Characteristics Associated With Awareness, Perceptions, and Use of Electronic Nicotine Delivery Systems Among Young US Midwestern Adults

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Objectives. We assessed the characteristics associated with the awareness, perceptions, and use of electronic nicotine delivery systems (e-cigarettes) among young adults.

Methods. We collected data in 2010–2011 from a cohort of 2624 US Midwestern adults aged 20 to 28 years. We assessed awareness and use of e-cigarettes, perceptions of them as a smoking cessation aid, and beliefs about their harmfulness and addictiveness relative to cigarettes and estimated their associations with demographic characteristics, smoking status, and peer smoking.

Results. Overall, 69.9% of respondents were aware of e-cigarettes, 7.0% had ever used e-cigarettes, and 1.2% had used e-cigarettes in the past 30 days. Men, current and former smokers, and participants who had at least 1 close friend who smoked were more likely to be aware of and to have used e-cigarettes. Among those who were aware of e-cigarettes, 44.5% agreed e-cigarettes can help people quit smoking, 52.8% agreed e-cigarettes are less harmful than cigarettes, and 26.3% agreed e-cigarettes are less addictive than cigarettes.

Conclusions. Health communication interventions to provide correct information about e-cigarettes and regulation of e-cigarette marketing may be effective in reducing young adults' experimentation with e-cigarettes. (*Am J Public Health.* 2013;103:556–561. doi:10.2105/AJPH.2012.300947)

Electronic nicotine delivery systems (commonly known as electronic cigarettes or e-cigarettes) are battery-operated vaporizing devices in the shape of a cigarette that deliver nicotine vapor to users. Although the product has been marketed as a safe alternative to cigarettes because it contains only nicotine and not the other harmful ingredients found in cigarettes,[1] the US Food and Drug Administration[2] showed that some tested samples of e-cigarettes also contained toxic substances such as tobacco-specific nitrosamines, and 1 contained diethylene glycol. Public health professionals are also concerned that e-cigarettes may impede the reduction in prevalence of smoking in the United States for 3 reasons.[1,3–5] First, the product may weaken the effect of clean indoor air policies on smokers because smokers can use e-cigarettes as bridging products indoors, which may lessen their motivation to quit smoking. Second, smokers may use e-cigarettes instead of proven-effective smoking cessation treatments when trying to quit smoking even though the e-cigarettes' effectiveness as quit aids is still largely unknown. Third, e-cigarettes may be gateways to cigarette smoking. Nonsmokers may experiment with e-cigarettes (especially when these products are flavored), develop nicotine addiction, and subsequently switch to smoking cigarettes.

Examining the awareness, perceptions, and use of e-cigarettes among young adults is important because they may still be in the stage of initiating tobacco use.[6] Furthermore, young adults are in general more likely to try new things.[7] They may therefore pay more attention to new products such as e-cigarettes and be more likely to try e-cigarettes. This hypothesis is partially supported by findings from a national survey of US adults in 2010 showing that young adults (aged 18–24 years) were most likely to have heard of e-cigarettes (41.0%, vs 32.2% among all adults).[8] Young adults also have a higher prevalence of tobacco use than any other age group, with 1 in 3 young adults smoking.[6] E-cigarettes may delay young adults from quitting smoking, making it even harder to reduce a nearly static trend in young adult tobacco use. However, little is known about the characteristics associated with awareness and use of e-cigarettes among young adults. Investigators of the previous national survey did not examine the characteristics of awareness and use of e-cigarettes specific to this age group.[8] Young adults' perceptions of e-cigarettes are largely unknown. We identified only 1 study that assessed the perceptions of e-cigarettes among an international sample of e-cigarette users recruited through the Internet,[9] which reported that 83.5% of users believed e-cigarettes are less toxic than tobacco and 76.8% used e-cigarettes to quit smoking or avoid relapse. However, the investigators did not report the prevalence of these perceptions specific to young adults and did not assess the characteristics associated with these perceptions.

In this study, we assessed the characteristics associated with awareness and use of e-cigarettes among young adults, using data from a population-based cohort study. We also assessed the characteristics associated with selected perceptions of e-cigarettes (potential to aid smoking cessation and harmfulness and addictiveness relative to cigarettes), as well as the associations between these perceptions and use of e-cigarettes.

METHODS

Data were from the Minnesota Adolescent Community Cohort, a population-based prospective cohort study designed to further the understanding of the transitional process from nonsmoking to smoking in adolescence and to assess the effect of state- and local-level tobacco prevention and control programs on

youths and young adults in Minnesota. The design of the study has been detailed elsewhere.[10] Briefly, participants were selected in 2000–2001 and 2001–2002 through cluster random sampling. Sixty geopolitical units in Minnesota (of 126) were randomly selected, and 5 geopolitical units from 4 comparison states (North and South Dakota, Michigan, and Kansas) were chosen because of their similarity to Minnesota. Clearwater Research, Inc., used modified random-digit dialing and a combination of probability and quota sampling methods to achieve an even distribution of youths from ages 12 to 16 years.

Of the eligible households, 3636 participants in Minnesota and 605 participants in the comparison states were recruited (recruitment rates of 58.5% and 58.3%, respectively). An additional cohort of 585 Minnesota 12-year-old youths from the 60 previously randomly selected geopolitical units was sampled and recruited using the same random-digit dialing method during 2001–2002 (a recruitment rate of 63.6%), resulting in an overall sample of 4826. Participants were surveyed every 6 months through 2007–2008 (except in 2003–2004 because of a gap in funding) and then annually between 2008 and 2011 by means of computer-assisted telephone interviews. In our analysis, we included the 2624 participants who completed survey round 21 (data collected between October 2010 and March 2011; response rate = 54.4% of the original cohort and 68.9% of those eligible for survey round 21). To investigate the sample's representativeness, we compared estimates of past-30-day cigarette use and e-cigarette use in our Minnesota sample with those from a population-based random sampling survey conducted in Minnesota in 2010.[11] The estimates from the 2 data sets were very comparable, which provides evidence that our sample was not severely biased. We included participants residing in and outside Minnesota in the analysis because they did not differ in prevalence of awareness and use of e-cigarettes ($P > .09$). Participants provided active consent before completing the interview, and monetary incentives ($25) were provided.

Measures

To assess the awareness and use of e-cigarettes, we first asked participants whether they were aware of "an e-cigarette or electronic cigarette, a cigarette-looking electronic device that delivers nicotine vapor when you puff it." We asked those who were aware of e-cigarettes whether they had ever used e-cigarettes and the number of days they had used e-cigarettes in the past 30 days (dichotomized into whether they had used e-cigarettes in the past 30 days, yes or no). We measured participants' perceptions of e-cigarettes and used the following items as both independent and outcome variables. Participants who were aware of e-cigarettes were asked to indicate their level of agreement (on 5-point Likert scales ranging from *strongly agree* to *strongly disagree*) with 3 statements: (1) e-cigarettes can help people quit smoking, (2) e-cigarettes are less harmful than cigarettes, and (3) e-cigarettes are less addictive than cigarettes. When used as independent variables, responses were collapsed to *agree* (including *strongly agree* and *agree*), *undecided,* and *disagree* (including *disagree* and *strongly disagree*). When used as outcome variables, these variables were further collapsed to *agree* or *other.*

We also measured other independent variables including age, gender, race/ethnicity, education, smoking status, and peer smoking. Race/ethnicity was measured as non-Hispanic White or other (Black, American Indian, Asian, Hispanic, and other races were collapsed because of the small number of participants in these categories). Participants who were currently enrolled in college were asked the type of college (2-year or 4-year) in which they were enrolled. Participants who were not enrolled in college were asked to indicate their highest level of education. We categorized participants into 3 education levels (completed high school or less, enrolled in or graduated from a 2-year college, and enrolled in or graduated from a 4-year college) on the basis of the responses to these 2 items. We assessed smoking status through 2 survey items: whether they had smoked 100 cigarettes or more in their lifetime (yes or no) and number of days on which they had smoked in the past 30 days. On the basis of responses to these items, we classified participants into 3 smoking statuses: (1) never established smokers (those who had not smoked ≥ 100 cigarettes), (2) former smokers (those who smoked ≥ 100 cigarettes but had not smoked in the past 30 days), and (3) current smokers (those who smoked ≥ 100 cigarettes and had smoked in the past 30 days). Participants were asked the number of close friends they had who smoked (dichotomized into none or at least 1).

Statistical Analysis

We first assessed the multivariate associations between awareness or use of e-cigarettes and the independent variables (demographic characteristics, smoking status, and peer smoking). Next, among those who were aware of e-cigarettes, we assessed the associations between each perception variable and ever having used e-cigarettes by means of multivariate regression models including demographic characteristics, smoking status, and peer smoking. Finally, we treated the perception variables as outcomes (agree or other) and assessed the associations between each perception and the independent variables (demographic characteristics, smoking status, peer smoking).

We used generalized linear models to estimate all the associations, accounting for the clustering by geopolitical units by including geopolitical unit as a random effect, and estimated odds ratios and 95% confidence intervals. We conducted all analyses with SAS version 9.2 (SAS Institute Inc., Cary, NC) using PROC GLIMMIX.[12]

RESULTS

Among all participants (n = 2624), 1835 (69.9%) were aware of e-cigarettes, 184 (7.0%) had ever used e-cigarettes, and 31 (1.2%) had used e-cigarettes in the past 30 days. Men, those who were enrolled in or graduated from college, those who were current or former smokers, and those who had at least 1 close friend who smoked had higher odds of awareness of e-cigarettes than those who did not attend college, were never established smokers, and whose friends did not smoke ($P < .05$; Table 1). Among those who were aware of e-cigarettes, being younger (aged 20–24 years), being male, being a current or former smoker, and having at least 1 close friend who smoked were associated with higher odds of ever having used e-cigarettes than being older (aged 25–28 years), never having been an established smoker, and having

TABLE 1—Characteristics Associated With Awareness and Ever Having Used Electronic Cigarettes Among Young Adults (Aged 20–28 Years): The Minnesota Adolescent Community Cohort Study, 2010–2011

Independent Variable	Awareness of Electronic Cigarettes (n = 2624)		Ever Used Electronic Cigarettes (n = 1835)	
	No. (%)	AOR (95% CI)	No. (%)	AOR (95% CI)
Age, y				
20–24	1197 (69.8)	1.04 (0.87, 1.25)	132 (11.0)	1.52* (1.06, 2.20)
25–28	638 (70.1)	1.00 (Ref)	52 (8.2)	1.00 (Ref)
Race/ethnicity				
Non-Hispanic White	1654 (70.5)	1.00 (Ref)	167 (10.1)	1.00 (Ref)
Other	181 (65.3)	0.79 (0.60, 1.04)	17 (9.4)	0.83 (0.47, 1.47)
Gender				
Male	925 (74.5)	1.47* (1.23, 1.75)	119 (12.9)	1.98* (1.40, 2.80)
Female	910 (65.8)	1.00 (Ref)	65 (7.1)	1.00 (Ref)
Education				
Enrolled in or graduated from a 4-y college or more	1053 (67.9)	1.35* (1.04, 1.76)	58 (5.5)	0.70 (0.45, 1.10)
Enrolled in or graduated from a 2-y college	484 (74.0)	1.39* (1.04, 1.85)	76 (15.7)	1.23 (0.80, 1.89)
High school graduate or less	291 (71.2)	1.00 (Ref)	50 (17.2)	1.00 (Ref)
Smoking status				
Current smoker	452 (85.0)	2.70* (2.03, 3.58)	129 (28.5)	10.07* (6.38, 15.89)
Former smoker	237 (74.5)	1.53* (1.16, 2.04)	23 (9.7)	3.51* (1.97, 6.27)
Never established smoker	1141 (34.5)	1.00 (Ref)	31 (2.7)	1.00 (Ref)
≥ 1 close friend smokes				
Yes	1057 (76.1)	1.44* (1.20, 1.74)	158 (15.0)	3.51* (1.97, 6.27)
No	778 (63.0)	1.00 (Ref)	26 (3.3)	1.00 (Ref)
Electronic cigarettes can help people quit				
Strongly agree or agree			119 (14.6)	2.05* (1.41, 2.98)
Undecided			13 (5.8)	0.67 (0.36, 1.36)
Disagree or strongly disagree			52 (6.5)	1.00 (Ref)
Electronic cigarettes are less harmful than cigarettes				
Strongly agree or agree			131 (13.5)	2.09* (1.37, 3.17)
Undecided			18 (6.5)	1.00 (0.53, 1.87)
Disagree or strongly disagree			35 (6.0)	1.00 (Ref)
Electronic cigarettes are less addictive than cigarettes				
Strongly agree or agree			73 (15.0)	1.42 (0.97, 2.06)
Undecided			31 (8.1)	0.83 (0.52, 1.33)
Disagree or strongly disagree			80 (8.3)	1.00 (Ref)

Note. AOR = adjusted odds ratio; CI = confidence interval. Estimates for sociodemographic variables and smoking status are adjusted for each other. Each perception of electronic cigarettes is adjusted for sociodemographic variables and smoking status. Analyses for ever used only include those who have heard of electronic cigarettes.
*$P < .05$.

friends who did not smoke ($P < .05$). Participants who agreed that e-cigarettes can help people quit smoking and those who agreed that e-cigarettes are less harmful than cigarettes had higher odds than those who disagreed of ever having used e-cigarettes ($P < .05$). Given the low prevalence of past-30-day e-cigarette use, we were unable to conduct a multivariate analysis between past-30-day e-cigarette use and the independent variables.

Among participants who were aware of e-cigarettes, 44.5% agreed that e-cigarettes can help people quit smoking, 52.9% agreed that e-cigarettes are less harmful than cigarettes, and 26.4% agreed that e-cigarettes are less addictive than cigarettes (Table 2). Participants who were non-Hispanic White, were enrolled in or graduated from a 2-year college, were current or former smokers, and had at least 1 close friend who smoked had higher odds of agreeing that e-cigarettes can help people quit smoking ($P < .05$) than participants who were other races/ethnicities, did not attend college, and were never established smokers and whose friends did not smoke. Participants who were non-Hispanic White, male, and current or former smokers also had higher odds of agreeing that e-cigarettes are less harmful than cigarettes ($P < .05$) than did participants who were other races/ethnicities, female, and never

TABLE 2—Characteristics Associated With Perceptions of Electronic Cigarettes Among Young Adults (Aged 20–28 Years): The Minnesota Adolescent Community Cohort Study, 2010–2011

Independent Variable	Agreed That They Can Help People Quit Smoking		Agreed That They Are Less Harmful Than Cigarettes		Agreed That They Are Less Addictive Than Cigarettes	
	No. (%)	AOR (95% CI)	No. (%)	AOR (95% CI)	No. (%)	AOR (95% CI)
Participants who were aware of e-cigarettes	816 (44.5)	. . .	971 (52.9)	. . .	486 (26.4)	. . .
Age, y						
20–24	517 (43.2)	0.87 (0.71, 1.06)	622 (52.0)	0.90 (0.74, 1.10)	311 (26.0)	0.96 (0.77, 1.20)
25–28	299 (46.9)	1.00 (Ref)	349 (54.7)	1.00 (Ref)	175 (27.4)	1.00 (Ref)
Race/ethnicity						
Non-Hispanic White	754 (45.6)	1.00 (Ref)	889 (53.8)	1.00 (Ref)	431 (26.1)	1.00 (Ref)
Other	62 (34.3)	0.60* (0.44, 0.84)	82 (45.3)	0.73* (0.53, 0.99)	55 (30.4)	1.24 (0.88, 1.75)
Gender						
Male	433 (46.8)	1.19 (0.99, 1.44)	529 (57.2)	1.39* (1.15, 1.67)	263 (28.4)	1.19 (0.96, 1.47)
Female	383 (42.1)	1.00 (Ref)	442 (48.6)	1.00 (Ref)	223 (24.5)	1.00 (Ref)
Education						
Enrolled in or graduated from a 4-y college or more	457 (43.4)	1.31 (0.99, 1.74)	561 (53.3)	1.30 (0.98, 1.72)	248 (23.6)	0.83 (0.61, 1.13)
Enrolled in or graduated from a 2-y college	235 (48.6)	1.47* (1.09, 1.98)	254 (52.5)	1.13 (0.84, 1.52)	141 (29.1)	0.93 (0.67, 1.28)
High school graduate or less	120 (41.2)	1.00 (Ref)	151 (51.9)	1.00 (Ref)	94 (32.3)	1.00 (Ref)
Smoking status						
Current smoker	233 (51.6)	1.35* (1.05, 1.73)	268 (59.3)	1.42* (1.11, 1.83)	153 (33.9)	1.51* (1.15, 1.99)
Former smoker	103 (43.5)	0.98 (0.73, 1.32)	127 (53.6)	1.13 (0.41, 1.51)	78 (32.9)	1.64* (1.19, 2.25)
Never established smoker	479 (42.0)	1.00 (Ref)	573 (50.2)	1.00 (Ref)	252 (22.1)	1.00 (Ref)
≥ 1 close friend smokes						
Yes	503 (47.6)	1.27* (1.03, 1.57)	585 (55.4)	1.18 (0.96, 1.46)	318 (30.1)	1.28* (1.00, 1.63)
No	313 (40.2)	1.00 (Ref)	386 (49.6)	1.00 (Ref)	168 (21.6)	1.00 (Ref)

Note. AOR = adjusted odds ratio; CI = confidence interval. Adjusted for all variables in the table. The sample size was n = 1835.
*$P < .05$.

established smokers. Being a current or former smoker and having at least 1 close friend who smoked were associated with higher odds of agreeing e-cigarettes are less addictive than cigarettes ($P < .05$) than never having been an established smoker and having friends who did not smoke.

DISCUSSION

Little is known about the awareness, perceptions, and use of e-cigarettes in young adults in the United States. We found, among a US regional sample of young adults participating in a population-based cohort study, that about 70% of the sample reported awareness of e-cigarettes, 7.0% reported ever having used e-cigarettes, and about 1% reported having used e-cigarettes in the past 30 days. To our knowledge, this study is the first of young adults' perceptions of e-cigarettes. Our results showed that about half of participants who were aware of e-cigarettes believed that e-cigarettes can help people quit smoking and are less harmful than cigarettes and about a quarter believed that e-cigarettes are less addictive than cigarettes.

The low prevalence of ever using e-cigarettes among this regional sample of young adults may be the result of the relatively high initial monetary investment in the product. According to a Google product search, a trial version of e-cigarettes (single-use, nonrechargeable) costs about $12, and a full e-cigarette starter kit (with charger and refills) ranges between $60 and $120. However, because some e-cigarette marketers have started giving out free samples,[13] more people (including nonsmokers) may try the products and subsequently start smoking e-cigarettes. Particularly concerning is that young people may obtain these free samples and start using e-cigarettes (particularly when some of these e-cigarettes are flavored) and subsequently develop nicotine addiction. Results from a statewide survey conducted in Utah demonstrated adolescents' interest in e-cigarettes. Investigators found that nearly 8% of 12th graders had experimented with e-cigarettes, and 3% had used e-cigarettes in the past 30 days.[14] Although the US Court of Appeals for the D.C. Circuit ruled that the US Food and Drug Administration could regulate e-cigarettes as tobacco products,[15] the Family Smoking Prevention and Tobacco Control Act of 2009 only prohibits giving out free cigarettes, but not e-cigarettes. Because the Institute of Medicine[16] has already included e-cigarettes as modified-risk tobacco products, updating the regulatory definition of tobacco products to include e-cigarettes is important to prohibit e-cigarette marketers from giving away free samples.

We found that current smokers in our sample (vs never established smokers) had higher odds of awareness and use of e-cigarettes, as supported by a previous study.[8] These findings provide some support for the argument that current smokers use e-cigarettes in addition to cigarettes (dual use), potentially as a bridging product when they are in places in which smoking is prohibited.[9] If this is true, it will weaken the positive effect of clean indoor air policies on encouraging smokers to quit smoking. We found that former smokers were also more likely to have used e-cigarettes. Given that a previous report showed that intention to quit smoking and past quit attempts were not associated with experimentation with e-cigarettes,[8] it is unlikely that these former smokers were cigarette smokers who completely switched to e-cigarettes. We speculate, rather, that e-cigarettes tempt former smokers to resume their smoking habit. Because our data did not allow us to test this hypothesis, future longitudinal analysis should examine the effect of e-cigarettes on former smokers.

We also observed that having close friends who smoke was associated with awareness and use of e-cigarettes, after adjusting for demographics and smoking status. Perhaps information about e-cigarettes is spread through interpersonal communication among friends, because communication scholars have suggested that interpersonal communication can amplify the effect of media campaigns,[17] such as e-cigarette advertisements on the Internet and social networking sites.[4] Additionally, the fairly high cost of e-cigarettes may prompt young adults (regardless of their smoking status) to share e-cigarettes, particularly if they just want to try the product. Regan et al.,[8] using an adult sample (aged ≥ 18 years), found that women in general were more likely than men to have ever used e-cigarettes. We found that among young adults, men were more likely than women to have ever used e-cigarettes. Perhaps the characteristics associated with use of e-cigarettes differ by age. This hypothesis should be tested in the future to better understand the pattern of e-cigarette use in the adult population.

Regarding characteristics associated with perceptions of e-cigarettes, racial/ethnic minority group participants had lower odds of agreeing that e-cigarettes can help people quit smoking and that e-cigarettes are less harmful than cigarettes. Reasons for this finding are largely unknown. Perhaps young adult racial/ethnic minorities are less likely than non-Hispanic Whites to be exposed to e-cigarette marketing, which promotes these products as a safe alternative to cigarettes.[1] By contrast, participants who were smokers and those with at least 1 friend who smoked had higher odds of agreeing that e-cigarettes can help people quit smoking and that e-cigarettes are less addictive than cigarettes. Because of the limited data on the perceptions of e-cigarettes, we can only speculate that smokers in general pay more attention to new tobacco products (as support by our data on awareness of e-cigarettes) and their associated marketing strategies. Subsequently, the misinformation about e-cigarettes conveyed in marketing strategies are spread through social interactions between smokers and between smokers and nonsmokers.

More importantly, positive perceptions of e-cigarettes were associated with ever having used e-cigarettes. Although previous studies reported that some e-cigarette users use the product to quit smoking or prevent relapse,[9] no evidence has supported the use of e-cigarettes to treat nicotine addiction. A recent study in Italy assigned 40 smokers to use e-cigarettes and found that 32.5% reduced cigarette consumption more than 50% and 22.5% completely stopped smoking cigarettes by week 24.[18] However, most of these smokers used 2 to 3 cartridges of e-cigarette refills per day during the study period. Given that 1 cartridge usually contains the amount of nicotine equivalent to 15 to 20 cigarettes, participants in that study who cut back their cigarette consumption still consumed a significant amount of nicotine. Furthermore, the content of e-cigarettes is not regulated, and they are known to include toxic substances, as shown in the FDA analysis.[2] Strategic health communication campaigns to confront these misperceptions, particularly targeting those who are more likely to endorse these perceptions (e.g., smokers and non-Hispanic Whites) may prevent young adults from trying e-cigarettes or using e-cigarettes to displace proven-effective cessation treatments as quit aids.

Because of the study's cross-sectional design, we were not able to distinguish whether the selected perceptions of e-cigarettes are antecedents or consequences of e-cigarette use. Future longitudinal analysis is needed to disentangle the association and provide better evidence for causal inference. Our regional sample also limits the generalizability of the findings to all young adults in the United States. Because we relied on self-report for all of the measures, participants may have underreported their perceptions and use of e-cigarettes, which would make our estimates of the prevalence and characteristics associated with perceptions and use of e-cigarettes more conservative.

In conclusion, more than two thirds of young adults in our sample were aware of e-cigarettes, but a relatively small proportion had tried and used e-cigarettes in the past 30 days. Considerable proportions of young adults perceived that e-cigarettes can help people quit smoking and are less harmful and less addictive than cigarettes, despite the lack of scientific evidence related to e-cigarettes. These perceptions are also associated with ever having used e-cigarettes. Strategic health communication interventions to communicate to the public that evidence to support these perceptions is lacking and strengthening tobacco control regulations to include e-cigarettes could potentially reduce the prevalence of e-cigarette use among young adults. ■

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Contributors

K. Choi and J. Forster conceptualized and designed the study, collected the data, conducted the analyses, and wrote the article.

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Human Participant Protection

This study was approved by the University of Minnesota institutional review board. Participants provided written informed consent before taking part in the study.

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