Participants were shown generic pictures of ENDS. ENDS device types were categorized as follows in the PATH survey: 1) disposable ENDS (device is not rechargeable, does not use tank system or cartridges, cannot refill with e-liquid); 2) non-refillable cartridge ENDS (device is rechargeable, does not use tank system or cartridges, cannot refill with e-liquid); 3) refillable cartridge ENDS (device is rechargeable, does not use tank system, uses cartridges, can refill with e-liquid); 4) refillable tank system ENDS (device is rechargeable, uses tank system, can refill with e-liquid); 5) refillable mod system ENDS (device is rechargeable or non-rechargeable, may or may not use tank system or cartridges, can refill with e-liquid); 6) unknown (any other combination).

Among ENDS users, detailed questions about ENDS device type, nicotine content were asked about the type of device they mostly used. Reasons to use ENDS were asked with yes/no options. Ever ENDS users were asked if they currently used ENDS "everyday", "someday", or "not at all". Those who chose "everyday" were categorized as daily ENDS users and "someday" users as non-daily users. Nicotine dependence was coded as continuous variable using a 16-item scale.[13] Details of all measures are presented in the Appendix.

Outcome measure: Adult smokers were asked, "In the past 12 months, have you tried to quit cigarettes completely?" Those who either made a quit attempt in the past 12 months or became a former user in the past 12 months were defined as quit attempters. Past 12-month quit attempt was examined as the main outcome which was dichotomously coded as yes/no.

Analyses

Analyses were run on the Wave 3 Public Use File[14] obtained from the National Addiction & HIV Data Archive Program using SAS Survey Procedures, version 9.4 (SAS Institute Inc., Cary, NC). Variances were estimated using the balanced repeated replication method[15] with Fay's adjustment set to 0.3 to increase estimate stability.[16] First, weighted estimates were calculated for ENDS device types among all past year cigarette smokers who also used ENDS (n=4,952). The device types were described by demographics, ENDS device characteristics, and reasons to use ENDS. Statistically significant differences between device types and users characteristics were assessed using chi-square tests (Table 1). Separate bivariate and multivariate logistic regression models were fit to predict cigarette quit attempts among daily ENDS users (n=474) and non-daily ENDS users (n=1,040) by ENDS device types adjusting for age, gender, race/ethnicity, income, and nicotine dependence (Table 2). The models are based on complete cases with no missing values in the dependent variable and the covariates; less than 5% of the data were missing.

Results

As shown in Table 1, prevalence estimates of ENDS by device type among past 12 month-cigarette and ENDS users are as follows: Disposable 10.4% (95% CI: 9.4–11.4), Non-Refillable Cartridge 8.1% (95% CI: 7.2–9.1), Refillable Cartridge 3.5% (95% CI: 2.9–4.2), Refillable Tank System 38.5% (95% CI: 36.4–40.6), Refillable Mod System 4.9% (95% CI: 4.1–5.6) and Unknown type 34.6% (95% CI: 32.7–36.5). Table 1 also shows statistically significant differences in age, sex, race/ethnicity, and income among users of different ENDS device types. For example, adults who use Refillable Mod System ENDS **a**re more likely to be younger compared to users of other device types and disposable ENDS are less likely to be White compared other device type users. Similarly, device type users differ in reasons for use. Compared to other type users, disposable users are least likely to report that the device does not contain nicotine. Disposable users are also least likely to use ENDS "as an alternative to quitting tobacco" or "as a way of cutting down on cigarette smoking".

Table 2 presents odds ratios from bivariate and multivariate models predicting quit attempts among past year cigarette smokers who used ENDS daily and non-daily in separate models. The odds of attempting to quit smoking cigarettes were higher among daily ENDS users who used non-refillable cartridge (AOR=7.3, 95% CI: 1.5 – 34.9), refillable tank (AOR=5.3, 95% CI: 1.5 – 19.3) or refillable mod systems (AOR=5.9, 95% CI: 1.2 – 30.1) compared to those who used disposables after adjusting for age group, gender, race, ethnicity, and nicotine dependence. The likelihood to attempt to quit smoking among non-daily ENDS users did not differ by device type.

Discussion

This is the first study to (a) describe detailed patterns of ENDS device type use in a nationally representative sample of U.S. adults and (b) to explore if quit attempts among cigarette smokers differ by ENDS device type. The study found that disposable ENDS users are least likely while refillable tank users are most likely to endorse using ENDS as an

alternative to quitting tobacco or as a way of cutting down on cigarette smoking. Refillable tank users were also most likely to perceive that ENDS might be less harmful than smoking cigarettes. Reports of exposure to nicotine from ENDS are highly variable and depend on characteristics of the device.[8] It is likely that because refillable devices are customizable, if ENDS users use high concentration nicotine resulting in higher nicotine yield, they may be more likely to use tanks for attempting to quit smoking than other devices.[17] However, more recent nonrefillable cartridge products like JUUL can also contain high concentrations of nicotine and need to be further explored by future studies.

There were also differences in quit attempts by device type among daily ENDS users. Compared to disposable users, the likelihood of attempting to quit was higher among those who used refillable cartridge or tanks and nonrefillable cartridge after adjusting for covariates. Later generation refillable cartridges and tanks deliver aerosols with nicotine to the lungs more efficiently.[11,17] Differences between refillable cartridge or tanks and disposable devices may be responsible for differences in utility of ENDS as a smoking cessation aid.[11] This analysis, however, did not find differences in successful quitting by device type among non-daily ENDS users. These findings are consistent with earlier studies showing that those who use ENDS more frequently are more likely to quit,[18,19].

Limitations

Study limitations include use of self-reported data, which are subject to recall bias. Because analyses were cross-sectional, we were unable to establish temporal relationships between intent to quit smoking, use of ENDS device, and successful quits over time. Almost 35% of ENDS users could not correctly identify the device type of use (labelled as "unknown" in this analysis). This may have led to over or underestimation of other device type users. These findings may have changed as the data was collected 3–4 years ago and in recent times the landscape of ENDS devices has changed significantly. Brands like JUUL and JUUL-like entities that are available in high nicotine concentrations may affect quit attempts and successful quits differently. In addition, new flavor regulations may also impact device types of choice. In January 2020, the Food and Drug Administration issued a policy to prioritize enforcement against unauthorized flavored cartridge-based e-cigarettes other than tobacco or menthol. Restriction in sales and distribution of such ENDS devices may also impact choice of ENDS devices; future studies are needed in this area.

Conclusions

Although findings are cross-sectional, they contribute to our understanding of differences in ENDS device types and their association with cigarette quit attempts in a nationally representative sample. Research to date on the impact of ENDS device types on quitting has been fairly limited; more research is needed to understand the impact of device types on smoking and vaping behaviors. For example, if some device types are more effective than others in aiding smokers to quit, this could have major public health implications. Future longitudinal studies are needed to determine frequency and duration of ENDS use and nicotine content by device type in relation to quit attempts and successful quitting. .

Given the recent surge in brands like JUUL, examining characteristics of brands within device types could also have regulatory implications for ENDS products.

Funding Sources:

Appendix:: Glossary of Measures

Construct	Definitions
Demographics	
Age group	18–24, 25 or older
Gender	Male/ Female
Race	Identifies as White alone, Black alone or Other race
Ethnicity	Hispanic/Non-Hispanic
Income level	Defined as less than $10,000, $10,000 to $24,999, $25,000 to $49,999, $50,000 to $99,999, $100,000 or more
ENDS use characteristics	
Contain nicotine	Yes/No
Past-12 month ENDS use	Yes/No irrespective of use of any other tobacco product At Wave 3, the PATH Study described ENDS as the following "E-cigarettes look like regular cigarettes, but are battery-powered and produce vapor instead of smoke. There are many types of e-cigarettes. Some common brands include NJOY, Blu and Smoking Everywhere." Some ENDS can be bought as one-time, disposable products, while others can be bought as re-usable kits with a cartridge or tank system. Some people refill their own ENDS with nicotine fluid, sometimes called "e-liquid" or "e-juice". Disposable ENDS cartridges and e-liquid come in many different flavors and nicotine concentrations. Some common brands include Vuse, Blu, Logic, MarkTen, NJOY, and eGo.
Past 12-month cigarette use	Yes/No irrespective of use of any other tobacco product
E-Product device type	1 Disposable ENDS (device type is not rechargeable, does not use tank system or cartridges, cannot refill with e-liquid). The device is one time use, and is discarded after it no longer works because a) the e-liquid runs out; b) the atomizer wears out; or c) the battery dies. Examples include NJOY, PUFF Bar, Blu. 2 Non-Refillable Cartridge ENDS (device type is rechargeable, does not use tank system, uses cartridges, cannot be refilled with e-liquid). Examples include Blu and JUUL. When the cartridge is empty, the user replaces it with another pre-filled disposable cartridge. 3 Refillable Cartridge ENDS (device type is rechargeable, does not use tank system, uses cartridges, cannot be refilled with e-liquid). Example includes Suorin. Users initially buy a prefilled cartridge but the cartridge is manufactured to be refillable up to 3 or 4 times, before replacing with a new prefilled cartridge. 4 Refillable Tank System ENDS (device type is rechargeable, uses tank system, could be refilled with e-liquid). Examples include Smok, eGO, iTaste. They come in pen shaped (e.g. vape pens, tank pens) or box shaped (e.g. larger battery; some have digital displays). Users can refill tank devices with their own e-liquid. 5 Refillable Mod System ENDS (device type could be rechargeable or non-rechargeable, refillable and may or may not contain a reservoir or tank). Mod devices are customized by the user with their own combination of batteries, atomizers, etc. 6 Unknown (any other combination)
Reasons to Use ENDS	Reasons to use include the following with yes/no options: [1] it was affordable, [2] use it at times when or in places where smoking cigarettes not allowed, [3] it might be less harmful than smoking cigarettes, [4] it might be less harmful to people around me than smoking cigarettes, [5]

Construct	Definitions
	comes in flavors respondent liked, [6] helps people to quit smoking cigarettes, [7] do not smell, [8] feels like smoking a regular cigarette, [9] it is more acceptable to non-tobacco users, [10] as a way of cutting down on cigarette smoking, [11] as an alternative to quitting tobacco altogether
Frequency of ENDS use	Ever ENDS users are asked if they currently use ENDS, "every day", "someday", or "not at all"; those who respond "everyday" were included as daily users and those whose who selected "some day" were included as non-daily users in this analysis.
Concentration level of nicotine usually used	ENDS users who used an electronic nicotine product that contained nicotine were asked about the concentration level of nicotine categorized into: I don't know the concentration, 0 mg or 0.0%, 1 – 12 mg or 0.1 – 1.2%, 13 – 17 mg or 1.3 – 1.7%, 18 – 24 mg or 1.8 – 2.4%, 25+ mg or 2.5+%
Nicotine dependence	Composite tobacco dependence summary measure, reduced from several multi-item measures of tobacco dependence using item response theory analyses, and representing a common 16-item tobacco dependence measure from tobacco product such as cigarettes, ENDS, cigars, pipe, hookah, and smokeless tobacco Each of the original 16 items were rescaled to 3-level response categories (0, 50, 100) and averaged to create a continuous variable with a range of 0–100 and representing, respectively, low to high levels of dependence. Non- users were coded a value of 0.
Outcomes	
Past 12-month quit attempt	Adult cigarette smokers were asked, "In the past 12 months, have you tried to quit cigarettes completely?" Adult smokers who either made a quit attempt in the past 12 months or became a former user in the past 12 months are included.

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Table 1.

Descriptive Analysis of Sample Characteristics by ENDS Device Types among Past 12-month Cigarette and ENDS users

	ENDS Device Types						
	Disposable ENDS	Non-Refillable Cartridge ENDS	Refillable Cartridge ENDS	Refillable Tank System ENDS	Refillable Mod System ENDS	Unknown	
Characteristics	unweighted N= 530 (10.4%)	unweighted N= 370 (8.1%)	unweighted N= 162 (3.5%)	unweighted N= 1908 (38.5%)	unweighted N= 284 (4.9%)	unweighted N= 1698 (34.6%)	p value*
	Weighted Column% (95% CI)	Weighted Column% (95% CI)	Weighted Column% (95% CI)	Weighted Column% (95% CI)	Weighted Column% (95% CI)	Weighted Column% (95% CI)	
Demographics							
Age group							
18–24	27.8 (23.8 – 31.8)	10.3 (7.3 – 13.8)	21.5 (15.1 – 29.1)	28.7 (26.5 – 30.9)	47.3 (39.1 – 55.4)	25.9 (23.4 – 28.4)	<.0001
25+	72.2 (68.2 – 76.3)	89.8 (86.2 – 92.7)	78.5 (70.9 – 84.9)	71.3 (69.1 – 73.6)	52.7 (44.6 – 60.9)	74.1 (71.6 – 76.6)	
Sex							
Male	52.9 (48.8 – 57.0)	46.7 (41.2 – 52.1)	46.1 (37.9 – 54.3)	58.9 (56.5 – 61.4)	56.2 (48.9 – 63.5)	53.5 (50.9 – 56.1)	0.0004
Female	47.1 (43.0 – 51.2)	53.4 (47.9 – 58.8)	53.9 (45.7 – 62.1)	41.1 (38.6 – 43.6)	43.8 (36.5 – 51.1)	46.5 (43.9 – 49.2)	
Race							
White alone	68.7 (63.7 – 73.7)	84.8 (80.7 – 88.4)	83.2 (75.6 – 89.2)	82.3 (79.7 – 84.7)	75.4 (68.7 – 81.4)	76.1 (73.4 – 78.6)	<.0001
Black alone	21.3 (17.2 – 26.0)	6.9 (4.4 –10.3)	14.0 (8.4 – 21.4)	8.0 (6.3 – 9.9)	12.7 (8.3 – 18.2)	13.8 (11.9 – 16.0)	
Other	10.0 (6.9 – 13.8)	8.3 (5.5 – 11.9)	2.8 (0.8 – 6.8)	9.7 (8.1 – 11.4)	11.9 (7.4 – 17.8)	10.1 (8.5 – 11.9)	
Ethnicity							
Hispanic	19.3 (15.9 – 23.1)	7.7 (5.1 – 10.9)	17.6 (10.5 – 26.9)	11.6 (10.2 – 13.2)	22.6 (17.2 – 28.9)	16.3 (14.0 – 18.8)	<.0001
Non-Hispanic	80.7 (76.9 – 84.1)	92.4 (89.1 – 94.9)	82.4 (73.1 – 89.5)	88.4 (86.8 – 89.8)	77.4 (71.1 – 82.9)	83.7 (81.2 – 86.0)	
Income							
Less than $10,000	28.3 (24.0 – 32.6)	18.7 (14.4 – 23.7)	18.8 (11.9 – 27.3)	16.1 (14.0 – 18.3)	28.0 (21.5 – 34.5)	20.7 (18.8 – 22.8)	<.0001
$10,000 to $24,999	23.2 (19.1 – 27.8)	24.0 (19.7 – 28.9)	28.7 (19.7 – 37.7)	24.9 (22.9 – 27.0)	22.4 (17.0 – 28.5)	25.5 (22.9 – 28.2)	
$25,000 to $49,999	23.5 (19.6 – 27.8)	24.1 (18.5 – 30.4)	27.4 (19.4 – 35.3)	27.6 (24.8 – 30.5)	25.1 (18.8 – 31.4)	24.5 (21.9 – 27.3)	
$50,000 to $99,999	16.6 (13.1 – 20.5)	21.6 (16.6 – 27.3)	15.7 (10.3 – 22.4)	21.2 (18.6 – 24.1)	16.3 (10.9 – 23.1)	21.2 (18.6 – 24.1)	
$100,000 or more	8.4 (6.1 – 11.3)	11.6 (7.3 – 17.2)	9.5 (5.3 – 15.5)	10.2 (8.3 – 12.4)	8.3 (4.9 – 12.9)	8.0 (6.5 – 9.8)	
ENDS user characteristics							
ENDS used most of the time contain nicotine							

| | ENDS Device Types | | | | | | |
| | Disposable ENDS | Non-Refillable Cartridge ENDS | Refillable Cartridge ENDS | Refillable Tank System ENDS | Refillable Mod System ENDS | Unknown | |
Characteristics	unweighted N= 530 (10.4%) Weighted Column% (95% CI)	unweighted N= 370 (8.1%) Weighted Column% (95% CI)	unweighted N= 162 (3.5%) Weighted Column% (95% CI)	unweighted N= 1908 (38.5%) Weighted Column% (95% CI)	unweighted N= 284 (4.9%) Weighted Column% (95% CI)	unweighted N= 1698 (34.6%) Weighted Column% (95% CI)	p value*
Yes	45.2 (40.3 – 50.0)	90.3 (86.5 – 93.3)	85.1 (76.6 – 91.4)	86.8 (84.7 – 88.7)	74.8 (69.0 – 80.7)	75.0 (69.9 – 80.1)	<.0001
No	54.8 (50.0 – 59.7)	9.7 (6.7 – 13.5)	14.9 (8.6 – 23.4)	13.2 (11.4 – 15.3)	25.2 (19.3 – 31.0)	25.0 (19.9 – 30.1)	
Self-reported concentration level of nicotine usually used							
I don't know the concentration	75.5 (68.3 – 81.8)	62.4 (56.6 – 68.2)	57.9 (49.1 – 66.8)	21.3 (18.6 – 24.3)	40.0 (32.2 – 47.8)	64.5 (56.2 – 72.7)	<.0001
0 mg or 0.0%	0.6 (0.0 – 3.4)	0.2 (0.0 – 1.4)	0.9 (0.0 – 4.4)	0.4 (0.1 – 0.8)	0.6 (0.0 – 3.0)	1.1 (0.2 – 3.5)	
1 – 12 mg or 0.1 – 1.2%	15.1 (10.5 – 20.7)	18.4 (13.4 – 24.4)	21.2 (14.0 – 30.1)	50.3 (47.1 – 53.5)	46.1 (38.8 – 53.4)	20.3 (14.4 – 27.3)	
13 – 17 mg or 1.3 – 1.7%	4.2 (1.6 – 8.7)	6.8 (3.7 – 11.3)	12.4 (6.3 – 21.2)	10.7 (8.9 – 12.6)	4.9 (2.3 – 8.8)	6.7 (3.2 – 12.2)	
18 – 24 mg or 1.8 – 2.4%	3.6 (1.4 – 7.3)	9.8 (6.7 – 13.6)	6.6 (2.5 – 13.7)	13.4 (11.6 – 15.3)	6.3 (2.7 – 12.0)	4.4 (1.8 – 8.7)	
25+ mg or 2.5+%	1.1 (0.2 – 3.6)	2.5 (0.9 – 5.3)	1.0 (0.0 – 5.3)	4.0 (2.9 – 5.4)	2.1 (0.4 – 6.2)	3.1 (0.8 – 8.1)	
Reasons to use							
Affordable	40.3 (35.4 – 45.2)	55.9 (49.7 – 62.2)	51.9 (42.8 – 61.0)	62.5 (60.1 – 65.0)	53.8 (47.0 – 60.7)	46.8 (39.8 – 53.8)	<.0001
Use It at Times When or in Places Where Smoking Cigarettes Not Allowed	55.3 (49.8 – 60.8)	79.4 (74.0 – 84.2)	72.9 (64.4 – 81.3)	78.1 (75.5 – 80.5)	70.1 (63.7 – 76.6)	66.0 (59.8 – 72.3)	<.0001
Might be Less Harmful Than Smoking Cigarettes	54.1 (48.6 – 59.6)	73.0 (68.1 – 77.9)	74.7 (66.6 – 82.7)	79.7 (77.4 – 81.8)	68.7 (61.3 – 76.1)	66.9 (60.1 – 73.6)	<.0001
Might be Less Harmful to People Around Me Than Smoking Cigarettes	60.2 (55.2 – 65.3)	78.5 (73.9 – 82.6)	72.9 (64.7 – 81.0)	83.8 (81.4 – 85.9)	70.0 (62.8 – 77.1)	72.0 (65.1 – 78.8)	<.0001
Comes in flavors I like	54.5 (49.4 – 59.6)	61.8 (55.2 – 68.3)	74.4 (66.6 – 82.2)	84.4 (82.0 – 86.7)	81.0 (75.6 – 85.7)	66.4 (59.6 – 73.3)	<.0001
Helps people quit smoking cigarettes	45.7 (40.3 – 51.1)	60.1 (53.0 – 67.2)	68.8 (59.8 – 77.8)	74.3 (71.9 – 76.7)	65.5 (58.5 – 72.5)	63.2 (57.0 – 69.5)	<.0001
Do not Smell	55.0 (50.7 – 59.3)	72.1 (67.1 – 77.1)	63.7 (55.0 – 72.5)	69.8 (67.3 – 72.4)	62.1 (56.3 – 68.0)	63.5 (57.5 – 69.4)	<.0001
Feels Like Smoking a regular Cigarette	34.0 (29.5 – 38.5)	47.7 (42.1 – 53.4)	40.3 (31.9 – 48.7)	39.8 (37.1 – 42.4)	35.3 (29.1 – 41.6)	45.2 (38.6 – 51.7)	0.0018
More acceptable to non-tobacco users	56.2 (51.2 – 61.3)	72.1 (66.7 – 77.5)	68.6 (59.3 – 77.8)	74.2 (72.0 – 76.3)	65.8 (58.4 – 73.2)	66.3 (60.8 – 71.9)	<.0001

ENDS Device Types							
Characteristics	**Disposable ENDS** unweighted N= 530 (10.4%) Weighted Column% (95% CI)	**Non-Refillable Cartridge ENDS** unweighted N= 370 (8.1%) Weighted Column% (95% CI)	**Refillable Cartridge ENDS** unweighted N= 162 (3.5%) Weighted Column% (95% CI)	**Refillable Tank System ENDS** unweighted N= 1908 (38.5%) Weighted Column% (95% CI)	**Refillable Mod System ENDS** unweighted N= 284 (4.9%) Weighted Column% (95% CI)	**Unknown** unweighted N= 1698 (34.6%) Weighted Column% (95% CI)	**p value** [*]
As a Way of Cutting Down on Cigarette Smoking	35.4 (30.6 – 40.1)	59.8 (53.1 – 66.5)	64.8 (55.0 – 74.7)	75.4 (72.5 – 78.1)	61.8 (52.8 – 70.7)	59.4 (51.6 – 67.2)	<.0001
As an Alternative to Quitting Tobacco Altogether	28.5 (23.9 – 33.1)	51.4 (44.3 – 58.6)	53.8 (43.9 – 63.7)	58.3 (55.5 – 61.2)	42.4 (34.2 – 50.7)	47.6 (40.1 – 55.1)	<.0001
Nicotine dependence							
Nicotine dependence (mean, 95% CI)	45.2 (41.9 – 48.4)	53.4 (49.7 – 57.1)	44.8 (37.4 – 62.0)	46.2 (44.3 – 48.1)	40.0 (33.9 – 46.1)	45.4 (43.2 – 47.6)	0.005

Note. Table 1 incudes past 12-month cigarette smokers and ENDS users (N=4,952). Records with missing values for the given characteristic were not analyzed. The sum of unweighted N's by each characteristics and each Device type is not always equivalent to the total N of the given Device Type.

ENDS=Electronic Nicotine Delivery System

[*] Wald log-linear chi-square test was used for the test of independence or no association between device types and each characteristic

Table 2.

Associations between ENDS Device Types and Cigarette Quit Attempts among Past 12-month Cigarette smokers who currently use ENDS

| | Attempt to Quit Cigarette Smoking Among Cigarette Smokers | | | | | | | | | | | |
| | Non-daily ENDS Users (N=1,040) | | | | | | Daily ENDS Users (N=474) | | | | | |
	OR	95% CI	p value	AOR#	95% CI	p value	OR	95% CI	p value	AOR#	95% CI	p value
Disposable ENDS (reference)												
Non-Refillable Cartridge ENDS	1.1	0.6 – 1.9	0.84	1.0	0.5 – 1.8	0.92	**14.9**	3.1 – 71.4	0.00	**7.3**	1.5 – 34.9	0.01
Refillable Cartridge ENDS	1.4	0.6 – 3.2	0.40	1.4	0.6 – 3.2	0.40	3.2	0.1 – 74.3	0.46	1.1	0.1 – 21.0	0.94
Refillable Tank System ENDS	1.2	0.8 – 2.1	0.39	1.2	0.7 – 2.1	0.49	**10.9**	2.9 – 41.0	0.00	**5.3**	1.5 – 19.3	0.01
Refillable Mod System ENDS	1.0	0.5 – 2.0	0.98	1.0	0.5 – 2.0	0.90	**8.6**	1.8 – 41.4	0.01	**5.9**	1.2 – 30.1	0.03
Unknown	0.9	0.5 – 1.9	0.86	0.9	0.4 – 1.8	0.67	**4.9**	1.0 – 23.7	0.05	1.7	0.3 – 9.1	0.56

Note.

[1] SAS Proc SurveyLogistic was used to fit a multivariate logistic regression model to the data.

[2] The models analyzed only complete cases with all non-missing values for covariates and the dependent variable.

adjusted for age, sex, race, ethnicity, nicotine dependence.

OR=Odds Ratio; AOR=Adjusted Odds Ratio; CI=Confidence Interval