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### Emerging Adults' Experiences with E-Cigarette Cessation [post-print]

Laura Holt

*Trinity College*, [laura.holt@trincoll.edu](mailto:laura.holt@trincoll.edu)

Leah J Latimer

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**Emerging Adults' Experiences with E-Cigarette Cessation**

Laura J. Holt\* and Leah J. Latimer

Trinity College, Hartford, CT

\*Corresponding author: Laura Holt, PhD, Trinity College, 300 Summit St. Hartford, CT 06106.

[Laura.Holt@trincoll.edu](mailto:Laura.Holt@trincoll.edu)

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### Abstract

*Background:* The use of electronic nicotine delivery systems (ENDS) is one of the most common substance use behaviors in college students, yet most individuals show some interest in quitting. The current study added to the limited literature on ENDS cessation by examining readiness to quit and the use and perceived efficacy of ENDS cessation methods in a heterogeneous sample of college students. *Methods:* Students 18-24 years in Psychology courses ( $N=1563$ ; 73% female) from six US universities completed an online survey between September 2021-April 2022. *Results:* Nearly half the sample ( $n=738$ , 47%) reported lifetime ENDS use and nearly half of lifetime users ( $n=356$ , 48%) reported a quit attempt. Most ENDS users reported some readiness to quit ( $n=251$ , 67%). Quitting “cold turkey”, using willpower, and replacing ENDS use with another activity were endorsed most frequently; strategies were perceived as more helpful if students had direct experience with them. Social support (e.g., counseling, groups, family/friend support) and nicotine replacement products were perceived as effective but were utilized infrequently. Digital tools (i.e., apps, text messaging) were perceived to be least helpful and were utilized infrequently. *Conclusion:* Most college students who use ENDS are interested in quitting and have relied on unassisted methods for cessation. Our data suggest a significant opportunity for college personnel and public health officials to further enhance awareness and uptake of ENDS cessation resources for this demographic. Digital tools that integrate social support may be especially effective given their low cost, demonstrated efficacy, and alignment with students' preferences for social support.

*Keywords:* E-cigarette; cessation; college students; quitting; motivation

### **Emerging Adults' Experiences with E-Cigarette Cessation**

Despite a decline in electronic nicotine delivery system (i.e., ENDS) use by young adults early in the COVID-19 pandemic (Kreslake et al. 2021), ENDS use has returned to pre-pandemic levels among those ages 18-20 and now is even higher among 21-24 year olds (Kreslake et al., 2023). ENDS use is especially common among college students, with more than half (55%) reporting lifetime use and over one-quarter (27%) reporting past 30-day use (Holt et al., 2022). ENDS use is associated with numerous adverse physiological effects, including compromised respiratory, cardiovascular, and gastrointestinal functioning; changes in brain function that can potentiate addiction; and increased risk for initiating combustible cigarette use (see Virgili et al., 2022 for a review).

Due to health concerns, a desire to save money, be free from addiction, and avoid interpersonal conflict, many adolescent and young adult ENDS users report an interest in quitting (Amato et al., 2021; Garey et al., 2021; Struik & Yang, 2021). Indeed, approximately one-third of young adults made a quit attempt in the previous year (Berg et al., 2021; Cuccia et al., 2021) and over half (57-63%) reported some intention to quit (Cuccia et al., 2021). Similarly, in a sample of adolescent and young adult ENDS users, 74% expressed an interest in quitting and made an average of 1.7 quit attempts (Garey et al., 2021). Digital methods for ENDS cessation seem to be of particular interest: over 27,000 adolescents and emerging adults registered for a text messaging program five weeks after it began (Graham et al., 2020) and when queried about preferred cessation methods, adolescents and young adults were most willing to engage with an app-based program (Garey et al., 2021). On the other hand, a recent study of young adults interested in quitting showed that none had used an app for ENDS cessation (Huma et al., 2022), suggesting that, despite their promise as an effective and low-cost resource, widespread uptake of digital tools still might be limited.

Research on experiences with ENDS cessation and preferred cessation methods is critical to evaluate actual uptake of ENDS cessation strategies and to determine which

strategies need further development and/or broader dissemination. The literature on ENDS cessation strategy use is lacking, however, particularly among emerging adults. To that end, the current study aimed not only to replicate prior research on readiness to quit ENDS use, but also to make a more novel contribution by reporting on utilization of ENDS cessation strategies, potential sociodemographic differences in readiness to quit and strategy utilization, and perceived helpfulness of cessation strategies among both strategy users and non-users in a heterogeneous college sample.

Based on prior research, we first hypothesized that more than half our sample would express an intention to quit ENDS. Due to limited previous research, however, we did not advance any hypotheses about which cessation strategies would be most utilized or preferred. We also did not advance hypotheses regarding potential demographic differences in ENDS quit attempts, given that prior research has been mixed. For example, Sobieski et al. (2022) showed that gender, race, and age were not associated with making an ENDS quit attempt. In contrast, Cuccia et al. (2021) showed that male and non-Hispanic Black ENDS users were more likely to make a quit attempt, while Krishnan et al. (2022) showed that younger age (18-24) and identifying with a racial group other than non-Hispanic White was associated with a quit attempt.

Finally, we examined potential gender differences in ENDS cessation strategy use, given that, to our knowledge, this area was unexplored previously. Prior research on combustible tobacco cessation showed that females were more likely to use more evidence-based tools such as the nicotine patch and prescription medication (Jayakumar et al., 2020; Reid et al., 2009), self-help resources and online/phone quit support (Jayakumar et al., 2020), and counseling (Reid et al., 2009) compared to males. Accordingly, we hypothesized that females would be more likely than males to report using formal intervention methods for ENDS cessation including nicotine replacement, cessation medications, cessation texting programs or apps, group support, self-help materials, counseling or a quit line.

## **Method**

## Participants and Procedure

Undergraduates from six colleges/universities in the US (largely from Psychology courses) between ages 18-24 were invited to participate in an anonymous 60–90-minute online survey inquiring about health behaviors and substance use between September 2021-April 2022. Prospective participants learned about the study through the SONA research system, flyers, and classroom announcements. Most participants were compensated with course research participation. (A subset of participants at the Northeast site was instead eligible for extra credit or, if they were not seeking credit, could elect to be entered into a drawing for one of two \$25 gift cards to an online merchant each semester.) Participation was confirmed through a second survey or SONA record unlinked to participants' responses.

The survey contained an attention check question at the beginning of the survey. If participants responded incorrectly, they were given feedback, and had two additional attempts to respond correctly. Participants who did not ultimately respond correctly had their participation end immediately, were not given any research participation credit, and were excluded from all analyses. Three similar attention/quality check questions appeared throughout the survey, although participants were not necessarily excluded based on their responses; instead, this information was used in combination with other aspects of participants' responding (e.g., completeness of their response) to determine whether to retain the record. The study was approved by the St. Louis University IRB under a single-site IRB model with institutional authorization agreements with the remaining universities.

## Measures

Participants reported on lifetime history of ENDS ["Have you ever used an Electronic Nicotine Delivery System (ENDS) product, (i.e., e-cigarettes, vape pen, or e-hookah) as intended (i.e., with nicotine cartridges and/or e-liquid/e-juice), even one or two puffs?"] and combustible cigarette use, age(s) of initiation, and amount of past 30-day ENDS use. Past 30-day ENDS users indicated how many days in the last 30 they used disposable e-cigarettes,

vape pens, JUUL/PHIX (i.e., devices that use a pod), and/or advanced personal vaporizers (Hinds et al., 2016). Days of use across all devices were summed to yield an ENDS frequency score. Participants also reported if they had ever tried to quit/stop using an ENDS product. Readiness to quit was assessed by asking past 30-day ENDS users: "Are you seriously thinking about quitting the use of e-cigarettes?" Responses included: *within the next 30 days*; *within the next 6 months*; *in more than 6 months*; or *I am not thinking about quitting the use of e-cigarettes* (USDHHS, 2021).

Participants who endorsed a quit attempt selected resources they utilized from a list of 15 services/resources including online (e.g., texting program, app), nicotine replacement, professional (e.g., one-on-one counseling), medications, and various forms of social support. There also was one open-response "Other" option. This list was adapted from Camenga et al.'s (2021) measure of combustible smoking cessation resources. Participants also indicated the perceived helpfulness of each resource on a 1=*not at all* to 5=*very helpful* scale.

### **Data Analysis**

To examine potential demographic differences in quit attempts and in cessation methods, we used Chi-square tests (or Fisher's Exact tests in cases where cell sizes were <5) and assessed whether cell frequencies differed significantly from expected values after a Bonferroni adjustment. To determine whether strategy utilizers differed from non-utilizers regarding perceived helpfulness of the strategies, we used t-tests and report adjusted statistics when the  $p < .05$  for Levene's test for equality of variances.

### **Results**

A total of 1869 students accessed the online survey; data from 1563 students were used. A subset of records ( $n=306$ ) was removed for the following reasons:  $n=118$  (38%) were ineligible (i.e., outside of the 18-24 age range and/or not a full- or part-time student) or discontinued at the eligibility criteria;  $n=63$  (21%) failed the attention check;  $n=5$  (2%) declined consent;  $n=50$  (16%) were duplicate participants; and  $n=70$  (23%) discontinued prematurely

before completing a sufficient number of our study measures to be included in the analyses.

Table 1 displays information on participants' demographics and ENDS use. Among past 30-day ENDS users, 67% expressed some desire to quit, which was consistent with our hypothesis. Specifically, 14% ( $n=52$ ) planned to quit in more than 6 months; 25% ( $n=94$ ) within the next 6 months; 28% ( $n=105$ ) within the next 30 days; and one-third ( $n=123$ ; 33%) were not thinking of quitting. Of 738 students endorsing a lifetime history of ENDS use, nearly half ( $n=356$ ; 48%) reported one or more quit attempts, using an average of 2.13 ( $SD=1.28$ ) strategies. Regarding sociodemographic differences in history of an ENDS quit attempt, Chi-square tests showed there was no difference based on gender [ $\chi^2(1)=.52$ ,  $p=.47$ ]; year in school [ $\chi^2(3)=4.53$ ,  $p=.21$ ]; any past 30-day combustible tobacco use [ $\chi^2(1)=.08$ ,  $p=.77$ ]; or identifying as Hispanic (vs. non-Hispanic) [ $\chi^2(1)=.241$ ,  $p=.62$ ]. Although the Chi-square value for racial group membership was significant [ $\chi^2(5)=15.64$ ,  $p=.01$ ], the cell frequencies did not differ significantly from the expected values after a Bonferroni correction.

Figure 1 shows the percentage of participants endorsing each strategy and the mean perceived helpfulness of each strategy, broken down by whether a participant utilized that strategy. Quitting "cold turkey", using willpower, and replacing ENDS use with another activity were the most frequently utilized strategies. Chi-test and Fisher's Exact tests showed that the proportion of male and female participants using each strategy did not differ, which was contrary to our second hypothesis that females would be more likely to report using evidence-based strategies such as cessation medications, nicotine replacement products, or self-help materials. A subset of respondents ( $n=34$ ) reported using a strategy "other" than those from the list and provided an open-ended response. The majority ( $n=18$ , 53%) noted they only used ENDS once or a few times or that they were never addicted.

Among participants who utilized a particular strategy, cessation medications (e.g., Zyban) were perceived to be most helpful, with a mean of 5 out of 5 (although this mean was



based on  $n=3$ ), followed by replacing vaping with another activity and garnering support from family and friends. Perceived helpfulness ratings were lower, overall, among those who did not employ a particular strategy; however, the pattern of findings was similar to strategy users. Specifically, replacing ENDS with another activity and support from friends and family were rated most highly, in addition to using willpower. After applying a Bonferroni correction for 12 comparisons ( $p<.004$ ) (quit lines, acupuncture, and hypnosis were not endorsed by any participants), there were significant differences in the mean perceived helpfulness ratings between strategy users and non-users for 5 of the 12 strategies. Ratings were higher among strategy users for quitting cold turkey ( $t_{349}=6.70, p<.001$ ); using willpower ( $t_{275.35}=5.58, p<.001$ ); replacing ENDS with another activity ( $t_{313.03}=6.25, p<.001$ ); getting support from family/friends ( $t_{217.12}=6.80, p<.001$ ); using books, pamphlets, or videos ( $t_{344}=4.40, p<.001$ ); and using cessation medications ( $t_{343.0}=40.84, p<.001$ ) (see Figure 1 for all means and standard errors).

There were three strategies (i.e., nicotine replacement products, group support, and one-on-one counseling) for which perceived helpfulness was close to or above the midpoint of 3 on the 5-point scale for both strategy users and non-users, but utilized by fewer than 10% of participants. Finally, cessation texting programs and apps were utilized infrequently (4%) and were among the least preferred of the 15 presented (Figure 1).

### Discussion

The current study examined college students' readiness to quit ENDS use, use and perceived helpfulness of ENDS cessation strategies, and demographic differences in quit attempts and strategy use. Consistent with Cuccia et al. (2021) and our hypothesis that over half of participants would express an interest in quitting ENDS, two-thirds of our sample reported some intention to quit. Contrary to Garey et al. (2021), who reported digital tools to be most desirable and Graham et al. (2020), who showed substantial uptake of a text messaging program, digital and web-based methods were not the preferred methods for ENDS cessation, nor were they utilized by most of our sample. This discrepancy may be due to a lack of these

resources and/or limited dissemination. A review of 787 apps related to vaping in the Google Play or Apple App stores showed that only 8 were free and focused on ENDS cessation (Sanchez et al., 2022). Most apps *encouraged* vaping (e.g., making one's own e-liquids) as opposed to cessation (Meacham et al., 2020). Our findings suggest that it may be beneficial for college health and counseling centers, physicians and other health care providers, and public health officials to publicize legitimate and effective digital tools more widely and frequently, since perceived lack of effectiveness may reflect lack of experience with these tools. Our finding that ENDS cessation strategies were rated as more helpful if participants endorsed using them corroborates this idea. It also may be beneficial for college personnel and/or health care providers to highlight specific app features that are desirable to young adults, such as an ability to set independent goals, connect with other app users anonymously, and receive messages about the benefits of quitting (Huma et al., 2022).

In the current study, students most often endorsed going “cold turkey”, using willpower, and/or replacing vaping with another activity, which was consistent with research showing that “unassisted” strategies were most common among young adult smokers with a quit attempt (Watkins et al., 2020). Yet, there was also significant interest in support from family/friends, groups, and a counselor, consistent with Huma et al.'s (2022) finding that social support, even from anonymous sources, was a desired element of digital cessation tools. Lack of utilization of social support in the current study, as indicated by the low number of students getting support from family/friends, using group support, or obtaining counseling suggests that students might benefit from more specific guidance on how/where they can access support, in addition to encouragement to use multiple cessation strategies concurrently. Quit the Vape, an automated text message program for ENDS cessation, was more effective when augmented with messages from a counselor (Krishnan et al. 2023), illustrating the point that multiple methods - particularly those that involve social support - may confer an advantage for ENDS cessation in young adults.

Perceived helpfulness ratings of ENDS cessation strategies were higher in cases where students had direct experience with a strategy. This was particularly true for using willpower, replacing vaping with another activity, getting support from family/friends, using self-help materials (i.e., books, pamphlets, videos), and taking cessation medications. Although this finding needs to be replicated, it suggests that it might be beneficial to make students aware of the fact that *any* strategy they try is likely to be more helpful to them than anticipated.

We did not find demographic differences in ENDS quit attempts or cessation strategies. Specifically, likelihood of a quit attempt did not differ by gender, race, ethnicity, class year, or current combustible tobacco use. These findings were consistent with Cuccia et al. (2021), who found no differences for age or combustible use, but also inconsistent in that males and non-Hispanic Black participants were more likely to endorse an ENDS quit attempt (Cuccia et al., 2021) as were individuals identifying as a racial/ethnic group besides non-Hispanic White (Krishnan et al., 2022). Our discrepant findings might have been due to our focus on college-attending adults, who evidenced less variability in age, gender, and education compared to the heterogeneous national samples reported on previously. We also did not observe differences in strategy use by gender, which was inconsistent with previous research on combustible tobacco cessation, where females were more likely to use evidence-based strategies to quit (Jayakumar et al., 2020; Reid et al., 2009). Although our research did not show differences, future research should continue to examine potential demographic differences in ENDS quit attempts and ENDS cessation strategies, as this information might allow for more targeted outreach with ENDS cessation efforts should any differences emerge.

There were several limitations to the current study. Our measure of cessation tools did not inquire about tapering the nicotine concentration in ENDS devices, which was the most common cessation strategy after “cold turkey” (Struik & Yang, 2021). Of note, participants in the current study did not report this approach as an open response, suggesting it might not have been common in this sample. In addition, since few students endorsed using some of the

strategies (e.g., nicotine replacement, cessation texting/apps, etc.), our comparisons between males' and females' strategy use may not have detected differences that would have emerged in a larger sample. Relatedly, our findings may not generalize to male college students, who were underrepresented in our sample, and non-college attending adults, who are now the demographic most likely to report past 30-day ENDS use (Patrick et al., 2022). Finally, our study did not capture in-depth information about participants' quit attempts and which were more/less successful. Future research should investigate these questions, along with more effective ways to disseminate ENDS cessation tools.

In conclusion, this study showed that most college student ENDS users are interested in quitting, yet there has been limited uptake of evidence-based tools for tobacco cessation, such as counseling, digital, over-the-counter nicotine replacement, and pharmacological tools. This limited uptake may be due not only to a lack of awareness of resources, but also to the fact that the efficacy for ENDS cessation strategies, such as nicotine replacement (Palmer et al., 2023; Sikka et al., 2021; Silver et al. 2016) and prescription medications (e.g., Caponnetto et al., 2023) is only beginning to be established. To ensure an ENDS habit does not become life-long, it will be necessary to coordinate public health and institutional resources to continue investigation of effective cessation strategies and to provide young adults with more specific guidance on how to access these strategies.

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Post-print

**Declaration of Interest Statement**

The authors report there are no competing interests to declare.

Post-print

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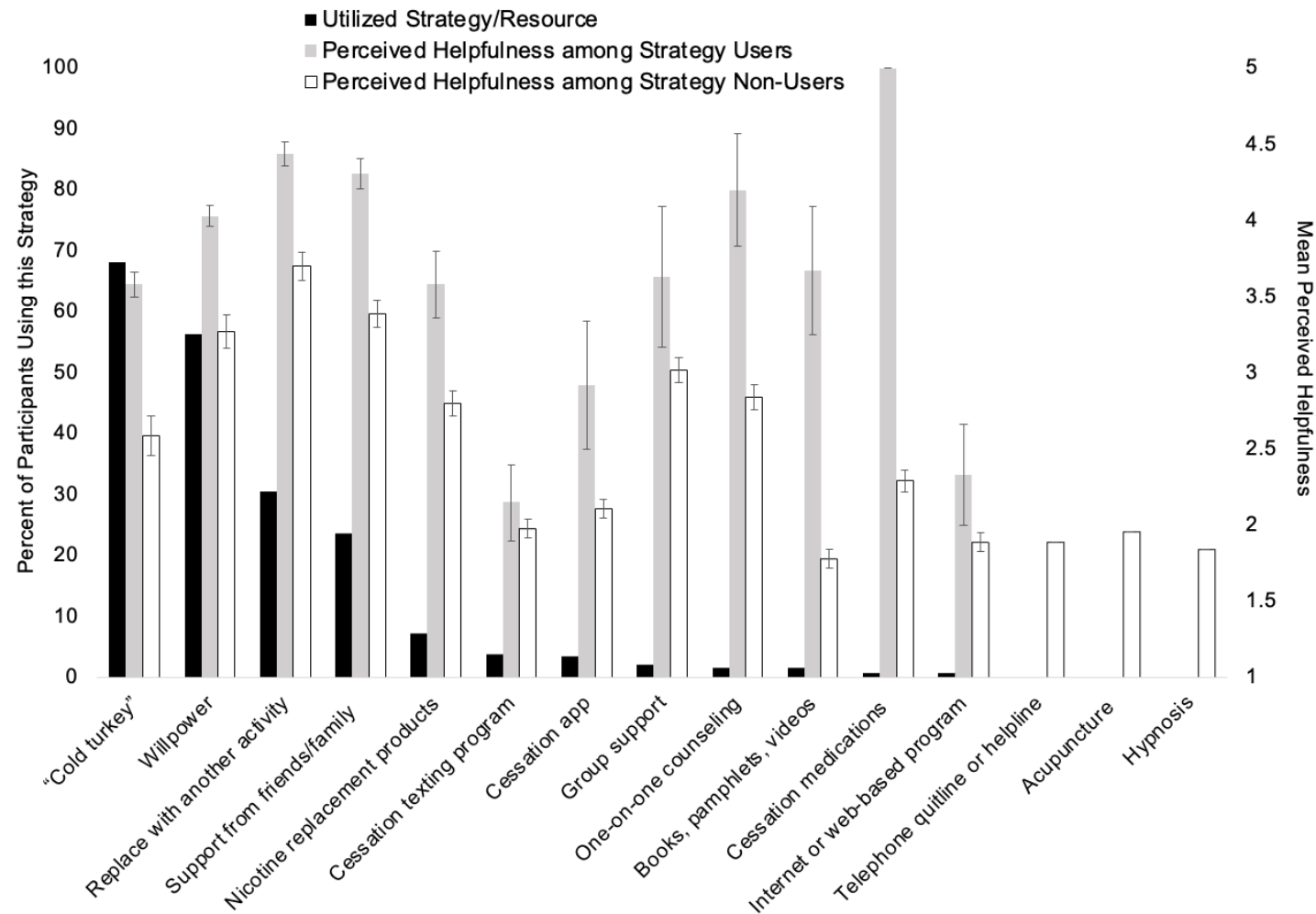
**Table 1***Characteristics of Overall Sample and Participants Endorsing a Quit Attempt*

Study variable	Overall sample <i>N</i> = 1563	Reported a quit attempt <i>n</i> = 356
Age ( <i>M</i> , <i>SD</i> )	19.33 (1.36)	19.40 (1.37)
Female biological sex at birth ( <i>n</i> , %)	1180 (75%)	283 (79%)
Gender identity		
Male	378 (24%)	72 (20%)
Female	1145 (73%)	274 (77%)
Transgender (female to male)	5 (<1%)	3 (1%)
Transgender (male to female)	1 (<1%)	0 (0%)
Gender queer	32 (2%)	7 (2%)
Race/ethnicity		
White	1096 (70%)	284 (80%)
African American/Black	117 (8%)	13 (4%)
Asian/Asian American	177 (11%)	19 (5%)
American Indian/Alaska Native	25 (2%)	8 (2%)
Hispanic/Latino*	263 (17%)	59 (17%)
Bi/Multiracial	84 (5%)	22 (6%)
Other	60 (4%)	10 (3%)
Class year		
Freshman	826 (53%)	187 (52%)
Sophomore	321 (21%)	63 (18%)
Junior	241 (15%)	63 (18%)
Senior	174 (11%)	43 (12%)
College/university US region		
Northeast/Mid-Atlantic	165 (11%)	41 (12%)
Southeast	471 (30%)	121 (34%)
Midwest	410 (26%)	75 (21%)
Southwest	517 (33%)	119 (33%)
Any lifetime ENDS use	738 (47%)	356 (100%)
Age of ENDS initiation	16.53 (1.85)	16.28 (1.77)
Any past 30-day ENDS use	378 (24%)	218 (61%)
Types of ENDS device used <sup>†‡</sup>		
Disposable	154 (41%)	101 (46%)
Vape pen, hookah pen, EGO	120 (32%)	62 (28%)
Pod device (e.g., JUUL, PHIX)	212 (56%)	127 (58%)
Mod or advanced personal vaporizer	49 (13%)	28 (13%)
Days ENDS use in past 30 by device <sup>§</sup> ( <i>M</i> , <i>SD</i> )		
Disposable	15.92 (11.82)	17.02 (11.64)
Vape pen, hookah pen, EGO	11.02 (11.12)	11.89 (11.10)
Pod device (e.g., JUUL, PHIX)	13.99 (12.15)	15.11 (11.88)
Mod or advanced personal vaporizer	10.80 (11.52)	11.46 (10.84)
Any past 30-day combustible cigarette use	84 (5%)	40 (19%)

*Note.* \*Ethnicity was assessed with a separate question (Hispanic/Non-Hispanic), so *ns* and percentages exceed 100% under race/ethnicity. <sup>†</sup>Among participants reporting past 30-day ENDS use. <sup>‡</sup>A small number of respondents (*n*=26) endorsed past 30-day ENDS use, but did not report frequency of use and/or type of device used; thus, data on device use does not reflect these records. <sup>§</sup>Among participants who reported using that device.

**Figure 1**

*Utilization and Perceived Helpfulness of ENDS Cessation Resources Among Participants with a Quit Attempt*



Note. Error bars depict standard errors of the means.