Quitting e-cigarettes: Quit attempts and quit intentions among youth and young adults

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A B S T R A C T

While youth and young adult e-cigarette use has risen in the U.S., few studies have explored e-cigarette cessation behavior. This study estimates quit attempts and intentions among young people (aged 15–36) since the rise of high-nicotine products, and examines factors associated with e-cigarette quit attempts and intentions. Current e-cigarette users (past 30-day use, not already quit) were drawn from a national probability-based cohort sample. Data were collected from September to December 2019 (n = 1158). Weighted proportions of past-year quit attempts, intentions to quit in next 30 days, and general intentions to quit (at some point) were calculated. Models estimated cessation outcomes with respect to harm perceptions, friend use, dependence, use frequency, combustible use and demographic factors. Among current e-cigarette users, 54.2% reported general intentions to quit, 15.3% reported intention to quit within 30 days, and 33.3% reported a past-year quit attempt. Past-year quit attempts were associated with higher levels of harm perceptions (adjusted odds ratio (aOR) = 2.08, 95% confidence interval (CI): 1.49–2.92), dependence (aOR = 1.92, 95% CI: 1.44–2.56) and daily use (28 + days) compared to infrequent use (1–5 days) (aOR = 0.23, 95% CI: 0.12–0.43). General intentions to quit were positively associated with harm perceptions (aOR = 1.77, 95% CI: 1.23–2.56) and dependence (aOR = 1.89, 95% CI: 1.41–2.52), and negatively associated with daily use compared to infrequent use (aOR = 0.35, 95% CI: 0.19–0.65). Findings indicate that over half of young e-cigarette users want to quit, highlighting a critical need for policies and resources to promote and sustain e-cigarette cessation among young people.

1. Introduction

Youth and young adult e-cigarette use has grown dramatically in the United States (U.S.). Over a quarter of high school students used e-cigarettes in the past 30 days in 2019 (Cullen et al., 2019). Similarly, 7.6% of adults aged 18–24 in 2018 were current e-cigarette users, up from 5.2% in 2014 (Centers for Disease Control and Prevention, 2018). This growth coincided with an evolution in the e-cigarette market towards products containing higher nicotine concentrations that may be harder to quit (Romberg et al., 2019; U.S. Department of Health and Human Services (USDHHS), 2016).

Although e-cigarette use has gained notoriety in the popular press and the tobacco control community, few studies have focused on e-cigarette cessation. Initial evidence from cessation programs suggests that young users are interested in quitting (Graham et al., 2020), yet little is known about e-cigarette cessation at the population level. With Population Assessment of Tobacco and Health (PATH) Study data, researchers estimated that over a quarter of adult e-cigarette users had a past-year quit attempt and nearly two thirds planned to quit (Rosen and Steinberg, 2020). Additional research using PATH data predicted nearly half of youth e-cigarette users planned to quit, and a quarter made a past-year quit attempt (Smith et al., 2020). However, these samples

were collected from October 2015–2016 and 2017, respectively, prior to the popularity of high-nicotine devices among youth and young adults. A study using the National Youth Tobacco Survey estimated that 3.30 million middle and high school students reported a past-year quit attempt, and 3.33 million intended to quit all tobacco in the future. However, given item limitations, researchers could not differentiate which products respondents were trying to quit, though over half exclusively used e-cigarettes (Wang et al., 2019).

Few studies have examined the role of individual-level factors and e-cigarette cessation. Although International evidence suggests that affordability (Saminathan et al., 2019) and harm perceptions (Ma et al., 2018) are associated with intentions to quit, the population, market, and policies differ from the U.S., and findings may not be applicable. While friend use (Cengelli et al., 2012), harm perceptions (Vangeli et al., 2011), dependence and use frequency (Kasza et al., 2020; Vangeli et al., 2011), along with some sociodemographic variables (Kasza et al., 2020) influence combustible cigarette cessation, it remains unclear whether and to what extent these factors influence e-cigarette cessation.

Using a nationally representative sample, this study estimates the proportion of young e-cigarette users who report a past-year quit attempt and intentions to quit. We also explore factors associated with quitting e-cigarettes.

2. Methods

2.1. Sample

Data were drawn from the Truth Longitudinal Cohort (TLC), a national, probability-based sample. Respondents were recruited through address-based sampling augmented with commercially available auxiliary data to identify target populations. Wave 1 recruited participants aged 15–21 in 2014, with a weighted response rate of 38.7%. Follow-up online surveys were conducted every 6 months. Additional TLC sample methods have been described elsewhere (Cantrell et al., 2018). Beginning in 2018, adults age 25–34 were recruited from the Ipsos KnowledgePanel (Vallone et al., 2019). This study was approved by Advarra IRB.

The analytic sample for this study included current e-cigarette users aged 15–36 from wave 9 of the TLC, collected from September to December 2019 (n = 1158). Current users were defined as e-cigarette use in the past 30 days and not already quit.

2.2. Measures

2.2.1. Past-year quit attempts

Current users were asked "In the past 12 months, have you stopped using e-cigarettes/vapes for 1 day or longer because you were trying to quit for good?" (yes/no).

2.2.2. Intention to quit

Past 30-day users were asked the multiple-choice item, "Are you seriously thinking about quitting e-cigarettes/vapes?" Positive response options included the timeframe in which the respondent intended to quit (30 days, 6 months, 1 year, more than a year). Two separate dichotomous outcomes were calculated. The first identified intention to quit within 30 days (subsequently referred to as a "serious" intention to quit) (Biener and Abrams, 1971). The second identified intention to quit within any timeframe ("general" intention to quit) to capture all interest in cessation. Participants who selected "I've already quit," were excluded from all analyses. Though this group likely includes recent quitters, deniers, and others, their inclusion would have rendered the outcome variables nonsensical. These participants (n = 316) did not differ in demographics from the analytic sample (n = 1158), but had lower dependence, fewer friends who used e-cigarettes, and most were infrequent users.

2.2.3. Use frequency

Ever e-cigarette users reported frequency of use in the past 30 days. Responses were categorized into three levels: 1–5 days "infrequent users," 6–27 days "intermediate users," and 28–30 days "daily users" to include participants who were temporarily abstinent for artificial reasons (Amato et al., 2016).

2.2.4. Dependence

The 4-item PROMIS-E measured dependence (Morean et al., 2019) using a 5-point Likert scale (0 = never, 4 = almost always): (1) "I find myself reaching for my e-cigarette without thinking about it," (2) "I vape more before going into a situation where vaping is not allowed," (3) "When I haven't been able to vape for a few hours, the craving gets intolerable," and (4) "I drop everything to go out and get e-cigarettes or e-juice." Responses were averaged to create a single composite metric, with higher scores indicating higher dependence.

2.2.5. Harm perception

The 4-item harm perception scale used a 4-point agreement scale (strongly disagree to strongly agree) (Hair et al., Under Review). Participants reported agreement with the statements "vaping/using e-cigarettes, including JUUL…" (1) "is safe" (reverse-coded), (2) "contain flavors that are safe to use in vapes/e-cigarettes" (reverse-coded), (3) "contain dangerous chemicals," and (4) "are harmful to your health." Responses were averaged to create a single composite metric ranging from 1 to 4 (alpha = 0.79), with higher scores indicating higher perceived harm.

2.2.6. Friend use

Participants identified how many of their four closest friends used "e-cigarettes, pod mods, e-hookahs, e-cigars, vape pens, hookah pens, or tank system/box mod vaporizers," (range 0–4) (Vallone et al., 2019).

2.2.7. Combustible use and demographics

Demographic covariates included age, gender, race/ethnicity, and perceived financial situation. Age was categorized to reflect different developmental stages and to account for the distribution of participants in the study (15–17, 18–20, 21–24, 25–36). Current combustible use was determined by past 30-day use of cigarettes, cigars, or hookah.

2.3. Analysis

Analyses were conducted on Stata SE, version 15.1, and robust post-stratification weights were applied with the svy extension package (StataCorp, 2017). Weighted proportions of sample characteristics and the three cessation outcomes (past-year quit attempt, serious and general intention to quit) were calculated. Bivariate differences in the dependent variables were compared using chi-square and Wald tests (for continuous independent variables). Multivariable logistic regression models estimated adjusted odds ratios (aORs) and 95% confidence intervals (95% CI) of individual-level factors on cessation outcomes. Models included harm perception, friend e-cigarette use, dependence, e-cigarette use frequency, combustible use, and demographics. Independent variables were selected a priori to reflected previous research and to identify potential health disparities among subgroups who were less likely to quit. Post-hoc analyses explored the interaction of dependence and use frequency, and were plotted using a margins plot. Statistical significance was set to p = 0.05, and all tests were two-tailed.

3. Results

3.1. Participant characteristics

The analytic sample (n = 1158) was majority male, non-Hispanic (NH) white, 15–24 years old, and reported high perceived financial situation (Table 1). E-cigarette use frequency was evenly distributed,

Table 1
Weighted demographic characteristics, psychosocial characteristics, and e-cigarette quitting behavior among current e-cigarette users in the U.S., September-December 2019 (n = 1158).

	Total sample		Past-year quit attempt [a] wt.%	Serious intention to quit [b] wt.%	General intention to quit [c] wt.%
	n	*wt. %*			
TOTAL	1158	–	33.3	15.3	54.2
Age					
15–17	53	9.2	36.1	15.2	53.8
18–20	298	23.1	38.2	17.4	63.0
21–24	494	26.4	39.0	16.7	57.3
25–36	313	41.3	26.4	13.3	47.4
Gender					
Male	581	55.9	36.0	15.7	54.0
Female	577	44.1	30.0	14.8	54.4
Race/ethnicity					
White, NH	725	54.7	28.7	13.7	55.1
Black, NH	98	13.9	48.8	22.1	48.1
Hispanic	140	11.3	30.8	10.8	54.5
Other, NH	195	20.0	36.7	17.4	55.8
Perceived financial situation [d]					
Living comfortably	306	26.5	35.4	19.4	60.2
Meeting needs with a little left	476	44.1	34.0	15.3	51.1
Just meeting basic expenses	283	22.6	30.1	11.2	48.0
Not meeting basic expenses	90	6.8	32.2	13.5	72
Combustible use [e]			**	*	
No	608	46.3	26.9	11.2	50.3
Yes	550	53.7	38.9	18.9	57.5
Use Frequency [f]			**	*	
Infrequent	477	37.7	40.7	20.3	58.8
Intermediate	341	32.9	36.2	15.9	55.2
Daily	340	29.4	20.7	8.3	47.3
	wt. mean	*SE*	*wt. mean (No wt. mean)[i]*	*wt. mean (No wt. mean)[i]*	*wt. mean (No wt. mean)[i]*
Dependence [g]	1.24	0.05	1.46 (1.13) **	1.51 (1.19)	1.40 (1.05) **
Harm perceptions [h]	2.59	0.03	2.24 (2.07) **	2.29 (2.09)*	2.17 (2.07)
Friend use	1.95	0.07	2.22 (1.82) **	1.95 (0.99)	2.08 (1.80)*

* p < 0.05; ** p < 0.01 for bivariate association.
Abbreviations: wt. = weighted, NH = non-Hispanic, SE = standard error.
[a] In the past 12 months, stopped using e-cigarettes/vapes for 1 day or longer because trying to quit for good.
[b] Intention to quit within 30 days.
[c] Intention to quit within any timeframe.
[d] n = 3 missing values for this variable.
[e] Current combustible tobacco use was determined if respondents said yes to past 30-day use of cigarettes, cigars, and hookah.
[f] Infrequent = 1–5 days, Intermediate = 6–27 days, Daily = 28–30 days e-cigarette use in past 30 days.
[g] Average responses of agreement with: (1) I find myself reaching for my e-cigarette without thinking about it, (2) I vape more before going into a situation where vaping is not allowed, (3) When I haven't been able to vape for a few hours, the craving gets intolerable, and (4) I drop everything to go out and get e-cigarettes or e-juice. Range 0–4, higher response indicated higher dependence.
[h] Average responses of agreement with the statements "vaping/using e-cigarettes, including JUUL…" (1) "is safe" (reverse-coded), (2) "contain flavors that are safe to use in vapes/e-cigarettes" (reverse-coded), (3) "contain dangerous chemicals," and (4) "are harmful to your health." Range from 1 to 4, with higher scores indicated higher dependence.
[i] "No wt. mean" represents the mean score for a given scale (e.g. Dependence) for those who did not have each outcome. Difference in means were compared using the Wald test.

with 37.7% of participants infrequent users, 32.9% intermediate users, and 29.4% daily users. Roughly half the sample (53.7%) used combustible tobacco.

3.2. Cessation outcomes

Among current e-cigarette users, 33.3% reported a past-year quit attempt, 15.3% reported serious intentions to quit, and 54.2% reported general intentions to quit. Bivariate analyses indicated no significant differences in cessation outcomes by age, race/ethnicity, gender, or perceived financial situation.

3.3. Multivariate associations with cessation outcomes

Multivariate adjusted logistic regression models indicated that increased harm perceptions (aOR = 2.08, 95% CI: 1.49–2.92), dependence (aOR = 1.92, 95% CI: 1.44–2.56), friend e-cigarette use (aOR = 1.24, 95% CI: 1.04–1.46), and Black, NH (compared to white, NH, aOR = 2.13, 95% CI: 1.02–4.42) all increased odds of a past-year quit attempt (Table 2). Women had lower odds than men of a quit attempt (aOR = 0.56, 95% CI: 0.37–0.86), and daily users had lower odds of a quit attempt compared to infrequent users (aOR = 0.23, 95% CI: 0.12–0.43).

Similar associations were observed across both serious and general intentions to quit models (Table 2). Greater harm perceptions (serious aOR = 3.34, 95% CI: 2.13–5.24; general aOR = 1.77, CI: 1.23–2.56) and dependence (serious aOR = 2.00, 95% CI: 1.31–3.05; general aOR = 1.89, 95% CI: 1.41–2.52) increased odds of intention to quit. Daily users had lower odds of intending to quit than infrequent users (serious aOR = 0.25, 95% CI: 0.11–0.57; general aOR 0.35, 95% CI: 0.19–0.65). No demographic differences were significantly associated with quit intentions.

In post-hoc analyses, a multi-level interaction between use frequency and dependence was statistically significant only in the model predicting general intentions to quit. A predictive margins plot indicated that the effect of dependence varied across levels of e-cigarette use frequency (Supplemental Fig. 1). Higher levels of dependence were associated with greater increases in the likelihood of a general intention to quit among infrequent users than among daily users.

4. Discussion

To our knowledge, this is the first study to present nationally representative estimates of interest in quitting e-cigarettes among youth and young adults. Findings reflect a unique period in the U.S. during which use among young people grew exponentially and high nicotine e-cigarettes dominated the market. Results indicate that one-third of current youth and young adult e-cigarette users made a quit attempt in the past year, over half reported intention to quit in the future (54%), and 15% reported intention to quit in the next 30 days. Results are generally consistent with estimates of youth (Smith et al., 2020; Wang et al., 2019) and adult (Rosen and Steinberg, 2020) e-cigarette cessation attempts and intentions. Differences between these findings and previous surveillance data may reflect the different age groups surveyed, measurement language (particularly e-cigarette vs. all tobacco product), or fielding period.

While demographics and combustible use are associated with e-cigarette initiation and prevalence (U.S. Department of Health and Human Services (USDHHS), 2016), we found few differences by quitting. Multivariate models estimating quit attempts showed gender and race were significant while combustible use was not, which differs from bivariate analyses. These effects were likely confounded by harm perceptions and dependence (analyses not presented). Prior research consistently indicates few demographic characteristics and other tobacco use are associated with e-cigarette cessation (Kasza et al., 2020; Smith et al., 2020). Thus, resources that support and encourage cessation should be made widely available.

Table 2
Weighted adjusted logistic regression models of e-cigarette quit attempts and e-cigarette quit intentions among current users in the U.S., September-December 2019 (n = 1155)[a].

	Past-year quit attempt [b] aOR (95% CI)	Serious intention to quit [c] aOR (95% CI)	General intention to quit [d] aOR (95% CI)
Age			
15–17	1.25 (0.54–2.91)	0.96 (0.32–2.92)	0.98 (0.41–2.33)
18–20	1.44 (0.84–2.46)	1.09 (0.53–2.24)	1.37 (0.81–2.29)
21–24	1.42 (0.85–2.37)	0.92 (0.46–1.84)	1.21 (0.75–1.96)
25–36	Ref	Ref	Ref
Gender			
Male	Ref	Ref	Ref
Female	0.56** (0.37–0.86)	0.64 (0.36–1.14)	0.92 (0.61–1.40)
Race/ethnicity			
White, NH	Ref	Ref	Ref
Black, NH	2.13* (1.02–4.42)	1.35 (0.58–3.17)	0.63 (0.31–1.31)
Hispanic/Latino	1.05 (0.58–1.89)	0.61 (0.23–1.62)	1.04 (0.55–1.96)
Other, NH	1.10 (0.66–1.85)	1.05 (0.55–2.00)	0.86 (0.51–1.44)
Perceived financial situation			
Living comfortably	Ref	Ref	Ref
Meeting needs with a little left	1.06 (0.64–1.74)	0.79 (0.41–1.52)	0.75 (0.43–1.31)
Just meeting basic expenses	0.88 (0.51–1.51)	0.59 (0.29–1.20)	0.69 (0.40–1.21)
Not meeting basic expenses	0.73 (0.33–1.62)	0.48 (0.17–1.35)	1.46 (0.64–3.34)
Combustible used [e]			
No	Ref	Ref	Ref
Yes	1.15 (0.75–1.77)	1.25 (0.74–2.10)	0.95 (0.61–1.49)
Use frequency [f]			
Infrequent	Ref	Ref	Ref
Intermediate	0.68 (0.41–1.13)	0.61 (0.31–1.19)	0.78 (0.46–1.30)
Daily	0.23** (0.12–0.43)	0.25** (0.11–0.57)	0.35** (0.19–0.65)
Dependence [g]	1.92** (1.44–2.56)	2.00** (1.31–3.05)	1.89** (1.41–2.52)
Harm perception [h]	2.08** (1.49–2.92)	3.34** (2.13–5.24)	1.77** (1.23–2.56)
Friend use	1.24* (1.04–1.46)	0.91 (0.73–1.15)	1.10 (0.93–1.31)

*p < 0.05, **p < 0.01.

Abbreviations: aOR = adjusted odds ratio, 95% CI = 95% Confidence Interval, Ref = reference, NH = non-Hispanic.

[a] Perceived financial situation missing data (n = 3) resulted in smaller sample size.

[b] Stopped using e-cigarettes/vapes for 1 day or longer because trying to quit for good in past 12 months.

[c] Intention to quit within 30 days.

[d] Intention to quit within any timeframe.

[e] Current combustible tobacco use was determined if respondents said yes to past 30 day use of cigarettes, cigars, and hookah.

[f] Infrequent = 1–5 days, Intermediate = 6–27 days, Daily = 28–30 days e-cigarette use in past 30 days.

[g] Average responses of agreement with: (1) I find myself reaching for my e-cigarette without thinking about it, (2) I vape more before going into a situation where vaping is not allowed, (3) When I haven't been able to vape for a few hours, the craving gets intolerable, and (4) I drop everything to go out and get e-cigarettes or e-juice. Range 0–4, higher response indicated higher dependence.

[h] Average responses of agreement with the statements "vaping/using e-cigarettes, including JUUL…" (1) "is safe" (reverse-coded), (2) "contain flavors that are safe to use in vapes/e-cigarettes" (reverse-coded), (3) "contain dangerous chemicals," and (4) "are harmful to your health." Range from 1 to 4, with higher scores indicated higher dependence.

Use frequency was found to be negatively associated with cessation outcomes whereas dependence was found to be positively associated with cessation outcomes. This differs from cigarette cessation where both dependence and use frequency are negatively associated with cessation (Kasza et al., 2020). One possible explanation is that the dependence scale (PROMIS-E) measured users' perceptions of their own dependence, while the use frequency variable may measure physiological dependence. The observation that the effect of dependence on general intentions to quit was strongest for infrequent users, and weakest for daily users, provides some evidence to suggest that perceived dependence may be particularly important among the least physically addicted users. Since both measures had predictive validity for cessation outcomes, further research is warranted to understand the relationship between use frequency and dependence on e-cigarette cessation.

4.1. Limitations

This study has limitations. The data is cross-sectional, and findings cannot be used to infer causal relationships. Additionally, cessation methodology, abstinence length, and time since last quit attempt were not assessed. However, these data provide a valuable snapshot of recent cessation behavior among youth and young adults, a population with increasing rates of e-cigarette use.

5. Conclusion

Although the recent rise in e-cigarette use among young people is concerning, results indicate that over half of young users want to quit, and many have already unsuccessfully tried. While this analysis explores the factors associated with interest in quitting and quit attempts, further research is needed to determine how to best promote and support e-cigarette cessation, particularly in the context of little to no federal, state, or local regulation of these products. Nonetheless, these contemporary findings underscore the critical need for programs and policies to reduce the e-cigarette epidemic among young people.

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CRediT authorship contribution statement

Alison F. Cuccia: Methodology, Writing - original draft, Project administration. **Minal Patel:** Methodology, Writing - original draft, Supervision. **Michael S. Amato:** Methodology, Writing - original draft. **Daniel K. Stephens:** Methodology, Formal analysis, Data curation, Writing - original draft. **Stephanie N. Yoon:** Visualization, Project administration. **Donna M. Vallone:** Supervision.

Declaration of Competing Interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2020.101287.

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