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**Smoking Behaviors and Intentions among Current E-Cigarette Users, Cigarette Smokers,
and Dual Users: A National Survey of U.S. High School Seniors**

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Abstract

E-cigarette use among adolescents has increased significantly in recent years, but it remains unclear whether cigarette smoking behaviors and intentions differ among current (i.e., 30-day) non-users, only e-cigarette users, only cigarette smokers, and dual users. A nationally representative sample of 4385 U.S. high school seniors (modal age 18 years) were surveyed during the spring of their senior year via self-administered questionnaires in 2014. An estimated 9.6% of U.S. high school seniors reported current (30-day) e-cigarette use only, 6.3% reported current cigarette smoking only, and 7.2% reported current dual use of e-cigarettes and cigarette smoking. There were no significant differences between current only cigarette smokers and dual users in the odds of early onset of cigarette smoking, daily cigarette smoking, future cigarette smoking intentions, friends' cigarette smoking behaviors, attempts to quit cigarette smoking, or the inability to quit cigarette smoking. Adolescents who only used e-cigarettes had higher odds of cigarette smoking behaviors and intentions than current non-users, including intentions for future cigarette smoking in the next 5 years (AOR = 2.57, 95% CI: 1.21—5.24). Dual users and only cigarette smokers had higher odds of cigarette smoking behaviors and intentions than non-users or only e-cigarette users. Adolescents who engage in current dual use appear to have cigarette smoking behaviors and intentions that more closely resemble cigarette smokers than e-cigarette users. Adolescents who only use e-cigarettes have higher intentions to engage in cigarette smoking in the future relative to their peers who do engage in e-cigarette use or cigarette smoking.

Keywords: Electronic cigarettes; Cigarette smoking; Adolescents; Nicotine; Cigarettes; Tobacco products; Epidemiology

1. Introduction

E-cigarettes are battery-powered vaporizer devices that may contain nicotine, flavorings or both nicotine and flavorings and include a wide variety of flavors such as bubble gum, candy and fruit (Pepper et al., 2016). The prevalence of current e-cigarette use (i.e., defined as e-cigarette use in the past 30 days) among U.S. high school students has increased from 1.5% in 2011 to 16.0% in 2015 (Singh et al., 2016). E-cigarette use is more prevalent among U.S. adolescents compared to the use of any other tobacco product (Arrazola et al., 2015; Johnston et al., 2016; Singh et al., 2016) and e-cigarettes have the lowest *perceived* risk relative to other substances in a national sample of 8th, 10th and 12th grade students (Johnston et al., 2016). Based on the high prevalence and recent increases in e-cigarette use among U.S. adolescents, there is growing empirical evidence and public health concerns that early exposure to e-cigarettes could lead to increased risk of cigarette smoking and other tobacco use (CDC, 2013; Leventhal et al., 2015; Primack et al., 2015).

Both regional and national U.S. studies have found that adolescents and young adults who never smoked cigarettes in their lifetime and used e-cigarettes at baseline were more likely than those who never used e-cigarettes to initiate tobacco use including cigarette smoking over time (Leventhal et al., 2015; Primack et al., 2015). As a result, there are legitimate public health concerns that e-cigarette use can lead to the use of more harmful tobacco products such as cigarette smoking and result in nicotine dependence (Bunnell et al., 2015; CDC, 2013; Leventhal et al., 2015; Primack et al., 2015). Based on the emerging evidence that e-cigarette use could be a gateway to cigarette smoking among adolescents, there remain questions about whether e-cigarettes should be used as a cessation method, and thus, made freely available on the market -- or not.

There is mixed evidence as to whether e-cigarettes help cigarette smokers reduce their tobacco smoking or help them change to less hazardous tobacco products based on several small and short-term studies (e.g., Adkison et al., 2013; Adriaens et al., 2014; Berg et al., 2014; Bullen et al., 2013; Grana et al., 2014; Kasza et al., 2014; Polosa et al., 2014) and review articles (Drummond et al., 2014; McRobbie et al., 2014; Odum et al., 2012). However, these studies were largely conducted with adult samples and concluded that more research is needed among adolescents.

There is emerging epidemiological evidence that a large proportion of adolescent e-cigarette users are dual users defined as those who report both e-cigarette use and cigarette smoking (Hughes et al., 2015; Jeon et al., 2016; Kristjansson et al., 2015). Furthermore, the most common reasons for e-cigarette use among adolescents are for experimentation and recreational purposes while adults were most likely to report using e-cigarettes for smoking cessation purposes (Hughes et al., 2015; Patel et al., 2016; Patrick et al., 2016). Thus, it is imperative to improve our understanding regarding the smoking-related behaviors and intentions associated with e-cigarette use, cigarette smoking, and dual use among U.S. adolescents. Based on existing studies on e-cigarette use among adolescents, the present study examined the following hypotheses: 1) Adolescent dual users have lower cigarette smoking behaviors and intentions than only cigarette smokers; 2) Adolescents who only used e-cigarettes have greater cigarette smoking behaviors and intentions than non-users.

2. Methods

2.1. Data and sample

The Monitoring the Future (MTF) study annually surveys a cross-sectional, nationally representative sample of high school seniors in approximately 122 public and private schools (2014, 105 public schools, 17 private schools) in the U.S. (excluding Alaska and Hawaii), using self-administered paper-and-pencil questionnaires in classrooms. The MTF study used a multi-stage sampling procedure, and this study analyzed data from high school seniors from the 2014 cohort. In stage 1, geographic areas (or primary sampling units) were selected; in stage 2, schools within primary sampling units were selected (with probability proportionate to school size); and in stage 3, students within schools were selected. The MTF assigned weights to compensate for differential probabilities of selection at each stage of sampling. Final weights for public use were normalized so that the weighted number of cases equaled the unweighted number of cases overall. Accordingly, all the analyses presented in this study used the weights provided by the MTF to account for the unequal probabilities of selection that occurred at any stage of sampling. Finally, it should also be highlighted that the response rate high school seniors for the 2014 MTF was 82%

The annual MTF randomly distributes six different forms (i.e., surveys) to high school seniors due to the number of questions included in the MTF study (this allows the MTF to ask a wide range of questions while reducing respondent burden). The measures most relevant for this study were asked on Forms 1 and 6, so this study focuses on the cross-sectional subsamples receiving these two forms. Additional details about the MTF design and methods are available elsewhere (Johnston et al., 2016; Miech et al., 2016). Institutional Review Board approval was granted for this study by the University of Michigan Institutional Review Board.

The sample for this study included 4,385 individuals (unweighted; $n = 4,369$) who completed questionnaires during the spring of their senior year in 2014, including 710 (17.2%)

individuals who reported e-cigarette use and 577 (13.3%) individuals who reported cigarette smoking. The modal age of the individuals in the sample was 18 years of age. The sample represented a population that was 51.3% female, 51.2% White, 12.4% African-American, 16.3% Hispanic, and 20.2% other / not disclosed during this time period. Refer to Table 1 for additional sample characteristics.

2.2. Measures

The MTF study assesses a wide range of behaviors, intentions, and values. For the present study, we selected specific validated measures for analyses, including demographic characteristics and standard measures of substance use behaviors and intentions including cigarette smoking and e-cigarette use (Bachman et al., 2015; Johnston et al., 2016; Miech et al., 2016).

The key independent variable for the analyses consisted of two questions that measured current e-cigarette use and cigarette use. *Current e-cigarette use* was assessed with the following item: “During the last 30 days, on how many occasions (if any) have you used electronic cigarettes (e-cigarettes)?” The response options ranged from (1) none to (6) 20-30 days. *Current cigarette smoking* was assessed with the following item: “How frequently have you smoked cigarettes during the past 30 days?” The response options ranged from (1) none to (7) two packs or more per day. Both questions were dichotomized (i.e., any 30-day use versus no 30-day use) in order to create a mutually exclusive variable that consisted of the following categories for current e-cigarette and cigarette use: (1) no e-cigarette use or cigarette smoking, (2) only e-cigarette use, (3) dual use (i.e. both e-cigarette use and cigarette smoking), and (4) only cigarette smoking.

The major outcome variables consisted of eight items that included future cigarette smoking intentions, quit attempts from smoking, first cigarette smoking onset, daily cigarette smoking onset, cigarette smoking dependence symptom, friends' cigarette smoking, frequency of e-cigarette use, and frequency of cigarette smoking. *Future cigarette smoking intentions* was assessed with the following item: "Do you think you will be smoking cigarettes five years from now?" The response options ranged from (1) Definitely will to (4) Definitely will not. *Cigarette smoking quit attempts* was assessed with the following item: How many times (if any) have you tried to stop smoking? Response options ranged from (1) None to (6) 10 or more times. *Cigarette smoking onset* was assessed with the following two items: "When (if ever) did you first do each of the following things?" (a) Smoke your first cigarette and (b) Smoke cigarettes on a daily basis. Response options ranged from (1) Grade 6 or below to (7) Grade 12 (Senior). *Cigarette smoking dependence symptom* was assessed with the following item: "Have you ever tried to stop smoking and found that you could not?" Response options were (1) Yes and (2) No. *Friends' cigarette smoking* was assessed with the following item: "How many of your friends would you estimate. . . Smoke cigarettes?" Response options ranged from (1) None to (5) All. *Frequency of e-cigarette use* and *frequency of cigarette smoking* were derived from the two items used to construct the major independent variable outlined above. Accordingly, all eight outcome measures were dichotomized for the analyses (refer to Table 2 for more details on how these measures were recoded).

2.3. Analysis

Descriptive statistics were provided to examine sociodemographic characteristics, cigarette smoking behaviors and intentions among current non-users, e-cigarette users, cigarette smokers,

and dual users. Multiple logistic regression was used to examine the odds of several cigarette smoking behaviors and intentions among the four subgroups based on current e-cigarette use and cigarette smoking when controlling for potentially confounding factors known to be associated with substance use in the MTF including sex, region, urbanicity, age, race, and parental education – refer to Table 1 for more information on these variables (Bachman et al., 2015; Johnston et al., 2016; Miech et al., 2016). For the analyses, STATA 14.0 was the software used to estimate the models outlined above (Version 14.0; StataCorp LP, College Station, Texas). All logistic regression models provide adjusted odds ratios (AOR) and 95% confidence intervals (95% CI) while controlling for the potentially confounding factors. All analyses used the weights provided by the MTF to account for the probability of selection into the sample. It should be noted that the results presented handled missing data using listwise deletion. The analyses were also conducted using multiple imputation and found identical results in terms of significance levels (along with similar prevalence rates and adjusted odds ratios in multiple logistic regression models). Accordingly, listwise deletion was seen as the optimal approach due to similar results across models (listwise versus multiple imputation) and for other researchers to identically reproduce the results from this study using the publically available data provided by the MTF.

The multistage sampling design used for MTF resulted in clustering of the data, which may cause some overstatement of the statistical significance of results when conducting analyses that do not account for the complex sampling. Because MTF did not provide the information needed to account for the complex sampling design (e.g., primary sampling unit and Strata variables) in the public-use data files, West and McCabe's (2012) Stata program (Stata .ado file – `deft2corr`) was used to apply the appropriate adjustments to the variance estimates in the analytic models.

Accordingly, the 95% confidence intervals (CIs) provided in all of the tables reflect the adjustments made to account for the complex sampling procedure in the MTF data.

3. Results

3.1. Prevalence of current e-cigarette use, cigarette smoking and dual use

Table 2 provides descriptive statistics and adjusted odds ratios (AOR) for current e-cigarette use and cigarette smoking across several sociodemographic characteristics. Approximately 9.6% of U.S. high school seniors reported current only e-cigarette use, 6.3% reported only cigarette smoking, and 7.2% reported dual e-cigarette use and cigarette smoking. Current e-cigarette use and cigarette smoking significantly varied across several important sociodemographic characteristics (refer to Table 2 for AOR's and accompanying 95 % confidence intervals for these sociodemographic characteristics).

3.2. Cigarette smoking behaviors and intentions based on current e-cigarette use, cigarette smoking and dual use

Table 3 shows the descriptive results for cigarette smoking behaviors and intentions among current non-users, only e-cigarette users, only cigarette smokers, and dual users. The results indicate that both current dual users and only cigarette smokers had the highest prevalence of cigarette smoking behaviors and intentions. Moreover, it should be noted that most of the differences between dual users and only cigarette smokers were not found to be statistically significant.

Table 4 and 5 provides the results from the multiple logistic regression analyses. In particular, the results show that current dual users and only cigarette smokers have comparable

odds regarding cigarette smoking behaviors and intentions. Moreover, both current dual users and only cigarette smokers have significantly higher odds across each outcome for cigarette smoking behaviors, when compared to either non-users or only e-cigarette users. Finally, it should also be noted that only e-cigarette users had higher odds of initiating cigarette smoking in the 8th grade or earlier, intentions of cigarette smoking in the next 5 years, and having a peer group that consists almost entirely of cigarette smokers when compared to non-users.

4. Discussion

There is an estimated 3 million U.S. secondary school students who report current e-cigarette use in 2015 (Singh et al., 2016). The present study found that current dual use was more prevalent than only cigarette smoking among adolescents. The findings from the present study *did not* provide support for the first hypothesis and offer new evidence that dual users and only cigarette smokers do not differ in terms of cigarette smoking behaviors (e.g., daily smoking, early onset, inability to quit) that have robust associations with steeper acceleration and greater persistence in cigarette smoking over time as well as and nicotine dependence (Breslau and Peterson, 1996; Chassin et al., 2000, 2009; Riggs et al., 2007).

We found that current dual users and only cigarette smokers have similar smoking behaviors and intentions suggesting that dual use may not facilitate beliefs about non-smoking among adolescents. Although more than 4 in every 5 adults reported the most common reason for e-cigarette use was for smoking cessation, other studies found that adolescents appeared motivated primarily by curiosity, taste, and pleasure, rather than for smoking cessation (Patel et al., 2016; Patrick et al., 2016). The leading reasons for e-cigarette use among adolescents included experimentation, taste, boredom, having a good time, and relaxation (Patrick et al., 2016). To

date, there is mixed evidence regarding the efficacy of e-cigarettes to reduce or completely abstain from cigarette smoking among regular adult smokers (e.g., Adriaens et al., 2014; Berg et al., 2014; Grana et al., 2014; Polosa et al., 2014). However, the majority of previous studies examining the role of e-cigarettes in assisting with smoking cessation have focused on adults rather than adolescents.

The present study found that approximately 40% of only cigarette smokers and 45% of dual users had at least one quit attempt (no significant differences were found between these two groups). Prior work has found that nearly 70% of adult smokers wanted to stop smoking and nearly half of adolescents and adults had made a quit attempt in the past year (CDC, 2014; USDHHS, 2014). The lack of differences between adolescents who report only cigarette smoking compared to dual users suggests these two subgroups hold similar prevalence of quit attempts, future smoking intentions, and peer groups made up of friends who smoke. Taken together, more than two in every five e-cigarette users are at comparable risk with cigarette smokers to experience negative health consequences associated with nicotine and tobacco use as a result of their dual use.

The results of the present study provide strong support for the second hypothesis and indicate adolescents who report only e-cigarette use have greater future intentions of cigarette smoking relative to adolescents who do not currently use e-cigarettes or smoke cigarettes. The findings from this study and other studies raise important clinical and policy concerns because e-cigarette use may be associated with the transition to cigarette smoking and other tobacco use among adolescents but more research is warranted to determine whether this association is causal (Leventhal et al., 2015; Primack et al., 2015; SAMHSA, 2014). Although the long-term health effects of e-cigarettes remain unknown (Collaco et al., 2015), e-cigarettes may induce inhalation

and nicotine exposure during adolescence and may have long-term adverse consequences for brain development and could lead to nicotine dependence and initiation or sustained use of more harmful tobacco products (CDC, 2014; Leigh et al., 2016; Leventhal et al., 2015; Primack et al., 2015; USDHHS, 1988). Studies have found evidence of nicotine variability as high as 45-131% relative to the label disclosure when tested by standard methods (Peace et al., 2016). Such lack of regulation and low perceived risk associated with regular e-cigarette use may give adolescents the illusion of safety for experimentation and regular use (Miech et al., 2016). Although U.S. adolescents report the greatest interest in trying fruit-flavored e-cigarettes and perceive less harm to health associated with fruit-flavored e-cigarettes (Pepper et al., 2016), fruit-flavored cartridges (e.g., strawberry flavored) may carry the most carcinogens to the bronchial epithelium based on in vitro testing (Leigh et al., 2016).

The findings from the present study have important clinical and policy implications for e-cigarette use and smoking cessation programs geared towards adolescents. First, we found that current only e-cigarette users had higher odds of future intentions of cigarette smoking in the next 5 years when compared to adolescents who have not recently used e-cigarettes or smoked cigarettes. Clearly, policy efforts must balance the possible efficacy of e-cigarettes in smoking cessation with the risk of smoking-naïve adolescents transitioning from e-cigarette use to cigarette smoking. More prospective studies are needed worldwide to assess whether e-cigarettes lead to cigarette smoking to help inform policies about e-cigarette availability in the U.S. and worldwide. Second, the present study found that dual users engaged in more frequent/daily e-cigarette use than only e-cigarette users. Furthermore, dual users had similar levels of daily cigarette smoking compared to only cigarette smokers. As a result, it is highly likely that dual users consume higher levels of nicotine than only e-cigarette users or only

cigarette smokers. However, this is difficult to truly ascertain given the previous lack of regulation of e-cigarette products and variability in nicotine levels (Miech et al., in press). While the present study found no differences in one tobacco use disorder (TUD) symptom (i.e., "inability to quit smoking") between dual users and cigarette smokers, future research is needed to study the nicotine levels and full array of tobacco use disorder symptoms between these subgroups over time with multiple cohorts.

The present study has several strengths that build upon previous literature examining e-cigarette use and other health behaviors. A major strength of the present study is the large national sample of adolescents with a diverse range of socio-demographic characteristics. The large heterogeneous MTF sample also allowed for subgroups to be defined based on frequency of e-cigarette use and dual use involving cigarette smoking. This study contained all the limitations associated with large-scale school-based survey research using self-administered surveys and retrospective assessment including nonresponse bias and missing data. For instance, there are some important subgroups of the U.S. youth population missing from the MTF data collected each year, such as students who were home-schooled, have dropped out of school, or were absent on the day of data collection and therefore did not participate in the study. High school students who drop out or who are often absent from school are more likely to engage in substance use and other problem behaviors (Miech et al., 2016; SAMHSA, 2014) while home-schooled youth were less likely to engage in substance use behaviors (Vaughn et al., 2015).

While prior work has found that self-report data in the MTF study have been found to be reliable and valid, studies on youth suggest that misclassification and under-reporting of sensitive behaviors such as substance use can occur (Harrison and Hughes, 1997; Johnston and O'Malley, 1985; O'Malley et al., 1983). In the MTF study, no adjustments are made to correct

for any missing data or under-reporting; thus, results from the present study may be conservative and underreport the actual prevalence of sensitive behaviors. Multiple imputation analyses were conducted in the present study to examine the sensitivity of our inferences to possible biases introduced by missing data and found our results were robust to the possibility of bias introduced by item-missing data in the analysis variables. Finally, the e-cigarette use and cigarette smoking measures could only assess past 30-day use. Lifetime measures of e-cigarette use were not included on the MTF forms used in the current study making it impossible to assess lifetime patterns of e-cigarette use. Future studies on adolescents and young adults should examine cigarette smoking behaviors and future intentions using measures that capture the lifetime history of e-cigarette use.

Despite these limitations and the ability to only assess associations due to the data being cross-sectional, previous research examining e-cigarette use and smoking cessation efforts has focused heavily on adult samples. The present study provides a unique opportunity to examine several smoking-related behaviors and intentions among adolescents with substantial and broad public health implications as nearly all individuals in the U.S. are impacted—directly or indirectly—by e-cigarette and tobacco use. The U.S. Food and Drug Administration recently extended its authority to e-cigarettes and announced proposed regulations to this \$2.5 billion dollar U.S. industry such as prohibiting retailers from selling e-cigarettes to those under age 18 years old and requiring manufacturers to include health warnings on e-cigarettes. Based on the recent changes in the federal oversight of e-cigarettes, the findings of the present study have important policy implications for tobacco control and provide a valuable baseline assessment to evaluate future associations between e-cigarette use and cigarette smoking.

Conflict of interest

None.

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Table 1. Sample Characteristics

	Overall Sample % (n) (n = 4385)	
	%	95% CI
Sex		
Male	48.6%	(46.2%, 51.0%)
Female	51.3%	(48.9%, 53.7%)
Geographical region		
Northeast	19.6%	(17.8%, 21.3%)
Midwest	19.9%	(18.1%, 21.6%)
South	38.2%	(35.9%, 40.4%)
West	22.3%	(20.3%, 24.3%)
Metropolitan statistical area/urbanicity		
Large MSA	28.7%	(26.6%, 30.7%)
Other MSA	51.1%	(48.8%, 53.4%)
Non-MSA	20.2%	(18.3%, 21.9%)
Age		
Less than 18 years	41.4%	(39.1%, 43.7%)
18 years or older	58.6%	(56.3%, 60.9%)
Race		
White	51.2%	(48.8%, 53.4%)
Black	12.4%	(10.8%, 13.9%)
Hispanic	16.3%	(14.6%, 17.9%)
Other	20.2%	(18.4%, 22.1%)
Parental education		
No college	24.7%	(22.7%, 26.7%)
Some college	64.5%	(62.3%, 66.7%)
Don't know/missing	10.8%	(9.4%, 12.2%)
E-cigarette use and cigarette smoking behaviors		
No current 30-day e-cigarette use or cigarette use	76.9%	(74.9%, 78.9%)
Current 30-day e-cigarette use only	9.6%	(8.3%, 10.9%)
Current 30-day e-cigarette use and cigarette use	7.2%	(6.0%, 8.4%)
Current 30-day cigarette smoking only	6.3%	(5.1%, 7.4%)

Weighted estimates are provided. % = percent (prevalence within column)

Data source: 2014 Monitoring the Future study.

Table 2. Demographic characteristics associated with current 30-day e-cigarette use, cigarette smoking, and dual use among U.S. high school seniors

	Current e-cigarette users only (n = 3863)				Current dual uses (n = 3863)				Current cigarette smokers only (n = 3863)			
	%	95% CI	AOR	95% CI	%	95% CI	AOR	95% CI	%	95% CI	AOR	95% CI
Sex												
Male	61.0%	(53.4%, 68.4%)			59.6%	(50.5%, 68.7%)			52.7%	(42.7%, 62.9%)		
Female	39.0%	(31.5%, 46.6%)	.562	(.399, .792)	40.4%	(31.2%, 49.5%)	.627	(.421, .933)	47.3%	(37.1%, 57.3%)	.872	(.571, 1.33)
Geographical region												
Northeast	16.4%	(11.1%, 21.7%)			18.3%	(11.9%, 24.6%)			18.4%	(11.1%, 25.4%)		
Midwest	23.2%	(17.2%, 29.3%)	1.71	(1.01, 2.87)	22.0%	(14.9%, 29.1%)	1.02	(.560, 1.86)	19.5%	(12.1%, 26.7%)	.962	(.497, 1.86)
South	34.4%	(27.3%, 41.6%)	1.34	(.819, 2.20)	38.0%	(29.5%, 46.6%)	1.12	(.656, 1.93)	44.8%	(35.5%, 54.6%)	1.19	(.668, 2.14)
West	25.6%	(19.1%, 32.7%)	1.45	(.845, 2.48)	21.7%	(14.2%, 28.8%)	1.05	(.571, 1.94)	17.2%	(9.3%, 25.1%)	.875	(.404, 1.89)
Metropolitan statistical area/urbanicity												
Large MSA	28.5%	(21.8%, 35.2%)			20.0%	(13.5%, 26.6%)			24.1%	(16.0%, 32.6%)		
Other MSA	59.6%	(52.3%, 66.9%)	1.11	(.767, 1.63)	60.3%	(51.7%, 68.6%)	1.83	(1.12, 2.98)	41.4%	(31.7%, 50.9%)	.894	(.520, 1.53)
Non-MSA	11.9%	(7.1%, 16.8%)	.526	(.300, .923)	19.7%	(12.7%, 26.7%)	1.35	(.733, 2.50)	34.5%	(25.5%, 43.2%)	1.59	(.900, 2.83)
Age												
Less than 18 years	40.0%	(32.5%, 47.4%)			38.7%	(29.7%, 47.4%)			28.5%	(19.8%, 37.2%)		
18 years or older	60.0%	(52.5%, 64.9%)	1.03	(.735, 1.44)	61.3%	(52.6%, 70.2%)	1.07	(.714, 1.62)	71.5%	(62.7%, 80.2%)	1.76	(1.12, 2.75)
Race												
White	54.0%	(46.5%, 61.5%)			69.6%	(61.4%, 77.3%)			60.8%	(51.1%, 69.9%)		
Black	5.0%	(1.9%, 8.1%)	.374	(.188, .746)	3.0%	(0.4%, 5.8%)	.169	(.062, .459)	11.2%	(4.5%, 17.9%)	.719	(.335, 1.54)
Hispanic	19.0%	(13.1%, 24.9%)	1.07	(.661, 1.75)	9.4%	(4.5%, 14.4%)	.483	(.247, .942)	9.6%	(4.5%, 14.7%)	.396	(.191, .821)
Other	22.0%	(15.7%, 28.2%)	1.04	(.662, 1.65)	18.1%	(11.5%, 24.8%)	.470	(.254, .871)	18.5%	(11.1%, 25.9%)	.745	(.383, 1.44)
Parental education												
No college	23.4%	(16.9%, 29.7%)			23.3%	(16.0%, 30.7%)			37.2%	(27.7%, 46.5%)		
Some college	65.3%	(58.1%, 72.6%)	1.01	(.670, 1.53)	67.7%	(59.3%, 75.7%)	.908	(.565, 1.46)	51.3%	(41.6%, 60.8%)	.431	(.265, .700)
Don't know/missing	11.3%	(6.3%, 16.4%)	1.31	(.607, 2.84)	9.0%	(3.9%, 14.4%)	.158	(.033, .764)	11.5%	(5.6%, 17.5%)	.834	(.364, 1.91)

***p<.001; Weighted estimates are provided. % = percent (prevalence within column)

All multiple logistic regression models controlled of sex, geographical region, metropolitan statistical area, age, race, and parental education.

Data source: 2014 Monitoring the Future study.

Table 3. Cigarette smoking, quit attempts, intentions and peer smoking as a function of current e-cigarette use and cigarette smoking among U.S. high school seniors

	No current e-cigarette use or cigarette smoking % 95% CI	Current e-cigarette use only % 95% CI	Current dual use % 95% CI	Current cigarette smoking only % 95% CI	(n) Chi-2/(df)
E-cigarette frequency 1-2 days 3+ days	N/A	48.0% (40.6%, 55.5%) 52.0% (44.5%, 59.4%)	32.3% (24.2%, 40.2%) 67.7% (59.7%, 75.8%)	N/A	(n = 700 ^a) 17.3*** (1)
Daily cigarette smoking Less than daily Daily	N/A	N/A	48.3% (39.7%, 57.2%) 51.7% (42.7%, 60.3%)	47.5% (37.9%, 57.2%) 52.5% (42.7%, 62.0%)	(n = 561 ^b) .038 (1)
Age of onset of smoking first cigarette Grade 8 or below Grades 9-12/Never	6.1% (4.8%, 7.5%) 93.9% (92.5%, 95.2%)	22.0% (15.2%, 28.8%) 78.0% (71.2%, 84.7%)	46.6% (37.2%, 56.0%) 53.4% (43.9%, 62.7%)	39.6% (29.4%, 49.9%) 60.4% (50.0%, 70.5%)	(n = 3590 ^c) 549.3*** (3)
Age of onset of daily cigarette smoking Grade 8 or below Grades 9-12/Never	0.7% (0.2%, 1.2%) 99.3% (98.8%, 99.8%)	1.1% (0.0%, 2.8%) 98.9% (97.2%, 100%)	14.9% (7.6%, 21.7%) 85.1% (78.2%, 92.3%)	8.3% (2.8%, 13.6%) 91.7% (86.3%, 97.1%)	(n = 3714 ^c) 262.3*** (3)
Unable to quit smoking Yes No	3.6% (1.2%, 6.0%) 96.4% (93.9%, 98.7%)	5.4% (1.0%, 9.5%) 94.6% (90.5%, 99.1%)	23.1% (15.6%, 30.5%) 76.9% (69.5%, 84.3%)	21.6% (13.9%, 29.5%) 78.4% (70.4%, 86.1%)	(n = 1334 ^d) 105.2*** (3)
Smoking quit attempts 2 or more times None or at least once	5.5% (2.5%, 8.5%) 94.5% (91.5%, 97.5%)	9.6% (3.9%, 15.2%) 90.4% (84.7%, 96.1%)	31.2% (23.0%, 39.5%) 68.8% (60.5%, 76.9%)	25.5% (17.0%, 33.6%) 74.5% (66.4%, 82.9%)	(n = 1323 ^d) 121.1*** (3)
Future cigarette smoking plans (5-years) Definitely/probably will Definitely/probably won't	2.5% (1.7%, 3.4%) 97.5% (96.5%, 98.3%)	6.8% (2.9%, 10.7%) 93.2% (89.3%, 97.0%)	39.4% (30.8%, 48.0%) 60.6% (51.9%, 69.2%)	40.6% (31.1%, 50.1%) 59.4% (49.9%, 68.9%)	(n = 4137 ^c) 904.1*** (3)
Friends cigarette smoking Most/All None/A Few/Some	4.6% (3.4%, 5.8%) 95.4% (94.1%, 96.6%)	9.7% (5.1%, 14.3%) 90.3% (85.7%, 94.9%)	29.9% (21.5%, 38.5%) 70.1% (61.5%, 78.5%)	31.0% (21.8%, 40.2%) 69.0% (59.8%, 78.2%)	(n = 3834 ^c) 365.5*** (3)

Chi-square significance values provided, ***p<.001; Weighted estimates are provided.

^aOnly respondents who indicated e-cigarette use during the past 30 days were included in the analyses.

^bOnly respondents who indicated cigarette smoking during the past 30 days were included in the analyses.

^cAll available respondents were included in the analyses (sample sizes vary due to missing data).

^dOnly respondents who indicated cigarette smoking during their lifetime were included in the analyses.

Data source: 2014 Monitoring the Future study.

Table 4. Logistic regression: Smoking onset, intentions, and peer smoking as a function of current cigarette smoking, e-cigarette use or dual use among U.S. high school seniors

Current 30-day use status	Age of onset of first cigarette (8 th grade or earlier) (n = 3,479) ^{ab} AOR (95% CI)	Age of onset of first daily cigarette smoking (8 th grade or earlier) (n = 3,573) ^{ab} AOR (95% CI)	Will definitely/probably smoke cigarettes 5 years from now (n= 3,845) ^{ab} AOR (95% CI)	Most/all friends smoke cigarettes (n= 3,683) ^{ab} AOR (95% CI)
Dual use	Ref.	Ref.	Ref.	Ref.
No current use	.076 (.047, .122)	.044 (.017, .116)	.035 (.019, .064)	.108 (.064, .185)
E-cigarette use only	.314 (.178, .554)	.074 (.017, .316)	.091 (.043, .194)	.275 (.138, .545)
Cigarette smoking only	.701 (.383, 1.28)	.471 (.168, 1.31)	1.06 (.584, 1.94)	.919 (.482, 1.75)
No current use	Ref.	Ref.	Ref.	Ref.
E-cigarette use only	4.12 (2.56, 6.62)	1.67 (.385, 7.25)	2.57 (1.21, 5.44)	2.52 (1.38, 4.62)
Dual use	13.1 (8.15, 21.0)	22.4 (8.57, 58.8)	27.9 (15.5, 50.2)	9.18 (5.39, 15.6)
Cigarette smoking only	9.19 (5.55, 15.2)	10.5 (3.46, 32.2)	29.8 (16.4, 54.1)	8.44 (4.92, 14.4)
E-cigarette use only	Ref.	Ref.	Ref.	Ref.
No current use	.242 (.150, .389)	.598 (.137, 2.59)	.388 (.183, .823)	.395 (.216, .723)
Dual use	3.17 (1.80, 5.59)	13.4 (3.16, 57.0)	10.8 (5.14, 22.9)	3.63 (1.83, 7.19)
Cigarette smoking only	2.22 (1.20, 4.11)	6.32 (1.34, 29.6)	11.6 (5.27, 25.5)	3.33 (1.65, 6.72)
Control Variables				
Sex				
Male	Ref.	Ref.	Ref.	Ref.
Female	.861 (.612, 1.21)	.820 (.379, 1.77)	.734 (.474, 1.13)	1.05 (.713, 1.55)
Geographical region				
Northeast	Ref.	Ref.	Ref.	Ref.
Midwest	1.34 (.757, 2.37)	1.30 (.396, 4.30)	1.17 (.580, 2.39)	.550 (.302, 1.00)
South	1.56 (.929, 2.64)	1.40 (.446, 4.41)	1.05 (.554, 1.99)	.817 (.487, 1.37)
West	1.52 (.834, 2.77)	.520 (.109, 2.47)	1.12 (.545, 2.33)	.560 (.298, 1.05)
Metropolitan statistical area/urbanicity				
Large MSA	Ref.	Ref.	Ref.	Ref.
Other MSA	1.41 (.922, 1.96)	1.17 (.441, 3.13)	1.21 (.711, 2.06)	1.04 (.647, 1.69)
Non-MSA	1.63 (.981, 2.71)	1.40 (.478, 4.14)	1.25 (.687, 2.29)	1.72 (.993, 2.97)
Age				
Less than 18 years	Ref.	Ref.	Ref.	Ref.
18 years or older	1.34 (.947, 1.92)	1.47 (.638, 3.41)	.745 (.483, 1.15)	.932 (.621, 1.39)

Race				
White	Ref.	Ref.	Ref.	Ref.
Black	.612 (.307, 1.21)	.334 (.045, 2.45)	1.56 (.730, 2.91)	.814 (.391, 1.69)
Hispanic	1.17 (.691, 2.01)	1.74 (.598, 5.10)	1.71 (.916, 3.22)	.852 (.446, 1.62)
Other	1.14 (.691, 1.89)	1.02 (.300, 3.51)	1.76 (.945, 3.28)	1.32 (.743, 2.34)
Parental education				
No college	Ref.	Ref.	Ref.	Ref.
Some college	.929 (.619, 1.39)	.944 (.388, 2.30)	.754 (.465, 1.22)	.819 (.517, 1.29)
Don't know/missing	1.62 (.789, 3.32)	.674 (.105, 4.32)	2.32 (.959, 5.63)	.834 (.353, 1.97)

^aAll analyses control for sex, region, urbanicity, age, race, and parental education (please refer to table 1 for details regarding these variables).

^bAll available respondents were included in the analyses (sample sizes vary due to missing data).

Data source: 2014 Monitoring the Future study.

Table 5. Logistic regression: E-cigarette use frequency, daily cigarette smoking, and quit attempts as a function of current cigarette smoking, e-cigarette use or dual use among U.S. high school seniors

Recent 30-day use status	E-cigarette use frequency (3+ days) (n= 649) ^{ab} AOR (95% CI)	Daily cigarette smoking (n = 485) ^{ac} AOR (95% CI)	Unable to quit cigarette smoking (n= 1,220) ^{ad} AOR (95% CI)	Multiple attempts to quit cigarette smoking (n= 1,207) ^{ad} AOR (95% CI)
Dual use	Ref.	Ref.	Ref.	Ref.
No current use	NA	NA	.120 (.048, .302)	.122 (.055, .268)
E-cigarette use only	.434 (.291, .648)	NA	.193 (.070, .528)	.264 (.119, .585)
Cigarette smoking only	NA	.918 (.501, 1.68)	.831 (.402, 1.71)	.701 (.358, 1.37)
No current use	Ref.	Ref.	Ref.	Ref.
E-cigarette use only	NA	NA	1.60 (.495, 5.17)	2.15 (.855, 5.43)
Dual use	NA	NA	8.27 (3.30, 20.6)	8.15 (3.72, 17.8)
Cigarette smoking only	NA	NA	6.87 (2.78, 17.0)	5.71 (2.60, 12.5)
E-cigarette use only	Ref.	Ref.	Ref.	Ref.
No current use	NA	NA	.624 (.193, 2.01)	.463 (.183, 1.16)
Dual use	2.30 (.255, .738)	NA	5.16 (1.89, 14.1)	3.78 (1.70, 8.38)
Cigarette smoking only	NA	NA	4.29 (1.46, 12.5)	2.65 (1.14, 6.14)
Control Variables				
Sex				
Male	Ref.	Ref.	Ref.	Ref.
Female	.636 (.381, 1.06)	.617 (.345, 1.10)	.913 (.506, 1.65)	1.15 (.685, 1.94)
Geographical region				
Northeast	Ref.	Ref.	Ref.	Ref.
Midwest	.923 (.420, 2.02)	.389 (.157, .959)	.595 (.227, 1.55)	.619 (.272, 1.41)
South	1.80 (.877, 3.72)	.606 (.269, 1.36)	1.04 (.474, 2.29)	.855 (.423, 1.72)
West	1.42 (.648, 3.15)	.510 (.196, 1.32)	.681 (.239, 1.93)	.530 (.209, 1.34)
Metropolitan statistical area/urbanicity				
Large MSA	Ref.	Ref.	Ref.	Ref.
Other MSA	1.47 (.796, 2.72)	.941 (.434, 2.04)	1.07 (.511, 2.25)	1.19 (.603, 2.37)
Non-MSA	.959 (.430, 2.13)	1.35 (.588, 3.13)	1.42 (.623, 3.24)	1.46 (.683, 3.12)
Age				
Less than 18 years	Ref.	Ref.	Ref.	Ref.
18 years or older	.982 (.588, 1.64)	.775 (.425, 1.41)	.923 (.498, 1.71)	1.25 (.721, 2.17)

Race				
White	Ref.	Ref.	Ref.	Ref.
Black	1.16 (.368, 3.65)	1.44 (.413, 5.04)	1.45 (.503, 4.21)	1.36 (.509, 3.65)
Hispanic	.888 (.436, 1.81)	.489 (.183, 1.30)	.769 (.265, 2.22)	.776 (.322, 1.86)
Other	1.73 (.827, 3.62)	2.38 (.949, 5.96)	1.65 (.739, 3.71)	2.03 (.994, 4.14)
Parental education				
No college	Ref.	Ref.	Ref.	Ref.
Some college	.821 (.452, 1.49)	.439 (.229, .842)	.889 (.448, 1.76)	.730 (.402, 1.32)
Don't know/missing	.851 (.234, 3.09)	.228 (.048, 1.09)	2.42 (.765, 7.66)	1.38 (.476, 4.04)

Weighted estimates are provided. Sample sizes vary due to missing data.

^aAll analyses control for sex, region, urbanicity, age, race, and parental education (please refer to table 1 for more details regarding these variables).

^bOnly respondents who reported e-cigarette use during the past 30 days were included in the analyses.

^cOnly respondents who reported cigarette smoking during the past 30 days were included in the analyses.

^dOnly respondents who indicated cigarette smoking during their lifetime were included in the analyses.

Data source: 2014 Monitoring the Future study.

Highlights

- One in every ten U.S. high school seniors used only e-cigarettes in the past-month.
- Dual use (e-cigarette use/cigarette smoking) was higher than only cigarette smoking.
- Dual users and cigarette only smokers have similar smoking behaviors and intentions.
- E-cigarette only users have greater intentions of future cigarette smoking than non-users.
- Dual users resemble cigarette smokers more than e-cigarette users.