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Longitudinal Analysis of Associations Between Reasons for Electronic Cigarette Use and Change in Smoking Status Among Adults in the Population Assessment of Tobacco and Health Study

Eric K. Soule PhD, MPH¹, Andrew D. Plunk PhD², Paul T. Harrell PhD²,
Rashelle B. Hayes PhD³, Kathryn C. Edwards PhD⁴

¹Department of Health Education and Promotion, East Carolina University, Greenville, NC; ²Department of Pediatrics, Eastern Virginia Medical School, Norfolk, VA; ³Department of Psychiatry, Virginia Commonwealth University, Richmond, VA; ⁴Westat, Behavioral Health Group, Rockville, MD

Corresponding Author: Eric K. Soule, PhD, MPH, Department of Health Education and Promotion, East Carolina University, 2306 Carol Belk Building, Mail Stop 529, Greenville, NC 27858-4353, USA. E-mail: soulee18@ecu.edu

Abstract

Introduction: Electronic cigarette (ECIG) use and changes in cigarette smoking status may be influenced by self-reported reasons for using ECIGs.

Methods: We analyzed adult current and former cigarette smokers who were also current or former ECIG users at wave 1 ($n = 3044$) using wave 1 and wave 2 Population Assessment of Tobacco and Health Study data (2013–2015). Prevalence of reporting 13 reasons for ECIG use at wave 1 was examined and weighted logistic regressions were conducted predicting smoking status changes from wave 1 to wave 2.

Results: Reasons for ECIG use ranged from 18.1% (people in the media or public figures use them) to 82.5% (they might be less harmful to people around me than cigarettes). From wave 1 to wave 2, 27.2% of former smokers ($n = 249$) became current smokers and 11.6% of current smokers ($n = 246$) became former smokers. Among wave 1 former smokers, using ECIGs because of the availability of flavors (AOR = 0.57, 95% CI = 0.39–0.85) or because they don't smell (AOR = 0.64, 95% CI = 0.42–0.97) was associated with lower odds of relapse to smoking, but using ECIGs because using them helps people quit smoking (AOR = 1.55, 95% CI = 1.01–2.38) was associated with greater odds of relapse. Among wave 1 current smokers, using ECIGs because they can be used where smoking is not allowed (AOR = 0.56, 95% CI = 0.38–0.85) was associated with reduced odds of quitting cigarettes.

Conclusions: Some reasons for ECIG use are associated with changes in self-reported smoking status. Researchers should examine ECIG user characteristics when assessing associations between ECIG use and smoking status transitions.

Implications: Given that certain reasons for ECIG use, such as using ECIGs in locations where smoking is not allowed, may inhibit smoking reduction, policies may be developed to prevent ECIG use in locations where smoking is banned. In addition, because certain reasons for ECIG use may aid in relapse prevention, such as availability of desired flavors, efforts should be made to identify ECIG device characteristics that are appealing to smokers but not youth or nontobacco users. These results provide support for future research on reasons for ECIG use to inform regulatory policies.

Introduction

Electronic cigarettes (ECIGs) have grown in popularity in recent years^{1,2} and are a diverse class of products that use a heater to aerosolize a liquid often containing nicotine, propylene glycol, vegetable glycerin, and chemical flavorants for user inhalation.³ Among adults, the number of ECIG users who report never smoking cigarettes is low with an estimated 3.1% of current ECIG users never reporting cigarette smoking. Instead, the majority of adult ECIG users report being either current or former cigarette smokers.⁴ Though not approved by the US Food and Drug Administration as a smoking cessation aid, many smokers may view ECIGs as a tool to support cigarette smoking reduction or cessation with both being common reasons reported for ECIG use.^{5–18}

Numerous studies have attempted to examine the effectiveness of ECIG use for smoking cessation.¹⁹ Some studies indicate that ECIG use may increase the likelihood of smoking cessation,^{20–24} some studies suggest that ECIG use may decrease the likelihood of smoking cessation,²⁵ and others suggest that ECIGs are not associated with an increased or decreased likelihood of smoking cessation.^{5,26–30} There are many potential explanations as to why studies that ask essentially the same research question (ie, Does ECIG use help people quit smoking?) come to different conclusions. One possibility is that examining cigarette smoking transitions by focusing solely on if study participants are ever ECIG users versus never ECIG users may fail to account for important differences between subgroups of the ECIG user population, such as those who have briefly tried an ECIG versus those who have used them more regularly or those who have different motivations for their use.²⁵ These differences may be important when considering cessation-associated outcomes. Specifically, some ECIG user characteristics may be associated with smoking status transitions, but research has yet to identify these characteristics.

In addition, with few longitudinal studies and clinical trials, many studies examining ECIG use and cigarette smoking status transitions analyze cross-sectional data. Longitudinal analyses may be more useful for identifying potential factors that are associated with ECIG use and smoking status transitions. For example, a recent longitudinal analysis of transitions in smoking status among ECIG users indicated that baseline daily ECIG use (ie, reporting ECIG use “every day”) may be more associated with smoking cessation at follow-up, but using a “customizable” device (ie, device that is rechargeable, refillable, and do not use cartridges) is not.³¹ This example illustrates the importance of examining various ECIG user characteristics and how they may be associated with future cigarette use. Similarly, a recent report from the National Academies of Sciences concluded that although overall there is limited evidence that ECIGs may be effective aids to promote smoking cessation, there may be some characteristics of ECIGs or patterns of ECIG use that are more associated with smoking cessation such as frequency of ECIG use or use of nicotine in an ECIG.³² Examining ECIG user characteristics using longitudinal methods also allows for greater insight into potential causal mechanisms. Therefore, there is a need to identify many ECIG user characteristics that may be associated with cigarette smoking transitions over time.

Reported reasons for ECIG use may represent an important ECIG user characteristic that could predict cigarette smoking behavior.³³ ECIG users identify many reasons for using ECIGs such as lower financial costs,^{10,16,17,34} decreased harm perception,^{5,15,17,35–37} perceiving ECIGs help with smoking cessation,^{17,36,38} and reducing family smoke exposure.^{17,39} However, longitudinal studies using large samples of

nationally representative ECIG users and cigarette smokers have yet to examine how various reasons for using ECIGs may predict future cigarette smoking behavior. These studies are needed as reasons for ECIG use may be important for predicting transitions in cigarette smoking status, not only among current smokers transitioning to former smokers, but also among former smokers transitioning to current smokers to examine the potential benefits and harms of ECIG use regarding smoking status transitions. That is, ECIGs may play a role for some in promoting smoking reduction (ie, potential benefit), but also may play a role in relapse to smoking for others (ie, potential harm). Indeed, recent research indicates that although some smokers who use ECIGs report smoking cessation while using ECIGs, former smokers who report ECIG use may be at risk for smoking relapse.⁴⁰ In addition, reasons for using ECIGs may be heterogeneous, which may help to explain mixed findings of the association between ECIG use and smoking cessation or other important outcomes. That is, some ECIG users may be using ECIGs for reasons related to smoking cessation whereas others may be using ECIGs for convenience, for example. A greater understanding of how reasons for using ECIGs are associated with changing in smoking status over time could inform public health interventions and regulatory policy. Therefore, the purpose of this study was to examine the associations between user-endorsed reasons for ECIG use and subsequent cigarette smoking among current and former cigarette smokers using adult data from wave 1 to wave 2 of the Population Assessment of Tobacco and Health (PATH) Study.

Methods

Sample

The PATH Study is a nationally representative, longitudinal cohort study designed to assess tobacco use in the US population.⁴¹ In addition, the PATH Study design allows for monitoring of changes in smoking behavior over time and associations with reasons for ECIG use. Wave 1 of the PATH Study was conducted between 2013 and 2014 and surveyed 32 320 adults aged 18 years or older. Wave 2 of the PATH Study was conducted between 2014 and 2015, and of those respondents who participated in wave 1, 26 447 also participated in wave 2 (81.8% follow-up rate). Importantly, as part of the complex sample design, wave 2 participant weights were adjusted for nonresponse of wave 1 participants.⁴² Respondents completed an interview using audio computer-assisted self-interview. Weights were created to account for the complex sample design (see PATH Study Public-Use Files User Guide⁴³ for more detail). Weighted estimates represent the civilian (noninstitutionalized) US population at the time of wave 2, who were in the civilian (noninstitutionalized) population at the time of wave 1.⁴³

In this study, adult data from wave 1 to wave 2 of the PATH Study were analyzed. Participants were categorized into different groups based on their wave 1 smoking and ECIG use status (see [Supplementary Table 1](#)). Respondents were included if they were current or former cigarette smokers and reported current ECIG use or were former past-year ECIG users at wave 1. “Current” smoking status was assessed on the PATH study survey by asking participants “Do you now smoke cigarettes: [every day, some days, not at all].” Current established smoking status was determined based on whether respondents reported smoking at least 100 cigarettes in their lifetime and currently using cigarettes every day or some days, referred to as “current” smoker hereafter. Former smoking status was defined as ever smoking 100 cigarettes but not currently

smoking cigarettes at wave 1, referred to as “former” smoker hereafter. Therefore, former smokers included in the sample all smoked at least 100 cigarettes and included recent and long-term former smokers. Participants were considered current established ECIG users if they reported currently using ECIGs every day or some days and reported using ECIGs “fairly regularly,” referred to as “current” use hereafter. Participants were considered “current experimental” ECIG users if they reported currently using ECIGs every day or some days, but had not reported using ECIGs “fairly regularly,” referred to as “current experimental” ECIG user hereafter. Although all former ECIG users also were asked about reasons for ECIG use, only former ECIG users who had more recent ECIG use experience (ie, within the past year) and reported “fairly regular” ECIG use when they did use ECIGs were included in this study. This was done to include only ECIG users that would likely be able to recall accurately their reasons for ECIG use. Therefore, past-year former established ECIG users were also included in analyses and were defined as participants who were not currently using ECIGs but had reported using ECIGs “fairly regularly” within the past year at wave 1, referred to as a “past-year former” use hereafter. The term “fairly regularly” was not defined for participants and therefore represents participants’ own interpretations.

Measures

Demographic characteristics examined at wave 1 included sex, age group (18–24, 25–34, 35–44, 45–54, 55–64, ≥65), race and ethnicity (white, non-Hispanic; black or African American, non-Hispanic; other race or multiracial, non-Hispanic; Hispanic), education (less than high school diploma, General Education Diploma (GED), some college or associates degree), income (<100% of the federal poverty level, 100%–199% of the federal poverty level, and ≥200% of the federal poverty level), age of smoking initiation (<18 years old, ≥18 years old), and ECIG use status (current, current experimental, and past-year former).

Current, current experimental, and past-year former ECIG users were asked about 13 reasons for ECIG use in the PATH Study wave 1 survey. These reasons included “They are affordable,” “People in the media or other public figures use them,” “It can be used in places where smoking cigarettes is not allowed,” “They might be less harmful to me than cigarettes,” “They might be less harmful to people around me than cigarettes,” “It comes in flavors I like,” “Using them helps people quit smoking,” “They don’t smell,” “It feels like smoking a regular cigarette,” “They are more acceptable to non-tobacco users,” “People who are important to me use them,” “I like socializing while using one,” and “The advertising appeals to me” (see [Supplementary Figure 1](#)). For each reason, participants were asked to respond to the prompt, “I [use/used] e-cigarettes because . . .” and could respond “yes” or “no.” Participants were able to select as many reasons as they felt applicable.

Data Analysis

Descriptive analyses were conducted to examine prevalence of reasons for ECIG use endorsed and correlations between reasons for ECIG use. Analyses also modeled two transitions in cigarette smoking status: (1) wave 1 former smokers to wave 2 current smokers, and (2) wave 1 current smokers to wave 2 former smokers. Unadjusted and adjusted logistic regression was used to estimate the likelihood of a smoking status change from wave 1 to wave 2 based on respondent reasons for ECIG use assessed in wave 1. Version 3.3.2 of R was used for all analyses.⁴⁴ The complex survey design of

the PATH was accounted for using the R package “survey”⁴⁵ using the full sample weight and the 100 replicate weights.⁴³ Analyses were stratified by wave 1 cigarette smoking status and adjusted models controlled for sex, age, race, education, income, age of smoking initiation, and wave 1 ECIG use status (current, current experimental, or past-year former). An α level of .05 was used to determine statistical significance.

Results

Baseline (Wave 1) Participant Characteristics

A complete list of participant characteristics is displayed in [Table 1](#). Overall, there were 3044 participants (50.1% female) at wave 1 that were current or former smokers who also reported current ECIG use, reported current experimental ECIG use, or were past-year former ECIG users. Approximately two-thirds of the participants (67.7%) were white, non-Hispanic, over half (53.6%) were between the ages of 18 and 34 years, over half (53.5%) had at least some college or more education, and 65.4% were less than 200% of the federal poverty level. Nearly 80% of participants had initiated cigarette smoking before the age of 18 years.

Half of the wave 1 participants were current experimental ECIG users at baseline, 11.6% were current ECIG users, and 39.3% were past-year former ECIG users. Nearly 70% of the participants were current smokers at wave 1 and 30% were former smokers. Wave 1 current smokers were more likely to be older, be white, non-Hispanic, have completed less schooling, and to have initiated smoking before the age of 18 years compared to wave 1 former smokers. Among wave 1 current smokers, 77.5% were daily smokers. In the current sample, there were more current experimental ECIG users among current cigarette smokers compared to former smokers ($p < .05$) and more current and past-year former ECIG users among wave 1 former smokers compared to current smokers ($p < .05$; see [Table 1](#)).

Reasons for ECIG Use

The three most popular reasons endorsed for using ECIGs were “They might be less harmful to people around me than cigarettes” (82.5%), “They might be less harmful to me than cigarettes” (80.2%), and “It can be used in places where smoking cigarettes is not allowed” (79.6%) (see [Supplementary Figure 1](#)). The least endorsed reasons for ECIG use were “People in the media or other public figures use them” (18.1%), “The advertising appeals to me” (20.3%), and “People who are important to me use them” (20.5%). On average, participants endorsed 7.2 (SD = 2.9) reasons for ECIG use. With the exception of the correlation between “People in the media or other public figures use them” and “They don’t smell,” all reasons for ECIG use were significantly correlated (see [Table 2](#); $qs = 0.06$ – 0.38 , all $ps < .01$). The most highly correlated reasons for ECIG use were “People in the media or other public figures use them” with “The advertising appeals to me” ($q = 0.38$) and “They might be less harmful to people around me than cigarettes” with “They are more acceptable to non-tobacco users” ($q = 0.38$).

There were significant differences in the percentage of current and former smokers at wave 1 who endorsed 8 of the 13 reasons for ECIG use ($ps < .05$; see [Table 1](#)). The largest differences in endorsement rate for ECIG use between wave 1 current and former smokers were “It can be used in places where smoking is not allowed” (82.5% among current smokers, 72.8% among former smokers) and “People who are important to me use them” (17.9%

Table 1. Demographic Characteristics, Electronic Cigarette (ECIG) Use, and Reasons for ECIG Use Among Adult Current, Current Experimental, and Past-Year Former ECIG Users by Cigarette Smoking status From Wave 1 to Wave 2 (2013–2015) of the Population Assessment of Tobacco and Health (PATH) Study

	All wave 1 current and former smokers (%, <i>n</i>) (<i>n</i> = 3044)	Wave 1 current smokers (%, <i>n</i>) (<i>n</i> = 2128)	Wave 1 former smokers (%, <i>n</i>) (<i>n</i> = 916)	<i>p</i> value
Overall	100 (3044)	69.9 (2128)	30.1 (916)	
Sex				.641
Male	49.9 (1520)	50.2 (1069)	49.2 (451)	
Female	50.1 (1524)	49.8 (1059)	50.8 (465)	
Age group (y)				<.001
18–24	29.4 (895)	27.2 (579)	34.5 (316)	
25–34	24.2 (735)	24.7 (525)	22.9 (210)	
35–44	17.5 (534)	18.9 (403)	14.3 (131)	
45–54	15.3 (466)	15.9 (338)	14.0 (128)	
55–64	10.2 (311)	10.1 (215)	10.5 (96)	
>65	3.4 (103)	3.2 (68)	3.8 (35)	
Race/ethnicity				<.001
White, non-Hispanic	67.7 (2060)	71.2 (1515)	59.5 (545)	
Black or African American, non-Hispanic	9.5 (289)	8.4 (178)	12.1 (111)	
Other or multiracial, non-Hispanic	8.5 (259)	8.7 (185)	8.1 (74)	
Hispanic	14.3 (436)	11.8 (250)	20.3 (186)	
Education				.011
Less than high school diploma	13.0 (395)	13.3 (282)	12.3 (113)	
GED	10.3 (313)	11.4 (242)	7.8 (71)	
High school diploma	23.2 (707)	22.9 (488)	23.9 (219)	
Some college/associates degree	41.5 (1263)	41.3 (878)	42.0 (385)	
Bachelor's degree or more	12.0 (366)	11.2 (238)	14.0 (128)	
Income				.057
<100% of the FPL for income	39.1 (1189)	39.3 (837)	38.4 (352)	
100%–199% of the FPL for income	26.3 (799)	27.2 (579)	24.0 (220)	
≥200% of the FPL for income	34.6 (1056)	33.5 (712)	37.6 (255)	
Age of smoking initiation (y)				<.001
<18	78.8 (2397)	81.6 (1736)	72.2 (661)	
≥18	21.3 (647)	18.4 (392)	27.8 (255)	
Wave 1 ECIG use status				<.001
Current experimental ECIG user	49.1 (1494)	53.4 (1136)	39.1 (358)	
Current ECIG user	11.6 (354)	10.4 (221)	14.5 (133)	
Past-year former ECIG user	39.3 (1196)	36.2 (771)	46.4 (425)	
Reasons for using ECIGs				
They are affordable	52.9 (1610)	51.5 (1095)	56.2 (515)	.018
People in the media or other public figures use them	18.1 (551)	17.2 (365)	20.3 (186)	.043
It can be used in places where smoking cigarettes is not allowed	79.6 (2422)	82.5 (1755)	72.8 (667)	<.001
They might be less harmful to me than cigarettes	80.2 (2440)	78.8 (1676)	83.4 (764)	.004
They might be less harmful to people around me than cigarettes	82.5 (2510)	83.2 (1771)	80.7 (739)	.101
It comes in flavors I like	65.1 (1980)	64.8 (1379)	65.6 (601)	.700
Using them helps people quit smoking	69.2 (2106)	70.1 (1491)	67.1 (615)	.119
They don't smell	73.6 (2240)	74.2 (1578)	72.3 (662)	.300
It feels like smoking a regular cigarette	47.2 (1438)	45.3 (963)	51.9 (475)	.001
They are more acceptable to nontobacco users	68.7 (2091)	68.6 (1459)	69.0 (632)	.846
People who are important to me use them	20.5 (623)	17.9 (380)	26.5 (380)	<.001
I like socializing while using one	38.0 (1157)	36.1 (769)	42.4 (388)	.001
The advertising appeals to me	20.3 (617)	18.9 (403)	23.4 (214)	.006

GED = General Education Diploma. *p* values for group comparison chi-square tests. Frequencies represent unweighted data and percentages represent weighted data. FPL stands for federal poverty level. Current ECIG users reported currently using ECIGs “fairly regularly” and every day or some days. Current experimental ECIG users reported ECIGs every day or some days, but not “fairly regularly.” Past-year former ECIG users reported using ECIGs “fairly regularly” within the past year, but did not report currently using ECIGs. Bold text indicates significant differences between wave 1 current and former smokers.

among current smokers, 26.5% among former smokers). There were no other significant differences in endorsed reasons to use ECIGs between current and former smokers (differences ranged from 1.2%

to 6.6%). Reason for ECIG use also varied by ECIG user category. With the exception of “People in the media or other public figures use them,” current ECIG users had the lowest percentage of all

Table 2. Intercorrelations for Reasons for Electronic Cigarette (ECIG) Use at Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study

Reason for ECIG use	1	2	3	4	5	6	7	8	9	10	11	12	13
1. They are affordable	—												
2. People in the media or other public figures use them	.16**	—											
3. It can be used in places where smoking cigarettes is not allowed	.22**	.11**	—										
4. They might be less harmful to me than cigarettes	.25**	.09**	.24**	—									
5. They might be less harmful to people around me than cigarettes	.26**	.11**	.36**	.51**	—								
6. It comes in flavors I like	.29**	.18**	.26**	.23**	.27**	—							
7. Using them helps people quit smoking	.24**	.06**	.18**	.37**	.32**	.14**	—						
8. They do not smell	.22**	.02	.31**	.29**	.36**	.23**	.21**	—					
9. It feels like smoking a regular cigarette	.20**	.09**	.14**	.20**	.19**	.13**	.22**	.19**	—				
10. They are more acceptable to nontobacco users	.22**	.18**	.33**	.27**	.38**	.28**	.17**	.28**	.16**	—			
11. People who are important to me use them	.18**	.27**	.09**	.12**	.11**	.21**	.11**	.06**	.07**	.18**	—		
12. I like socializing while using one	.22**	.25**	.21**	.16**	.19**	.28**	.10**	.17**	.18**	.28**	.25**	—	
13. The advertising appeals to me	.17**	.38**	.11**	.16**	.14**	.21**	.11**	.10**	.15**	.19**	.26**	.26**	—

** $p < .01$.** Table 3.** Reasons for Electronic Cigarette (ECIG) Use Among Adult Current and Former Cigarette Smokers by ECIG Use Status at Wave 1 (2013–2014) of the Population Assessment of Tobacco and Health (PATH) Study

	Current ECIG users	Current experimental ECIG users	Past-year former ECIG users	<i>p</i> value
	(%, <i>n</i>)	(%, <i>n</i>)	(%, <i>n</i>)	
	(<i>n</i> = 354)	(<i>n</i> = 1494)	(<i>n</i> = 1196)	
Reasons for using ECIGs				
They are affordable	40.4 (143) ^a	44.8 (670) ^a	66.6 (797) ^b	<.001
People in the media or other public figures use them	10.7 (10.7) ^a	20.5 (307) ^b	17.2 (206) ^c	<.001
It can be used in places where smoking cigarettes is not allowed	62.1 (220) ^a	78.2 (1168) ^b	86.5 (1034) ^c	<.001
They might be less harmful to me than cigarettes	65.8 (233) ^a	76.2 (1138) ^b	89.4 (1069) ^c	<.001
They might be less harmful to people around me than cigarettes	65.0 (230) ^a	80.9 (1209) ^b	89.5 (1071) ^c	<.001
It comes in flavors I like	46.9 (166) ^a	62.3 (931) ^b	73.8 (883) ^c	<.001
Using them helps people quit smoking	53.1 (188) ^a	64.1 (957) ^b	80.4 (961) ^c	<.001
They don't smell	55.4 (196) ^a	71.3 (1065) ^b	81.9 (979) ^c	<.001
It feels like smoking a regular cigarette	34.7 (123) ^a	40.5 (605) ^b	59.4 (710) ^c	<.001
They are more acceptable to nontobacco users	50.0 (177) ^a	67.7 (1012) ^b	75.4 (902) ^c	<.001
People who are important to me use them	13.6 (48) ^a	19.5 (291) ^b	23.7 (284) ^c	<.001
I like socializing while using one	27.7 (98) ^a	33.2 (496) ^b	47.1 (563) ^c	<.001
The advertising appeals to me	14.1 (50) ^a	20.7 (310) ^b	21.5 (257) ^c	.008

p values for group comparison chi-square tests. Percentages represent rates of endorsing a reason for ECIG use within ECIG use status category. Different superscript letters within a single row represent significant differences in reason for ECIG use between ECIG use status categories. Current ECIG users reported currently using ECIGs “fairly regularly” and every day or some days. Current experimental ECIG users reported ECIGs every day or some days, but not “fairly regularly.” Past-year former ECIG users reported using ECIGs “fairly regularly” within the past year, but did not report currently using ECIGs. Bold text indicates significant differences between wave 1 current and former smokers.

endorsed reasons for ECIG use, followed by current experimental ECIG users, and past-year former ECIG users endorsed the highest percentage of each of the reasons for ECIG use (see [Table 3](#)).

Smoking Status Transitions

In general, the majority of participants maintained their same smoking status between wave 1 and wave 2 (see [Supplementary Figure 2](#)): 88.4% of wave 1 current smokers were wave 2 current smokers and 72.8% of wave 1 former smokers were wave 2 former smokers. However, a significantly greater percentage of wave 1 former smokers transitioned to current smokers at wave 2 compared

to wave 1 current smokers transitioning to former smokers at wave 2 ($p < .001$). Specifically, 27.2% of wave 1 former smokers ($n = 249$ of 916) were current smokers (ie, had relapsed) at wave 2, whereas 11.6% of wave 1 current smokers ($n = 246$ of 2128) were former smokers (ie, had quit) at wave 2.

Associations Between Reasons for ECIG Use and Smoking Status Changes Among Wave 1 Former Smokers

Unadjusted and adjusted associations between endorsed reasons for ECIG use at wave 1 and odds of changing smoking status at wave

2 are displayed in Table 4. Among former smokers, there were two reasons for ECIG use that were associated with decreased likelihood of relapse to smoking at wave 2. Wave 1 former smokers who endorsed using ECIGs because “It comes in flavors I like” and because “They don’t smell” had 0.57 (95% CI = 0.39–0.85) and 0.64 (95% CI = 0.42–0.97) times likelihood respectively of relapsing to smoking at wave 2 compared to wave 1 former smokers who did not endorse these reasons for ECIG use. Wave 1 former smokers who reported using ECIGs because “Using them helps people quit smoking” were more likely to relapse to smoking at wave 2 compared to wave 1 former smokers who did not endorse this reason for ECIG use (AOR = 1.55, 95% CI = 1.01–2.38).

Associations Between Reasons for ECIG Use and Smoking Status Changes Among Wave 1 Current Smokers

One reason for ECIG use (“It can be used in places where smoking cigarettes is not allowed.”) was associated with decreased likelihood of transitioning from being a current smoker at wave 1 to a former smoker at wave 2 (AOR = 0.56, 95% CI = 0.39–0.83). That is, wave 1 current smokers who reported using ECIGs because they could be used in places where smoking cigarettes were not allowed were about half as likely to have stopped cigarette smoking at wave 2 compared to current smokers who did not endorse this reason for using ECIGs at wave 1.

Discussion

This is the first study to examine longitudinal associations between reasons for ECIG use and subsequent smoking behaviors among former and current cigarette smokers. Some of the most common reasons to use ECIGs were “using ECIGs where smoking is not allowed,” “reducing harm to self and others,” “availability of flavors,” “lack of unpleasant smells,” and “increased acceptability among non-smokers.” Reasons endorsed also differed for former and current cigarette smokers. However, a key finding of this study is that

an endorsed reason for ECIG use itself could affect future smoking status for both current and former cigarette smokers. This analysis indicated that a greater percentage of former smokers who were current or former ECIG users relapsed to smoking after 1 year than the percentage of current smokers who were current or former ECIGs users that quit smoking after 1 year. Although future analyses may provide greater insight into how specific reasons may affect smoking status transitions, the current analysis suggests that reasons for using ECIGs may affect the likelihood of smoking status transition differentially.

Future analyses on reasons for ECIG use are needed, however, the findings of this study as well as others^{25,32} demonstrate the importance of examining many ECIG use factors beyond ECIG use prevalence (yes or no) with associations with future cigarette use. The findings of this study, if reproduced, could have important implications for development of regulatory policy. For instance, this study suggests that for some cigarette smokers, ECIGs may be used as a means to obtain nicotine in locations where cigarette smoking is not allowed. As a result, for these cigarette smokers ECIG use may represent a way to administer nicotine in locations where they otherwise would not be smoking. In this scenario, ECIGs would represent an approach to decrease barriers to nicotine use and less of a potential harm reduction strategy. Therefore, policies that prevent indoor ECIG use may prevent ECIG use among current smokers as well as limit secondhand ECIG aerosol exposure to nonusers. In addition, while using ECIGs because “[they] come in flavors I like” was not associated with transitioning from current to former smoking status, availability of desired flavors was associated with continued abstinence at wave 2 among former smokers. Although this is important because it may indicate that ECIG flavors may play a role in supporting smoking abstinence for some former smokers, there are potential risks that this may maintain ECIG use or dependence. Also there is a potential risk that flavors may entice tobacco-naïve youth to use ECIGs, especially as previous research has shown that flavors are a common reason for using ECIGs among youth and young adults.⁴⁶ Finally, an unexpected finding was that former

Table 4. Adjusted Odds of Changing Smoking Status From Wave 1 to Wave 2 Among Wave 1 Current and Former Smokers Who Were Current Experimental, Current, or Past-Year Former Electronic Cigarette (ECIG) users

Reason for wave 1 ECIG use	Wave 1 current smokers to wave 2 former smokers		Wave 1 former smokers to wave 2 current smokers	
	OR (CI)	AOR (CI)	OR (CI)	AOR (CI)
They are affordable	0.91 (0.66–1.25)	0.91 (0.65–1.26)	1.13 (0.81–1.57)	1.10 (0.75–1.64)
People in the media or other public figures use them	0.94 (0.64–1.38)	0.91 (0.60–1.39)	1.00 (0.65–1.55)	0.91 (0.53–1.55)
It can be used in places where smoking cigarettes is not allowed	0.57 (0.39–0.83)	0.56 (0.38–0.85)	1.01 (0.67–1.52)	0.90 (0.55–1.47)
They might be less harmful to me than cigarettes	1.19 (0.81–1.74)	1.16 (0.75–1.81)	0.86 (0.54–1.37)	0.84 (0.48–1.47)
They might be less harmful to people around me than cigarettes	1.19 (0.81–1.75)	1.14 (0.73–1.80)	0.86 (0.60–1.23)	0.79 (0.51–1.22)
It comes in flavors I like	1.08 (0.81–1.44)	1.02 (0.72–1.46)	0.64 (0.47–0.87)	0.57 (0.39–0.85)
Using them helps people quit smoking	1.07 (0.80–1.43)	1.02 (0.70–1.47)	1.41 (0.96–2.09)	1.55 (1.01–2.38)
They don’t smell	1.06 (0.78–1.45)	0.98 (0.70–1.37)	0.73 (0.50–1.06)	0.64 (0.42–0.97)
It feels like smoking a regular cigarette	0.84 (0.61–1.15)	0.88 (0.63–1.23)	1.07 (0.79–1.44)	1.00 (0.70–1.44)
They are more acceptable to nontobacco users	1.21 (0.89–1.64)	1.08 (0.78–1.50)	0.99 (0.68–1.44)	0.95 (0.61–1.48)
People who are important to me use them	1.27 (0.88–1.84)	1.13 (0.77–1.65)	0.78 (0.52–1.18)	0.67 (0.41–1.07)
I like socializing while using one	0.94 (0.69–1.28)	0.92 (0.67–1.26)	0.82 (0.62–1.09)	0.86 (0.61–1.22)
The advertising appeals to me	0.72 (0.49–1.06)	0.68 (0.44–1.05)	1.00 (0.71–1.42)	0.93 (0.61–1.41)

Adjusted odds ratio (AOR) predicting likelihood of change in wave 1 smoking status. AORs controlled for sex, age, race, education, income, age of smoking initiation, and wave 1 ECIG use status. For current smokers, AORs greater than 1 represent increased likelihood of being a former smoker at wave 2. For former smokers, AORs greater than 1 represent increased likelihood of being a current smoker at wave 2. Bold text indicates significant AOR ($p < 0.05$). No analyses survived Bonferroni adjustment for multiple comparisons ($p < .004$). CI = confidence interval; OR = odds ratio.

smokers who reported using ECIGs because they perceived using ECIGs help people quit smoking were more likely to relapse back to smoking than former smokers who did not endorse this reason for use. Perhaps this was driven by recent former smokers who were still at high risk for relapse, but endorsed this particular reason for ECIG use given their recent cessation attempt. This finding may have implications for physicians and cessation counselors. Specifically, if physicians or cessation counselors become aware that a cigarette smoker is interested in using ECIGs for smoking cessation, additional efforts should be made to promote the use of empirically supported smoking cessation aids such as combination nicotine replacement therapy, cessation counseling, and pharmaceutical medications such as varenicline. However, additional research is needed to understand this finding and future efforts that may improve tobacco reduction strategies.

This study had several limitations. Data for this study were collected between 2013 and 2015. The ECIG products available on the market at the time of wave 1 data collection differed considerably than those available on the market today, such as JUUL,⁴⁷ dripboxes, or “squonk mods” with products continuing to evolve.⁴⁸ As a result, reasons for using ECIGs may be different for newer ECIG products and may not have been assessed in the PATH Study in wave 1 or wave 2. This study examined only individual reasons rather than combinations of reasons. ECIG users may report multiple reasons for ECIG use and some reasons may be correlated highly. Future studies may find additional associations between smoking status transitions and combinations or groups of reasons for ECIG use. In addition, the available data from wave 1 of the PATH Study do not examine device characteristics known to affect nicotine delivery (eg, device power) so they could not be included as covariates in the model. Though previous research³¹ found that “customizable” devices were not associated with wave 2 smoking status, future studies should continue to explore the role of device characteristics in subsequent smoking behavior as ECIG devices continue to evolve. Although the nicotine delivery of participants’ ECIGs also may have affected smoking status transitions, because only current ECIG users (and not current experimental or past-year former ECIG users) were asked if their ECIG device contained nicotine, we were not able to control for this in our analyses. Future studies may also consider controlling for this device characteristic. In particular, studies that use longitudinal designs to examine additional ECIG user and device characteristics will be better able to comment on potential causal pathways related to ECIG use and other tobacco use behaviors. Because of the exploratory nature of this study and to prevent the likelihood of Type II error, a correction for family-wise error was not applied. However, using a Bonferroni correction for the 13 models per outcome (ie, $\alpha = .004$) would have rendered findings nonsignificant. Therefore, because of the potential implications of the findings of the study, future research should continue to investigate the extent to which reasons for ECIG use might be associated with cigarette smoking status transitions and other tobacco use behaviors. Finally, though this study highlights that reasons for using ECIGs among current and former adult cigarette smokers may be associated with subsequent cigarette smoking behaviors, there are certainly other important factors that influence smoking behaviors as well. For example, wave 1 of the PATH Study examines ECIG use by asking about ECIGs including common brands such as NJOY, Blu, or Smoking Everywhere. These products are typically classified as “cigalikes,” which a recent pooled analysis of eight studies reported that only approximately 15% of vapers report primarily using these types of devices whereas 77% primarily used “later-generation” devices.⁴⁹ These later-generation

devices used commonly among ECIG users typically operate at a higher power (in watts),⁵⁰ a device characteristic known to increase ECIG nicotine emissions⁵¹ but that may also expose ECIG users to more toxicants.⁵² However, the wave 1 PATH survey did not assess these specific ECIG device characteristics.

This study demonstrates that reasons for ECIG use are associated with changes in smoking status for both former and current smokers. Future studies should examine if ECIG users report different reasons for ECIG use depending on device type or device characteristics and if these reasons are associated with other tobacco use behaviors. Reasons to use ECIGs could vary over time and individuals may have multiple reasons to use ECIGs. Future research may also examine if specific reasons for ECIG use are associated with differences in ECIG users characteristics, such as demographics, quit attempts, or other tobacco use behaviors. Furthermore, changes in smoking status may have been associated with a constellation of reasons to use ECIGs, rather than a single reason. This may be a future area of research. As research continues to inform on the public health impact of the product class of ECIGs and regulatory policies are developed in response to these data, in-depth assessment of multiple factors associated with ECIG use will need to be considered. In particular, close attention should be given to why individuals report ECIG use in addition to if individuals report ECIG use.

Supplementary Material

Supplementary data are available at *Nicotine and Tobacco Research* online.

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Declaration of Interests

None declared.

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