



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 for future cigarette smoking 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 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 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, intentions for future cigarette smoking, 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 intentions for future cigarette smoking in the next 5 years (AOR = 2.57, 95% CI: 1.21–5.24) than current non-users. Dual users and only cigarette smokers had higher odds of cigarette smoking behaviors and intentions for future cigarette smoking than non-users or only e-cigarette users. Adolescents who engage in current dual use have cigarette smoking behaviors and intentions for future cigarette smoking that more closely resemble cigarette smokers than e-cigarette users. Adolescents who only use e-cigarettes have higher intentions to engage in future cigarette smoking relative to their peers who do not engage in e-cigarette use or cigarette smoking.

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1. Introduction

E-cigarettes are battery-powered vaporizer devices that may contain nicotine, flavorings or both nicotine and flavorings 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 lifetimes 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

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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 and Upson, 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 among 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 4385 individuals (unweighted; $n = 4369$) 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 use and cigarette smoking: (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

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		
<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.

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