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Brief report
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Brief report

Current and Former Smokers' Use of Electronic Cigarettes for Quitting Smoking: An Exploratory Study of Adolescents and Young Adults

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Abstract

Background: This exploratory study examines the prevalence and predictors of current and former smokers' use of electronic (e-) cigarettes for smoking cessation among a sample of adolescent and young adult established smokers.

Methods: We conducted school-wide surveys in two middle (n = 1166) and four high schools (n = 3614) in fall 2013 and one public college (n = 625) in spring 2014. We analyzed data from 189 established smokers (reported smoking 100 cigarettes in their lifetime) who also reported ever-use of e-cigarettes (50.7% female, 89.4% White race, M_{age} 18.3 [SD = 2.8]). We further classified participants as current smokers (reported past-month cigarette smoking) and former smokers (no past-month smoking). Adjusted logistic regression assessed associations of using e-cigarettes to quit smoking with demographic, cigarette and e-cigarette use patterns, e-cigarette flavor preference, and risk perception variables.

Results: Overall, 41.8% of the sample reported that they "have used an e-cigarette to quit smoking." In adjusted models, older age, White race, higher e-cigarette frequency, and preference for using a combination of e-cigarette flavors predicted increased odds of having used e-cigarettes to quit smoking (p < .05). Using e-cigarettes to quit smoking was not associated with current or former cigarette smoking status or perceptions that "e-cigarettes help people quit smoking" or "e-cigarettes are safer than quit smoking medications."

Conclusions: Adolescents and young adults who report more frequent e-cigarette use and preference for using flavor combinations are more likely to use e-cigarettes for smoking cessation. Future studies are needed to determine whether e-cigarette use leads to tobacco abstinence in youth smokers.

Implications: Among young established smokers, more frequent e-cigarette use and preference for using flavors mixed together, but not perceptions of harmfulness of e-cigarettes or comparative safety of e-cigarettes compared with cigarettes or other smoking cessation medications or helpfulness of e-cigarettes in quitting smoking, are associated with using e-cigarettes for smoking cessation.

Introduction

Electronic (e-) cigarette use continues to rise rapidly among adolescents and young adults. From 2011 to 2015, the prevalence of past-month e-cigarette use increased 10-fold from 1.5% to 16.0% among US high school students. E-cigarette prevalence rates have surpassed cigarette prevalence rates in youth.[1,2] The prevalence of use among young adults similarly increased from 3.4% to 14.2% between 2012 and 2013.[3] A majority of adolescent e-cigarette users

are dual users who also smoke traditional cigarettes.[4,5] Potential benefits of e-cigarettes include lower levels of toxins than cigarettes and the promotion of cigarette smoking cessation.[6] However, there is continued concern that e-cigarettes may have adverse long-term health effects and serve as a gateway product to cigarettes.[7,8]

Smoking cessation is one of the primary reasons for e-cigarette use among adults.[9–11] Emerging data demonstrate that adult smokers who successfully use e-cigarettes for cessation are more likely to use e-cigarettes daily and use "open" e-cigarette systems that allow for customization.[9,12,13] Currently, few clinical trials evaluate whether e-cigarettes are effective for cessation and evidence suggests that e-cigarettes may be as effectiveness as nicotine replacement therapy.[14,15] However, the scientific data remain inconclusive due to the infancy of the research and the low number of existing studies with high methodological quality.[16]

Nonetheless, in order to determine the net population health impact of e-cigarettes, and their potential role in harm reduction, the scientific community must understand the role of e-cigarettes for smoking cessation in youth, a population with a unique vulnerability to continue tobacco use into adulthood.[17] A 2011 cross-sectional study found that adolescent cigarette smokers who had made a quit attempt were more likely to have used e-cigarettes than those who had not made a quit attempt.[18] However, a study of college student cigarette smokers demonstrated that e-cigarette use at baseline predicted continued past-month cigarette use at follow-up.[19] Studies have also shown that lower perceived risk of e-cigarettes, compared to cigarettes, is associated with e-cigarette use in adolescents and young adults,[20,21] but it is unknown whether these perceptions relate to cessation behavior in youth.

Our previous work has demonstrated that adolescents primarily try e-cigarettes for curiosity and flavors.[22] Manufacturers offer a multitude of e-liquid flavors. In 2014, a study of online e-cigarette vendors found that 466 brands offered 7764 flavors.[23] Both adults and adolescents report that the variety of available e-liquid flavors is attractive.[12,22,24] For example, a majority of adults recruited from an e-cigarette advocacy Web site rated the "availability of a variety of e-cigarette flavors" as "very important" in efforts to reduce/stop smoking cigarettes.[25] A study of adult current e-cigarette users also found that those who had quit cigarette smoking within the past 12 months were more likely to choose "open" e-cigarette systems that accommodate a variety of e-liquid flavors,[12,24] as well as the opportunity to mix flavors within the same cartridge. Although this preliminary evidence in adults suggests that flavor use is correlated with quit attempts, and possibly cessation, the public health community is concerned that in youth, flavors may promote e-cigarette initiation and progression of cigarette smoking, rather than cessation. However, it is largely unknown if e-cigarette flavoring contributes to smoking cessation in youth.

This exploratory study aims to (1) determine the prevalence of ever using e-cigarettes to quit smoking and (2) examine demographic, smoking status, flavor preference, and risk perception-related predictors of ever using e-cigarettes to quit cigarette smoking among a sample of adolescent and young adult established smokers. Given the finding that frequent e-cigarette use predicts successful cessation in adults,[9] we hypothesized that more frequent e-cigarette use would be positively associated with ever using e-cigarettes to quit smoking. We did not have specific hypotheses about the other predictors given the novelty of the data. This exploratory study provides data as a formative step to understanding the relationship between e-cigarettes and cigarette cessation in youth.

Methods

We analyzed data from a cross-sectional survey of a convenience sample of adolescents and young adults attending two middle schools (MS; grades 6–8; n = 1166), four high schools (HS; grades 9–12; n = 3614), and one public college (n = 625) in Connecticut. Full study methods have been published elsewhere.[5,22] We selected secondary schools from four different District Reference Groups (DRGs) across this state. DRGs are school groupings based on indicators of socioeconomic status, financial need, and school enrollment.[26,27] MS and HS students were surveyed in November 2013 and 87.1% of the HS and 94.1% of the MS students who attended school on the day of the survey participated in the study. The college was chosen from Southeast Connecticut and surveyed in May 2014 and a convenience sample of enrolled students completed the survey.

We examined adolescents and young adults in MS/HS (ages 14 through 18; grades 8–12) and college (ages 18 through 24) who reported smoking at least 100 cigarettes in their lifetime (established smokers) and ever-use of e-cigarettes. We restricted the sample to those with complete data regarding e-cigarette use, cigarette use, and use of e-cigarettes for smoking cessation (n = 189). Respondents with any missing data were more likely to be in HS ($p < .001$); there were no other differences between those with complete and incomplete data.

Procedures

The Institutional Review Board of Yale University and the participating school administrators approved the study. Parents of MS and HS students were mailed information sheets prior to the survey informing them of the nature of the survey and allowing them to opt out their child (12 students were opted out by parents). Students were informed that the surveys were voluntary and confidential. Teachers distributed the paper surveys to students during their advisories/homerooms.

College students were recruited in randomly selected classes and the student union. Students were handed cards with the study information and a link and a QR code that directed students to the online survey. In an effort to boost enrollment, college student respondents were eligible to enter a raffle to win $50 gift cards for their participation. College students provided consent prior to survey administration.

Measures

Cigarette smoking status was measured using responses to (1) "Have you smoked at least 100 cigarettes in your lifetime?" [yes, no] and (2) "During the past 30 days, how many days did you smoke a cigarette?" [None, 1 day, 2 days, 3–5 days, 6–10 days, 11–20 days, 21–28 days, Everyday]. Established smokers were defined as respondents who reported yes to question 1. We further classified the sample of established smokers into current smokers (respondents who indicated in question 2 smoking a cigarette ≥1 day in the past 30 days) and former smokers (respondents who indicated 0 days in the past 30 days).

Ever e-cigarette use was measured using responses [Yes/No] to "Have you ever tried e-cigarettes?" "Ever e-cigarette users" were defined as those who responded "yes."

E-cigarette frequency was determined by quantitative responses to "How many days out of the past 30 days did you use an e-cigarette?"

Use of e-cigarettes to quit smoking was measured using dichotomous responses [Yes/No] to "Have you used an e-cigarette to quit smoking?"

Flavor preferences were measured using responses to "Which flavor do you prefer when you smoke e-cigarettes?" [Select all that apply: Sweet Flavor (like candy, fruit, chocolate), Tobacco-flavored, Menthol, a Combination of 2 or more Flavors mixed together, Other, I don't know]. Participants were defined as preferring a combination of flavors if they selected "Combination of 2 or more flavors mixed together" (rather than more than one flavor category).

Risk perceptions were measured with four statements for which respondents could rate their agreement or disagreement on a 5-point Likert scale (1. Strongly Disagree to 5. Strongly Agree). The statements included those related to Harm ("E-cigarettes are harmful to your health."), Safety ("E-cigarettes are safer than regular cigarettes."), and Quitting ("E-cigarettes help people quit smoking" and "E-cigarettes are safer than quit smoking medications (ie, nicotine patch, gum)"). We defined responses of strongly agree/agree as "agree" and all others as "do not agree."

Statistical Analyses

We used descriptive statistics to examine demographics and tobacco use patterns among the sample. Comparisons between the groups of students who did and did not use e-cigarettes to quit smoking were conducted with *t* tests for continuous variables and chi-square/Fishers exact tests for categorical variables.

We conducted multivariable logistic regression analysis to evaluate the association between using e-cigarettes to quit smoking and the following variables: age, gender, race (ie, White vs. not White), e-cigarette frequency, cigarette smoking status, preferred e-cigarette flavor, and the risk perceptions variables. Proc survey logistic procedures were conducted with SAS v.9.3 (SAS Institute Inc., Cary, NC) to account for clustering by school and $p < .05$ was considered statistically significant.

Results

Table 1 demonstrates that the prevalence of using e-cigarettes to quit smoking was 41.8% among this sample of youth with a history of established smoking (n = 189; 50.7% female, 89.4% White race, M_{age} 18.3 [SD = 2.8]). The prevalence of using e-cigarettes to quit smoking did not differ by age or gender; however, a larger proportion of White students, than students of other races, reported using e-cigarettes to quit smoking (44.1% vs. 20.0%; $p < .03$). Bivariate analysis also showed that youth who used e-cigarettes to quit smoking reported higher days of e-cigarette use in the past 30 days (5.2 vs. 3.3 days; $p < .001$). Using e-cigarettes to quit smoking was not associated with current or former cigarette smoking status. Using e-cigarettes to quit smoking was not associated with e-cigarette perceptions related to harmfulness to health, safety compared with regular cigarettes, helpfulness in quitting smoking, or being safer than quit smoking medications.

Table 2 demonstrates the adjusted odds of using an e-cigarette to quit smoking. Older students, White race, higher e-cigarette frequency, and preference for "a combination of 2 or more flavors mixed together" predicted increased likelihood of using e-cigarettes to quit smoking.

Discussion

Many adolescents and young adults with a history of established smoking had ever used e-cigarettes to quit smoking (41.8%). Youth who used e-cigarettes to quit smoking were more likely to report frequent e-cigarette use and a preference for a combination of flavors mixed together. Use of e-cigarettes to quit smoking was not associated with current or former cigarette smoking status or perceptions

Table 1. Characteristics of Sample

Variable	Total (n = 189)	Used e-cigarettes to quit smoking?		p[a]
		Yes (n = 79)	No (n = 110)	
Demographics				
Age, mean (*SD*)	18.3 (2.8)	18.3 (2.8)	18.5 (2.7)	.9
Gender, n (%)				.9
Female	96 (100)	39 (40.6)	57 (59.4)	
Male	91 (100)	39 (42.6)	52 (57.1)	
Missing	2 (100)	1	1 (1.0)	
Race, n (%)				**.03**
White	169 (100)	75 (44.4)	94 (55.6)	
Other race	20 (100)	4 (20.0)	16 (80.0)	
Tobacco use behaviors				
Past-30-day e-cigarette frequency, mean (*SD*), days	4.1 (2.6)	5.2 (2.5)	3.3 (2.4)	**<.001**
Cigarette status, n (%)				.8
Current smoker	159 (100)	67 (42.1)	92 (57.9)	
Former smoker	30 (100)	12 (40.0)	18 (60.0)	
E-cigarette perceptions				
"E-cigarettes are harmful to health," n (%)	72 (100)	30 (58.3)	42 (41.7)	.9
"E-cigarettes are safer than cigarettes," n (%)	142 (100)	59 (41.6)	83 (58.5)	.9
"E-cigarettes help people quit smoking," n (%)	104 (100)	49 (47.1)	55 (52.9)	.1
"E-cigarettes are safer than quit smoking medications," n (%)	78 (100)	35 (44.9)	43 (55.1)	.5
Preferred e-cigarette flavor				
Sweet, n (%)	96 (100)	41 (37.3)	55 (56.7)	.6
Tobacco, n (%)	29 (100)	11 37.9)	18 (62.2)	.6
Menthol, n (%)	22 (100)	11 (50.0)	11 (50.0)	.2
Combination of flavors, n (%)	23(100)	14 (60.9)	9 (39.1)	**.04**

[a]Chi-square test or Fishers exact test.

Bolded results indicate $p < .05$.

Table 2. Multivariable Model Predictors of Using E-Cigarettes to Quit Smoking

Parameter	Estimate	*SE*	Wald	*p*	AOR (95% CI)		
Intercept	−1.90	0.81	5.45	.02			
Demographics							
Age	**0.07**	**0.03**	**5.05**	**.02**	**1.07**	**1.01**	**1.13**
Male vs. female	0.06	0.18	0.12	.73	1.13	0.55	2.34
White vs. non-White	**0.51**	**0.23**	**4.85**	**.03**	**2.79**	**1.12**	**6.96**
Tobacco use behaviors							
E-cigarette frequency in past 30 days	**0.07**	**0.02**	**11.07**	**.0009**	**1.07**	**1.03**	**1.12**
Current vs. former cigarette smoker	−0.23	0.47	0.24	.63	0.80	0.32	1.99
Agree (vs. not agree) with perception							
"E-cigarettes are harmful to health"	0.19	0.10	3.60	.06	1.47	0.99	2.20
"E-cigarettes are safer than cigarettes"	−0.33	0.16	3.99	.057	0.52	0.27	0.99
"E-cigarettes help people quit smoking"	0.28	0.21	1.69	.19	1.74	0.75	4.03
"E-cigarettes are safer than quit smoking medications"	0.18	0.19	0.93	.33	1.43	0.69	2.97
Prefer (vs. do not prefer) flavor							
Sweet	−0.20	0.23	0.74	.39	0.67	0.27	1.66
Tobacco	−0.17	0.21	0.70	.40	0.71	0.32	1.59
Menthol	0.41	0.21	3.75	.053	2.26	0.99	5.14
Combination of 2 or more flavors mixed together	**0.33**	**0.10**	**11.23**	**.0008**	**1.92**	**1.31**	**2.81**

AOR = adjusted odds ratio; CI = confidence interval. Bolded results indicate $p < .05$.

that e-cigarettes are harmful to health, are safer than cigarettes, help with quitting smoking, or are safer than smoking cessation medications.

This study provides one of the first estimates of the prevalence of using e-cigarettes to quit smoking among adolescent and young adult established smokers in Connecticut. Although studies in adults have not directly measured the rate of using e-cigarettes during a quit attempt, a nationally representative sample of adults found that 55.3% of current cigarette smokers who had tried to quit smoking in the past year had ever tried an e-cigarette.[28] Additionally, 80% of adult cigarette smokers who had switched to exclusive e-cigarette use in the past year reported e-cigarettes helped them quit smoking cigarettes.[29] In our study, although more frequent e-cigarette use was associated with using e-cigarettes to quit smoking, using e-cigarettes to quit smoking was not associated with being a current or former smoker. This finding suggests that while some adolescents and young adults who are established smokers may use e-cigarettes during quit attempts, use of e-cigarettes alone may not always lead to successful abstinence from cigarette smoking in this younger group of established smokers. While our findings support other previous cross-sectional studies of adolescents which have shown that e-cigarette use is not associated with intention to quit smoking, quit attempts, or reports of cigarette abstinence,[18,30,31] the cross-sectional nature of our study design prevents us making causal inferences. Future longitudinal research is needed to better describe the relationship between e-cigarette use and quit smoking trajectories.

Youth who used e-cigarettes "to quit smoking" were more likely to be older, which may demonstrate less experimentation and more goal-directed behaviors (such as quitting smoking) among young adults. Among this sample of established smokers, youth who used e-cigarettes to quit smoking were also likely to report White race. This finding may due to differences between White and non-White youth in motivation to quit, access to e-cigarettes during quit attempts, or support from peers to use e-cigarettes for this purpose; however, future studies are needed to test these hypotheses.

Youth who used e-cigarettes "to quit smoking" were also more likely to prefer (vs. not prefer) a combination of flavors mixed together. Although this study did not ascertain if users were using "closed" or "open" electronic nicotine delivery systems, this preference for using a combination of flavors mixed together among youth who have used e-cigarettes to quit smoking may reflect a preference for customizing product features, including flavors. Our findings were somewhat limited by the fact that we did not explore a wider variety of flavors or reasons for why flavors may or may not be helpful in smoking cessation. Future studies should measure a wider variety of flavors and explore which product features are necessary to promote cigarette smoking abstinence among adolescents and young adults.

The use of e-cigarettes for smoking cessation was not associated with perceptions related to the harmfulness or safety of e-cigarettes compared with cigarettes. These findings suggest that younger smokers' use of e-cigarettes for smoking cessation may not be related to beliefs that the product has less harm or greater safety than cigarettes. Similarly, use of e-cigarettes for smoking cessation was not related to perceptions that e-cigarettes may be helpful in quitting smoking or safer than other quit smoking medications. These findings suggest that, among youth, the use of e-cigarettes to quit smoking may be motivated by perceptions of approval by friends, available flavors, or how easy it is to obtain the product; factors which have been shown to influence initiation of use.[22] Ongoing research is underway to explore these and other possibilities.

This study has several limitations. As mentioned above, the cross-sectional design limits inferences about causality. It is important to point out that we did not measure whether youth were successful in using e-cigarettes for smoking cessation. Future longitudinal data are needed to determine if e-cigarette use affects smoking cessation outcomes among younger smokers. The generalizability of our findings may also be limited by the relative racial homogeneity of our convenience sample. Further, given the sample size, the estimates from this exploratory study have large confidence intervals and we may have been underpowered to detect statistically significant association. Examinations of larger samples are needed to validate our findings. Additionally, as e-cigarette products, and perceptions about these products, are rapidly evolving, the patterns and behaviors observed in our study may not accurately reflect current trends.

Regardless, this exploratory study provides one of the first estimates of the prevalence of ever using e-cigarettes to quit smoking among adolescent and young adult established smokers. Further research is needed to determine whether e-cigarette use leads to quit attempts and tobacco abstinence among youth. Importantly, the unique patterns of youth tobacco use should be considered when determining the net population health impact of e-cigarettes.

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Declaration of Interests

None declared.

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