Nicotine & Tobacco Research, 2016, 654–659
doi:10.1093/ntr/ntv217
Original investigation
Advance Access publication September 27, 2015

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E-Cigarettes and the Drug Use Patterns of Adolescents

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Abstract

Introduction: This study examines the role of e-cigarettes in the drug use patterns of adolescents. Of specific interest is whether adolescent e-cigarette users fall into a group of (1) youth who do not use traditional drugs of abuse or (2) polysubstance users.

Methods: Using latent class analysis, we identify major "classes" of substance users on the basis of recent use of e-cigarettes, alcohol, marijuana, cigarettes, and prescription drugs. Analyses are conducted separately for adolescents in 8th, 10th, and 12th grades. Data come from 16 615 participants in the 2014 Monitoring the Future survey.

Results: Youth who do not use traditional drugs of abuse account for about 50% of e-cigarette users in 8th grade, 35% in 10th grade, and 17% in 12th grade. These youth come from a large "low-level users" group found in each grade, characterized by low probability of use for all substances (e-cigarette probability in this group for 8th graders = .046; 10th graders = .071; 12th graders = .027). Other e-cigarette users come from a smaller, "poly-users" group found in each grade, characterized by high-to-moderate probabilities (.83–.21) of using e-cigarettes and other substances. Specific to 12th grade is a third, additional polysubstance group characterized by high likelihood of e-cigarette use (.93).

Conclusions: The proportion of e-cigarette users who do not use traditional drugs of abuse is larger at younger ages. Longitudinal panel studies starting at 8th and 10th grades may best inform the current debate on whether e-cigarette use is a risk or protective factor for future transition to the use of other substances.

Implications: The proportion of e-cigarette users who do not use traditional drugs of abuse is larger at younger ages. Longitudinal panel studies starting at 8th and 10th grades may best inform the current debate on whether e-cigarette use is a risk or protective factor for future transition to the use of other substances.

Introduction

The prevalence of adolescent e-cigarette use has increased abruptly in recent years. In 2014, 30-day prevalence was 9% among 8th graders, 16% among 10th graders, and 17% among 12th graders.[1,2] This is rapid growth from a 30-day prevalence of near 1% among middle and high school students just 3 years earlier in 2011.[3] Use has grown to such an extent that among adolescents today 30-day prevalence of e-cigarette use is now higher than prevalence of any other tobacco product, including traditional tobacco cigarettes.[4] Much remains unknown about these young e-cigarette users, including whether their e-cigarette use is part of a pattern of more extensive substance use.

This study examines current drug use patterns of adolescents to identify whether e-cigarette users are (1) youth who do not use traditional drugs of abuse or (2) polysubstance users. Specifically, we examine co-occurrence of e-cigarette use with the four most commonly used

substances of marijuana, alcohol, tobacco cigarettes, and prescription drugs[2] by applying latent class analysis to data from the 2014 Monitoring the Future Study. MTF is a large, nationally-representative study of US 8th-, 10th-, and 12th-grade students in the 48 contiguous states.[2]

E-cigarettes are battery-powered devices with a heating element. They produce an aerosol, or vapor, that users inhale. Typically this vapor contains nicotine, although the specific contents of the vapor are proprietary, are often not disclosed, and are currently unregulated. The liquid that is vaporized in e-cigarettes comes in hundreds of flavors. Some of these flavors, such as bubble gum and milk chocolate cream, likely are attractive to teens and have helped e-cigarettes become popular among US adolescents.

E-cigarette users may belong to different types or "classes" of users with very different drug use patterns. Current studies suggest this possibility, although evidence at this point is incomplete. Current analyses show that a substantial portion of adolescents who use e-cigarettes have never smoked a regular cigarette in their life.[4–6] However, cigarette smoking has largely fallen out of favor among today's youth and prevalence is at historic lows.[1,2] The e-cigarette user who does not smoke regular cigarettes could still potentially be a polysubstance user who is also using other substances,[7] such as traditional drugs of abuse including marijuana, alcohol, and prescription drugs outside of medical supervision.

To the extent that e-cigarette users are youth who do not use traditional drugs of abuse, they would be expected to fall into a "low-level" or "nonuser" class of adolescent drug user. This group has low levels of use for all traditional substances of abuse. It is one of the most robust classes of drug users found in practically all analyses of drug use based on population samples and comprises the majority of youth.[8–11] It is possible that today e-cigarettes may have made inroads into this group, which may have low probability for all substances except e-cigarettes. We examine this possibility in the current study.

To the extent that e-cigarette users are polysubstance users they could fall into at least two different, potential groups. The first consists of polysubstance users who report a high probability for use of all major substances. Such a group of polysubstance users is also a robust class of drug users found in practically all analyses of drug use based on population samples.[8–11] It would not be surprising if adolescents who have high levels of polysubstance use include e-cigarettes among the repertoire of drugs that they use.

E-cigarette users may also come from a polysubstance group that has emerged recently and is defined by predominant e-cigarette use. Such a finding would be consistent with previous national studies of youth that show drug use classes driven primarily by the use of a single drug, such as marijuana or alcohol, and accompanied by elevated risk for other substances.[9–11]

The role of e-cigarettes in the drug use patterns of adolescents may vary by age. To take into account this possibility we ran separate latent class analyses for respondents in 8th, 10th, and 12th grades. Existing studies lead to the expectation of higher levels of substance among older adolescents,[2] but the literature currently provides little guidance on whether e-cigarettes may be part of different classes of drug users at different ages. Absent strong, a priori expectations our empirical examination of age as a modifier of e-cigarette drug patterns is exploratory.

Methods

Data

Data come from the annual Monitoring the Future study, which since 1975 has used questionnaires administered in classrooms to survey nationally representative samples of students in the United States.[2] This analysis uses the annual sample of US 8th, 10th, and 12th graders from the year 2014, the first year that the survey asked questions about e-cigarette use.

In 2014 a total of 41 551 students located in 377 public and private schools participated. The survey consists of three separate, nationally-representative samples of 8th-, 10th-, and 12th-grade students and selects schools using a multistage, stratified research design (for more detail see ref.[12]). The first stage is geographic area and consists of 164 primary areas. The second stage consists of sampling of one or more schools within each of these areas, with probability proportionate to size. In 2014 either an original or replacement school was recruited for 92% of sample units. The third and final stage is the selection of students. Up to ~350 students of the target grade in the selected school may be included in the data collection. In schools with fewer than 350 students of the target grade the usual procedure is to include all of them in the data collection when feasible. Student response rates in 8th, 10th, and 12th grade were 90%, 88%, and 82%, respectively; almost all nonresponse was due to absenteeism.

Six randomly distributed forms of the questionnaire are used in 12th grade and four randomly distributed forms are used in 8th and 10th grades. Use of e-cigarettes in the past 30 days is asked in four forms in 12th grade (n = 8696) and in two forms in 10th (n = 4454) and 8th grades (n = 5079). The final analysis includes all respondents who provided information on at least one of the five drugs under study. The resulting sample sizes are 5060, 4443, and 8597; in 8th, 10th, and 12th grade respectively.

Measures

E-cigarette use in the past 30 days is coded 1 for respondents who reported e-cigarette use on at least 1 day in response to the question "During the LAST 30 DAYS, on how many days (if any) have you used electronic cigarettes (e-cigarettes)?" and 0 otherwise. Cigarette use in the past 30 days is coded 1 for respondents who reported any occasions of cigarette use in response to the question "How frequently have you smoked cigarettes during the past 30 days?" and 0 otherwise. Marijuana use in the past 30 days is coded 1 for respondents who report any occasions of marijuana use in response to the question "On how many occasions (if any) have you used marijuana (weed, pot) or hashish (hash, hash oil) during the last 30 days?" Prescription drug abuse in the past 30 days is coded 1 for respondents who report that in the last 30 days they had used prescription amphetamines, sedatives including barbiturates, tranquilizers, and/or narcotics "on your own—that is, without a doctor telling you to take them." Questions about each class of prescription drug include lists of example brand names and street names. To assess substantial alcohol use binge drinking in the past 2 weeks is coded 1 for respondents who report any instances in response to the question "During the last two weeks, how many times (if any) have you had five or more drinks in a row?" and 0 otherwise. Control variables and their definitions are listed in Table 1.

Analysis

This study uses latent class analysis[13] and includes use of e-cigarettes in addition to four other commonly used drugs to empirically identify the most common groups, or "classes," of drug use patterns, as well as the size of these classes. Latent class analysis describes groups of people with distinct patterns of responses using dichotomous indicators. The results of a latent class analysis model include "item probabilities," which are the probabilities of endorsing an indicator

Table 1. Sociodemographic and Drug Use Characteristics of Sample by Grade Level (Entries are Percentages, Standard Errors in Parentheses)

Variable	8th grade (n = 5060)	10th grade (n = 4443)	12th grade (n = 8597)
Female	51.25 (1.0)	50.06 (1.2)	51.17 (1.0)
Male	48.75 (1.0)	49.94 (1.2)	48.83 (1.0)
Parent with college degree[a]	56.69 (2.0)	58.05 (1.9)	51.69 (1.8)
No parent with college degree[a]	43.31 (2.0)	41.95 (1.9)	48.31 (1.8)
Has college plans[b]	92.25 (0.63)	91.49 (0.64)	82.42 (0.89)
No college plans[b]	7.75 (0.63)	8.51 (0.64)	17.58 (0.89)
White	45.71 (2.8)	55.77 (2.7)	56.98 (3.2)
Hispanic	22.34 (2.1)	17.66 (1.8)	17.80 (2.4)
Black	17.97 (2.3)	12.36 (2.2)	13.64 (1.9)
Other	13.98 (1.1)	14.21 (1.2)	11.57 (1.0)
Geographic residence[c]			
South	38.50 (3.2)	34.07 (3.6)	38.10 (4.9)
Northeast	16.74 (2.0)	19.35 (3.1)	19.41 (3.4)
Midwest	21.45 (2.0)	22.90 (3.5)	19.87 (3.7)
West	23.31 (2.5)	23.68 (3.2)	22.62 (4.5)
Population density[c]			
High	32.33 (2.7)	34.80 (2.8)	28.33 (3.8)
Middle	46.70 (3.3)	46.00 (3.9)	51.20 (3.9)
Low	20.97 (2.2)	19.20 (2.8)	20.47 (1.7)
E-cigarette use in past 30 days	8.94 (0.60)	16.27 (1.1)	17.22 (0.92)
Cigarette use in past 30 days	4.58 (0.46)	7.26 (0.65)	13.12 (0.62)
Binge drinking in past 2 weeks	5.06 (0.46)	13.08 (0.87)	19.01 (0.80)
Marijuana use in past 30 days	6.74 (0.55)	16.39 (0.83)	21.42 (0.85)
Prescription drug abuse in past 30 days	2.87 (0.29)	5.94 (0.45)	6.59 (0.48)

[a]Coded 1 for respondents with either a mother or father with a college degree and 0 otherwise.
[b]Coded 1 for respondents who reported they either "probably will" or "definitely will" graduate from college after they finish high school, and 0 otherwise.
[c]For detailed definition see Appendix B of ref.[13].

given membership in a particular class. The results also include "class sizes," which are estimates of the proportion of the sample that falls into each class.[13] Class size can either be a parameter estimated as part of the overall model or, instead, estimated by assigning individuals to their most likely class, and we report results from the overall model (the estimates are similar across the two methods).

Model selection for latent class analysis is informed by theory, information from other studies in the field, the "Bayesian information criterion" of model fit BIC,[14,15] and the "entropy" measure of classification certainty.[16] BIC takes into account differences in the number of classes and the number of parameters to be estimated across nonnested models. Lower BIC scores indicate better model fit, and higher values of the entropy measure indicate more precise classification.

For all descriptive and bivariate analyses we use Stata MP 12.1 software[17] and to handle missing data we use 20 imputed data sets constructed using the chained equations algorithm.[18] For the latent class analyses we use Mplus 7.3[19] and to handle missing data we use the full-information maximum likelihood algorithm.[20] All variables have missing data levels lower than 10% with the exception of parents' college degree status as reported by 8th-grade respondents (11% missing). All analyses account for the complex multistage sample design with the use of weights.

Results

Table 1 presents the demographic and drug use distribution of the sample by grade level. The results indicate that past 30-day e-cigarette use has the highest prevalence of all drug use measures used in 8th and 10th grades, at 9% and 16%, respectively. Among 12th graders, 17% used e-cigarettes in the past 30 days, while past 30-day marijuana use and binge drinking in the last 2 weeks exceeded past 30-day e-cigarette with prevalence of 21% and 19%, respectively.

Table 2 presents the sociodemographic distribution of past 30-day e-cigarette use. The distribution of e-cigarette use is consistent with the distribution of most other substances in three ways: In all grades it is (1) higher among males as compared with females, (2) higher in the lower as compared with the upper socioeconomic strata (as measured by parental education and adolescent college plans), and (3) is lower among black youth. In 8th grade past 30-day e-cigarette prevalence is lower in the Midwest and in low population density areas, but by later grades this difference attenuates and is no longer statistically significant.

Table 3 presents the bivariate drug use patterns of youth who have and have not used e-cigarettes in the past 30-days. The results indicate that youth who use e-cigarettes are, on average, highly likely to use other substances as well. In 8th grade prevalence of past 30-day cigarette smoking was 10 times higher among youth who had used an e-cigarette in the past 30 days as compared with those who had not. In 10th grade it was eight times higher and in 12th grade six times higher. For the other outcomes of binge drinking, marijuana use, and prescription drug abuse, the increased prevalence of past 30-day use among e-cigarettes users was at least four times higher in 8th and 10th grades, and at least three times higher in 12th grade.

Table 4 presents results from latent class analyses that examine the role of past 30-day e-cigarette use in the major patterns of substance use. It presents results for the model that best fits the data for each grade. In 8th grade, a two-class model fit better than a three-class model as indicated by a lower BIC score (8436

Table 2. Past 30-Day E-Cigarette Prevalence Across Sociodemographic Characteristics: Bivariate Comparisons (Standard Error in Parentheses)

Variable	8th grade (n = 5060)	10th grade (n = 4443)	12th grade (n = 8597)
Total	8.94 (0.60)	16.27 (1.1)	17.22 (0.92)
Female[a]	7.43 (0.70)	13.31 (1.0)	14.06 (0.88)
Male	10.52** (0.91)	19.24** (1.5)	20.53** (1.2)
Parent with college degree[a]	7.19 (0.69)	15.08 (1.1)	16.08 (1.1)
Parent w/o college degree	11.22** (0.90)	17.93* (1.5)	18.44 (1.2)
Has college plans	8.31** (0.58)	15.29** (1.0)	15.82** (0.90)
No college plans[a]	16.37 (2.5)	26.86 (2.7)	23.77 (1.7)
White[a]	8.09 (0.83)	17.05 (1.1)	19.93 (1.1)
Hispanic	14.22** (1.6)	18.01 (2.4)	16.68 (1.7)
Black	5.42* (0.88)	10.23**(1.9)	7.98** (1.3)
Other	7.56 (1.2)	16.48 (2.0)	15.50* (1.6)
Geographic residence			
South	8.84 (0.89)	16.47 (2.1)	15.81 (1.5)
Northeast	7.38 (1.7)	17.29 (3.1)	15.77 (1.9)
Midwest	6.91** (1.2)	15.25 (1.7)	19.67 (1.4)
West[a]	12.07 (1.5)	16.16 (1.4)	18.69 (2.2)
Population density			
High[a]	9.71 (1.2)	15.10 (1.4)	16.01 (1.5)
Mid	9.92 (0.88)	17.65 (1.9)	19.73 (1.4)
Low	5.54** (0.91)	15.13 (2.0)	12.62 (1.6)

[a]Reference category for group.

*P < .05, value differs from reference category for group, two-tailed test.

**P < .01, value differs from reference category for group, two-tailed test.

Table 3. Prevalence of Selected Substances by Past 30-Day E-Cigarette Use (Standard Errors in Parentheses)

	8th grade (n = 5060)		10th grade (n = 4443)		12th grade (n = 8597)	
Substance	No e-cig use in past 30 days	Used e-cig in past 30 days	No e-cig use in past 30 days	Used e-cig in past 30 days	No e-cig use in past 30 days	Used e-cig in past 30 days
Cigarette use in past 30 days	2.56 (0.30)	25.11 (3.0)	3.32 (0.47)	27.48 (2.2)	7.05 (0.48)	42.32 (1.7)
Binge drinking in past 2 weeks	3.43 (0.40)	21.67 (2.4)	8.39 (0.71)	37.21 (2.4)	13.13 (0.74)	47.27 (1.8)
Marijuana use in past 30 days	4.48 (0.48)	29.84 (2.9)	10.70 (0.71)	45.69 (2.4)	15.13 (0.84)	51.61 (1.8)
Nonmedical use of prescription drugs in past 30 days	2.26 (0.25)	9.13 (1.6)	3.63 (0.39)	17.82 (2.1)	4.78 (0.44)	15.27 (1.2)

All differences in prevalence across past 30-day e-cigarette use are significant at the level P < .01 for a two-tailed test.

Table 4. Conditional Probabilities of Substance Use by Class Membership: Latent Class Solution, by Grade (Standard Error in Parentheses)

	8th grade (n = 5060)		10th grade (n = 4443)		12th grade (n = 8597)		
Class size[a]	Low-level users 91%	Poly-users 9%	Low-level users 82%	Poly-users 18%	Low-level users 76%	Predominant e-cig users 8%	Poly-users 16%
E-cigarette use	0.046 (0.005)	0.50 (0.04)	0.071 (0.006)	0.60 (0.03)	0.027 (0.03)	0.93 (0.41)	0.50 (0.03)
Cigarette use	0.005 (0.002)	0.47 (0.04)	0.005 (0.002)	0.39 (0.03)	0.019 (0.009)	0.32 (0.10)	0.53 (0.03)
Binge drinking	0.009 (0.002)	0.43 (0.04)	0.040 (0.005)	0.56 (0.03)	0.077 (0.007)	0.32 (0.09)	0.67 (0.04)
Marijuana use	0.017 (0.004)	0.55 (0.05)	0.049 (0.006)	0.70 (0.03)	0.079 (0.005)	0.25 (0.06)	0.83 (0.04)
Prescription drug abuse	0.012 (0.002)	0.21 (0.03)	0.017 (0.003)	0.26 (0.02)	0.021 (0.003)	0.01 (0.03)	0.30 (0.03)

All substance use is past 30-day prevalence, except for binge drinking which is prevalence in the past 2 weeks.

[a]Class sizes estimated as parameters in the overall model, which allows for misclassification error with entropy estimates less than 1 (entropy values reported in the text).

for two-class vs. 8464 for three-class) and a higher entropy score (0.87 for two-class vs. 0.84 for three-class). In 10th grade, a two-class model also fit better than a three-class model (BIC, 13 016 for two-class vs. 13 025 for three-class; entropy score, 0.81 for two-class vs. 0.79 for three-class). In 12th grade, a three-class model fit better than a two-class model (BIC, 30 317 for three-class vs. 30 378 for two-class; entropy score, 0.80 for three-class vs. 0.76 for two-class) and also better than a four-class model, which had a relatively lower entropy score (0.78) and was not readily interpretable.

In 8th grade the two substance use classes are a "low-level users" group (91% of the sample) and a "poly-users" group (9% of the sample). In the "low-level users" group past 30-day e-cigarette use stands out as having the highest probability of use (4.7%), which is about three times higher than the probability of past 30-day use for any of the other substance use measures. Members of the "poly-users" class have a high probability to use any of the five substances, around 50% for each except prescription drugs (22%).

These results indicate that 8th grade students who used e-cigarettes in the past 30 days are about evenly split across the two substance use classes. An estimated 4.19 out of every 100 8th graders are in the "low-level users" group and have used e-cigarettes in the past 30 days, given that the "low-level users" group is estimated to be 91% of the 8th grade population and the probability of past 30-day e-cigarette use in this group is 4.6% (4.19 = 91 × 0.046). An estimated 4.5 out of every 100 8th graders are in the polysubstance group and have used e-cigarettes in the past 30 days, given that the polysubstance group is estimated to be 9% of the 8th grade population and the probability of past 30-day e-cigarette use is 50% (4.5= 9 × 0.50).

The 10th-grade model of drug use patterns is also a two-class model of "low-level users" and "polyusers" but differs from the 8th-grade model in three important ways. First, the "low-level users" group is not so heavily dominated by e-cigarette use as in the 8th grade results. In 10th grade the probability of past 30-day e-cigarette use (7.1%) is closer to the probabilities of use for binge drinking (3.9%) and marijuana use (4.6%). Second, substance use levels are higher as indicated by a smaller "low-level users" group (82% in 10th grade as compared with 91% in 8th grade) as well as a "poly-users" class that is twice as large as in the 8th grade results. Third, the split of past 30-day e-cigarette users across the two groups favors the "poly-users" by a 65 to 35 ratio (using the calculation method described for 8th graders above).

In 12th grade a three-class model is the best fit with the data and this grade contains a "predominant e-cigarette user" group in which members are characterized by a very high (95%) probability of past 30-day e-cigarette use. The "predominant e-cigarette user" group comprises 7% of the 12th-grade population and shows probabilities of past 30-day tobacco cigarette use (35%), binge drinking in the past 2 weeks (35%), and past 30-day marijuana use (26%) that lie between the probabilities for a "poly-users" group and the "low-level users" group. The 12th-grade "poly-users" group is similar to the 10th grade results both in size (17%) and item probabilities. The "low-level users" group is smaller than it is in 10th grade, in part because many past 30-day e-cigarette users are now in a separate class. As in models for younger grades, the "low-level users" group remains the largest class and members have low probabilities of substance use in relation to the other classes.

In 12th grade about 12% of past 30-day e-cigarette users come from the "low-level users" group. Probability of past 30-day e-cigarette use in this class is 2.6% and the class size is 76%, indicating that this class represents about two past 30-day e-cigarette users per 100 12th-grade students (1.98 = 0.026 × 76). Given that overall prevalence of past 30-day e-cigarette use at this grade is 17%, the "low-level" users group accounts for about 12% of all past 3-day e-cigarettes users (2/17 = 0.12). Using the same calculation method described above, the polysubstance class of "predominant e-cigarette users" accounts for about 39% of past 30-day e-cigarette users and the "polyusers" group accounts for about 50%.

Discussion

The aim of this study is to examine current drug use patterns of adolescents to identify if e-cigarette users (1) come from the large pool of youth who do not use traditional drugs of abuse or (2) are polydrug users. We find that e-cigarette users come from both groups, with the proportion coming from each group differing by grade level.

The portion of past 30-day e-cigarette users who are not using drugs of abuse is smaller at higher grade levels and is about 50% in 8th grade, 35% in 10th grade, and 12% in 12th grade. These past 30-day e-cigarette users come from the "low-level users" class, which in all grades is the largest group of adolescents. While this group has a low probability of drug use, in 8th grade e-cigarettes are about three times more likely to be used than any of the other substances. In comparison, among 10th and 12th graders e-cigarettes do not have such a high probability of use in relation to the other substances, in large part because the probabilities of use of the other substances are much higher than they were in the 8th grade results.

The other past 30-day e-cigarette users are polysubstance users. As expected, a polysubstance group with a heightened probability of use for each of the substances is found in every grade level. In addition, this study uncovers a unique class of polysubstance user emerging in 12th grade that we label "predominant e-cigarette users." Members of this group have a 95% probability of past 30-day e-cigarette use as well as a probability for binge drinking in the past 2 weeks, past 30-day cigarette use, and past 30-day marijuana use that is higher than the "low-level" group but also lower than the regular, polysubstance group.

The role of e-cigarettes in substance use is hotly debated, and the current study results indicate that longitudinal panel studies of 8th-grade and 10th-grade students have high potential to inform this discussion. At these grades substantial portions of e-cigarette users are not using traditional substances of abuse, and are consequently at a crossroads. On the one hand, these young e-cigarette users may transition into polysubstance use as they age, supporting claims that e-cigarettes serve as a launching pad to other forms of substance use. In this scenario e-cigarettes teach children how to smoke, accustom youth to substance use, possibly lead to biological changes in the brain that predispose youth to future substance use, and confer to youth a reputation of "drug user" that can lead to involvement in social networks that promote drug use. On the other hand, many e-cigarette users in 8th and 10th grades may never transition to use of other substances as they age. This finding would support claims that e-cigarette use can siphon youth away from cigarettes and prevent a lifelong addiction to tobacco. This scenario is possible if many of the polysubstance e-cigarette users in 12th grade are new users who started use after 10th grade. These competing interpretations of the results cannot be addressed with cross-sectional research designs and require a longitudinal research design.

Panel studies starting in 12th grade are less strategic because at this age e-cigarette users are predominantly polysubstance users. These findings suggest that older adolescents do not use e-cigarettes alone to the exclusion of other substances, and that e-cigarettes therefore serve as a supplement and do not substitute for traditional drugs of abuse. Surveys of future 12th-grade cohorts are needed to determine if this finding persists or if it is specific to this 12th-grade cohort, which has traversed adolescence early in the e-cigarette epidemic.

We note one caveat and one limitation. First, the drug use patterns of e-cigarette users may change in the future, particularly if government regulatory bodies impose restrictions on e-cigarettes

such as limits on flavoring additives, increases in the penalties for sales to minors, or stricter regulation of advertising. This article establishes a baseline analysis, and examination of future cohorts surveyed by Monitoring the Future will determine the extent of changes in future years.

Second, the data do not contain information on the content of the e-cigarettes that youth are using. It is possible that the drug use patterns of e-cigarette users may differ depending on whether they are inhaling nicotine, hash oil, or just flavoring. Future surveys of Monitoring the Future (beginning in 2015) will collect this more detailed information and allow a test of the potential moderating influence of e-cigarette contents.

In conclusion, among younger adolescents in 8th and 10th grades, 35% to 50% of e-cigarette users do not use any other traditional drugs of abuse. These results therefore point to these grades as particularly strategic for future panel studies to determine whether e-cigarette use is a risk factor or a protective factor for transition to the use of other substances.

Funding

This study was supported by the National Institute on Drug Abuse, part of the National Institutes of Health, grant # R01DA001411.

Declaration of Interests

None declared.

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