



Who is using and why: Prevalence and perceptions of using and not using electronic cigarettes in a statewide survey of adults



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ARTICLE INFO

Keywords:

Electronic cigarettes
Reasons to use
Latent class analysis
Prevalence

ABSTRACT

A statewide survey examined prevalence, reasons for using, discontinuing use, and not wanting to try e-cigarettes.

Methods: Participants (n = 6052) were adult Minnesota residents. E-cigarette initiation and current use prevalence rates were calculated for demographic characteristics and smoking status. The percent of respondents endorsing a reason for trying e-cigarettes are reported overall and by smoking status. The percent of respondents endorsing each reason for discontinuing or not using e-cigarettes are reported for daily and occasional smokers. All descriptive analyses were weighted. To develop profiles of e-cigarette users, a latent class analysis (LCA) was undertaken.

Results: Overall, 20.7% of adults reported ever use and 4.6% were current users. Use varied notably by age and smoking status. Only 2.8% of never smokers were current e-cigarette users. Among young adults, 14.6% reported current use but most (70.0%) were never smokers. The reasons given for using e-cigarettes varied by smoking status. Curiosity was the top reason for all groups except recent former smokers, for whom cutting down or quitting other tobacco products was primary. Most smokers discontinuing e-cigarettes preferred cigarettes, and four-fifths of smokers who never tried e-cigarettes lacked interest. From the LCA four profiles were evident: young adult experimenters, curious adults, smokers trying to quit cigarettes, and dual users.

Conclusions: Innovative higher nicotine content devices have sustained interest in e-cigarettes especially among young adults and smokers with a goal of cutting down or quitting smoking. Future regulations and communication should focus on reducing e-cigarette use among young adult nonsmokers.

Electronic cigarettes (e-cigarettes) are an expanding class of nicotine delivery products that use battery power to heat and deliver an inhaled aerosol of nicotine, flavors, and other additives. These products have gained considerable media attention following reports of increased use, especially among young people. In 2018, 21% of U.S. high school students reported recent use of e-cigarettes, a 78% increase from the previous year (Cullen et al., 2018). Alarmed by this dramatic increase, several health and medical groups sued the US Food & Drug Administration (FDA) for delaying the timeline for agency review of e-cigarettes (Wheeler, 2018). On May 15, 2019 a Federal court ruled against the FDA and said they could no longer delay and had to start accepting applications for e-cigarette product premarket review (Perrone, 2019), and a month later the agency issued its final guidance for e-cigarette makers to submit premarket applications (U.S. Food and Drug Administration, 2019a).

In response to the rapid rise in youth e-cigarette use the FDA

launched “The Real Cost” media-based education campaign targeted at adolescents (U.S. Food and Drug Administration, 2019b). In addition the agency has taken enforcement actions against retailers found to be selling to underage youth (U.S. Food and Drug Administration, 2019c). States and local municipalities have also taken steps to address e-cigarettes, most notably a complete ban on sales in San Francisco (Sabatini, 2019). Other efforts have included requiring a retail license to sell, enacting tax policies, and banning use in public spaces (American Nonsmokers Rights Foundation, 2019).

Understanding the profiles of who is using e-cigarettes and their motivations can help inform future public policies. These policies should be designed to selectively discourage nonsmokers from starting without unnecessarily restricting smokers from using e-cigarettes to quit smoking (Fairchild, Bayer, & Lee, 2019). Studies of e-cigarette use frequently investigate what interests and motivates smokers to use them (Amato, Boyle, & Levy, 2016; Bauhoff, Montero, & Scharf, 2017;

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<https://doi.org/10.1016/j.abrep.2019.100227>

Received 26 July 2019; Received in revised form 26 September 2019; Accepted 5 October 2019

Available online 17 October 2019

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Li, Newcombe, & Walton, 2015; Patel et al., 2016; Pepper, Ribisl, Emery, & Brewer, 2014; Schmidt, Reidmohr, Harwell, & Helgerson, 2014). However, any benefit from e-cigarettes will be realized only if smokers entirely quit smoking, but often e-cigarette use is supplemental rather than a replacement for cigarettes (Simonavicius, McNeill, Arnott, & Brose, 2017). Understanding what motivates smokers to try and consistently use e-cigarettes as a substitute for smoking is important. In an assessment of smokers' reasons to use e-cigarettes, Pepper and colleagues (Pepper et al., 2014) found committed users were more likely to hold goal-oriented reasons such as quitting smoking, and were thus less likely to abandon use in contrast to curious experimenters. Similarly, increased days using e-cigarettes was associated with goal-oriented reasons in a previous study of Minnesota adults (Amato et al., 2016).

The current study provides further insight into the time period after the introduction of the higher nicotine prefilled 'pod' devices, and it provides perspectives from a representative sample of Minnesota adults. The goals of this paper were to: (1) present the prevalence of ever and current use of e-cigarettes in 2018, (2) report the reasons for trying e-cigarettes and to explore why some smokers report not wanting to try e-cigarettes, (3) classify e-cigarette ever users from latent class analysis into representative profiles.

1. Methods

Using a statewide tobacco use survey, we had an opportunity to ask adult Minnesota residents about their use and perceptions of e-cigarettes. Data were collected as part of the 2018 Minnesota Adult Tobacco Survey (MATS). MATS has been conducted as a series of repeated cross-sectional telephone surveys to collect general health and tobacco-related information from a random sample of Minnesota adults aged 18 and older. The survey was conducted between February and July 2018 using a random digit dialing (RDD) sampling method for landlines and cellular telephones and the final analytic sample ($N = 6052$) was weighted to represent the entire civilian, non-institutionalized adult population in Minnesota. The RDD response rates, which reflect the net response across both the household screener and the questionnaire, were 17.5% for the landline sample and 13.4% for the cell phone sample. MATS was conducted in collaboration with the Minnesota Department of Health (MDH), and the survey instrument and methods were reviewed and approved by the MDH Institutional Review Board (IRB). More methodological detail is available at <http://www.clearwaymn.org/MATS>.

1.1. Measures

Current smokers were defined as those who had smoked at least 100 cigarettes and reported smoking every day ('daily') or some days ('occasional') at the time of survey. Former smokers were defined as those who have smoked at least 100 cigarettes and reported smoking not at all. In addition, former smokers were asked how long since they had stopped smoking. We classified 'recent' as within the past 5 years, and 'long-term' as 5 or more years, or unknown (unspecified). Anyone who had smoked 0 to 99 cigarettes were classified as never smokers, while 'former casual smokers' had smoked 100 cigarettes but had never smoked regularly and currently did not smoke. Demographic factors included age, race, sex, household income, and highest completed level of education.

All MATS respondents were read a preamble: "The next questions are about electronic cigarettes or vaping devices, often called e-cigarettes. These products are battery powered and produce a vapor instead of smoke", and were then asked if they had "ever used an electronic cigarette or vaping device even just one time." Then from a second question, current e-cigarette use was using them every day or some days.

All respondents who reported ever using e-cigarettes were read a randomized list of 10 common reasons people use e-cigarettes including

an 'other reason' option, and then asked for each reason whether or not it was a reason they have used or use an e-cigarette. The list of reasons was generated from a review of previously published papers on the topic (Pepper et al., 2014; Zhu et al., 2013). Current smokers who reported never trying an e-cigarette were asked why they had not tried an e-cigarette or vaping device. The randomized list of 7 reasons were generated from a similar review of other papers (Bauhoff et al., 2017). Finally, current smokers with no recent use of e-cigarettes were presented a randomized list of 12 reasons for no longer using e-cigarettes and asked to indicate which reasons applied to them.

1.2. Statistical analysis

Prevalence of trying e-cigarettes and current use of e-cigarettes were calculated for each demographic characteristic and smoking status. The percent of respondents endorsing each reason for trying e-cigarettes is reported overall and by smoking status. The percent of respondents endorsing each reason for discontinuing or never trying e-cigarettes is reported for daily and occasional smokers. Corresponding 95% confidence intervals were calculated and chi-square tests were conducted to compare groups; all descriptive analyses used survey weights.

To classify profiles of e-cigarette ever users, a latent class analysis (LCA) was undertaken. Variables in the LCA included e-cigarette current use, smoking status, and the reasons for e-cigarette use described above. The questions about using e-cigarettes to quit or cut down were highly correlated ($\rho = 0.79$), and were combined into one goal-oriented reason to reduce tobacco use based on previous research (Amato et al., 2016; Pepper et al., 2014). Reasons that were endorsed by fewer than 10% of respondents were excluded (i.e. using for menthol flavor). Models with two to eight classes were assessed. Model fit criteria including AIC, BIC, adjusted BIC, and G-squared were examined as well as class membership probabilities and contextual interpretation of item response probabilities in determining the best model. After considering a full model with all reasons for use, reasons that were correlated with other reasons and not providing any additional discrimination in the classes were removed (e.g. affordability, using e-cigarettes in places where other tobacco is not allowed, and thinking that e-cigarettes are less harmful).

Statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC). Descriptive analyses were conducted using PROC SURVEYFREQ; and the latent class analysis using PROC LCA (PROC LCA & PROC LTA, 2015). Results for subgroups that included unweighted sample sizes of less than ten were not reported.

2. Results

The prevalence of ever and current (every day or some days) e-cigarette use among Minnesota adults is presented in Table 1. Overall, 20.7% of adults reported ever using e-cigarettes and 4.6% were current users. Of current users, 44.7% were using every day and 55.3% some days. Ever use and current use varied most notably by age. Very few retirement-aged adults (65+) reported ever trying e-cigarettes (3.7%) and even fewer were current users (0.3%). In contrast, 44.6% of young adults had tried e-cigarettes and many were current users (14.6%). There was an inverse gradient of e-cigarette use with income and education. College educated adults and those with higher household incomes were less likely to try or currently use e-cigarettes.

As expected, current smokers had the highest rates of ever use, with 63.4% of daily smokers reporting they had tried e-cigarettes. Among former smokers, ever use was more likely among those who quit smoking in the last 5 years compared to longer-term former smokers (5+ years) (55.1% vs 11.1%, $p < 0.0001$). About 11.1% of never smokers had tried an e-cigarette. The highest prevalence of current use (16.4%) was among occasional smokers. Low rates of use were observed among longer-term former smokers (1.7%) and never smokers (2.8%). Among all current e-cigarette users, 63.3% were current

Table 1
E-cigarette prevalence by selected demographics and smoking status.

	Total N (column %)	Ever use of e-cigarettes %	Current use of e-cigarettes %	Ratio current to ever use
Overall	6052 (100.0)	20.7 (19.3, 22.1)	4.6 (3.8, 5.4)	0.22
Age				
18–24 years old	438 (7.2)	44.6 (39.1, 50.1)	14.6 (10.8, 18.5)	0.33
25–44 years	1397 (23.1)	28.8 (26.0, 31.6)	5.7 (4.2, 7.3)	0.20
45–64 years	2096 (34.6)	14.1 (12.0, 16.1)	2.4 (1.5, 3.3)	0.17
65+ years	2121 (35.0)	3.7 (2.6, 4.8)	–	
Gender				
Male	2785 (46.0)	23.8 (21.7, 25.9)	6.1 (4.8, 7.4)	0.26
Female	3267 (54.0)	17.7 (15.8, 19.6)	3.1 (2.2, 4.0)	0.18
Race/ethnicity				
White	4999 (83.7)	20.1 (18.6, 21.7)	4.7 (3.8, 5.6)	0.23
Hispanic	289 (4.8)	30.0 (21.8, 38.2)	6.5 (1.9, 11.2)	0.22
Black	257 (4.3)	19.7 (13.4, 26.1)	–	
Other/multi	234 (3.9)	34.4 (24.5, 44.3)	3.7 (1.4, 5.9)	0.11
Asian	162 (2.7)	14.2 (7.8, 20.7)	–	
Amer. Indian	35 (0.6)	–	–	
Education				
Less than high school	203 (3.4)	35.4 (27.1, 43.7)	9.7 (4.2, 15.1)	0.27
High school graduate/GED	1291 (21.5)	21.6 (18.9, 24.4)	5.5 (4.0, 6.9)	0.25
Some college or technical school	1955 (32.5)	26.0 (23.4, 28.6)	5.4 (4.0, 6.9)	0.21
College graduate or beyond	2566 (42.7)	10.9 (9.4, 12.4)	1.6 (1.0, 2.3)	0.15
Income				
\$35,000 or less	1269 (24.0)	26.5 (23.0, 30.0)	6.8 (4.9, 8.8)	0.26
\$35,001–\$50,000	649 (12.3)	23.7 (19.1, 28.4)	5.1 (2.5, 7.8)	0.22
\$50,001–\$75,000	951 (18.0)	20.4 (16.9, 24.0)	3.9 (2.2, 5.7)	0.19
\$75,001 or more	2410 (45.7)	17.7 (15.7, 19.8)	3.1 (2.1, 4.1)	0.18
Smoking Status				
Daily smoker	492 (8.2)	63.4 (57.8, 68.9)	12.5 (8.7, 16.3)	0.20
Occasional smoker	156 (2.6)	57.4 (47.6, 67.3)	16.4 (8.4, 24.4)	0.29
Recent former smoker (< 5 yrs)	288 (4.8)	55.1 (47.9, 62.2)	10.4 (6.4, 14.3)	0.19
Long-time former smoker (5+ yrs)	1332 (22.2)	11.1 (8.5, 13.7)	1.7 (0.4, 2.9)	0.15
Former casual smokers	172 (2.9)	17.0 (8.8, 25.2)	–	
Never smoker	3555 (59.3)	11.1 (9.6, 12.5)	2.8 (2.0, 3.6)	0.25

Source: Minnesota Adult Tobacco Survey, 2018.

Weighted percent; 95% CI

Current use of e-cigarettes defined as using some days or every day.

Unweighted sample sizes of less than 10 were not reported.

smokers or former smokers, and 36.7% were never smokers. The percentage of e-cigarette users who were never smokers varied dramatically by age group: 70.0% of current e-cigarette using young adults (18–24 years) had never smoked cigarettes compared to 15.9% of 24–44 year olds, 19.1% of 45–64 year olds, and 7.4% of those aged 64+.

Respondents reporting ever use of e-cigarettes were asked about reasons they use or had used. Overall, 19.1% reported a single reason for trying e-cigarettes, 15.9% reported 2 reasons, and 65.0% reported more than 2 reasons. As presented in Table 2, the reasons for using e-cigarettes varied by current smoking status. The most consistent top reason for using was curiosity, and the next 3 most popular reasons were related to smoking: to quit tobacco, to cut down, and to reduce harm. These reasons in particular were endorsed by recent former smokers, with 72.1% reporting having used e-cigarettes to quit tobacco products, and notably fewer endorsing curiosity as a reason they used e-cigarettes (57.8%). The next group of reasons to use e-cigarettes had much lower endorsement across all groups (20.0–38.8%): flavors, use in places tobacco is banned, and because they are affordable. The exception was flavors which had the highest rate of endorsement among never smokers (42.0%). Using e-cigarettes because of menthol flavor was least likely to be endorsed across all groups.

The reasons smokers stopped using e-cigarettes are reported in Table 3. Both daily and occasional smokers endorsed a similar pattern for discontinuing. The top 3 reasons were related to cigarettes – they prefer cigarettes (67.3%), e-cigarettes were not as satisfying (50.5%), and did not help them quit smoking (34.8%). The next top reason was

health concerns with using e-cigarettes (27.8%). Other reasons for stopping included disliking the taste (25.4%) and concerns with device safety (21.4%).

In general, daily and occasional smokers endorsed similar reasons for never trying e-cigarettes (Table 3). The top reason was a lack of interest in the products (80.7%), followed by health concerns from using them (24.7%). Other reasons included the expense, perceived difficulty of use, and safety risk. From analyses of demographic differences in never trying e-cigarettes, women were significantly more likely than men to endorse health concerns (34.7% vs 15.8%, $p = 0.0075$). Disapproval from friends or family was rarely endorsed (3.5%). The open-ended ‘Other’ responses were tabulated and the most common reasons reported were lack of trust in the product and lack of knowledge.

2.1. E-cigarette user profiles

The final latent class model included four latent classes and was chosen based on its contextual interpretation and similar fit to models with five latent classes (AIC = 215.68; BIC = 364.90; adjusted BIC = 266.44; $G^2 = 153.68$). In addition, the likelihood of belonging to each class was examined and each respondent was assigned to the class with the highest likelihood. Descriptions of the respondents in each class based on age, sex, education level, and years since quitting smoking are presented in Table 4 along with the item-response probabilities. The largest class (class 2; 35.2%) included current smokers who tried e-cigarettes to quit or cut down, with very few young adults

Table 2
Reasons for using e-cigarettes among those who have tried them by smoking status.

	Overall	Daily Smoker	Occasional Smoker	Recent Former Smoker	Long-term Former Smoker	Never Smoker
N	902	294	82	144	96	264
Because you were curious about e-cigarettes	70.1 (66.4, 73.9)	69.2 (62.8, 75.6)	77.1 (65.1, 89.1)	57.8 (48.1, 67.5)	69.4 (57.1, 81.7)	75.0 (68.7, 81.3)
Because they might be less harmful than other tobacco products	47.8 (43.8, 52.0)	47.7 (40.7, 54.8)	58.1 (44.6, 71.7)	66.4 (57.3, 75.5)	36.7 (24.0, 49.5)	39.6 (32.5, 46.8)
To cut down on other tobacco products	45.8 (41.8, 49.8)	64.8 (58.0, 71.5)	66.5 (53.4, 79.7)	78.0 (70.2, 85.7)	30.0 (17.8, 42.1)	10.7 (6.0, 15.3)
To quit other tobacco products	43.0 (39.0, 47.0)	63.7 (57.0, 70.5)	63.0 (49.8, 76.2)	72.1 (63.4, 80.9)	27.9 (16.1, 39.8)	7.6 (3.7, 11.6)
Because you enjoyed them	41.1 (37.1, 45.1)	29.4 (22.9, 35.9)	40.2 (26.6, 53.9)	51.1 (41.3, 60.9)	41.4 (28.7, 54.1)	48.2 (41.0, 55.4)
Because they come in flavors other than menthol	37.0 (33.1, 41.0)	33.2 (26.4, 40.1)	38.2 (24.8, 51.4)	38.8 (29.3, 48.4)	28.6 (16.8, 40.4)	42.0 (34.9, 49.2)
Use them in places other tobacco products are not allowed	28.5 (24.8, 32.1)	31.4 (24.8, 38.0)	35.8 (22.8, 48.8)	35.2 (25.9, 44.5)	26.4 (14.8, 38.0)	20.9 (14.8, 27.0)
Because they are affordable	23.0 (19.5, 26.5)	23.5 (17.6, 29.3)	38.0 (24.2, 51.7)	28.7 (20.0, 37.4)	-	20.0 (13.7, 26.2)
Because they come in menthol flavor	8.6 (6.2, 10.9)	8.7 (4.7, 12.6)	-	12.5 (5.7, 19.4)	-	7.0 (3.0, 11.0)

Source: Minnesota Adult Tobacco Survey, 2018.

Weighted percent; 95% CI; Unweighted sample sizes less than 10 are not reported.

Occasional smoker use on some days; Former smokers quit in the last 5 years (recent) or more than 5 years (long-term).

Reasons for using were asked in random order.

(only 7.7%). Also in this class were some recent former smokers. Overall, class 2 members were not interested in flavors and were less likely to be currently using e-cigarettes. The next largest class (class 4; 30.3%) were smokers, former smokers (> 5 years), and never smokers who were curious and tried e-cigarettes, but were not current users. The third class (20.6%) is best described as concurrent users of both cigarettes and e-cigarettes; who enjoy them and have a preference for flavors. The smallest class (class 1; 14.0%) is best described as never smokers who were curious and interested in flavors and many are current users. This class had the largest percent of young adults (63.7%). In general, sex and education level were evenly distributed across each class.

3. Discussion

There were three important findings from this research. First, although smokers were the largest group of e-cigarette users, the proportion of nonsmokers that reported vaping was surprisingly large (36.7%). Although on a population level, nonsmokers who are current e-cigarette users is small, the proportion in this study was much higher than other surveys when most current users were cigarette smokers (Coleman et al., 2017; Delnevo et al., 2016; Patel et al., 2016). Second, more than a decade after their introduction e-cigarettes continue to generate curiosity among smokers and nonsmokers. This is likely because of newer products that deliver higher nicotine levels and are widely popular on social media platforms (Huang et al., 2019). Third, despite the media attention on possible risks, smokers using e-cigarettes to quit or reduce smoking represents the largest group of users (35.2%), and young adult experimenters the smallest group of users (14.0%).

Similar to other states, Minnesota was not immune to the rapid popularity of high-nicotine content, prefilled pod devices, beginning with JUUL. The prevalence of Minnesota adults who reported trying vaping increased 3 percentage points (17.7 vs 20.7) from 2014 to 2018 (Amato et al., 2016). This increase in experimentation is perhaps not surprising considering the amount of news and social media coverage that e-cigarettes have generated (Czaplicki et al., 2019), coinciding with a rapid rise in sales in the past several years, particularly in Minnesota (Wang et al., 2018).

The e-cigarette public policy challenge is how to find a balance between reducing the harm of tobacco for smokers (to quit or cut down) and preventing the risk of nicotine exposure among never smokers. Proposed policy options to reduce use among young people include retail sales restrictions (increasing the age of sale to 21) and increasing the price. Based on current research, increasing the minimum sale age of tobacco products to 21 is expected to reduce adolescent smoking and vaping (Abouk & Adams, 2017; Meernik, Baker, Lee, & Goldstein, 2017). However, the relationship between higher tobacco taxes and use of e-cigarettes is less clear. For example, some have found higher cigarette taxes lead to increased sales of e-cigarettes (as a substitution product) (Stoklosa, Drope, & Chaloupka, 2016), whereas others have not found a similar relationship (Huang, Tauras, & Chaloupka, 2014), or have found higher cigarette taxes reduce e-cigarette purchases (Cotti, Nesson, & Tefft, 2018). Overall, studies have found increased taxes on e-cigarettes reduce sales of e-cigarettes (Amato & Boyle, 2016; Huang et al., 2014; Stoklosa et al., 2016).

Curiosity as a common reason to use has been reported by others (Amato et al., 2016; Li et al., 2015; Pepper et al., 2014; Schmidt et al., 2014), but the current, sustained interest in e-cigarettes likely reflects the industry's continuing innovation and successful use of social media platforms and other marketing (Huang et al., 2019). In addition to the novelty factor (curiosity) as a reason never smokers tried e-cigarettes, flavors, enjoyment, and lower perceived harm were common reasons. The endorsement of flavors has been reported previously (Coleman et al., 2017; Patel et al., 2016), and flavors are consistently considered a risk factor for youth initiation (U.S. Department of Health and Human Services, 2016). Future public policy analysis should examine the

Table 3
Reasons for not using e-cigarettes reported by daily and occasional smokers.

	Overall	Daily Smoker	Occasional Smoker
Reasons for discontinuing e-cigarette			
N	274	221	53
Prefer cigarettes	67.3 (60.2, 74.3)	70.8 (63.3, 78.3)	53.7 (36.4, 71.0)
Not as satisfying as cigarettes	50.5 (43.1, 57.9)	52.6 (44.4, 60.7)	42.7 (26.0, 59.5)
Didn't help quitting smoking cigarettes	34.8 (27.7, 41.9)	34.4 (26.5, 42.3)	36.2 (19.8, 52.6)
Health concerns	27.8 (21.3, 34.4)	28.9 (21.6, 36.2)	23.7 (9.6, 37.8)
Didn't like the taste	25.4 (19.2, 31.7)	27.6 (20.3, 34.9)	17.0 (6.4, 27.6)
Too much trouble to use	25.0 (18.8, 31.3)	27.8 (20.4, 35.1)	14.4 (4.7, 24.2)
Too harsh	22.7 (16.5, 28.9)	26.0 (18.8, 33.2)	–
Might leak, catch fire, or explode	21.4 (15.4, 27.4)	22.8 (16.0, 29.7)	15.9 (3.8, 28.1)
Too expensive	18.7 (12.7, 24.7)	18.3 (11.7, 24.8)	20.2 (6.0, 34.4)
Didn't like the way they made me feel	12.3 (7.1, 17.4)	14.2 (8.0, 20.3)	–
Family or friends did not approve	6.3 (2.7, 10.0)	5.6 (1.7, 9.5)	–
Other	12.6 (7.5, 17.7)	10.0 (5.0, 15.0)	22.8 (7.9, 37.8)
Reasons for never trying an e-cigarette			
N	268	195	73
Just not interested	80.7 (74.1, 87.3)	77.1 (68.6, 85.7)	90.0 (83.3, 96.7)
Health concerns about using them	24.7 (17.4, 31.9)	26.9 (17.9, 35.9)	19.0 (7.9, 30.0)
Might leak, catch fire, or explode	16.9 (10.5, 23.3)	19.2 (11.2, 27.2)	10.9 (1.8, 20.1)
Too much trouble to use	16.5 (9.8, 23.2)	19.1 (10.4, 27.8)	9.8 (2.8, 16.7)
Too expensive	14.5 (8.9, 20.0)	14.9 (8.1, 21.7)	13.3 (3.6, 23.0)
Other	12.1 (7.2, 17.1)	13.0 (6.8, 19.1)	–

Source: Minnesota Adult Tobacco Survey, 2018.

Weighted percent; 95% CI; Unweighted sample sizes less than 10 are not reported. Reasons were asked in random order.

planned FDA restriction of sweet-flavored products on the uptake of e-cigarettes.

A unique finding from this study was the four profiles of e-cigarette users identified in the latent class analysis. These profiles revealed the complicated influence of age, smoking status, flavors, and quitting smoking motivations for e-cigarette use. The two largest classes were smokers who were trying to quit or cut back on smoking, and smokers and nonsmokers who were curious and tried them but are not currently using. In addition, there was a substantial group using both cigarettes and e-cigarettes concurrently. In a recent paper, [Borland et al. \(2019\)](#) identified a typology of 8 groups who were vaping and/or smoking. They had a large enough sample across multiple countries to discern exclusive and concurrent, daily and nondaily vaping and smoking.

Very few studies have examined why smokers have not tried e-cigarettes ([Bauhoff et al., 2017](#); [McKeganey & Dickson, 2017](#)), and reasons have included seeing them as quitting devices, safety concerns, and disinterest. Among smokers in the current study, there was an apparent dichotomy of beliefs with disinterest on one side and concerns with the product on the other. Some of these concerns are reflected in social media discussions of e-cigarette battery malfunctions that have been increasing over time ([Trigger & Coleman, 2019](#)). Similarly, concerns with e-cigarettes as harmful have increased between 2012 and 2017 ([Huang et al., 2019](#)).

The perceived benefits of quitting or cutting down on cigarettes were the top reasons cited by smokers and recent quitters. This has been found consistently in other population-based studies ([Coleman et al., 2017](#); [Dockrell, Morrison, Bauld, & McNeill, 2013](#); [Patel et al., 2016](#); [Yong et al., 2019](#)), and in surveys of convenience samples, such as primary care patients ([Kalkhoran et al., 2017](#)). The challenge for public health messaging, is to communicate that using e-cigarettes to cut down on cigarette use is progress but only if the outcome is smoking cessation. Especially as early evidence suggests simultaneously smoking cigarettes and using e-cigarettes is associated with greater exposure to harmful toxicants compared to only smoking ([Goniewicz et al., 2018](#)).

There are several limitations that should be considered when

interpreting the results. As the survey relied on self-reported information, there could be a misrepresentation of retrospective variables. In particular, respondents' recall of reasons for using e-cigarettes could be subject to recall bias. The design also prevents analyses of causal associations or trends over time. As a state-wide survey there is a restriction on the questions that can be asked, for example, respondents were not asked the brand and types of e-cigarettes they were using or had used.

3.1. Conclusions

This study identified interest in e-cigarettes among smokers, former smokers and never smokers that likely reflects the continuing innovation in the marketing of new products, and in particular the introduction of higher nicotine content devices. This has led to considerable experimentation and some regular use by nonsmoking young adults, but smokers with a goal of quitting or cutting down on smoking were the largest use group. Future public policy has to address the challenges of smokers using concurrently and young adults taking up use of e-cigarettes.

Role of funding sources

ClearWay Minnesota, a nonprofit tobacco control organization, supported the Minnesota Adult Tobacco Survey data collection. The content is solely the responsibility of the authors and does not necessarily represent the official views of ClearWay Minnesota. ClearWay Minnesota had no role in the analysis or writing of the paper.

Contributors

RB designed the study and led the writing of the manuscript. SR conducted the analyses. SH interpreted the analysis. All authors contributed to the writing.

Table 4
Latent class model of respondents who had tried e-cigarettes (n = 910).

Class labels:	Younger experimenters	Using to quit/cut down	Concurrent users	Curious adults
Latent class prevalence estimates:	0.140	0.352	0.206	0.303
Variables and item-response probabilities				
Current e-cigarette user				
Yes	0.388	0.114	0.522	0.001
No	0.612	0.886	0.478	0.999
Smoking status				
Current smoker	0.031	0.692	0.454	0.252
Former smoker	0.172	0.282	0.417	0.269
Never smoker	0.798	0.026	0.130	0.479
Tried e-cigarettes to quit or reduce other tobacco				
Yes	0.008	0.878	0.896	0.008
No	0.992	0.123	0.104	0.992
Tried e-cigarettes for flavors other than menthol				
Yes	0.551	0.218	0.665	0.159
No	0.449	0.782	0.335	0.841
Tried e-cigarettes for curiosity				
Yes	0.622	0.556	0.727	0.912
No	0.378	0.444	0.273	0.088
Tried e-cigarettes for enjoyment				
Yes	0.851	0.114	0.991	0.085
No	0.149	0.886	0.009	0.916
Demographics:				
Sex				
Male	0.606	0.512	0.623	0.550
Female	0.394	0.488	0.377	0.450
Age				
18–24	0.637	0.077	0.262	0.197
25–44	0.270	0.465	0.524	0.558
45–64	0.092	0.411	0.174	0.206
65+	0.001	0.046	0.040	0.038
Completed Education				
< High School	0.160	0.111	0.202	0.072
High School/GED	0.225	0.298	0.269	0.243
Some college	0.466	0.474	0.390	0.434
College graduate	0.149	0.117	0.140	0.252

SAS output BEST class was used to create the demographic percent likelihoods (age, education, sex).

Item-response probabilities ≥ 0.5 in bold to facilitate interpretation.

Declaration of Competing Interest

The authors declared that there is no conflict of interest.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.abrep.2019.100227>.

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