



HHS Public Access

Author manuscript

Drug Alcohol Depend. Author manuscript; available in PMC 2021 June 01.

Published in final edited form as:

Drug Alcohol Depend. 2020 June 01; 211: 107855. doi:10.1016/j.drugalcdep.2020.107855.

What are the Reasons that Smokers Reject ENDS? A National Probability Survey of U.S. Adult Smokers, 2017-2018

Scott R. Weaver, PhD^{a,b,*}, J. Wesley Heath, MPH^b, David L. Ashley, PhD^{a,b}, Jidong Huang, PhD^{b,c}, Terry F. Pechacek, PhD^{b,c}, Michael P. Eriksen, ScD^{b,c}

^aDepartment of Population Health Sciences, School of Public Health, Georgia State University, Atlanta, GA, USA

^bTobacco Center of Regulatory Science (TCORS), School of Public Health, Georgia State University, Atlanta, GA, USA

^cDepartment of Health Policy & Behavioral Sciences, School of Public Health, Georgia State University, Atlanta, GA, USA

Abstract

Background: The objective was to examine the reasons smokers have discontinued or chosen not to use electronic nicotine delivery systems (ENDS).

Methods: Data were obtained from a national probability sample of 1843 US adult current smokers who were not current ENDS users pooled from the 2017 and 2018 annual, cross-sectional Tobacco Products and Risk Perceptions Surveys. Participants reported their ENDS use, reasons for discontinuing or not initiating ENDS use, quit smoking intentions, perceptions, and use intentions. Weighted proportions and logistic regression models were estimated.

Results: Twenty-three percent of smokers were former ENDS users who reported prior “regular use”, and 7.5% were former ENDS users who reported regular use. Three most cited reasons for discontinuing ENDS were: ENDS “didn’t feel like smoking” (23%), “only ever tried them to see what they were like” (20%), and “didn’t help me deal with cravings for smoking” (14%). Reasons for discontinuing ENDS were associated with the regularity of former ENDS use and ENDS type. Nearly 40% of current smokers had not tried ENDS with the most commonly cited reasons being not wanting to substitute one addiction for another (60%), concerns about their safety (53%), skepticism that ENDS could help them quit smoking (52%), and cost (43%). Reasons were associated with smoking quit intentions, harm perceptions, and age.

*Corresponding Author: PO Box 3995, School of Public Health, Georgia State University Atlanta, GA, USA 30302-3995, Tele: 404.413.1349, Fax: 404.413.1140, srweaver@gsu.edu.

Contributors

All authors contributed to the design of the study and interpretation of the data. SW developed the analysis plan, and JH performed the data analysis. SW wrote the first draft and all authors contributed to revision of the paper and approve the submitted version.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conclusion: Whereas smokers who had formerly used ENDS cited inadequate craving reduction or incomparability to smoking for their discontinuation, the larger segment of smokers who have never used ENDS cited “safety,” “effectiveness,” and “costs” as reasons for non-use.

Keywords

Electronic cigarettes; smoking/harm reduction; smokers; survey research

1. INTRODUCTION

The weight of current scientific evidence about electronic nicotine delivery systems (ENDS) suggests that these products can be a substantially less harmful, though not harmless, alternative source of nicotine for cigarette smokers with potential for population harm reduction under the right conditions (McNeill et al., 2018; National Academies of Sciences, Engineering, and Medicine, 2018; Royal College of Physicians, 2016). For ENDS to achieve population health improvement, smokers who would not have otherwise quit smoking would need to completely substitute their smoking with ENDS, optimally in transition to complete tobacco and nicotine abstinence, at levels that counter any concomitant increases in youth and young adult nicotine and tobacco use caused by ENDS (Levy et al., 2017; Warner and Mendez, 2018). Most smokers who use ENDS report using them to quit or reduce smoking, and a recent randomized trial found that a second-generation ENDS was more efficacious than nicotine replacement therapy under advantageous circumstances where trial participants were provided a newer generation ENDS, cessation counseling, and instruction and guidance on using the provided ENDS (Hajek et al., 2019; Simonavicius et al., 2017; Yong et al., 2019). Studies of U.S. smokers’ use of ENDS under real-world conditions have generated inconsistent findings regarding their effectiveness for quitting smoking (Giovenco and Delnevo, 2018; Halpern et al., 2018; Levy et al., 2018; Rigotti et al., 2018; Sweet et al., 2019; Weaver et al., 2018; Zhu et al., 2017).

While much focus has been on the dual use of cigarettes and ENDS, the smokers who have tried or used but discontinued ENDS while continuing to smoke has been referred to as “a missed opportunity for harm reduction” (Simonavicius et al., 2017). Although fewer in number compared to dual users, approximately one-quarter of US adult smokers in 2015 had tried or used but discontinued ENDS while continuing to smoke (Weaver et al., 2017). In recent longitudinal research, more than one-third of dual users at baseline had discontinued using ENDS while continuing to smoke within one year and more than one-half had done so within two years (Kasza et al., 2018; Manzoli et al., 2017; Weaver et al., 2018). In a 2016 survey of British smokers, the most common reasons given for discontinuing ENDS were that they did not sufficiently mimic the feel of smoking or reduce cravings to smoke (Simonavicius et al., 2017). Two US surveys conducted in 2013–2014 found that one-third of smokers who discontinued ENDS indicated they were too expensive or did not feel “like smoking cigarettes”, while substantial proportions also referred to their taste, concerns about health risks, and malfunction or poor function as reasons (Biener et al., 2015; Biener and Hargraves, 2015). A more recent, multi-country study that included U.S. participants reported the top reasons given by smokers for discontinuing ENDS centered around dissatisfaction with ENDS, particularly with relieving cravings to smoke or helping them

quit smoking (Yong et al., 2019). Since these studies were conducted, the ENDS market and regulatory landscapes have continued to evolve (Huang et al., 2019a; Rigotti, 2018). These changes, as well as the intense public scrutiny of ENDS in the U.S., over the past couple years could have led to shifts in reasons for non-use.

Smokers who want to quit smoking but have not tried ENDS also warrant examination. Most smokers express regret having ever started smoking and want to quit, but nearly 40% of smokers have not tried ENDS despite their marketing and promotion as an alternative to smoking (Pechacek et al., 2017; Weaver et al., 2017). To the extent that ENDS can be effective for achieving complete smoking abstinence, factors that reduce their appeal to and inhibit their uptake by a substantial segment of adult smokers could limit their population harm reduction potential. One possible explanation is the growing perception among smokers that using ENDS is equally or more harmful than smoking cigarettes (Huang et al., 2019b; Majeed et al., 2017; Nyman et al., 2019). In the UK, which has observed lower prevalence but similar trends in this perception, the modal reason given by smokers for not trying ENDS in 2016 was concerns about their safety (27%), followed closely by not wanting to substitute one addiction for another (25%) and doubts about their effectiveness for quitting or cutting down their smoking (22%) (Action on Smoking and Health, 2016; Wilson et al., 2019).

Continued monitoring is needed of smokers' reasons for the disuse of ENDS, which may be changing as a result of market evolution and the intense and highly public, polarized discussions around ENDS. Understanding the smoking and ENDS use characteristics, perceptions, and intentions to use ENDS in the future of smokers who have tried or used but discontinued ENDS or who have chosen not to use ENDS while continuing to smoke and their reasons for doing so could inform efforts to achieve their harm reduction potential. For instance, targeted education campaigns could inform smokers who cite concerns about the safety of ENDS as their reason for not trying or for discontinuing ENDS use and perceive them to be as harmful as or more harmful than smoking cigarettes about the current evidence on the relative harm of ENDS relative to cigarettes. And data about these smokers' openness and intentions for future use of ENDS provide useful information about the extent to which their decision to not use ENDS could be malleable to external factors. Accordingly, the objectives of this study are to examine: (a) smoking and ENDS use characteristics, perceptions (such as perceived harm and, for former users, perceived enjoyment), and future use intentions among those smokers who have either not tried or discontinued using ENDS; (b) the reasons a segment of smokers give for discontinuing ENDS, overall and by extent of their prior ENDS use (experimental vs. regular), type of ENDS, and flavor; and (c) the reasons given by smokers for not trying ENDS, overall and by smoking quit intentions, age, and perceived harm of ENDS.

2. METHODS

2.1. Study Sample and Procedures

Data were from the 2017 (August-September) and 2018 (November-December) Tobacco Products and Risk Perceptions Surveys of national probability samples drawn from GfK's online KnowledgePanel. Survey participants were adults (18+ years) and were selected with

probabilities proportional to size after application of the panel demographic poststratification weight. The 2018 sample excluded anyone who completed the 2017 survey. Computers with internet access were provided for panelists who did not have them. All participants received a cash equivalent of \$5 for their participation. A study-specific poststratification weight was computed using an iterative proportional fitting (raking) procedure to adjust for survey non-response as well as for oversampling of smokers. Demographic and geographic distributions from the most recent Current Population Survey were employed as benchmarks for adjustment, and included sex, age, race/ethnicity, education, household income, census region and metropolitan area.

In 2017, 8229 KnowledgePanel members were invited to participate in the survey, and 6033 qualified for and completed the survey. Twenty-two cases were excluded due to refusing to answer more than half the survey questions and 19 were removed due to low duration or being flagged for highly improbable or incompatible responses, yielding a final stage completion rate of 72.8%. In 2018, 7997 KnowledgePanel members were invited to participate in the survey, and 6018 qualified for and completed the survey. Twenty-nine cases were excluded due to refusing to answer more than half of the survey questions, to low survey duration (< 3 minutes), or being flagged twice for highly improbable or incompatible responses, yielding a sample of 5989 cases and a final stage completion rate of 75.8%. The analytic sample for the present study includes 1843 current smokers who were not current ENDS users pooled from the 2017 and 2018 surveys.

2.2. Measures

2.2.1. Cigarette Smoking and ENDS Use Status.—Participants who reported smoking at least 100 cigarettes in their lives were classified as current smokers if currently smoking cigarettes *every day* or *some days*. Current daily smokers were asked to report the typical number of cigarettes they smoked each day. To assess ENDS use, respondents were first provided a description and an image of ENDS depicting various device types. Lifetime (ever) use of ENDS was then assessed by asking, “Have you ever used electronic vapor products, even one or two times?” If they reported *no*, they were classified as never ENDS users. Those respondents reporting lifetime ENDS use were classified as former ENDS users if they selected *not at all* to “Do you now use electronic vapor products every day, some days, rarely, or not at all?” Former ENDS users were then sub classified as either never regular users if they selected *no* to, “Have you ever used electronic vapor products fairly regularly?” or as regular (former) ENDS users if they selected *yes*.

2.2.2. Reasons for Discontinuing/Not Initiating ENDS Use.—Current smokers who reported previous but not current use of ENDS were asked a question obtained from the 2016 ASH Smokefree GB survey (Action on Smoking and Health, 2016), “What is the main reason you stopped using electronic vapor products?” Respondents could select one reason among twelve provided reasons, including options for *Other* and *Don’t know/can’t remember* (see Table 2). Current smokers who reported never using ENDS were asked, “Which of the following are reasons you have not tried an electronic vapor product” and responded either *yes* or *no* for each of twelve reasons (see Table 3). They were also asked if there was some other reason and prompted to specify the reason. These responses were

independently reviewed by two coders, and responses that by consensus matched an existing response option were re-coded to reflect the matched response.

2.2.3. Quit Smoking Intentions.—Current smokers indicated their intentions to quit smoking in response to “What best describes your plans regarding quitting smoking cigarettes?” with six response options ranging from *intend to quit in the next 7 days* to *never plan to quit*. Responses were dichotomized to reflect either intentions to quit within the next 6 months or after the next 6 months (or never).

2.2.4. ENDS Characteristics, Perceptions, and Use Intentions.—Former ENDS users reported whether the electronic vapor device they had used most of the time was rechargeable and whether it was refillable (has a tank or cartridge that is intended by the manufacturer to be refilled with e-liquid by the user).

Perceptions of the harmfulness of ENDS relative to cigarettes among those who reported awareness of ENDS was measured by the question, “Is using electronic vapor products less harmful, about the same, or more harmful than smoking regular cigarettes?” and a 5-point response scale ranging from *much less harmful* to *much more harmful* or *I don’t know*. For analyses, response options *much less harmful* and *less harmful* were collapsed, as were the options *more harmful* and *much more harmful*. The perceived harm of nicotine for adults was assessed by the question, “Most tobacco products, including most electronic vapor products, contain nicotine. When used by the following groups, how harmful is nicotine in amounts usually found in tobacco products?” and a 4-point response scale ranging from *not harmful* to *definitely harmful* or *don’t know*. The perceived enjoyability of ENDS compared to combustible cigarettes was assessed among smokers who reported ever use of ENDS with the question, “How would you compare the experience of using electronic vapor products to smoking regular cigarettes?” Participants responded to a three-point scale: *electronic vapor products are more enjoyable*, *equally enjoyable*, or *electronic vapor products are less enjoyable*.

Intentions to use ENDS in the future was assessed by two items: “Do you think you will try an electronic vapor product (again) soon?” and “If one of your best friends were to offer you an electronic vapor product, would you [try/use] it?” Responses were measured on a four-point response scale ranging from *definitely not* to *definitely yes*.

2.2.5. Respondent Characteristics.—Data on demographic and other respondent characteristics were obtained from profile surveys administered by GfK to KnowledgePanel panelists. These characteristics included sex, age, race/ethnicity, educational attainment, and annual household income.

2.3. Statistical Analysis

Among cigarette smokers, stratified by their prior ENDS use, we calculated proportions and their 95% confidence intervals for smoking and ENDS use characteristics. Binary and multinomial logistic regression models were used to conduct likelihood ratio tests to test differences in these proportions by ENDS use. Among smokers who had tried but discontinued ENDS, proportions were estimated for the reasons they selected for

discontinuing ENDS and multinomial logistic regression models were estimated to perform likelihood ratio tests to test whether reasons were associated with whether ENDS had been used regularly and with device type. Among smokers who never tried ENDS, proportions were estimated for their endorsement of each of the reasons provided for never trying ENDS. For each reason, likelihood ratio tests via binary logistic regression were conducted to test whether endorsement of the reason was associated with smoking quit intentions, the perceived relative harm of ENDS, and age (as we expected that reasons pertaining to addiction may be less salient and reasons pertaining to cost or may be more salient for younger adults). Both unadjusted models and models that adjusted for sociodemographic and, depending on the analysis, other variables were estimated. For all analyses, a study-specific poststratification weight was used to adjust analyses for sources of sampling and non-sampling error. Proportions were estimated using the Survey package (v. 3.33–2) for the R statistical program (v. 3.5.0) (Lumley, 2017, 2004). A two-tailed $\alpha = .05$ was set *a priori* for the likelihood ratio tests, which were.

3. RESULTS

3.1. Smoking Status and ENDS Use Characteristics, Perceptions, and Future Use Intentions

Among all current smokers, 39.9% (95% CI: 37.4, 42.4) were never ENDS users, 23.4% (95% CI: 21.3, 25.6) were former but never regular ENDS users, and 8.1% (95% CI: 6.8, 9.6) were former, regular ENDS users. Table 1 provides a summary of the smoking and ENDS use characteristics and perceptions of these smoker groups (sociodemographic characteristics are reported in supplementary Table S1). Statistically significant group differences were observed for all variables shown.

Smokers who formerly used ENDS regularly, as well as experimentally, were more likely to smoke daily (74.5% and 75.2%, respectively) compared to never ENDS users (70.1%). Among former ENDS users, former experimental ENDS users (27.9%) were less likely to indicate intentions to quit smoking within the next six months compared to their counterparts who had used ENDS regularly (38.2%). Among smokers who had used ENDS, those who never used regularly (29.8%) were most likely to have used a non-rechargeable ENDS device (vs. 9.0%) and less likely to have used a rechargeable, refillable ENDS (39.6%) compared to former regular ENDS users (71.4%).

Former regular ENDS users were more likely to believe ENDS were less harmful than smoking cigarettes (37.8%) than never (15.3%) and former experimental ENDS users (29.2%). Never (33.2%) and former experimental ENDS users (28.1%) were more likely to be uncertain than former regular users (21.7%). Most smokers believed that nicotine was definitely harmful, with only minor differences in harm perceptions of nicotine observed among the groups. Most former ENDS users reported that using ENDS was less enjoyable than smoking cigarettes, with former experimental users (82.8%) more likely to hold this believe than former regular ENDS users (71.7%). Smokers who were formerly regular users of ENDS indicated greater intentions to use them (again) soon or use them if a best friend were to offer them one than never or former experimental users.

3.2. Reasons Smokers Provided for Discontinuing ENDS

Most smokers (57.6%) who discontinued ENDS reported that the three main reasons for discontinuation were that “they didn’t feel like smoking a cigarette” (22.9%), “I only ever tried them to see what they were like” (20.3%), or “they didn’t help me deal with cravings for smoking” (14.4%) (Table 2). Also salient was concerns about their safety (10.2%).

A statistically significant association ($p < .003$) was observed between regularity of former ENDS use and reasons cited for no longer using ENDS, adjusting for covariates. Whereas regular and experimental former users similarly endorsed the reasons that use of ENDS did not feel like smoking (23.0% and 22.5%, respectively) and that ENDS did not satisfy their cravings for smoking (13.2% and 17.9%, respectively), experimental users were more than four times more likely to cite that they only tried ENDS out of curiosity than those who had used ENDS regularly (25.2% vs. 5.8%). In contrast, those who had used ENDS regularly were more likely to endorse the reasons that they felt they were “using them too often compared with smoking” (9.4% vs. 3.0%).

Differences were also observed depending on which type of ENDS device they had primarily used ($p < .001$). Former users of non-rechargeable ENDS were much more likely to say they did not feel like smoking a cigarette (34.2%) than rechargeable, refillable ENDS users (24.0%) and non-rechargeable users (18.8%). In comparison, former non-rechargeable ENDS users were more likely to indicate they only tried them out of curiosity (25.2%) than rechargeable, refillable ENDS users (12.8%).

3.3. Reasons Smokers Provided for Not Trying ENDS

Overall, most smokers who have not tried ENDS stated as reasons that they did not want to substitute one addiction for another (60.0%), concern about their safety (52.7%), or skepticism that ENDS could help them quit or cut down on smoking (52.0%) (see Table 3). (Smokers could select more than one reason.) Nearly as many cited concerns about their cost (42.8%).

Compared to smokers with weaker quit intentions, those smokers with intentions to quit during the next 6 months were more likely to indicate that they did not want to substitute one addiction for another (68.9% vs. 55.7%), doubts of their effectiveness for helping them quit or reduce their smoking (55.7% vs. 50.5%), that they were not safe enough (61.5% vs. 48.3%), and that they were using other approaches for quitting smoking (28.8% vs. 9.2%). Compared to adults over age 30, young adult smokers (18–29 years) were significantly more likely to endorse that they “haven’t gotten around to” using them yet (39.7% vs. 25.4%).

Smokers who perceived ENDS as more harmful than cigarettes were much more likely to cite concerns about their safety compared to those who perceived ENDS as less harmful or were uncertain about their relative harm (74.5% vs. 46.9% or 48.6%) (Table 4). Conversely, smokers who perceived ENDS as less harmful were approximately twice as likely to cite as a reason that they “haven’t gotten around to it yet” compared to those that perceived the same level of risk or were uncertain about relative risk (45.4% vs. 17.7% or 25.3%).

4. DISCUSSION

The findings of this study provide important, more recent insights into the reasons U.S. smokers give for their discontinuance or never use of ENDS and have implications for policies and regulations aimed at optimizing their potential for harm reduction. In this study, more than 70% of current smokers had either never used or discontinued using ENDS while continuing to smoke. While the question whether these smokers represent a missed opportunity for harm reduction depends on whether ENDS are effective for quitting, the reasons these smokers provided may indicate why previous studies have not found ENDS to be effective for quitting under real-world use conditions (Halpern et al., 2018; Rigotti et al., 2018; Sweet et al., 2019; Weaver et al., 2018).

Not satisfactorily replicating the “feel” of smoking or reducing their cravings to smoke were the primary reasons that 37% of current smokers who formerly used ENDS gave for discontinuing them, particularly by smokers who had used rechargeable, non-refillable system ENDS. Indeed, more than 75% of these smokers reported that using ENDS was less enjoyable than smoking cigarettes. These reasons were also commonly reported by UK smokers, a multinational sample that included some US smokers, and earlier studies of US smokers and are consistent with research indicating that ENDS generally have not delivered nicotine comparably to cigarettes (Action on Smoking and Health, 2016; Biener et al., 2015; Farsalinos et al., 2018; Hajek et al., 2017; Yong et al., 2019). In contrast to two earlier US-based studies (Biener et al., 2015; Biener and Hargraves, 2015), the current study did not find cost or malfunction to be dominant reasons. Although curiosity was also a prevalent reason, it was mostly endorsed by smokers who only used ENDS experimentally – most of these former ENDS users – or smokers who had used non-rechargeable ENDS (the least used device type). A UK survey also reported curiosity has the second most endorsed reason for no longer using ENDS (Action on Smoking and Health, 2016). Non-rechargeable (disposable) ENDS typically have a cigarette-like appearance, are generally sold where smokers would purchase cigarettes, and have lower upfront costs than rechargeable e-cigarettes, which might make them more attractive to smokers who are merely curious to try them (Braak et al., 2019; Grana et al., 2014; Liber et al., 2017; Sussman and Barker, 2017). Smokers who had used ENDS regularly, on the other hand, were more likely than experimental former users to endorse that they were using them too often as reasons for their discontinuation. Disposable and rechargeable, closed-system ENDS are likely to be easier to use, but they were less likely to provide comparable delivery of nicotine relative to rechargeable, refillable systems (Farsalinos et al., 2018; Hajek et al., 2017). Smokers who had used these ENDS regularly may have had to use them more frequently than they had to smoke cigarettes in order to satisfy their cravings. However, this is likely to change with the rising use of JUUL and other similar ENDS that use nicotine-salts and higher nicotine concentrations that deliver nicotine comparable to the refillable ENDS and cigarettes such that smokers may no longer need to use these newer ENDS more frequently to satisfy their cravings (Goniewicz et al., 2018; Huang et al., 2019a; Talih et al., 2019). These former regular ENDS users may also have been using ENDS in situations in which they could not smoke cigarettes. To a lesser extent, though at levels twice that of UK smokers, concerns about their safety were also reported (Simonavicius et al., 2017). Less than 40% of former

regular ENDS users and less than 30% of former experimental ENDS users believed ENDS were less harmful than smoking cigarettes. The difference with UK smokers may stem from more prevalent perceptions in the US that ENDS are equally or more harmful than cigarettes and differences in media coverage and messaging from public health and medical organizations in the two countries (Huang et al., 2019b; Wackowski et al., 2019; Wilson et al., 2019). That 33% of former users who had used regularly would probably or definitely try ENDS soon (51% would probably or definitely try if offered by a best friend) indicates that this group has not completely rejected ENDS and is open to future use. Former experimental users were less open to trying ENDS in the future (14% said they would probably or definitely try soon), though at least one-third would probably or definitely try them if offered by a friend.

Whereas current smokers who had formerly used ENDS largely cited reasons of inadequate craving reduction or incomparability to smoking for their discontinuation, the larger segment of current smokers who have never used ENDS cited different reasons for non-use, namely concerns about substituting one addictive product for another, perceived ineffectiveness for quitting smoking, and concerns about their safety. Indeed, these smokers were less likely to perceive ENDS as less harmful than smoking and more likely to be uncertain about the relative harms than former, regular ENDS users. In addition, most of these smokers perceived nicotine as definitely harmful to adults, which might explain their reluctance to substitute one addictive product (ENDS) for another (cigarettes) and concerns about the safety of ENDS. That smokers with stronger quit intentions were also more likely to cite as a reason that they were using other methods for quitting smoking might suggest that they perceived ENDS to be less effective and/or less safe relative to other quit approaches and may have a stronger motivation to cease their nicotine addiction. While these smokers have no direct experience using ENDS, their perceptions of their safety (or lack of) could be explained by the media coverage and public health messaging on ENDS (Wackowski et al., 2018, 2015). Similarly, the medical and public health organizations have been cautious, if not resistant, to endorse ENDS for smoking cessation as the US-based research on their effectiveness has been mixed, if not generally negative; and this too has received extensive media coverage (Bhatnagar et al., 2019; Douglas et al., 2018; National Academies of Sciences, Engineering, and Medicine, 2018). Concerns about substituting one addiction for another was the most commonly endorsed reason for not trying ENDS. Perhaps for these smokers, particularly those with greater quit intentions, the best approach may be to help them quit rather than encourage them to switch to ENDS. The perceived financial cost of ENDS was also cited as a reason for not using them. While the long-term costs of ENDS are generally lower than smoking, their initial costs are often greater (Cantrell et al., 2018; Wang et al., 2018). Taxation and other policies that increase the cost to purchase ENDS may deter their use among smokers who have not yet used them (Huang et al., 2018).

4.1. Limitations

The data used in this study are based on a cross-sectional, self-report study and may be subject to recall biases and inaccuracies, and shared-method variance bias. Causality cannot be inferred from the correlational data. This study did not assess the nicotine concentration used by former ENDS users, which might have influenced smokers' experiences and

decisions to discontinue using ENDS. In addition, the relatively few young adult smokers that had not tried ENDS limited the statistical power available for tests comparing the reasons reported by young adults with older adults. Furthermore, this study was conducted prior to the outbreak of EVALI (electronic cigarette or vaping associated lung injury). It is plausible that concerns about ENDS safety have become more salient for smokers and a reason for their non-use of ENDS.

4.2. Implications

To the extent that exclusive use of ENDS by current smokers may be less harmful than smoking cigarettes, achieving ENDS' potential for harm reduction would require that they are sufficiently appealing to smokers to initiate and continue using them in complete replacement of smoking cigarettes. Needed is research to better understand the conditions under which ENDS are effective for craving reduction and smoking cessation. Regulations and policies could help ensure that the ENDS on the market yield comparable nicotine delivery to cigarettes while allowing manufacturers to improve aspects that matter to smokers and enhance their substitutability for cigarettes. Education and communication efforts could help smokers understand the conditions in which ENDS can be more effective for quitting and inform them of the relative and absolute risks. Regulatory and communication strategies that encourage their use for harm reduction will need careful design and evaluation to guard against sustained dual use or unintended consequences, particularly use by youth, never smokers, or long-term former smokers. Recent increases in youth ENDS use and high rates of dual use, along with the difficulties of effectively communicating absolute and relative risks of ENDS to smokers without unintended consequences, represent some of the major challenges in achieving population harm reduction with ENDS (Gentzke et al., 2019; Miech et al., 2019; Weaver et al., 2018).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGEMENTS

This work was supported by the National Institute on Drug Abuse and the FDA Center for Tobacco Products (P50DA036128). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the FDA.

Role of Funding Source

This work was supported by the National Institute on Drug Abuse and the Food and Drug Administration (FDA) Center for Tobacco Products (CTP) (grant number P50DA036128). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the Food and Drug Administration. The funding agencies had no involvement in the study design; collection, analysis and interpretation of the data; writing of this report; or in the decision to submit the article for publication.

Conflict of Interest

Dr. Michael Eriksen received unrestricted research funding support from Pfizer, Inc. ("Diffusion of Tobacco Control Fundamentals to Other Large Chinese Cities" Michael Eriksen, Principal Investigator). David L. Ashley has received funds for work done for the World Health Organization Tobacco Free Initiative, as a Special Government Employee of the U.S. Food and Drug Administration, as a consultant for Pfizer, and as an independent contractor for McKing Consulting. No financial disclosures were reported by the other authors of this paper. The authors declare that there are no other financial relationships with any organizations that might have an interest in the

submitted work, and there are no other relationships or activities that could appear to have influenced the submitted work.

REFERENCES

- Action on Smoking and Health, 2016 ASH fact sheet: Use of electronic cigarettes (vapourisers) among adults in Great Britain.
- Bhatnagar A, Whitsel LP, Blaha MJ, Huffman MD, Krishan-Sarin S, Maa J, Rigotti N, Robertson RM, Warner JJ, 2019 New and emerging tobacco products and the nicotine Endgame: the role of robust regulation and comprehensive tobacco control and prevention: A presidential advisory from the American Heart Association. *Circulation* 139, e937–e958. 10.1161/CIR.0000000000000669 [PubMed: 30862181]
- Biener L, Hargraves JL, 2015 A longitudinal study of electronic cigarette use in a population-based sample of adult smokers: association with smoking cessation and motivation to quit. *Nicotine Tob Res* 17, 127–133. 10.1093/ntr/ntu200 [PubMed: 25301815]
- Biener L, Song E, Sutfin EL, Spangler J, Wolfson M, 2015 Electronic cigarette trial and use among young adults: Reasons for trial and cessation of vaping. *Int. J. Environ. Res. Public Health* 12, 16019–16026. 10.3390/ijerph121215039 [PubMed: 26694438]
- Braak DC, Cummings KM, Nahhas GJ, Heckman BW, Borland R, Fong GT, Hammond D, Boudreau C, McNeill A, Levy DT, Shang C, 2019 Where do vapers buy their vaping supplies? Findings from the International Tobacco Control (ITC) 4 Country Smoking and Vaping Survey. *Int. J. Environ. Res. Public Health* 16 10.3390/ijerph16030338
- Cantrell J, Huang J, Greenberg M, Willett J, Hair E, Vallone D, 2018 History and current trends in the electronic nicotine delivery systems retail marketplace in the United States: 2010–2016. *Nicotine Tob. Res* 10.1093/ntr/nty214
- Douglas CE, Henson R, Drope J, Wender RC, 2018 The American Cancer Society public health statement on eliminating combustible tobacco use in the United States. *CA. Cancer J. Clin* 68, 240–245. 10.3322/caac.21455 [PubMed: 29889305]
- Farsalinos KE, Yannovits N, Sarri T, Voudris V, Poulas K, 2018 Nicotine delivery to the aerosol of a heat-not-burn tobacco product: Comparison with a tobacco cigarette and e-cigarettes. *Nicotine Tob. Res* 20, 1004–1009. 10.1093/ntr/ntx138 [PubMed: 28637344]
- Gentzke AS, Creamer M, Cullen KA, Ambrose BK, Willis G, Jamal A, King BA, 2019 Vital Signs: Tobacco product use among middle and high school students - United States, 2011–2018. *MMWR* 68, 157–164. 10.15585/mmwr.mm6806e1 [PubMed: 30763302]
- Giovenco DP, Delnevo CD, 2018 Prevalence of population smoking cessation by electronic cigarette use status in a national sample of recent smokers. *Addict. Behav* 76, 129–134. 10.1016/j.addbeh.2017.08.002 [PubMed: 28802179]
- Goniewicz ML, Boykan R, Messina CR, Eliscu A, Tolentino J, 2018 High exposure to nicotine among adolescents who use Juul and other vape pod systems ('pods'). *Tob. Control* 10.1136/tobaccocontrol-2018-054565
- Grana R, Benowitz N, Glantz SA, 2014 E-cigarettes: a scientific review. *Circulation* 129, 1972–1986. 10.1161/CIRCULATIONAHA.114.007667 [PubMed: 24821826]
- Hajek P, Phillips-Waller A, Przulj D, Pesola F, Myers Smith K, Bisal N, Li J, Parrott S, Sasieni P, Dawkins L, Ross L, Goniewicz M, Wu Q, McRobbie HJ, 2019 A randomized trial of e-cigarettes versus nicotine-replacement therapy. *N. Engl. J. Med* 380, 629–637. 10.1056/NEJMoa1808779 [PubMed: 30699054]
- Hajek P, Przulj D, Phillips A, Anderson R, McRobbie H, 2017 Nicotine delivery to users from cigarettes and from different types of e-cigarettes. *Psychopharmacology (Berl.)* 234, 773–779. 10.1007/s00213-016-4512-6 [PubMed: 28070620]
- Halpern SD, Harhay MO, Saulsgiver K, Brophy C, Troxel AB, Volpp KG, 2018 A pragmatic trial of e-cigarettes, incentives, and drugs for smoking cessation. *N. Engl. J. Med* 378, 2302–2310. 10.1056/NEJMsa1715757 [PubMed: 29791259]
- Huang J, Duan Z, Kwok J, Binns S, Vera LE, Kim Y, Szczypka G, Emery SL, 2019a Vaping versus JUULing: How the extraordinary growth and marketing of JUUL transformed the US retail e-

cigarette market. *Tob. Control* 28, 146–151. 10.1136/tobaccocontrol-2018-054382 [PubMed: 29853561]

- Huang J, Feng B, Weaver SR, Pechacek TF, Slovic P, Eriksen MP, 2019b Changing perceptions of harm of e-cigarette vs cigarette use among adults in 2 US national surveys from 2012 to 2017. *JAMA Netw. Open* 2, e191047 10.1001/jamanetworkopen.2019.1047 [PubMed: 30924893]
- Huang J, Gwamnicki C, Xu X, Caraballo RS, Wada R, Chaloupka FJ, 2018 A comprehensive examination of own- and cross-price elasticities of tobacco and nicotine replacement products in the U.S. *Prev. Med* 117, 107–114. 10.1016/j.ypmed.2018.04.024 [PubMed: 29684418]
- Kasza KA, Borek N, Conway KP, Goniewicz ML, Stanton CA, Sharma E, Fong GT, Abrams DB, Coleman B, Schneller LM, Lambert EY, Pearson JL, Bansal-Travers M, Murphy I, Cheng Y-C, Donaldson EA, Feirman SP, Gravely S, Elton-Marshall T, Trinidad DR, Gundersen DA, Niaura RS, Cummings KM, Compton WM, Hyland AJ, 2018 Transitions in tobacco product use by U.S. adults between 2013–2014 and 2014–2015: Findings from the PATH Study Wave 1 and Wave 2. *Int. J. Environ. Res. Public. Health* 15 10.3390/ijerph15112515
- Levy DT, Cummings KM, Villanti AC, Niaura R, Abrams DB, Fong GT, Borland R, 2017 A framework for evaluating the public health impact of e- cigarettes and other vaporized nicotine products. *Addiction* 112, 8–17. 10.1111/add.13394 [PubMed: 27109256]
- Levy DT, Yuan Z, Luo Y, Abrams DB, 2018 The Relationship of E-Cigarette Use to Cigarette Quit Attempts and Cessation: Insights From a Large, Nationally Representative U.S. Survey. *Nicotine Tob. Res* 20, 931–939. 10.1093/ntr/ntx166 [PubMed: 29059341]
- Liber AC, Drope JM, Stoklosa M, 2017 Combustible cigarettes cost less to use than e-cigarettes: Global evidence and tax policy implications. *Tob. Control* 26, 158–163. 10.1136/tobaccocontrol-2015-052874 [PubMed: 27022059]
- Lumley T, 2017 Survey: analysis of complex survey samples.
- Lumley T, 2004 Analysis of complex survey samples. *J. Stat. Softw* 9, 1–19.
- Majeed BA, Weaver SR, Gregory KR, Whitney CF, Slovic P, Pechacek TF, Eriksen MP, 2017 Changing perceptions of harm of e-cigarettes among U.S. adults, 2012–2015. *Am. J. Prev. Med* 52, 331–338. 10.1016/j.amepre.2016.08.039 [PubMed: 28341303]
- Manzoli L, Flacco ME, Ferrante M, Vecchia CL, Siliquini R, Ricciardi W, Marzuillo C, Villari P, Fiore M, 2017 Cohort study of electronic cigarette use: Effectiveness and safety at 24 months. *Tob. Control* 26, 284–292. 10.1136/tobaccocontrol-2015-052822 [PubMed: 27272748]
- McNeill A, Brose LS, Calder R, Bauld L, Robson D, 2018 Evidence review of e-cigarettes and heated tobacco products 2018. Public Health England, London.
- Miech R, Johnston L, O'Malley PM, Bachman JG, Patrick ME, 2019 Trends in adolescent vaping, 2017–2019. *N. Engl. J. Med* 381, 1490–1491. 10.1056/NEJMc1910739 [PubMed: 31532955]
- National Academies of Sciences, Engineering, and Medicine, 2018 Public health consequences of e-cigarettes. The National Academies Press, Washington, DC 10.17226/24952
- Nyman AL, Huang J, Weaver SR, Eriksen MP, 2019 Perceived Comparative Harm of Cigarettes and Electronic Nicotine Delivery Systems. *JAMA Netw. Open* 2, e1915680 10.1001/jamanetworkopen.2019.15680 [PubMed: 31747029]
- Pechacek TF, Nayak P, Slovic P, Weaver SR, Huang J, Eriksen MP, 2017 Reassessing the importance of “lost pleasure” associated with smoking cessation: implications for social welfare and policy. *Tob. Control* 10.1136/tobaccocontrol-2017-053734
- Rigotti NA, 2018 Monitoring the rapidly changing landscape of e-cigarettes. *Ann. Intern. Med* 169, 494–495. 10.7326/M18-2176 [PubMed: 30167664]
- Rigotti NA, Chang Y, Tindle HA, Kalkhoran SM, Levy DE, Regan S, Kelley JHK, Davis EM, Singer DE, 2018 Association of e-cigarette use with smoking cessation among smokers who plan to quit after a hospitalization: A prospective study. *Ann. Intern. Med* 168, 613–620. 10.7326/M17-2048 [PubMed: 29582077]
- Royal College of Physicians, 2016 Nicotine without smoke: Tobacco harm reduction. RCP, London.
- Simonavicius E, McNeill A, Arnott D, Brose LS, 2017 What factors are associated with current smokers using or stopping e-cigarette use? *Drug Alcohol Depend.* 173, 139–143. 10.1016/j.drugalcdep.2017.01.002 [PubMed: 28246049]

- Sussman S, Barker DC, 2017 Vape shops: The e-cigarette marketplace. *Tob. Prev. Cessat* 2, 11 10.18332/tpc/76484
- Sweet L, Brasky TM, Cooper S, Doogan N, Hinton A, Klein EG, Nagaraja H, Quisenberry A, Xi W, Wewers ME, 2019 Quitting behaviors among dual cigarette and e-cigarette users and cigarette smokers enrolled in the tobacco user adult cohort. *Nicotine Tob. Res* 21, 278–284. 10.1093/ntr/nty222 [PubMed: 30346585]
- Talih S, Salman R, El-Hage R, Karam E, Karaoghlanian N, El-Hellani A, Saliba N, Shihadeh A, 2019 Characteristics and toxicant emissions of JUUL electronic cigarettes. *Tob. Control* 10.1136/tobaccocontrol-2018-054616
- Wackowski OA, Bover Manderski MT, Delnevo CD, 2015 Smokers' sources of e-cigarette awareness and risk information. *Prev. Med. Rep* 2, 906–910. 10.1016/j.pmedr.2015.10.006 [PubMed: 26576338]
- Wackowski OA, Giovenco DP, Singh B, Lewis MJ, Steinberg MB, Delnevo CD, 2018 Content Analysis of US News Stories About E-Cigarettes in 2015. *Nicotine Tob. Res* 20, 1015–1019. 10.1093/ntr/nty170 [PubMed: 29065205]
- Wackowski OA, Sontag JM, Hammond D, 2019 Youth and young adult exposure to and perceptions of news media coverage about e-cigarettes in the United States, Canada and England. *Prev. Med* 121, 7–10. 10.1016/j.ypmed.2019.01.013
- Wang TW, Coats EM, Gammon DG, Loomis BR, Kuiper NM, Rogers T, King BA, 2018 National and state-specific unit sales and prices for electronic cigarettes, United States, 2012–2016. *Prev. Chronic. Dis* 15, E99 10.5888/pcd15.170555 [PubMed: 30073948]
- Warner KE, Mendez D, 2018 E-cigarettes: Comparing the Possible Risks of Increasing Smoking Initiation with the Potential Benefits of Increasing Smoking Cessation. *Nicotine Tob. Res* 10.1093/ntr/nty062
- Weaver SR, Huang J, Pechacek TF, Heath JW, Ashley DL, Eriksen MP, 2018 Are electronic nicotine delivery systems helping cigarette smokers quit? Evidence from a prospective cohort study of U.S. adult smokers, 2015–2016. *PloS One* 13, e0198047 10.1371/journal.pone.0198047 [PubMed: 29985948]
- Weaver SR, Kemp CB, Heath JW, Pechacek TF, Eriksen MP, 2017 Use of nicotine in electronic nicotine and non-nicotine delivery systems by US adults, 2015. *Public Health Rep.* 132, 545–548. 10.1177/0033354917723597 [PubMed: 28880788]
- Wilson S, Partos T, McNeill A, Brose LS, 2019 Harm perceptions of e-cigarettes and other nicotine products in a UK sample. *Addiction.* 10.1111/add.14502
- Yong H-H, Borland R, Cummings KM, Gravely S, Thrasher JF, McNeill A, Hitchman S, Greenhalgh E, Thompson ME, Fong GT, 2019 Reasons for regular vaping and for its discontinuation among smokers and recent ex-smokers: findings from the 2016 ITC Four Country Smoking and Vaping Survey. *Addiction.* 10.1111/add.14593
- Zhu S-H, Zhuang Y-L, Wong S, Cummins SE, Tedeschi GJ, 2017 E-cigarette use and associated changes in population smoking cessation: evidence from US current population surveys. *The BMJ* 358 10.1136/bmj.j3262

Highlights

- Over 30% of smokers have tried and discontinued e-cigarettes
- Inadequate craving reduction and incomparability to smoking are key reasons
- Nearly 40% of smokers have not tried e-cigarettes
- Concerns about addiction, safety, and effectiveness were key reasons for non-use
- E-cigarette type, perceptions, and other factors were associated with reasons

Smoking and ENDS use characteristics among US adult smokers by prior ENDS use (2017–2018)

Table 1.

	Former ENDS users (n=208)		Former experimental ENDS users (n=613)		Never ENDS users (n=1022)	
	n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)
Smoking quit plans ($p_{\text{unadj}} = .027, p_{\text{adj}} < .001$)						
Within 6 months	83	38.2 (30.2, 46.9)	190	27.9 (23.7, 32.5)	357	34.6 (30.9, 38.4)
> 6 months	125	61.8 (53.1, 69.8)	421	72.1 (67.5, 76.3)	659	65.4 (61.6, 69.1)
Smoking frequency ($p_{\text{unadj}} = .024, p_{\text{adj}} < .001$)						
Non-daily	49	25.6 (18.5, 34.3)	144	24.9 (20.5, 29.8)	289	29.9 (26.4, 33.7)
Daily (1–9 CPD)	27	13.5 (8.8, 20.0)	92	14.7 (11.5, 18.6)	178	18.9 (16.0, 22.3)
Daily (10+ CPD)	132	61.0 (52.1, 69.2)	376	60.5 (55.3, 65.4)	551	51.2 (47.2, 55.1)
ENDS device type ($p_{\text{unadj}} < .001, p_{\text{adj}} < .001$)						
Non-rechargeable	20	9.0 (5.3, 15.0)	138	29.8 (24.6, 35.5)	--	--
Rechargeable, non-refillable	42	19.6 (13.3, 27.9)	139	30.7 (25.4, 36.5)	--	--
Rechargeable, refillable	128	71.4 (62.7, 78.8)	173	39.6 (33.9, 45.6)	--	--
Perceived relative harm of ENDS ($p_{\text{unadj}} < .001, p_{\text{adj}} < .001$)						
Less harmful than cigarettes	82	37.8 (29.7, 46.7)	191	29.2 (24.8, 34.1)	148	15.3 (12.6, 18.6)
About the same harm as cigarettes	69	30.8 (23.6, 39.0)	212	35.6 (30.8, 40.8)	356	41.7 (37.5, 45.9)
More harmful than cigarettes	15	9.7 (5.2, 17.4)	47	7.0 (5.0, 9.9)	75	9.8 (7.5, 12.6)
I don't know	40	21.7 (15.0, 30.3)	158	28.1 (23.6, 33.1)	287	33.2 (29.3, 37.4)
Perceived harm of nicotine for adults ($p_{\text{unadj}} = .032, p_{\text{adj}} < .001$)						
Definitely harmful	118	55.6 (46.7, 64.2)	347	56.5 (51.3, 61.6)	587	56.1 (52.1, 60.0)
Maybe harmful	60	25.7 (19.0, 33.7)	175	28.3 (23.9, 33.2)	243	23.8 (20.6, 27.3)
Unlikely harmful	7	4.2 (1.4, 11.6)	22	3.9 (2.2, 6.9)	59	5.9 (4.3, 7.9)
Not harmful	6	4.6 (1.5, 12.8)	7	1.5 (0.7, 3.4)	19	2.1 (1.2, 3.9)
Don't know	17	9.9 (5.6, 16.8)	61	9.8 (7.0, 13.4)	110	12.1 (9.6, 15.1)
Enjoyability of ENDS compared to cigarettes ($p_{\text{unadj}} < .001, p_{\text{adj}} < .001$)						
ENDS are less enjoyable	155	71.7 (63.1, 79.1)	521	82.8 (77.9, 86.7)	--	--
Equally enjoyable	37	18.2 (12.6, 25.6)	73	15.6 (11.8, 20.4)	--	--

	Former ENDS users (n=208)		Former experimental ENDS users (n=613)		Never ENDS users (n=1022)	
	n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)
ENDS are more enjoyable	16	10.1 (5.4, 18.0)	10	1.6 (0.8, 3.4)	--	--
Will try ENDS soon ($p_{unadj} < .001, p_{adj} < .001$)						
Definitely not	52	18.6 (13.5, 25.1)	261	43.5 (38.5, 48.7)	467	52.8 (48.5, 57.1)
Probably not	91	48.4 (39.7, 57.2)	262	42.5 (37.4, 47.7)	289	33.8 (29.8, 38.0)
Probably yes	57	29.0 (21.4, 37.9)	81	12.1 (9.2, 15.6)	92	11.9 (9.4, 15.1)
Definitely yes	8	4.1 (1.7, 9.4)	8	1.9 (0.8, 4.5)	12	1.4 (0.7, 3.1)
Would try ENDS if best friend offered ($p_{unadj} < .001, p_{adj} < .001$)						
Definitely not	33	12.2 (8.2, 17.7)	176	31.9 (27.2, 36.9)	306	35.7 (31.7, 40.0)
Probably not	76	36.6 (28.7, 45.4)	220	33.8 (29.1, 38.7)	241	28.4 (24.7, 32.5)
Probably yes	77	40.0 (31.5, 49.2)	174	26.5 (22.2, 31.4)	259	29.2 (25.5, 33.2)
Definitely yes	20	11.1 (6.8, 17.7)	38	7.8 (5.2, 11.6)	56	6.6 (4.8, 9.1)

ENDS = electronic nicotine delivery system; n = unweighted frequency; CI = confidence interval; CPD = cigarettes per day. Column percentages are reported. Weighted unadjusted and adjusted logistic regression models were estimated and a likelihood ratio test was performed to evaluate the association between the column variable (former/never ENDS user group) with each row variable. P-values are reported for unadjusted (p_{unadj}) and adjusted (p_{adj}) models. Adjusted models controlled for age, sex, race/ethnicity, household income, and education.

Table 2.

The reasons US adult current smokers provide for discontinuing ENDS use, overall and by regularity of ENDS use and ENDS device type (2017–2018)

Reason for Discontinuing ENDS	Overall (n=816)		Former Experimental vs. Former Regular ENDS Users ($p_{\text{unadj}} < .001, p_{\text{adj}} = .0003$)				ENDS Device Type ($p_{\text{unadj}} = .012, p_{\text{adj}} < .001$)					
	n	Weighted % (95% CI)	Former experimental ENDS users (n=611)		Former regular ENDS users (n=205)		Rechargeable, refillable users (n=299)		Rechargeable, non-refillable users (n=180)		Non-rechargeable users (n=158)	
			n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)
They didn't feel like smoking a cigarette	183	22.9 (19.3, 26.9)	139	23.0 (18.9, 27.6)	44	22.5 (15.7, 31.1)	68	24.0 (18.1, 31.1)	60	34.2 (25.7, 43.9)	31	18.8 (12.4, 27.5)
I only ever tried them to see what they were like	177	20.3 (17.0, 24.0)	165	25.2 (21.1, 29.8)	12	5.8 (3.0, 11.0)	42	12.8 (8.9, 18.2)	27	15.7 (9.7, 24.4)	42	25.2 (17.6, 34.6)
They didn't help me deal with cravings for smoking	131	14.4 (11.7, 17.6)	89	13.2 (10.2, 16.9)	42	17.9 (12.5, 25.1)	59	19.6 (14.6, 25.8)	33	14.2 (9.3, 21.1)	28	15.4 (9.6, 23.8)
I was concerned they were not safe enough	77	10.2 (7.7, 13.3)	54	9.7 (6.9, 13.4)	23	11.7 (7.0, 18.8)	38	12.1 (8.3, 17.4)	16	10.6 (5.6, 19.4)	12	8.3 (4.2, 15.8)
Don't know/can't remember	68	9.3 (6.8, 12.6)	52	9.7 (6.9, 13.6)	16	8.2 (4.0, 15.8)	17	4.9 (2.8, 8.3)	9	8.9 (3.9, 19.2)	16	12.5 (6.3, 23.3)
They cost too much	43	5.2 (3.6, 7.4)	31	5.4 (3.5, 8.2)	12	4.4 (2.3, 8.3)	12	3.2 (1.7, 5.9)	9	4.6 (2.3, 9.1)	10	8.9 (4.0, 18.6)
Other (specify)	39	4.2 (2.8, 6.2)	31	4.5 (2.8, 7.0)	8	3.3 (1.6, 6.8)	9	2.8 (1.3, 5.6)	9	4.3 (1.7, 10.2)	7	2.2 (0.9, 5.3)
I felt I was using them too often compared with smoking	27	4.6 (3.0, 7.0)	11	3.0 (1.5, 5.7)	16	9.4 (5.4, 15.7)	16	6.9 (3.9, 11.7)	2	1.1 (0.3, 4.5)	6	5.3 (2.2, 12.2)
Refills and replacements were not easily available	20	2.9 (1.6, 5.3)	8	2.0 (0.8, 4.9)	12	5.6 (2.6, 11.8)	7	3.2 (1.3, 7.6)	7	2.6 (1.1, 5.9)	1	0.4 (0.1, 2.8)
They were difficult to use or refill	16	1.3 (0.7, 2.4)	9	0.9 (0.4, 1.9)	7	2.6 (1.1, 6.3)	8	2.3 (1.0, 5.1)	4	1.3 (0.5, 3.7)	1	0.2 (0.0, 1.6)
They kept leaking	14	1.6 (0.7, 3.4)	9	1.5 (0.5, 4.1)	5	1.8 (0.7, 4.5)	13	3.5 (1.5, 7.8)	0	0.0 (0.0, 0.0)	1	1.2 (0.2, 8.2)
A health professional told me to stop	9	1.2 (0.4, 3.1)	6	0.7 (0.3, 1.7)	3	2.6 (0.5, 12.3)	5	1.9 (0.5, 7.8)	2	0.8 (0.2, 3.6)	1	0.8 (0.1, 5.3)
They felt too much like smoking a cigarette	8	1.5 (0.7, 3.3)	4	0.8 (0.2, 2.5)	4	3.6 (1.2, 10.3)	3	2.3 (0.7, 7.3)	1	1.2 (0.2, 8.2)	2	0.9 (0.2, 3.7)

Reason for Discontinuing ENDS	Overall (n=816)		Former Experimental vs. Former Regular ENDS Users ($P_{unadj} < .001, P_{adj} = .003$)				ENDS Device Type ($P_{unadj} = .012, P_{adj} < .001$)					
	n	Weighted % (95% CI)	Former experimental ENDS users (n=611)		Former regular ENDS users (n=205)		Rechargeable, refillable users (n=299)		Rechargeable, non-refillable users (n=180)		Non-rechargeable users (n=158)	
			n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)
I was embarrassed to use them in public	4	0.6 (0.2, 1.8)	3	0.6 (0.1, 2.4)	1	0.6 (0.1, 3.9)	2	0.5 (0.1, 2.3)	1	0.3 (0.0, 2.2)	0	0.0 (0.0, 0.0)

ENDS = electronic nicotine delivery system; n = unweighted frequency; CI = confidence interval. Column percentages are reported. Weighted unadjusted and adjusted logistic regression models were estimated and a likelihood ratio test was performed to evaluate the association between the column variables (former experimental vs. former regular ENDS user; ENDS device type) with the row variable (reason for discontinuing ENDS). P-values are reported for unadjusted (P_{unadj}) and adjusted (P_{adj}) models. Adjusted models controlled for age, sex, and the other column variable.

Table 3.

The reasons US adult current smokers provide for never having tried or used ENDS, overall and stratified by smoking quit attentions and age (2017–2018)

	Overall			Smoking Quit Intentions						Age					
	n	Weighted % (95% CI)	P _{unadj} ; P _{adj}	Less than 6 months		More than 6 months or no plan		18–29 years		30+ years		P _{unadj} ; P _{adj}			
				n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)				
I do not want to substitute one addiction for another	546	60.0 (55.7, 64.1)		223	68.9 (61.5, 75.4)	321	55.7 (50.3, 60.9)	33	52.2 (36.3, 67.7)	513	61.0 (56.7, 65.2)	(.17, .29)			
I am concerned they are not safe enough	490	52.7 (48.4, 56.9)		198	61.5 (54.1, 68.3)	289	48.3 (43.0, 53.7)	28	42.7 (27.9, 58.9)	462	54.1 (49.7, 58.4)	(.082, .056)			
I do not think they would help me to quit or cut down	477	52.0 (47.8, 56.3)		179	55.7 (48.4, 62.7)	297	50.5 (45.1, 55.8)	32	53.3 (37.3, 68.6)	445	51.9 (47.5, 56.2)	(.83, .97)			
They cost too much	362	42.8 (38.6, 47.1)		134	43.9 (37.0, 51.0)	227	42.4 (37.2, 47.8)	29	50.9 (35.2, 66.5)	333	41.7 (37.5, 46.0)	(.16, .59)			
I do not want to quit smoking	293	35.1 (31.0, 39.3)		49	17.1 (12.2, 23.4)	243	44.0 (38.8, 49.4)	17	39.9 (25.1, 56.8)	276	34.4 (30.4, 38.6)	(.38, .77)			
There are too many products to choose from	290	32.0 (28.3, 36.1)		115	34.7 (28.5, 41.5)	173	30.7 (26.0, 35.8)	18	29.1 (16.8, 45.5)	272	32.4 (28.6, 36.5)	(.58, .49)			
I haven't gotten around to it yet	240	27.2 (23.5, 31.1)		89	30.1 (23.9, 37.1)	149	25.6 (21.2, 30.6)	19	39.7 (25.0, 56.5)	221	25.4 (21.9, 29.2)	(.018, .031)			
I do not like the way they look	232	24.5 (21.2, 28.2)		90	24.9 (19.8, 30.9)	141	24.4 (20.1, 29.2)	14	23.3 (12.7, 38.8)	218	24.7 (21.3, 28.5)	(.81, .76)			
I am not addicted to smoking and don't need help to quit	166	19.7 (16.5, 23.4)		55	17.4 (12.9, 23.1)	108	20.6 (16.5, 25.4)	13	28.7 (15.7, 46.4)	153	18.5 (15.5, 21.9)	(.061, .25)			
I am using other things to help me quit smoking	163	15.7 (13.0, 18.8)		103	28.8 (23.1, 35.3)	59	9.2 (6.6, 12.6)	9	11.6 (4.7, 25.8)	154	16.3 (13.5, 19.5)	(.31, .43)			
I would be embarrassed to use them in public	150	16.7 (13.8, 20.0)		56	17.2 (12.8, 22.8)	93	16.4 (12.8, 20.7)	12	22.9 (11.8, 39.8)	138	15.8 (13.1, 18.9)	(.16, .25)			
They are too difficult to get hold of	78	9.2 (7.1, 11.8)		33	10.2 (6.8, 14.9)	44	8.6 (6.1, 12.1)	4	9.3 (3.0, 25.0)	74	9.2 (7.1, 11.8)	(.97, .67)			
Other	53	6.0 (4.4, 8.3)		18	7.2 (4.3, 11.9)	35	5.5 (3.7, 8.2)	2	5.0 (1.2, 18.6)	51	6.2 (4.5, 8.5)	(.69, .91)			

ENDS = electronic nicotine delivery system; n = unweighted frequency; CI = confidence interval. Column percentages are reported for each reason. Participants could select multiple reasons. Weighted unadjusted and adjusted logistic regression models were estimated and a likelihood ratio test was performed to evaluate the association between the column variables (smoking quit intentions; age) with each row variable (reason for never having tried or used ENDS). P-values are reported for unadjusted (P_{unadj}) and adjusted (P_{adj}) models. Adjusted models controlled for sex, race/ethnicity, household income, education, perceived relative harm of ENDS vs. cigarettes, and the other column variable. Statistically significant effects (p < .05) are denoted by boldface p-values.

Table 4. The reasons US adult current smokers provide for never having tried or used ENDS stratified by the perceived relative harm of ENDS (2017–2018)

	Perceived Relative Harm of ENDS								
	Less harmful than cigarettes		About the same harm		More harmful than cigarettes		I don't know		p
	n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)	n	Weighted % (95% CI)	
I do not want to substitute one addiction for another	80	55.7 (45.2, 65.7)	240	62.8 (55.8, 69.3)	46	56.2 (42.0, 69.4)	179	60.4 (52.9, 67.5)	
I am concerned they are not safe enough	62	46.9 (36.5, 57.5)	211	53.4 (46.6, 60.1)	57	74.5 (60.8, 84.7)	158	48.6 (41.3, 56.0)	(.004, < .0001)
I do not think they would help me to quit or cut down	68	46.5 (36.2, 57.1)	205	55.5 (48.7, 62.0)	39	53.0 (39.4, 66.2)	163	50.7 (43.2, 58.0)	(.53, .063)
They cost too much	62	45.7 (35.3, 56.3)	144	42.9 (36.4, 49.8)	37	43.8 (31.1, 57.4)	117	41.3 (34.3, 48.7)	(.93, .23)
I do not want to quit smoking	43	39.4 (29.1, 50.8)	123	36.3 (30.0, 43.2)	27	28.7 (18.8, 41.2)	98	33.4 (26.8, 40.8)	(.57, .16)
There are too many products to choose from	57	40.4 (30.5, 51.1)	100	26.4 (21.0, 32.5)	26	34.6 (23.1, 48.2)	105	34.7 (28.1, 41.9)	(.083, .014)
I haven't gotten around to it yet	67	45.4 (35.2, 56.0)	87	24.2 (18.7, 30.8)	12	17.7 (9.6, 30.2)	73	25.3 (19.5, 32.2)	(< .0001, < .0001)
I do not like the way they look	38	29.8 (20.6, 41.0)	94	24.5 (19.3, 30.5)	24	27.6 (17.6, 40.5)	74	21.3 (16.3, 27.2)	(.43, .17)
I am not addicted to smoking and don't need help to quit	26	21.5 (13.6, 32.2)	64	19.7 (14.7, 26.0)	24	27.9 (17.9, 40.9)	51	16.5 (12.0, 22.3)	(.33, .12)
I am using other things to help me quit smoking	25	16.9 (10.1, 27.1)	69	16.7 (12.5, 21.8)	17	18.2 (10.5, 29.6)	52	13.5 (9.7, 18.5)	(.76, .42)
I would be embarrassed to use them in public	25	21.6 (13.2, 33.5)	63	17.6 (13.2, 23.2)	16	18.6 (10.6, 30.5)	46	12.9 (9.3, 17.6)	(.31, .46)
They are too difficult to get hold of	9	8.1 (3.2, 19.1)	29	6.5 (4.3, 9.9)	11	16.1 (8.5, 28.5)	29	11.0 (7.3, 16.3)	(.14, .10)
Other	11	5.4 (2.6, 10.7)	23	7.4 (4.6, 11.8)	2	3.9 (0.9, 15.1)	17	5.3 (3.0, 9.1)	(.71, .67)

ENDS = electronic nicotine delivery system; n = unweighted frequency; CI = confidence interval. Column percentages are reported for each reason. Participants could select multiple reasons. Weighted unadjusted and adjusted logistic regression models were estimated and a likelihood ratio test was performed to evaluate the association between the column variables (perceived relative harm of ENDS vs. cigarettes) with each row variable (reason for never having tried or used ENDS). P-values are reported for unadjusted (*p*_{unadj}) and adjusted (*p*_{adj}) models. Adjusted models controlled for age, sex, race/ethnicity, household income, education, and smoking quit intentions. Statistically significant effects (*p* < .05) are denoted by boldface p-values.