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Prevalence and correlates of electronic-cigarette use in young adults: Findings from three studies over five years

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Abstract

Background—We aimed to examine prevalence and correlates of past-month electronic cigarette (“e-cigarette”) use and use of e-cigarettes to aid a cessation attempt in three samples of young adult smokers recruited online in 2009–2010 (Study 1), 2010–2011 (Study 2), and 2013 (Study 3).

Methods—Participants were young adults aged 18 to 25 who smoked at least one cigarette in the previous month (Study 1, N=1987 and Study 2, N=570) or smoked 3 or more days each week and used Facebook 4 or more days per week (Study 3, N=79). We examined both past-month e-cigarette use and ever use of e-cigarettes to quit conventional cigarettes.

Results—Prevalence of past-month use of e-cigarettes was higher in each subsequent study: Study 1 (6%), Study 2 (19%), Study 3 (41%). In multivariate analyses, significant correlates of past-month e-cigarette use were identified for Study 1 (male sex OR=2.1, p=.03; past-year quit attempt OR=1.6, p=.03) and Study 2 (male sex, OR=1.7, p=.03; younger age OR=0.88, p=.05), but not Study 3. In multivariate analyses, significant correlates of ever use of e-cigarette to quit conventional cigarettes were identified for Study 1 (education, OR=1.2, p=.02; smoking within 30

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Contributors

Dr. Ramo designed the parent studies and wrote the protocols, in consultation with Dr. Prochaska. Dr. Young-Wolff conducted the analyses in consultation with Dr. Ramo. Drs. Ramo, Young-Wolff, and Prochaska all contributed to the writing of the manuscript, and reviewed and revised subsequent drafts of the manuscript. All authors contributed to and have approved the final manuscript.

Conflict of Interest

All three authors declare that they have no conflict of interest.

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minutes of waking, OR=2.8, $p=.02$; past year quit attempt OR=4.1, $p=.02$), and Study 3 (desire to quit smoking, OR=1.3, $p=.02$), but not Study 2.

Conclusions—E-cigarette use is increasingly common among young adults, particularly men. E-cigarette use for quitting conventional cigarettes appears more common among those more nicotine dependent and interested in quitting.

Keywords

electronic cigarette; e-cigarette; ENDS; vaping; young adults; smoking

1. INTRODUCTION

Electronic cigarettes, or “e-cigarettes”, are battery-operated devices that generate an aerosol for inhalation typically containing nicotine. Although there remains controversy, some propose that e-cigarettes are a safer alternative or form of harm reduction for current smokers since these products are not thought to contain many of the harmful elements found in traditional cigarettes (Hajek, Foulds, Le Houezec, Sweanor, & Yach, 2013). With rapid development of electronic nicotine delivery products, most manufactured in China, the safety of these devices has not been established. Yet, this has not appeared to hinder their sales.

Currently unregulated, e-cigarettes are being widely marketed on the web (Grana & Ling, 2014), as well as on television and radio in the US; media outlets that banned tobacco products from advertising back in the 1970s. Not included in the FDA’s ban on characterizing flavoring for conventional cigarettes, the liquid nicotine used in e-cigarettes is available in youth friendly flavors (e.g., chocolate, bubble gum, cotton candy), and there is concern that these products may be a gateway for youth to traditional cigarette smoking (Grana, Benowitz, & Glantz, 2014).

According to the Centers for Disease Control and Prevention, e-cigarette ever use more than doubled among middle and high school students in the US between 2011 and 2012, from 3% to 7%, and dual use of e-cigarettes and conventional cigarettes was common, with 76% of current e-cigarette users reporting concurrent use of conventional cigarettes in 2012 (Corey et al., 2013). Analyzing the same data, ever e-cigarette users were significantly more likely to be boys, Caucasian, of older age, and to have higher allowances (Dutra & Glantz, 2014). Data from the 2013 Legacy Media Tracking Online survey indicated 9% of youth aged 13–18 reported ever and 5% current e-cigarette use with 24% of e-cigarette users reporting current (past-month) dual use with conventional cigarettes (Rath, 2014). Multivariate analysis identified older age, current smoking status, and the number of close smoking friends as significant correlates of e-cigarette use. In a convenience sample of 504 adolescents surveyed in New York City, 13% had tried e-cigarettes with use highest among ever smokers, 17 year-olds (compared to 13 or 14 year olds), and those with at least one smoking friend (Johns, 2014). Among 307 college students surveyed in Hawaii, evenly divided as current, never, and former smokers, e-cigarette ever use was reported by 18% of never smokers, 48% of former smokers/experimenters, and 68% of current smokers; positive outcome expectancies for e-cigarettes was associated with their use (Pokhrel, Little, Fagan,

Muranaka, & Herzog, 2014). Use of e-cigarettes among youth is not limited to the US. In 2011, 5% of Korean adolescents were using e-cigarettes, 77% of whom reported dual use with conventional cigarettes (Lee, Grana, & Glantz, 2013).

Use of e-cigarettes also is rising among adults. In the HealthStyles national consumer online panel survey, 3% of US adults in 2010 and 6% in 2011 reported ever using an e-cigarette (King, Alam, Promoff, Arrazola, & Dube, 2013). The greatest increase and prevalence of use was among current smokers: 10% in 2010 and 21% in 2011. Ever-use of e-cigarettes did not differ at either year by sex, age, race/ethnicity, education, income, or US region (King et al., 2013). Other studies have reported age differences. In two 2010 surveys -- one a nationally representative online study (Knowledge Networks' KnowledgePanel), the other a large cohort study of smokers (Legacy Longitudinal Smoker Cohort) -- e-cigarette ever use among adults was inversely related to age and more likely among current smokers (Pearson, Richardson, Niaura, Vallone, & Abrams, 2012). Similarly, in the 2010 ConsumerStyles mail survey, ever use of e-cigarettes was the highest at 10% for young adults aged 18–24 compared to all other age groups (Regan, Promoff, Dube, & Arrazola, 2013). The 2011 Legacy Young Adult Cohort Study, with participants aged 18–34 years, reported on past 30-day e-cigarette use: 7% among current smokers (Rath, Villanti, Abrams, & Vallone, 2012).

Most recently, in a 2014 survey of 1006 e-cigarette users in the UK (53% men; 9% under 25 years old), 47% indicated they started using e-cigarettes to cease use of conventional cigarettes, yet 84% regularly continued dual use with conventional cigarettes (Dicey, 2014). The concern with dual use is that individuals will become exposed and dependent on higher levels of nicotine and thereby reduce their chances of cessation or will delay cessation attempts believing they are being healthier by reducing their conventional tobacco use with e-cigarettes. Smoking reduction without cessation provides no real health benefits (Godtfredsen, Osler, Vestbo, Andersen, & Prescott, 2003; Godtfredsen, Prescott, & Osler, 2005; Godtfredsen, Vestbo, Osler, & Prescott, 2002; Hughes & Carpenter, 2006); and notably, the two randomized controlled trials published to date do not indicate efficacy of e-cigarettes for aiding with quitting of conventional cigarettes (Bullen et al., 2013; Caponnetto et al., 2013).

Much discussion in the field at this point is largely speculation, and more research is needed. Of particular interest are young adult smokers, given the rise in targeted marketing and e-cigarette use as well as challenges with quitting conventional cigarette smoking among this age group (Curry, Sporer, Pugach, Campbell, & Emery, 2007) and indications that at least some young adult smokers are using these products in an attempt to quit smoking. Of specific interest are the following questions: 1) What are prevalence of any e-cigarette use and use to aid cessation attempts among young adults in the United States over the five year period between 2009 and 2013? 2) What are the correlates of any use and use to aid a cessation attempt, and are there differences in predictors for any use compared to use to aid cessation? Comparing data on e-cigarette use among young adult smokers collected in three studies conducted in 2009–2010, 2010–2011, and 2013, the current study aimed to examine e-cigarette use and correlates of use among young adult smokers across five years.

2. METHODS

2.1 Participants and Procedure

Data were taken from three samples of English literate young adult smokers, age 18 to 25, throughout the United States. Study 1 participants reported smoking at least one cigarette in the past 30 days. The sample was recruited online between April 2009 and December 2010, using three methods described previously (Ramo, Hall, & Prochaska, 2010; Ramo & Prochaska, 2012a). Participants completed a 20-minute survey about tobacco and other substance use and thoughts about use (Ramo, Delucchi, Hall, Liu, & Prochaska, 2013; Ramo & Prochaska, 2012b). The online survey was anonymous, and data were encrypted for added security protection. Participants were required to answer all questions before they could continue to the next page of the survey but could quit and return to the survey at any time. Computer Internet Protocol (IP) addresses were tracked, and only one entry was allowed from a single computer to prevent duplicate entries from the same person; however, multiple entries were allowed from the same Internet connection (dormitories, apartment buildings). Eligibility checks excluded respondents who (a) had discrepant data on similar demographic questions (e.g., date of birth and age, indicating that they were either too young or too old to participate) or grossly discrepant data on substance use measures (e.g., indicating that they had used tobacco daily in the past month on one measure and not at all on another item), (b) reported the same email address across multiple survey entries, and (c) had clearly invalid data (e.g., every entry was the same across the entire survey). Respondents found to be ineligible based on initial screening questions or the above criteria were considered invalid, and data were not analyzed. In Study 1, of the 4,242 respondents who met criteria to complete the survey, 3,748 (88%) were valid cases and 1,987 (53%) of those completed the entire survey and were used in the present analysis. Survey completers differed significantly from those who completed demographic information only ($n = 369$) on several variables, but the differences were of small magnitude (e.g., the complete group had a mean age of 20.6 years, compared with a mean age of 20.1 years for the incomplete group). Because significant differences were more likely attributable to the large sample size than to meaningful group differences, we used only the completed cases ($N = 1,987$) in analyses for the present study.

The sample in Study 2 was recruited through Facebook between September 2010 and September 2011 for an online survey about tobacco, Internet, and social media use (Ramo, Liu, & Prochaska, 2014). Inclusion criteria and survey procedures were identical to those in Study 1. Of the 718 respondents who met study criteria, 679 (70%) yielded valid data and 570 (84%) completed the entire survey. Survey completers were more likely to be female (29.8% vs. 17.1%, $\chi^2 = 5.34$, $p = .021$) than those who only completed demographic items ($n=76$) and less likely to be daily smokers (70% vs. 88%, $\chi^2 = 4.48$, $p = .043$), smoked fewer cigarettes per day on average (6.0 vs. 6.8, $t = -2.86$, $p = .004$), and were less likely to smoke their first cigarette within the first 30 minutes of waking (42% vs. 56%, $\chi^2 = 10.57$, $p = .014$) than those who only completed smoking items ($n=24$). Data analyses were restricted to those who completed the entire survey ($N = 570$).

The third sample (Study 3) was recruited through Facebook between June and July 2013 for a smoking cessation intervention pilot study (Ramo, Rodriguez, Chavez, Sommer, & Prochaska, in press). In total, 36 advertisements were targeted to young adult Facebook users who smoke, varying by ad type and targeting. Two of the ads targeted users by “interest” (operationalized by Facebook as pages users have liked or activities or interests users indicate on their profile) including “electronic cigarettes” among six tobacco related terms. Inclusion criteria were having smoked 100 or more cigarettes in one’s lifetime, currently smoking at least 1 cigarette per day on 3 or more days of the week, and accessing Facebook 4 or more days per week. Intention to quit smoking was not required for study participation as intervention strategies were relevant to all smokers and not just those ready to take action. Facebook led participants to the study’s secure eligibility screener and then the online informed consent. In order to be considered “consented,” participants had to indicate willingness to be enrolled in the study for one year, participate in a Facebook group, read an online consent form, and answer three questions correctly about the study and its risks. Eligible and consented participants were then asked to verify their identity through email or Facebook. Those who verified their identity were sent a link to the password-protected baseline assessment using Qualtrics software. Of the 1307 individuals screened, 586 (45%) were eligible, 230 of those (39%) signed online consent, and 79 of those (34%) verified identity and completed a baseline assessment, included in the current analysis.

2.2 Measures

E-cigarette use—Participants in all three studies were asked the same question: “In the past month, have you used any tobacco products other than cigarettes?” and given ten answer choices, including “e-cigarette/electronic cigarettes” and “other”; any “other” answers that included electronic cigarettes were recoded as such. Additionally, in Studies 1 and 2, participants were asked, “In any previous quit attempts, what other quitting strategies have you used?;” spontaneous reports of e-cigarette use were coded. In Study 3, participants were asked directly about ever use of e-cigarettes for quitting conventional cigarettes with the question: “In any previous quit attempts, which of the following have you used to help you quit: E-cigarettes? (y/n).”

Sociodemographics—Participants self-reported their gender, age, race/ethnicity, years of education, and annual family income. Residential zip codes were obtained and categorized into one of four U.S. Census Regions: Northeast, Midwest, South, and West (U. S. Census Bureau, 2010).

Tobacco use and thoughts about quitting—A smoking questionnaire (Hall et al., 2006) assessed participants’ current usual cigarettes smoked per day and days smoked per week, total years of smoking, and past year quit attempt (y/n). The Fagerstrom test for Nicotine Dependence was administered and assessed time to first cigarette upon waking (<30 min or >30 min) and whether participants find it difficult to refrain from smoking in areas where it is banned (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). Another item assessed social smoking, “Are you a social smoker?” (y/n; Song & Ling, 2011).

The Thoughts about Abstinence form (Hall, Havassy, & Wasserman, 1990) assessed the desire to quit, abstinence self-efficacy, and perceived difficulty staying quit (each scored on a scale from 1 to 10) in Studies 1 and 3 (not included in Study 2). Abstinence goals for cigarettes were categorized as total abstinence or not. The Smoking Stages of Change Questionnaire (Prochaska & DiClemente, 1983) categorized smokers into one of three pre-action stages of change: precontemplation (no intention to quit within the next 6 months), contemplation (intention to quit within the next 6 months), and preparation (intention to quit within the next month with a 24-hour quit attempt in the past year).

2.3 Analyses

Analyses were run for each sample separately. We calculated prevalence of past month e-cigarette use overall and in the context of a cessation attempt. We examined correlates of e-cigarette use by running a series of bivariate logistic regression analyses with e-cigarette use as the dependent variable and demographic and smoking characteristics as the independent variables. Next, we ran multiple logistic regression analyses that included all demographic and smoking variables that were significantly associated with e-cigarette use in any of the bivariate analyses. We repeated this series of bivariate and multivariate analyses with use of e-cigarettes to aid a cessation attempt as the dependent variable. A p-value of .05 was used as a cutoff for significance in all analyses.

3. RESULTS

Sample demographics and smoking characteristics are presented in Table 1. There were no significant differences on any demographic or smoking variables among the samples (all ANOVA and χ^2 $p > .05$). Past month e-cigarette use and ever use to aid a cessation attempt varied from Study 1 to Study 3 (Figure 1). Table 2 presents the bivariate logistic regression models by study examining correlates for past month e-cigarette use and ever use of e-cigarettes for quitting conventional smoking. Across the three studies, e-cigarette ever users were 72% male, 73% White, and 82% were daily smokers. Study 1 had fewer men (57%) compared to studies 2 (89%) and 3 (80%).

Past Month E-Cigarette Use

In Study 1, male gender; daily, heavier (cigarettes/day), and more dependent smoking (i.e., within 30 min of waking); a past year quit attempt; lower self-efficacy with quitting; and greater expected difficulty with staying quit each were associated with past month e-cigarette use. In a multivariate logistic regression analysis that included all significant bivariate predictors, only male sex (OR = 2.1, 95% CI 1.4, 3.3, $p = .03$) and a past-year quit attempt (OR = 1.57, 95% CI 1.0, 2.4, $p = .03$) remained significant. In Study 2, male gender, younger age, and daily smoking each were significantly associated with past month e-cigarette use in bivariate models. In the multivariate logistic regression, male sex (OR = 1.7, 95% CI 1.0, 2.9, $p = .03$) and younger age (OR = 0.88, 95% CI 0.78, 1.00, $p = .05$) remained significant. In Study 3, none of the measured variables were significantly associated with past month e-cigarette use.

Ever Use of E-Cigarettes to Quit Conventional Cigarette Use

In Study 1, bivariate analyses, greater education, smoking within 30 minutes of waking, a past year quit attempt, and greater expected difficulty staying quit each were significantly associated with ever use of e-cigarettes for quitting conventional cigarettes. In the multivariate logistic regression, greater education (OR = 1.17, 95% CI 1.0, 1.3, $p = .02$), smoking within 30 minutes of waking (OR = 2.77, 95% CI 1.2, 6.6, $p = .02$), and a past year quit attempt (OR = 4.14, 95% CI 1.2, 14.1, $p = .02$) remained significant. In Study 2, a past year quit attempt and being in the preparation stage of change (versus precontemplation) each were significantly associated with ever use of e-cigarettes for quitting conventional cigarettes in bivariate analyses; however, in the multivariate logistic regression, neither variable remained significant. In Study 3 bivariate analyses, a past year quit attempt and greater desire to quit each were significantly associated with ever use of e-cigarettes for quitting conventional cigarettes. In the multivariate logistic regression, only desire to quit smoking remained significantly associated (OR = 1.3, 95% CI 1.0, 1.5, $p = .02$).

Variables of ethnicity, income, region of residence, difficulty resisting smoking in areas where it is banned, identification as a social smoker, years smoking, and smoking abstinence goal were unrelated to e-cigarette use in all three studies. In Studies 1 and 2, e-cigarette use did not differ among socio-demographic groups. Study 3 analyses should be replicated in a sample from 2013 or later that is powered to detect effects to confirm whether findings are consistent over time.

4. DISCUSSION

This study examined prevalence and correlates of e-cigarette use among young adults in three studies conducted from 2009 to 2013. Any e-cigarette use and use as a cessation aid were higher in later studies of young adult smokers, consistent with recent epidemiological reports. Ever use of e-cigarettes to cut down or quit conventional smoking was more commonly reported (and directly assessed) in Study 3 (38%), than in Studies 1 and 2 (1% and 3%, respectively). Given the changing nature of the tobacco market, direct assessment of use of nicotine and tobacco in all its evolving forms is needed including the variation in terminology (e.g., vape pens, e-hookah) (McQueen, Tower, & Sumner, 2011). Further, the observed differences in prevalence and correlates between past month use and ever use to quit conventional smoking suggests that differentiating patterns and motivations of e-cigarette use is likely warranted in research and clinical interactions.

Study 3 findings indicate that ever use of e-cigarettes as an aid for cessation was almost as high as past-month use at least among those recruited into a cessation trial tailored to readiness to quit. Although the small sample size suggests replication is needed, this finding contrasts with a recent review showing that young adults were more likely to use e-cigarettes as smoking substitutes and less likely to use e-cigarettes as cessation aids than older adults (Carroll Chapman & Wu, 2014). Research is needed to test the efficacy of these products as cessation aids, particularly among young adults. To date, the two randomized controlled trials of e-cigarettes for quitting conventional smoking in general adult aged samples found no significant difference relative to placebo e-cigarettes (Bullen et al., 2013; Caponnetto et al., 2013).

In Studies 1 and 2, men were twice as likely to use e-cigarettes than women, whereas there was no significant gender effect on e-cigarette use in Study 3, which recruited in 2013. This is consistent with previous observations that e-cigarettes originally appealed to men more than women (Etter & Bullen, 2011), and that adolescent boys were more likely to use e-cigarettes in 2012 (Dutra & Glantz, 2014), while there were no gender differences in two studies conducted in 2013 (Johns, 2014; Rath, 2014). Men may be “early adopters” of technology (Rich, 2010), and perhaps attracted to e-cigarettes earlier for their novelty. While the smaller sample size in Study 3 provided less power to detect an effect of gender on past month e-cigarette use, the OR of 1.17 suggested little to no true effect. In Study 2, younger age was associated with past-month e-cigarette use, consistent with some prior research (Pearson et al., 2012) but contrasting with studies of youth who did not necessarily smoke combustible cigarettes (Dutra & Glantz, 2014; Johns, 2014; Rath, 2014). Among young adults who smoke, younger adults may be early adopters of new technology such as e-cigarettes and are more likely to be recent dual-users; however there was no indication from findings that young adults are more likely to use e-cigarettes to attempt to quit smoking cigarettes. Given that all participants in these studies had smoked recently, any e-cigarette reports indicated dual use; longitudinal research is needed to examine patterns of dual use over time.

Smoking severity (daily smoking and quantity and frequency of smoking) significantly correlated with past month e-cigarette use in Study 1. Heavier smokers may have been exploring new ways to consume tobacco regardless of intention to quit smoking, and may have been more comfortable with the risk and potential reward of trying a new product. Not surprising, a past year quit attempt correlated with ever use of e-cigarettes to aid a cessation attempt. Clinicians should capitalize on the teachable moment that comes from client reports of using e-cigarettes. E-cigarette use may signal motivation to quit and an opportunity to engage young adult smokers in evidence-based cessation treatment including provider support, quitline referral, and/or FDA-approved cessation aids (Fiore, Jaén, Baker, & et al, 2008).

In the current study, greater anticipated difficulty with quitting conventional cigarettes was associated with past-month e-cigarette use; however, these associations and other significant bivariate associations among thoughts about abstinence and e-cigarette use were no longer significant in multivariate models. Cognitions around smoking may be less important in understanding e-cigarette use than other personal characteristics such as demographics. Non-significant odds ratios suggest that difficulty resisting smoking in areas where it is banned was likely unrelated to e-cigarette use; though the current cross-sectional data could not determine whether e-cigarettes may have helped to control smoking cravings or were used to subvert clean indoor air laws.

4.1 Limitations

Study limitations included online recruitment with uncertain generalizability and study differences in sample size, eligibility, recruitment ads, measurement of correlates, and directness of assessing e-cigarette use for cessation. In all three studies, the samples of young adult smokers were largely Caucasian, male, and daily smokers. Study 3 had different

inclusion criteria than Studies 1 and 2, including more frequent smoking of conventional cigarettes (3 days per week on average vs. 1 day in the past month), which in Studies 1 and 2 was related to e-cigarette use in bivariate, though not multivariate, analyses. Though Study 3 was an intervention study, it is worth noting that the recruited and enrolled sample on average, relative to the survey sample recruited in Study 1, had lower desire to quit, lower self-efficacy for quitting, greater perceived difficulty with staying quit and a smaller proportion was prepared to quit. That is, Study 3, which investigated an intervention tailored to stage of change, was successful in engaging participants at all levels of readiness to quit. I, two of the 36 ads used to recruit study participants included “electronic cigarette” as one of 10 keywords. Of note, the two ads mentioning e-cigarettes yielded fewer eligible and enrolled participants relative to the other 34 ads used in Study 3 (Ramo et al., in press). Finally, thoughts about abstinence were not assessed in Study 2, preventing replication of findings from Study 1. Despite these limitations, the current set of studies provides valuable insight into patterns, intentions, and correlates of e-cigarette use in young adults.

5. CONCLUSION

Findings from three studies of young adult smokers (two cross-sectional studies and baseline data from a stage-tailored cessation trial) indicate past-month e-cigarette use and ever use of e-cigarettes to quit conventional cigarettes has increased over time. Further, subject to replication, men were more likely to use e-cigarettes in earlier studies, while a gender difference was not evident in the data collected more recently. Making a past year quit attempt was a consistent predictor of ever use of e-cigarettes as a cessation aid. Future research should expand upon motives for using e-cigarettes and evaluate their efficacy for smoking cessation in young adult smokers.

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Research Highlights

- Analyses from three studies over five years looked at electronic cigarette use
- Young adult cigarette smokers living in the U.S. were recruited online
- Prevalence of past-month e-cigarette use was higher in each subsequent study
- Use for quitting smoking was greater among nicotine dependent and motivated to quit.
- Findings increase understanding of patterns and correlated of e-cigarette use

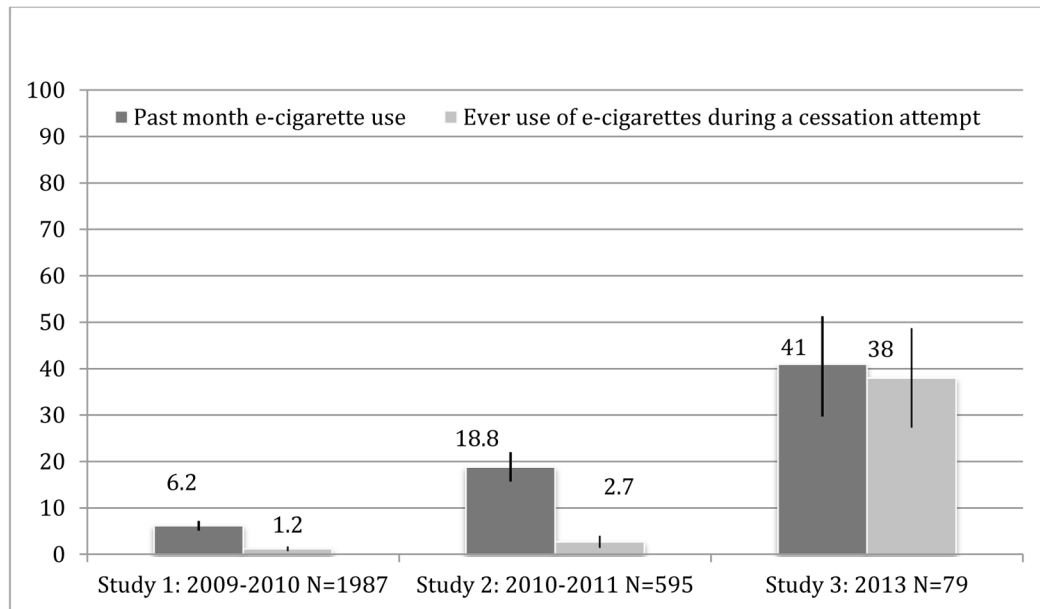


Figure 1. caption. Prevalence of past-month e-cigarette use and ever use of e-cigarettes to aid smoking cessation among young adult smokers recruited over 5 years in three studies. Error bars represent 95% confidence intervals. *Note:* Use of e-cigarettes during a cessation attempt was reported spontaneously in Studies 1 and 2, and prompted directly in Study 3.

Table 1

Demographic and smoking characteristics of three samples of young adult smokers

	Study 1 2009–2010 (N = 1987) M (SD)/%	Study 2 2010–2011 (N = 595) M (SD)/%	Study 3 2013 (N = 79) M (SD)/%
Demographics			
Age	20.6 (2.1)	19.8 (1.8)	20.9 (2.1)
Sex, % female	36.9	29.6	20.3
Ethnicity, %			
African American	3.1	2.5	1.3
Asian American/Pacific Islander	4.0	3.7	0.0
White	71.2	68.4	79.7
Hispanic/Latino	6.3	10.1	11.4
Multiethnic/Other	15.4	15.3	7.6
Years of education, M (SD)	13.2 (2.2)	12.5 (1.5)	12.4 (2.0)
Household income, %			
<\$20,000	27.1	27.9	27.8
\$20,000–\$60,000	36.4	37.0	44.3
\$60,000–\$100,000	19.2	21.0	19.0
>\$100,000	17.3	14.1	8.9
Region, %			
West	27.6	27.2	24.0
South	27.3	26.6	21.5
Midwest	25.5	26.4	41.8
Northeast	19.6	19.8	12.7
Combustible Cigarette Variables			
Cigarettes per day, M (SD)	9.0 (7.6)	10.5 (8.3)	11.5 (8.3)
% Daily smoker	67.8	71.1	74.7
% Smoke within first 30 mins of waking	36.5	42.5	51.9
% Difficult not to smoke where it's banned	21.6	24.5	30.4
% Identify as "social smoker"	70.8	64.9	69.6
Total years smoking, M (SD)	4.1 (3.1)	3.7 (2.8)	2.7 (0.7)
Past year quit attempt, %	62.0	56.1	57.0
Desire to stop smoking, M (SD)	5.3 (3.0)	N/A	4.8 (2.8)
Expected success for quitting, M (SD)	5.9 (2.9)	N/A	4.6 (2.7)
Expected difficulty for quitting, M (SD)	6.5 (2.8)	N/A	7.4 (2.4)
Smoking goal (% abstinence)	10.4	N/A	10.1
Smoking stage of change, %			
Precontemplation	47.3	58.0	41.8
Contemplation	30.4	27.9	45.6
Preparation	22.3	14.1	12.6

Results of bivariate logistic regression models predicting past month electronic cigarette use and ever use of electronic cigarettes to quit smoking in three study samples.

Table 2

	Study 1: 2009–2010 (n = 1987)		Study 2: 2010–2011 (n = 595)		Study 3: 2013 (n=79)	
	Past Month EC Use ^d OR (95% CI)	Ever EC Use to Quit ^b OR (95% CI)	Past Month EC Use ^d OR (95% CI)	Ever EC Use to Quit ^b OR (95% CI)	Past Month EC Use ^d OR (95% CI)	Ever EC Use to Quit ^b OR (95% CI)
Demographics						
Age	0.98 (0.90, 1.07)	1.17 (0.97, 1.41)	0.88 (0.78, 0.99)	0.95 (0.71, 1.27)	0.89 (0.72, 1.10)	0.94 (0.76, 1.17)
Male (vs. Female)	2.07 (1.34, 3.18)	0.76 (0.33, 1.74)	1.79 (1.09, 2.95)	3.01 (0.68, 13.4)	1.17 (0.38, 3.62)	1.03 (0.33, 3.18)
White (vs. Non-white)	1.17 (0.78, 1.78)	0.92 (0.38, 2.26)	0.84 (0.54, 1.29)	1.40 (0.45, 4.39)	0.62 (0.20, 1.86)	0.74 (0.24, 2.25)
Years of education	1.06 (0.98, 1.14)	1.16 (1.02, 1.33)	0.99 (0.87, 1.14)	1.23 (0.90, 1.68)	1.19 (0.92, 1.54)	0.94 (0.74, 1.18)
Household income (Ref: <\$20,000)						
\$20,000–\$60,000	0.90 (0.56, 1.44)	0.87 (0.29, 2.60)	1.12 (0.66, 1.88)	1.33 (0.38, 4.62)	1.47 (0.49, 4.40)	0.46 (0.15, 1.38)
\$60,000–\$100,000	1.41 (0.85, 2.33)	1.42 (0.46, 4.44)	1.24 (0.69, 2.24)	1.34 (0.33, 5.46)	1.53 (0.40, 5.82)	0.67 (0.18, 2.52)
>\$100,000	0.90 (0.50, 1.61)	1.05 (0.29, 3.74)	1.03 (0.51, 2.04)	0.49 (0.05, 4.43)	0.29 (0.03, 2.88)	0.40 (0.06, 2.52)
Region (Ref: West)						
South	0.67 (0.40, 1.10)	1.01 (0.32, 3.15)	0.61 (0.34, 1.07)	0.85 (0.25, 2.84)	1.22 (0.33, 4.57)	1.93 (0.50, 7.49)
Midwest	0.97 (0.61, 1.55)	1.08 (0.35, 3.38)	0.70 (0.40, 1.22)	0.51 (0.12, 2.06)	0.69 (0.22, 2.20)	1.08 (0.32, 3.63)
Northeast	0.73 (0.42, 1.25)	1.18 (0.36, 3.88)	0.86 (0.48, 1.54)	0.45 (0.09, 2.26)	1.38 (0.30, 6.40)	2.17 (0.45, 10.4)
Cigarette Variables						
Cigarettes per day	1.02 (1.00, 1.05)	1.02 (0.97, 1.07)	1.02 (0.99, 1.04)	1.05 (0.99, 1.10)	1.01 (0.96, 1.07)	0.99 (0.94, 1.05)
Daily smoker	1.85 (1.19, 2.88)	2.27 (0.77, 6.70)	1.62 (0.99, 2.65)	1.79 (0.50, 6.35)	1.84 (0.62, 5.44)	1.19 (0.41, 3.42)
Smoke within 30 mins of waking	1.63 (1.13, 2.35)	2.74 (1.18, 6.37)	1.33 (0.88, 2.01)	1.36 (0.50, 3.68)	1.09 (0.44, 2.67)	1.10 (0.44, 2.73)
Hard to not smoke where banned	1.40 (0.93, 2.16)	1.01 (0.37, 2.73)	1.52 (0.97, 2.40)	1.88 (0.67, 5.26)	1.75 (0.66, 4.62)	0.57 (0.20, 1.61)
Identify as “social smoker”	0.91 (0.61, 1.37)	0.86 (0.34, 2.18)	0.77 (0.50, 1.17)	0.53 (0.20, 1.44)	2.02 (0.72, 5.66)	1.03 (0.38, 2.77)
Total years smoking	1.01 (0.95, 1.07)	1.07 (0.95, 1.21)	0.98 (0.91, 1.06)	1.00 (0.84, 1.20)	1.09 (0.55, 2.17)	1.01 (0.51, 2.02)
Past year quit attempt	1.54 (1.03, 2.30)	4.15 (1.23, 14.0)	1.26 (0.83, 1.91)	5.67 (1.28, 25.1)	0.62 (0.25, 1.54)	3.11 (1.16, 8.32)
Desire to stop smoking	1.00 (0.94, 1.07)	1.10 (0.96, 1.26)	N/A	N/A	0.99 (0.84, 1.16)	1.29 (1.08, 1.55)
Expected success for quitting	0.93 (0.87, 0.99)	1.00 (0.87, 1.16)	N/A	N/A	1.05 (0.89, 1.23)	1.02 (0.87, 1.21)
Expected difficulty for quitting	1.08 (1.01, 1.16)	1.24 (1.03, 1.48)	N/A	N/A	1.11 (0.92, 1.35)	1.10 (0.91, 1.34)
Smoking goal of abstinence	0.58 (0.28, 1.20)	1.30 (0.38, 4.39)	N/A	N/A	0.18 (0.02, 1.58)	1.73 (0.40, 7.51)

	Study 1: 2009–2010 (n = 1987)		Study 2: 2010–2011 (n = 595)		Study 3: 2013 (n=79)	
	Past Month EC Use ^a <u>OR (95% CI)</u>	Ever EC Use to Quit ^b <u>OR (95% CI)</u>	Past Month EC Use ^a <u>OR (95% CI)</u>	Ever EC Use to Quit ^b <u>OR (95% CI)</u>	Past Month EC Use ^a <u>OR (95% CI)</u>	Ever EC Use to Quit ^b <u>OR (95% CI)</u>
Smoking stage of change (Ref: Precontemplation)						
Contemplation	0.85 (0.55, 1.32)	2.02 (0.75, 5.45)	1.09 (0.68, 1.75)	0.89 (0.23, 3.48)	0.53 (0.20, 1.41)	1.46 (0.54, 3.98)
Preparation	1.10 (0.70, 1.73)	2.14 (0.75, 6.14)	1.25 (0.69, 2.24)	3.71 (1.22, 11.36)	0.71 (0.17, 2.98)	3.45 (0.80, 15.0)

Notes: Ref = Reference group.

^a Past-month electronic cigarette use.

^b Ever use e-cigarette during a quit attempt. Use of e-cigarettes during a cessation attempt was reported spontaneously in first two studies, and prompted in third study. Significant values shown in bold.