

Adolescent Use of Different E-cigarette Products

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abstract

BACKGROUND: Little is known about the characteristics of electronic cigarettes (e-cigarettes) used by adolescents. Understanding the product landscape of adolescent e-cigarette use may inform counseling and policy strategies.

METHODS: Results are from 13 651 adolescents in wave 1 and 12 172 adolescents in wave 2 of the Population Assessment of Tobacco and Health Study, a nationally representative longitudinal study. Past 30-day regular e-cigarette users were asked about the characteristics of the e-cigarette they used most of the time.

RESULTS: In waves 1 and 2, 2.1% and 2.8% of adolescents were regular users in the past 30 days, respectively. These adolescents more often used rechargeable rather than disposable devices (wave 1: 76.0%; wave 2: 82.9%) and refillable rather than nonrefillable devices (wave 1: 66.6%; wave 2: 84.4%) and tended not to use cartridge systems (wave 1: 33.7%; wave 2: 30.5%). Most adolescent past 30-day users (wave 1: 87.5%; wave 2: 89.4%) reported using flavored e-cigarettes. An increased frequency of use was associated with the use of rechargeable (wave 1 adjusted odds ratio [aOR]: 2.7; wave 2 aOR: 2.7) and refillable e-cigarettes (wave 1 aOR: 2.0; wave 2 aOR: 2.7; $P < .05$). Most users in wave 1 did not continue regular use in wave 2 (70.2%). Among those who continued to use and had reported using closed systems (nonrechargeable and/or nonrefillable) in wave 1, most had progressed to open systems (rechargeable and refillable) in wave 2.

CONCLUSIONS: Most adolescents use open-system e-cigarettes, and frequent users are even more likely to use open-system e-cigarettes. The majority of regular users use rechargeable devices that are refillable. A change in product preferences across waves suggests a starter product phenomenon, with a graduation to products that have weaker quality controls and may increase health risks.



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WHAT'S KNOWN ON THIS SUBJECT: Tobacco companies tend to market closed-system products, whereas the vaping industry typically markets open-system products. Among adult current and former cigarette smokers, the open-system devices tend to be more popular than those that are closed system.

WHAT THIS STUDY ADDS: Little is known about the product preferences of adolescents. This study reveals that adolescent users prefer open systems, especially more frequent users. This pattern of use suggests a starter product phenomenon, with a graduation to potentially more dangerous products with weaker quality controls.

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There are 2 main types of electronic cigarettes (e-cigarettes): open systems, which are refillable with nicotine solutions, and closed systems, which are disposable or use disposable cartridges.¹ E-cigarettes that are not rechargeable are considered to be disposable closed systems, those that are rechargeable (but not refillable) are considered to be reusable closed systems, and those that are refillable are considered to be open systems. Established tobacco companies and the newer e-cigarette industry companies currently use different systems to attract e-cigarette users (see Fig 1). The products of US tobacco companies are not typically designed to be refillable with nonproprietary electronic cigarette liquid (e-liquid). Most of the MarkTen (Altria Group, Inc, Richmond, VA) and Vuse products (R.J. Reynolds Vapor Company, Winston Salem, NC) use closed systems with proprietary cartridge-based technology. On the other hand, vape shops typically market rechargeable products that are manufactured by smaller companies and can be refilled with any e-liquid.² The rechargeable systems with small reservoirs for nicotine solutions tend to be nonmodifiable, whereas many of these open systems with larger tank reservoirs can be modified to control voltage and wattage to increase flavor and aerosol production, airflow over heating coils to manipulate the density of the aerosol, and other characteristics to customize the nicotine and aerosol experience. Properties of both these closed- and open-system products present unique risks to public health, as described below.

The US tobacco companies have an established history of manipulating cigarettes to be more addictive and designing marketing campaigns to attract youth.³ These companies also have the resources and experience to produce reliable consumer products with accurate ingredient and nicotine content

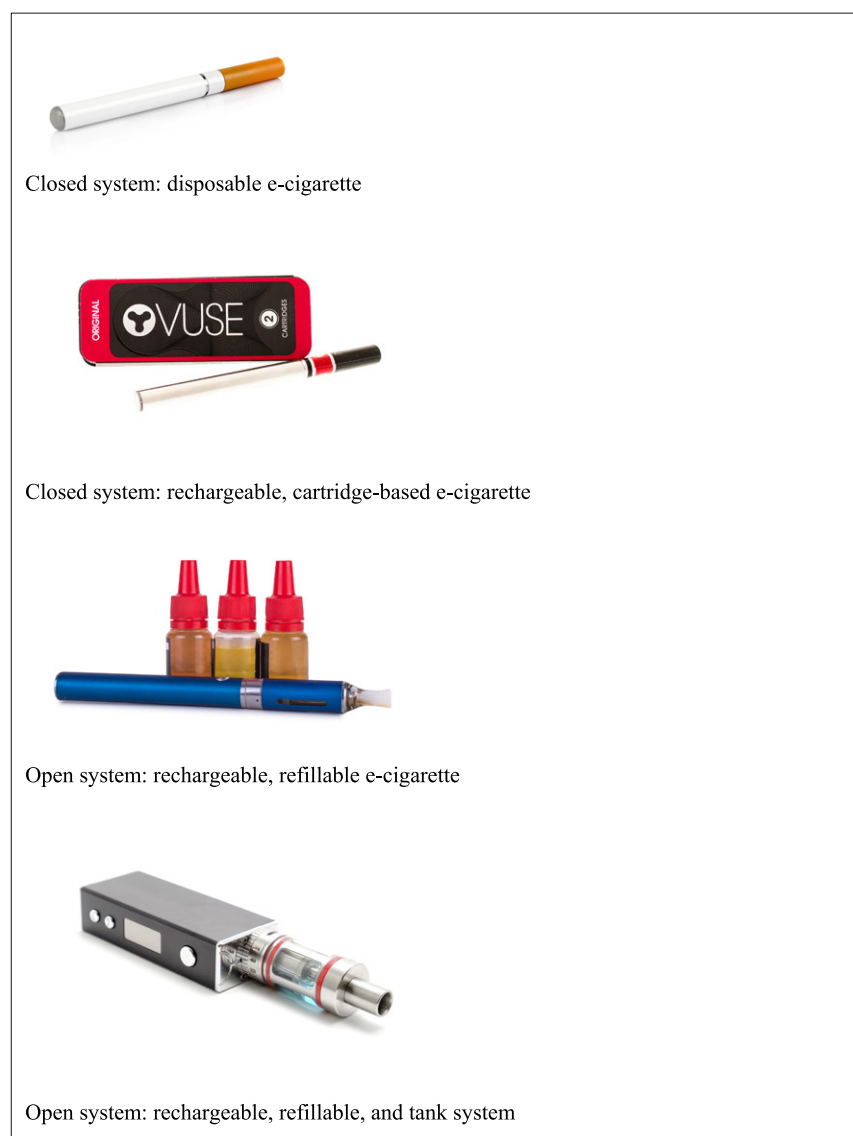


FIGURE 1
Categories of e-cigarettes.

labels. Although the open-system e-cigarette industry may not have an established record of targeting youth, they have struggled with consumer product safety issues in a market that currently places no regulatory oversight over these products or e-liquids. Among the concerns are inaccurate nicotine concentration labels,^{4,5} e-liquids containing diacetyl that are labeled as diacetyl free,⁶ and exploding lithium batteries.^{7,8}

Most investigations of whether users prefer 1 type of system over the other have been focused on

adult current and former cigarette smokers. Among this population, the open-system devices tend to be more popular than those that are closed system. Surveys administered to convenience samples of adults who were recruited from vape shops⁹ and e-cigarette Web sites¹⁰ revealed that users overwhelmingly preferred open systems with tank reservoirs.¹⁰ Moreover, preference for these products is associated with more frequent¹ and established use.¹¹ The preference of current and former smokers for open systems with tank reservoirs in these

studies may be attributed to these products' improved ability to deliver nicotine to the bloodstream over first-generation closed systems.^{12,13} However, the closed-system devices of the tobacco industry are much improved over their first-generation counterparts in terms of nicotine delivery.¹⁴

Little is known about the product preferences of adolescents, particularly more frequent users, who account for more of youth consumption. Understanding the landscape of teenaged e-cigarette use may lead to targeted counseling strategies that will be used to highlight the risks of these different systems. In this article, we use data from waves 1 and 2 of the Population Assessment of Tobacco and Health (PATH) Study to examine the characteristics of e-cigarettes used by adolescents and the relationship between the frequency of e-cigarette use and e-cigarette characteristics.

METHODS

Results are from 13 651 adolescents (aged 12–17 years old) in wave 1 (September 2013–December 2014) and 12 172 adolescents in wave 2 (October 2014–October 2015) of the PATH Study, a nationally representative longitudinal study. Among youth within participating households (weighted household screener rate: 54%), 78.4% participated in an audio, computer-assisted interview during wave 1.^{15,16} The retention rate for wave 2 was 88.4% ($n = 10\,081$). To supplement wave 2, additional participants were added, with 82.1% of those who were contacted agreeing to participate ($n = 2091$).

E-cigarette Questions

All respondents in wave 1 were asked, “Have you ever seen or heard of an electronic cigarette or e-cigarette before this study?” Those who replied “yes” ($n = 12\,177$;

89.5%) were asked, “Have you ever used an e-cigarette, such as NJOY, Blu, or Smoking Everywhere, even 1 or 2 times?” Those who replied “yes” ($n = 1451$; 11.9%) were asked, “In the past 30 days, on how many days did you use an e-cigarette?” Adolescents who reported use within the past 30 days were classified as past 30-day users ($n = 418$; 3.1%) and were asked, “How many disposable e-cigarettes or e-cigarette cartridges have you used in your entire life?” Among past 30-day users, the PATH protocol was used to classify those respondents who reported having used ≥ 1 e-cigarettes in their lifetime and those who last used an e-cigarette within the past 30 days as past 30-day “not-light” users.^{17,18} In this article, we refer to these adolescents as past 30-day regular users. Only past 30-day regular users ($n = 281$; 2.1%) were asked, “Please think about the e-cigarette you use most of the time. Is your e-cigarette rechargeable?” Those who reported “yes” ($n = 215$) were asked, “Does your e-cigarettes use cartridges?” All past 30-day regular users were asked, “Can you refill your [e-cigarette or e-cigarette cartridges] with e-liquid?” All past 30-day users were also asked, “In the past 30 days, were any of the e-cigarettes/ cartridges you used flavored to taste like menthol, mint, clove, spice, candy, fruit, chocolate, alcohol (such as wine or cognac), or other sweets?”

New respondents in wave 2 were asked, “Have you ever seen or heard of electronic nicotine products before this study? (Electronic nicotine products include e-cigarettes, e-cigars, e-pipes, e-hookahs, personal vaporizers, vape pens, and hookah pens).” Those who replied “yes” or were returning respondents ($n = 11\,724$) were asked, “Which of the following electronic nicotine products have you tried? E-cigarette (including vape pens and personal vaporizers), e-cigar, e-pipe, e-hookah (including hookah pens),

or something else.” Past 30-day regular users ($n = 330$) were asked, “Please think about the e-cigarette you use most of the time. Is your e-cigarette rechargeable?” Those who reported “yes” ($n = 273$) were asked, “Does your e-cigarettes use cartridges?” All past 30-day regular users were asked, “Can you refill you [e-cigarette or e-cigarette cartridges] with e-liquid?” Wave 2 included additional e-cigarette characteristics questions. Those who reported that their e-cigarette was rechargeable ($n = 277$) were asked, “Can you change the voltage on your e-cigarette?” Those who reported that their e-cigarette did not use cartridges were asked, “Does your e-cigarette use a tank system?” All past 30-day regular users ($n = 330$) were asked, “Have you modified your e-cigarette at all?” and “In the past 30 days, how did you usually get your own [e-cigarette or e-liquid]?” Those who reported that they “bought them myself” or “gave someone else money to buy them for me” ($n = 86$) were asked “Where do [you or they] buy your [e-cigarette or e-liquid] most of the time?” Response options included the following: a mall kiosk; a convenience store or gas station; a supermarket, grocery store, or drug store; a warehouse club (such as Sam’s or Costco); a smoke shop, tobacco specialty store, or tobacco outlet store; a duty-free shop or military commissary; a bar, pub, restaurant, or casino; a friend or relative; a swap meet or flea market; somewhere else; or a vape shop or vapor lounge.

Demographic Variables

Demographic variables used in multivariable analyses included sex, race, age, and cigarette smoking status. Those referred to as “never smokers” had never smoked a cigarette, those referred to as “ever smokers” had smoked at least 1 cigarette but had not done so in the past 30 days, and those referred to

TABLE 1 Sample Characteristics

Characteristic	Wave 1		Wave 2	
	Overall Sample (<i>N</i> = 13 651), <i>n</i> (%)	Past 30-d Regular E-cigarette Users (<i>N</i> = 281), <i>n</i> (%)	Overall Sample (<i>N</i> = 12 172), <i>n</i> (%)	Past 30-d Regular E-cigarette Users (<i>N</i> = 330), <i>n</i> (%)
Age, y				
12–14	6997 (50.4)	46 (15.3)	6266 (50.7)	67 (19.2)
15–17	6653 (49.6)	235 (84.7)	5906 (49.3)	263 (80.8)
Sex				
Male	6993 (51.3)	182 (65.4)	6225 (51.3)	201 (60.0)
Female	6657 (48.7)	99 (34.6)	5918 (48.7)	129 (40.0)
Race or ethnic group				
Non-Hispanic white	9471 (70.7)	219 (80.3)	7832 (69.7)	254 (82.9)
Non-Hispanic African American	2086 (15.2)	19 (6.6)	1826 (15.7)	13 (4.6)
Other	2093 (14.1)	43 (13.1)	1823 (14.6)	50 (12.5)
Cigarette smoker				
Current smoker	634 (4.6)	148 (49.4)	481 (4.0)	149 (44.1)
Ever smoker	1186 (8.7)	78 (30.7)	938 (7.7)	84 (25.7)
Nonsmoker	11 792 (86.7)	54 (19.8)	10 720 (88.4)	95 (30.2)

as “current smokers” had smoked a cigarette in the past 30 days.¹⁷

Institutional Review Board Approval

The PATH Study received approval from the Westat Institutional Review Board. The PATH Study also obtained a Certificate of Confidentiality from the National Institutes of Health. Amendment 2 of CC-DA-12-131, dated September 23, 2016, extends its expiration date from September 30, 2017, to August 31, 2022.¹⁸

Analyses

We used SPSS Complex Samples to calculate all variance estimations, adjusting for the 92 strata and 156 primary sampling units in the sample design and applying the weights provided with the public-use data set. We examined the association of frequency of use with product preferences. Frequency of use was measured as a continuous variable and then treated as both a continuous and binary measure. The continuous measure preserves information and statistical power, whereas the binary measure leads to easier interpretation of results. On the basis of the distribution of the continuous variable, the binary variable levels were less frequent users (<10 of the past 30 days) and frequent users (≥10 of the past 30 days). Sample characteristics

and the comparison of e-cigarette characteristics of less frequent users and frequent users were calculated by using CSTABULATE to conduct χ^2 tests of independence. Multivariable analyses included cigarette smoking status, age, sex, and race as covariates. These covariates were selected because of their association with e-cigarette use in previous research.¹⁹ To examine the association of frequency of use as a continuous variable with product preferences, a logistic regression of e-cigarette characteristics on frequency of use was calculated by using CSLOGISTIC to estimate logistic regression equations using the previous covariates. Comparisons of the retail source by e-cigarette characteristics in wave 2 were calculated by using CSTABULATE to conduct χ^2 tests of independence. Although past 30-day regular users were asked about the retail source in wave 1, the response options did not include vape shops or vapor lounges. Wave 2 data indicate that these are an important retail source and that the wave 1 data on this item may have decreased validity because of the omission of vape shops or vapor lounges.

RESULTS

Sample characteristics are presented in Table 1. In both waves, past 30-day

regular e-cigarette users were more likely than nonregular users to be cigarette smokers (older adolescents, boys, and non-Hispanic white; $P < .01$).

Overall E-cigarettes Characteristics

Overall, 3.1% and 3.6% of adolescents reported past 30-day e-cigarette use in wave 1 and wave 2, respectively, and 2.1% and 2.8% of adolescents were past 30-day regular users, respectively. Most past 30-day regular users used rechargeable (76.0% and 82.9%, respectively) rather than disposable devices (24.0% and 17.1%) and used refillable (66.5% and 84.4%) rather than nonrefillable devices (33.5% and 15.6%), and only one-third of past 30-day regular users used cartridge systems (33.7% and 30.5%). Most adolescent past 30-day users (87.5% and 89.4%, respectively) reported using a flavored e-cigarette in the past 30 days. One in 10 adolescents usually bought their e-cigarettes themselves (10.7% and 11.6%, respectively), whereas most obtained them from social sources (78.8% and 77.4%). The remainder either stole them or got them some other way. For questions added to the survey in wave 2, almost half of past 30-day regular users (46.2%) used tank

TABLE 2 Association of Frequency of Use and Characteristics of the E-cigarette Used Most of the Time (χ^2 Test for Independence and Logistic Regression Analyses)

E-cigarette Characteristic	Wave 1			Wave 2		
	Use <10 d	Use at Least 10 d per mo	<i>P</i>	Use <10 d	Use at Least 10 d per mo	<i>P</i>
E-cigarette used most of the time is rechargeable						
χ^2 test, <i>n</i> (%)	208 (71.8)	70 (87.3)	.006	203 (77.5)	123 (90.9)	.006
LR, aOR (95% CI)	Ref	2.7 (1.4–5.3)		Ref	2.7 (1.5–5.1)	
E-cigarette used most of the time uses cartridges						
χ^2 test, <i>n</i> (%)	200 (35.5)	70 (28.5)	ns	203 (34.4)	121 (23.0)	.049
LR, aOR (95% CI)	Ref	0.7 (0.4–1.3)		Ref	0.6 (0.4–1.1)	
E-cigarette used most of the time can be refilled						
χ^2 test, <i>n</i> (%)	206 (61.6)	70 (79.6)	.005	206 (79.7)	123 (91.4)	.012
LR, aOR (95% CI)	Ref	2.0 (1.2–3.5)		Ref	2.7 (1.6–4.6)	
E-cigarette used most of the time is a tank system						
χ^2 test, <i>n</i> (%)	n/a	n/a	n/a	205 (38.8)	123 (58.3)	.001
LR, aOR (95% CI)	n/a	n/a		Ref	1.9 (1.2–3.0)	
E-cigarette used most of the time has modifiable voltage						
χ^2 test, <i>n</i> (%)	n/a	n/a	n/a	205 (29.1)	123 (50.1)	.001
LR, aOR (95% CI)	n/a	n/a		Ref	2.5 (1.6–3.9)	
E-cigarette used most of the time has been modified at all						
χ^2 test, <i>n</i> (%)	n/a	n/a	n/a	204 (17.5)	123 (36.7)	<.001
LR, aOR (95% CI)	n/a	n/a		Ref	2.8 (1.7–4.6)	
Used a flavored e-cigarette in the past 30 d						
χ^2 test, <i>n</i> (%)	330 (84.6)	83 (88.2)	ns	245 (88.3)	122 (87.8)	ns
LR, aOR (95% CI)	Ref	0.8 (0.4–1.5)		Ref	1.1 (0.6–2.1)	

aOR was adjusted for smoking status, age, sex, and race. aOR, adjusted odds ratio; CI, confidence interval; LR, logistic regression; ns, not significant; n/a, not applicable.

systems. A minority of adolescents reported that the voltage in their e-cigarette could be modified (37.0%) or had been modified (24.9%).

Frequency of E-cigarette Use and Product Characteristics, Flavors, and Retail Locations

Bivariate and multivariable comparisons revealed that frequent users were more likely than less frequent users to use open-system rechargeable, refillable tank systems, voltage modifiable e-cigarettes, and modified e-cigarettes. Frequent and less frequent users were equally unlikely to use cartridge-based systems (in wave 1) and equally as likely to report using a flavored e-cigarette in the past 30 days (see Table 2). As reflected in the percentages reported for individual characteristics, unadjusted odds

ratios for the association between e-cigarette characteristics and use of >10 days per month were in the same direction (data not shown) as the adjusted ratios. Logistic regression analyses in which frequency of use was treated as a continuous variable and adjustments for covariates were included produced similar results (data not shown).

Past 30-day regular users who reported buying their own e-cigarettes or giving someone else money to buy them were asked about the retail source of their e-cigarettes (*n* = 101). Adolescents who used e-cigarettes with open features tended to buy their e-cigarette products at vape shops, whereas those who used e-cigarettes with closed features tended to buy them at retail stores (see Table 3). However, the sample size for adolescents who

used e-cigarettes with closed features was small, and only the comparison for having modifiable voltage was statistically significant.

Longitudinal Patterns

Most regular e-cigarette users in wave 1 did not continue regular use in wave 2. Among those who had reported regular use in wave 1, 11.3% were exclusively using e-cigarettes, 20.4% were dual using e-cigarettes and cigarettes, 23.1% were exclusively smoking cigarettes, and 45.1% were not using e-cigarettes or cigarettes at wave 2. Product preferences at baseline were not statistically associated with e-cigarette and cigarette use at follow-up.

Among those who continued regular use and had reported using closed

TABLE 3 Retail Location Used Most of the Time to Purchase E-cigarette Products, Wave 2 (χ^2 Test for Independence)

E-cigarette Product	Brick and Mortar Retail, <i>n</i> (%)	A Smoke Shop, Tobacco Specialty Store, or Tobacco Outlet Shop, <i>n</i> (%)	Vape Shop, <i>n</i> (%)
Disposable	8 (60.8)	2 (14.5)	3 (24.7)
Rechargeable	30 (35.9)	13 (15.6)	44 (48.5)
Uses a cartridge	14 (56.4)	11 (14.9)	9 (28.6)
Does not use a cartridge	24 (31.6)	4 (15.7)	38 (52.7)
Refillable	31 (35.1)	14 (16.5)	44 (48.4)
Not refillable	7 (67.8)	1 (6.7)	3 (25.5)
Uses a tank system	15 (27.9)	9 (18.1)	28 (54.0)
Does not use a tank system	23 (50.9)	6 (12.4)	19 (36.7)
Voltage can be modified*	12 (25.4)	8 (19.1)	26 (55.6)
Voltage cannot be modified	26 (50.9)	7 (12.1)	21 (37.0)
Has been modified	11 (32.4)	7 (19.3)	16 (48.3)
Has not been modified	27 (42.0)	8 (13.3)	31 (44.6)
Used a flavored e-cigarette	33 (36.5)	15 (17.7)	41 (45.8)
Did not use a flavored e-cigarette in past 30 d	4 (60.7)	0 (0)	4 (39.3)

* $P < .05$.

TABLE 4 Longitudinal Patterns of Use of E-cigarette Products (χ^2 Test for Independence)

Characteristics of E-cigarettes Used at Wave 1	Wave 2: No Longer a Past 30-d Regular User, %	Wave 2: Closed Systems, %	Wave 2: Open Systems, %
Disposable (<i>n</i> = 49)	68.6	Disposable	2.0
		Rechargeable	29.4
Rechargeable (<i>n</i> = 111)	68.4	Cartridge	27.2
		No cartridge	24.3
Uses a cartridge (<i>n</i> = 50)	75.7		33.5
		Does not use a cartridge (<i>n</i> = 103)	64.0
Refillable (<i>n</i> = 61)	72.6	Not refillable	26.0
		Refillable	33.9
Not refillable (<i>n</i> = 97)	61.4	4.7	

No tests were statistically significant.

systems in wave 1, most of those who reported continued e-cigarette use had switched to open systems in wave 2. Few adolescents reported using closed systems in wave 2 after using open systems in Wave 1 (see Table 4).

DISCUSSION

Similar to adults,¹ most adolescent e-cigarette users in this representative sample use open-system, refillable devices, and this finding was stronger among more frequent users. Approximately 9 out of 10 adolescent users reported using flavored e-cigarettes, and frequent and infrequent users were equally as likely to do so. Among

the one-third of adolescents who continued using e-cigarettes at follow-up, almost all had either transitioned to or continued to use open systems. These results suggest that the vaping industry products are more appealing to youth than the closed-system products of the tobacco companies. This preference for refillable devices may be of concern because of quality control and labeling inaccuracy, including nicotine presence in e-liquids that are labeled “0 nicotine,” which leads to unintended nicotine exposure.^{4,5} Most of the labeling discrepancies detected in 0-nicotine products involved trace amounts of nicotine; however, in 1 study, 2 out of 5 solutions tested had nicotine levels

of >10 mg/mL.⁴ These discrepancies could lead to unintended nicotine exposures and potential addiction to tobacco products. The US Surgeon General report revealed that 99% of e-cigarette products on the US market contain nicotine.²⁰

Speculation that open systems deliver higher levels of nicotine could explain their popularity as a cessation strategy for adult smokers.¹ However, these same delivery properties that satisfy the nicotine needs of adult smokers might also increase adolescents’ risk for nicotine addiction. Use of e-cigarettes with higher nicotine concentrations have been found to predict increased subsequent frequency and intensity of use among high school students.²¹

Our results also reveal the need for policies that restrict adolescents’ access to e-cigarettes. We found that a significant number of adolescents were getting products from peers or that older friends were buying for them, suggesting that social sources are a popular means for underaged adolescents to obtain e-cigarettes. Additionally, adolescents who bought open-system products themselves tended to be more likely to do so at vape shops than those who bought closed-system products. Having fewer retail outlets with tighter enforcement of existing regulations would help limit teenagers’ access to these products. These data also support moves to include e-cigarette products in Tobacco 21 sales regulation. Adults who purchase cigarettes for distribution to minors are frequently <21 years of age.²² High school students are less likely to have 21-year-old peers than 18-year-old peers in their social circles, suggesting reduced opportunities to access tobacco from older buyers.²³ Raising the age of sale for tobacco can break this distribution cycle by reducing minors’ ability to buy e-cigarettes from other high school students.²⁴

Understanding the landscape of teenaged e-cigarette use may improve prevention and cessation efforts. Screening may miss teenaged e-cigarette use if teenagers do not consider their nicotine aerosol products of choice to be e-cigarettes. In addition to reducing adolescents' access to e-cigarettes, targeted counseling strategies could be used to highlight the risks of these different systems. The finding that teenagers are more attracted to open-system and flavored products suggests that counseling and policies should be used to address these features.

There are some limitations to this study. First, the PATH data set is limited in that respondents were not asked about whether the solutions they used contained nicotine or about the concentration of nicotine in their preferred products. Second, the number of youth who reported past 30-day regular e-cigarette use was a small percentage of the overall sample. Some analyses, particularly those used to examine retail locations of e-cigarette purchases, were underpowered. Third, the classification of open- versus closed-system e-cigarettes is complicated by the dual nature of cartridges. Some

cartridge-based e-cigarettes are open systems in which the cartridge can be refilled; others are based on proprietary cartridges that are not intended to be refilled. Finally, the most recent publicly available data are from >2 years ago. The dynamic e-cigarette market could have changed over this time. To illustrate, recent media suggest that the closed, cartridge-based JUUL systems appear to be gaining popularity among youth and young adults.^{25–29} The JUUL device is small and allows for discreet use, resembles a flash drive, is available in several flavors (including cool mint, crème brûlée, fruit medley, mango, and menthol), and “accommodates nicotine levels akin to a cigarette’s,” according to the manufacturer.³⁰

CONCLUSIONS

Understanding the choices that lead to adolescent nicotine addiction through e-cigarette use has implications for more effective prevention and enforcement of the Family Smoking Prevention and Tobacco Control Act’s mandate to prevent youth initiation of tobacco use. Most adolescents use open-system e-cigarettes, and frequent

users are even more likely to use these products. Furthermore, we found evidence of adolescents transitioning from closed- to open-system e-cigarettes that can be modified to deliver higher levels of nicotine. A change in product preferences across waves suggests a starter product phenomenon, with a graduation to potentially more dangerous products with weaker quality controls. The lack of quality control regulation should be of urgent concern and should be acted on immediately without waiting for premarket reviews. Products that are potentially mislabeled or contaminated with nicotine should be treated as defective and dangerous to youth and removed from stores. These data support efforts to restrict adolescent access to nicotine-containing products and regulate the use of flavor additives in the e-cigarettes used by youth.

ABBREVIATIONS

e-cigarette: electronic cigarette
e-liquid: electronic cigarette liquid
PATH: Population Assessment of Tobacco and Health

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