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## Perceptions and Use of E-cigarettes across Time among Emerging Adults

Judy A. Andrews, PhD, Sarah E. Hampson, PhD, Herbert H. Severson, PhD, Erika Westling, PhD, Missy Peterson, MA

Judy A. Andrews, Senior Research Scientist, Oregon Research Institute, Eugene, OR. Sarah E. Hampson, Senior Research Scientist, Oregon Research Institute, Eugene, OR. Herbert H. Severson, Senior Research Scientist, Oregon Research Institute, Eugene, OR. Erika Westling, Research Scientist, Oregon Research Institute, Eugene, OR. Missy Peterson, Data Analyst, Oregon Research Institute, Eugene, OR.

### Abstract

**Objectives:** We present prevalence estimates of e-cigarette use and conventional cigarette use, and their co-occurrence, among emerging adults across 2 assessments, 11 months apart, conducted in 2013 and 2014. We also report on perceptions of using e-cigarettes and motives for using e-cigarettes and, among e-cigarette users, present data reflecting order of use of conventional tobacco products and e-cigarettes.

**Methods:** Participants (N = 884) in a longitudinal study, the Oregon Youth Substance Use Project, completed at least one of 2 questionnaires, at average age 22.9 and 23.8 years. Following each assessment, a subsample of e-cigarette users completed interviews using timeline follow-back strategies.

**Results:** The prevalence of e-cigarette use increased significantly across the 11 months. Compared to other nicotine products, risk perceptions associated with e-cigarettes are low. Data suggest co-occurrence between smoking conventional cigarettes and e-cigarette use, and that for most individuals, e-cigarettes are added to emerging adults' tobacco use repertoire.

**Conclusions:** Findings emphasize the need for common nomenclature for e-cigarettes, for counter advertising targeting emerging adults who are or were smokers, men, and those with less education. Findings also suggest that smoke-free policies designed to target conventional cigarettes incorporate e-cigarettes, as well.

### Keywords

e-cigarettes; emerging adults; smoking; perceptions

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Correspondence Dr Andrews; judy@ori.org.

Human Subjects Approval Statement

This research was approved by the Institutional Review Board of Oregon Research Institute, on June 25, 2014. The Assurance Identification No. is FWA00005934 and the IRB Registration No. is 00000278.

Conflict of Interest Statement

All authors declare that they have no conflicts of interest.

Use of novel tobacco and nicotine delivery products, including Electronic Nicotine Delivery Systems products (eg, e-cigarettes), has been more prevalent among emerging adults than older individuals and, until recently, younger individuals.<sup>1,2</sup> Emerging adulthood is conceptualized as a phase of the life span between adolescence and full adulthood.<sup>3,4</sup> This developmental period encompassed ages 18 through 29 and is characterized by exploration and identity formation. Young people in this age group are open to new experiences, and the novelty of smoking (or “vaping”) e-cigarettes may be particularly appealing. A review of the health consequences of e-cigarettes conducted by Pisinger and Dossing<sup>5</sup> was inconclusive, both due to the variation in e-cigarette products and methodological limitations of a previously conducted study. Nevertheless, e-cigarettes are a nicotine-based product and hence carry the risk of nicotine addiction,<sup>6,7</sup> as well as other health consequences associated with nicotine, such as an increase in heart rate and myocardial contractility.<sup>8</sup> Thus, it is important to examine the prevalence, increase in prevalence, and factors associated with e-cigarette use, among this at-risk group. To distinguish experimental from more established use,<sup>9</sup> it is also important to provide an estimate of the frequency and quantity of e-cigarette use among those who report current use.

By summer 2014, the sale of e-cigarettes had increased by 72% over the previous year.<sup>10</sup> This increase in sales is most likely reflective of an increase in use among youth as well as adults. According to the 2014 Monitoring the Future Study,<sup>11</sup> 8.7% of 8<sup>th</sup> graders reported using e-cigarettes in the past 30 days (current use). The prevalence increased with age, as 16.2% of 10<sup>th</sup> graders and 17.1% of 12<sup>th</sup> graders reported current use. A report based on 2010–2011 Minnesota emerging adults showed that 7.0% were ever users and 1.2% were current users.<sup>12</sup> Results from the Legacy Young Adult Cohort (aged 18 to 24) collected in January, 2013, showed that 6% had ever used e-cigarettes and 2% currently used.<sup>13</sup> Among university students attending school in the southeastern United States,<sup>14</sup> 13.2% reported ever using e-cigarettes in spring of 2013, and 4.5% reported current use. These estimates across studies suggest that the prevalence of e-cigarette use is increasing with time. However, estimates based on longitudinal data following the same sample across time have not yet been published. In the present paper we present prevalence and incidence estimates based on data from 2 assessments, approximately 11 months apart, in 2013 and 2014.

Among adults, use of e-cigarettes is most common among current smokers, followed by former smokers, with little use by non-smokers.<sup>15–17</sup> However, among adolescents, current use of e-cigarettes is more common among non-smokers than smokers.<sup>11</sup> Among emerging adults, the few studies that have reported data suggest that a notable proportion of e-cigarette users, defined by ever use, had never used tobacco before trying e-cigarettes.<sup>18,19</sup> Among emerging and older adults, former smokers are more likely than current smokers to be established e-cigarette users, defined by lifetime use of more than 50 times.<sup>9</sup> In this paper, we examine the lifetime and current co-occurrence between cigarette use and e-cigarette use. We present data regarding frequency and quantity of use among current users. We also delve deeper into the co-occurrence of conventional tobacco use (cigarette use and/or chewing tobacco) and e-cigarette use through the use of a time-line follow-back (TLFB) interview.<sup>20</sup> This interview provides data regarding the order of use/non-use of conventional tobacco products and e-cigarettes. This detailed data could provide support regarding whether among emerging adults: (1) the use of e-cigarettes reduces harm, through cessation or reduction

in amount of conventional tobacco product use;<sup>21</sup> (2) e-cigarettes are used primarily by non-smokers, perhaps experimentally; (3) e-cigarettes are associated with an increase in conventional tobacco product use;<sup>22</sup> and (4) e-cigarettes provide an alternative and/or more acceptable mode of nicotine delivery, and are used in addition to conventional tobacco products.<sup>18</sup>

Factors that may be associated with e-cigarette use include perceived risk of use and social images of e-cigarette users. According to risk perception theories<sup>20</sup> youth may be inclined to initiate and maintain e-cigarette use if they perceive the product as less harmful or less addictive than other tobacco products. Several studies have shown that e-cigarettes are viewed as being less harmful than conventional cigarettes.<sup>24,25</sup> Consistent with risk perception theory, in one study, emerging adults assessed in 2010 and 2011 perceived e-cigarettes as less harmful and less addictive than cigarettes<sup>12</sup> and perception of less harm predicted initiation of e-cigarette use.<sup>26</sup> The Prototype/Willingness model,<sup>27</sup> a model of health cognitions, suggests that youth with more favorable images of product users are more likely to engage in the health-risk behavior. Andrews, Hampson, Barckley, Gerrard and Gibbons<sup>28</sup> showed that favorable social images of smokers predict subsequent smoking. Our current study explores the prospective association between perceptions of relative harm of e-cigarettes as compared to cigarettes, perceived risk of addiction, and favorable social images and subsequent initiation of e-cigarettes across an 11-month period in emerging adulthood.

We also describe the motives for using e-cigarettes among emerging adults. Etter and Bullen<sup>29</sup> found that e-cigarette users reported that they used them to manage their cravings and as a smoking cessation aid. However, Chapman and Wu<sup>18</sup> suggested that emerging adults were more likely to use e-cigarettes as smoking substitutes and were less likely to use them as a cessation aid. Our current study will add to this literature regarding the reasons for using e-cigarettes among emerging adults.

## METHODS

### Participants

The sample consisted of 890 emerging adults who were participants in the Oregon Youth Substance Use Project (OYSUP). The original sample was recruited using epidemiological sampling techniques from elementary students in the 1<sup>st</sup> through 5<sup>th</sup> grade within one school district in a working class community in Western Oregon. Parents of 1075 children consented for their child to participate. At the first assessment, conducted in the 2008 school year, an average of 215 students in each grade cohort participated, 50.3% were girls and the mean age at T<sub>1</sub> was 9.0 years (SD=1.45). Participants were representative of students in the school district in terms of race/ethnicity (ie, primarily white) and participation in the free or reduced-price school lunch program at the first assessment (40%), but the 3<sup>rd</sup> and 5<sup>th</sup> grade cohorts had slightly higher achievement test scores on reading and math.<sup>30</sup> These youth were followed annually until age 20 to 22.

All of those in the original OYSUP sample who had not dropped from the study, and for whom we had current contact information (N = 906; 84% of the original 1075 participants),

were asked to complete a questionnaire regarding their novel tobacco/nicotine product use, including smoking shisha in a hookah, snus, dissolvables, little cigars, and e-cigarettes, at 2 times (T<sub>1</sub> and T<sub>2</sub>), approximately 11 months apart. In this sample, 884 completed at least one questionnaire (97.6%) with 862 completing the first questionnaire, 853 completing the second questionnaire, and 831 completing both questionnaires. At the T<sub>1</sub> assessment, participants were an average age of 22.9 years (range 20.1 to 26.4) and 31.7% were currently attending school. At the T<sub>2</sub> assessment, participants were an average age of 23.8 years (range 20.9 to 27.2) and 27.1% were currently attending school. Among those who completed at least one questionnaire, 51.8% were female, 85.7% were of European American descent, 40.5% were eligible for free- or reduced-price lunch during at least one elementary school assessment, an indicator of childhood poverty, and as of the T<sub>2</sub> assessment, 67.5% had continued their education past high school. Those who completed at least one novel tobacco questionnaire were similar to the original OYSUP sample in race/ethnicity, receipt of free- or reduced-price lunch in childhood, and whether or not they had a parent who smoked sometime in childhood or adolescence. However, a significantly higher proportion of women (84.6% of the original OYSUP female sample) than men (79.8% of the OYSUP male sample) participated in the present study,  $\chi^2(1, N = 1075) = 4.27, p < .05$ .

Based on their T<sub>1</sub> questionnaire responses, a sample (N = 300) participated in an interview which included an assessment of tobacco use across time using a time-line follow-back (TLFB) method.<sup>20</sup> The T<sub>1</sub> interview sample included those who had used a novel product at least 10 times in their lifetime and who were also lifetime users of conventional products (eg, cigarettes, chewing tobacco; N = 218) and those who used one or more novel products, but not conventional products (N = 47). Data from these individuals were analyzed for the present paper. Others interviewed included those who had used dissolvables at least once (N = 11) and those who had not used novel products but were willing to do so (N = 24). Based on their T<sub>2</sub> questionnaire, we interviewed another sample of 225 participants. These individuals included those who changed their level of dependence on a conventional product and used a novel product between T<sub>1</sub> and T<sub>2</sub> (N = 102), had tried a novel product between T<sub>1</sub> and T<sub>2</sub>, regardless of their level of conventional product use (N = 58) or changed their frequency or quantity of novel product use between T<sub>1</sub> and T<sub>2</sub> (N = 65). Among T<sub>2</sub> interview participants, 143 had also participated in the T<sub>1</sub> interview and 82 participated in only the T<sub>2</sub> interview.

Those who completed either the T<sub>1</sub> or T<sub>2</sub> interview (N = 382) were an average age of 23.52 years (range 20.79 to 26.72) at the time of their first interview, 45% were female, and 87% were of European American descent. Within the interview sample, 42% were eligible for free- or reduced-price lunch in childhood, and 59% had continued their education past high school. Those who were interviewed were similar to those who were eligible but not interviewed, with the exception of sex. Proportionately more eligible women than men participated in the interview.

## Procedures and Measures

The T<sub>1</sub> questionnaire was completed from January 2013 through October 2013 and the T<sub>2</sub> questionnaire from November 2013 through August 2014. The 2 questionnaires were completed an average of 11 months apart.

**Questionnaire procedures and measures.**—Following notification via postcard, all potential participants were sent either an email link to an online questionnaire or a paper-pencil version if we did not have a current email address. Non-responders were reminded via text, phone call, or e-mail, and some were subsequently assessed via phone.

**Assessment of use.**—To assess lifetime, annual, and 30-day use, participants were asked the number of times they had used an e-cigarette “in your entire life,” “in last 12 months,” and “in the past 30 days,” respectively. Annual and 30-day prevalence of use was defined as “at least once.” We classified those who had smoked at least 20 times in their life as lifetime e-cigarette users. Because e-cigarettes have a different topography than conventional cigarettes, we did not use the definition for lifetime cigarette user of 100 cigarettes. Rather, we used the definition parallel to the definition of a lifetime smoke-less tobacco user, using at least 20 times.

To assess frequency and quantity of use among those who reported using in the last 30-days, we asked “how many of the past 30-days, did you use an e-cigarette” and “on average, on those days, how many times a day did you use an e-cigarette?” Responses to this latter question ranged from “one” to “more than 20.”

**Relative harm of e-cigarettes as compared to conventional cigarettes.**—Using 4 items for each disease, participants rated the chance of getting oral cancer, lung cancer, a breathing disease, or heart disease, from vaping e-cigarettes and from smoking conventional cigarettes. Items were: “a few times,” “a few times a day for 2 years,” “20 times a day for 2 years,” and “20 times a day for 20 years.” Responses ranged from (1) “no chance” to (5) “certain to happen.” For e-cigarettes, responses were summed across all 4 items across all 4 diseases,  $\alpha=.98$ . For cigarettes, responses were also summed across all 4 items across all 4 diseases,  $\alpha=.96$ . Relative harm was calculated by dividing risk of harm of vaping e-cigarettes by risk of harm from smoking cigarettes.

**Risk of addiction.**—Participants estimated the chance of getting “addicted to nicotine from using an e-cigarette” “a few times,” “a few times a day for 2 years,” “20 times a day for 2 years,” and “20 times a day for 5 years.” Responses ranged from (1) “no chance” to (5) “certain to happen,”  $\alpha=.90$ .

**Social images.**—Participants rated if “people your age who use e-cigarettes” are “popular,” “exciting,” and “cool” with responses for each attribute, ranging from (1) “not at all” to (4) “very,”  $\alpha=.97$ .

**Motives for using.**—Only e-cigarettes users answered questions adapted from the Tobacco Motives Inventory.<sup>31,32</sup> The original scale consisted of 4 subscales, social ( $\alpha=.93$ ), self-enhancement ( $\alpha=.93$ ), boredom relief ( $\alpha=.91$ ) and affect regulation ( $\alpha=.92$ ). We added

one subscale assessing use as a cessation aid ( $\alpha=.93$ ). Responses to each item were on a 5-point scale ranging from (1), “not at all true” to (5) “very true.”

**Interview procedure and measures.**—We used a TLFB procedure to assess frequency and quantity of novel and conventional (eg, cigarettes, chew) product use, beginning 3 months prior to first reported use of any novel product. Using standard methods to aid recall regarding timing of events,<sup>33</sup> such as birthdays, the respondent indicated the approximate date they began use of each novel product. A new period began each time the participant tried a new product, or when their frequency or quantity of use of a novel or conventional product substantially changed (eg, e-cigarette use increased from twice a week to daily). For this present paper we used data from the first time that e-cigarettes were used at least 2 times during a 3-month period, if that period occurred within the previous 2 years of the interview date. The restriction of 2 times eliminated data from those who merely “tried” e-cigarettes once. Using these criteria, the interval between time of first use of e-cigarettes and the interview averaged .95 years ( $SD=.75$ ). We examined the frequency and quantity of e-cigarettes used during that period, along with the frequency and quantity of the 2 conventional products, cigarettes and chewing tobacco. The frequency of vaping e-cigarettes, smoking and chewing was measured by report of frequency of use from none (0) to daily (5). Quantity of e-cigarette use was measured by number of puffs each day, on average, and ranged from “less than 20” (1) “to more than 20” (5). Quantity of smoking was measured using an estimate of number of cigarettes smoked each day that ranged from “less than one” (1) to “greater than 41” (7). Quantity of chewing was measured by an estimate of how long a can of lasted from “greater than one week” (1) to at “least one tin a day” (8).

## RESULTS

### Awareness and Use

Based on the first assessment, most participants recognized and were aware of e-cigarettes (81.3%). We did not assess awareness at the T<sub>2</sub> assessment. As Table 1 shows, among those who completed both assessments, lifetime prevalence increased by 15.3%. At T<sub>2</sub>, based on feedback from the T<sub>1</sub> TLFB interview, we assessed lifetime e-hookah use. An additional 6.7% of respondents reported that they had used e-hookah in their lifetime, but did not report that they used e-cigarettes. Thus, the prevalence estimate based on report of e-cigarette use may be an underestimate of actual use. Notably, 9.4% became new users of e-cigarettes, defined by using at least 20 times or more, and 3.4% became new cigarette users. Most of those who were lifetime e-cigarette users were also lifetime smokers.

As Table 1 shows, within the 11-month period between assessments, the annual prevalence of e-cigarette use increased by 9.9%. By T<sub>2</sub> the prevalence of e-cigarette use was similar to that of smoking and among these emerging adults, the annual prevalence of smoking cigarettes remained relatively stable. In contrast to the findings regarding lifetime smoking, a fairly large proportion of those who used e-cigarettes smoked cigarettes during the same year. This proportion remained relatively stable across time (from 78% at T<sub>1</sub> to 69% at T<sub>2</sub>).

As Table 1 depicts, similar to the estimates of annual prevalence, the 30-day prevalence of e-cigarette use (current use) nearly doubled over the 11-month period. Among the 60 current

e-cigarette users at T<sub>1</sub>, 22.7% used on more than 15 of the last 30 days and 6.7% used daily. At T<sub>2</sub>, among the 116 participants who were current e-cigarettes users, 34.6% used on 15 days or more and 24.1% used daily. Thus, not only did the prevalence in e-cigarette use double between T<sub>1</sub> and T<sub>2</sub>, but the frequency of use among current users increased dramatically between T<sub>1</sub> and T<sub>2</sub>. Quantity of use did not increase between T<sub>1</sub> and T<sub>2</sub>. At T<sub>1</sub>, among the current users, 33.3% used e-cigarettes on average more than 5 times a day. At T<sub>2</sub>, the estimate of quantity was similar, as among the current users, 35.5% used e-cigarettes on average more than 5 times a day. In contrast, the 30-day prevalence of smoking cigarettes remained relatively stable between T<sub>1</sub> and T<sub>2</sub> and was much higher than that of e-cigarette use at both assessments. Seventy-five percent of e-cigarette users also smoked in the past 30-days at T<sub>1</sub>. At T<sub>2</sub>, this proportion decreased to about two-thirds.

We compared the frequency and quantity of e-cigarette use among current e-cigarette users who did not currently smoke cigarettes (solo users) with current e-cigarette users who were also current smokers (dual users). A comparable proportion in each group used e-cigarettes more than 15 of the last 30 days at both T<sub>1</sub> (dual users, 22.2%, solo users, 20%) and T<sub>2</sub> (dual users: 36.0%; solo users: 28.2%). However, an examination of quantity revealed one significant result. At T<sub>2</sub>, a significantly higher proportion of dual users (40.0%) than solo users (20.5%;  $\chi^2(1, N = 114) = 4.38; p < .05$ ) used more than 5 times per day. This difference was not significant at T<sub>1</sub> (dual users, 35.6%; solo users, 26.7%).

### Demographics and E-cigarette Use

At T<sub>1</sub>, men (9.9%) were significantly more likely than women (3.6%) to have used e-cigarettes 20 or more times in their lifetime,  $\chi^2(1, N = 861) = 13.90, p < .001$ . Participants who did not currently attend college or vocational school or had not graduated with an associate's or bachelor's degree (7.9%) were significantly more likely than college students or graduates (4.5%) to report a lifetime use of e-cigarettes of 20 or more times ( $\chi^2(1, N = 858) = 4.19, p < .05$ ). There were no differences in marital status among those who used them versus those who did not at T<sub>1</sub>. Among those who did not report using e-cigarettes at or prior to T<sub>1</sub>, we predicted onset of e-cigarettes at T<sub>2</sub> from each demographic variable. Those who initiated e-cigarette use between T<sub>1</sub> and T<sub>2</sub> were less likely to be college or vocational school attendees or graduates at T<sub>1</sub> (13.1% vs 20.2%;  $\chi^2(1, N = 826) = 6.78, p < .01$ ). Neither sex nor marital status was associated with the onset of e-cigarette use.

### Risk Perceptions, Social Images and E-cigarette Use

Lifetime e-cigarette users at T<sub>1</sub> were significantly more likely than non-users to perceive e-cigarettes as relatively less harmful than cigarettes ( $M = 2.24$  vs  $2.64; t(861) = 3.35; p < .001$ ). E-cigarette users also had significantly more favorable social images of e-cigarette users than did non-users ( $M = 5.25$  vs  $3.94; t = 4.20, p < .001$ ). There were no differences between e-cigarette users and non-users regarding the risk of addiction from using e-cigarettes.

Among those who did not report using at T<sub>1</sub>, we predicted onset from T<sub>1</sub> to T<sub>2</sub> from relative harm, risk of addiction, and favorable social images, entered together into the regression analysis. All 3 variables significantly predicted onset. If individuals perceived that

e-cigarettes were less harmful than cigarettes (OR = 3.89; 95% CI = 1.80, 8.40;  $p < .001$ ), that they were not addictive (OR = 1.42; 95% CI = 1.12, 1.79;  $p < .01$ ), and their social images were favorable (OR = 1.22, 95% CI = 1.10, 1.35;  $p < .001$ ), they were likely to initiate e-cigarette use between T<sub>1</sub> and T<sub>2</sub>.

### Motives for Using E-cigarettes

Individuals who had used e-cigarettes reported on their motive for using (N = 225). Data from the assessment following first report of use was used. As Table 2 shows, e-cigarette users reported that they had a stronger motive for using e-cigarettes as a cessation aid than for other motives. A comparison between using e-cigarettes as a cessation aid and the other 4 combined was statistically significant,  $t(222) = 12.23$ ,  $p < .001$ . Both boredom relief and affect regulation were significantly stronger motives than self enhancement,  $t(222) = 7.72$ ,  $p < .001$  and  $t(222) = 9.01$ ,  $p < .001$ , respectively, and social motives,  $t(222) = 5.24$ ,  $p < .001$ ,  $t(222) = 4.99$ ,  $p < .001$ , respectively. Using e-cigarettes for social motives was significantly stronger than for self enhancement,  $t(222) = 4.67$ ,  $p < .001$ .

### Timeline Follow-back Interview

Among those interviewed at least once (N = 382), 67.5% reported using e-cigarettes. When asked how they first heard about e-cigarettes, most (40.3%) had heard about them from a family member or a friend and 24.0% heard about e-cigarettes from a television advertisement.

Among those interviewed, 149 used an e-cigarette at least 2 times during their period of initial use. We examined the TLFB data from 119 of these individuals, who initiated e-cigarette use in the 2-year period prior to the interview, and who had a 3-month period prior to and following the initial period of e-cigarette use.

As Table 3 illustrates, we categorized individuals into 5 groups, based on their use of conventional products in the periods before and after this initial use period. Group 1 consisted of a relatively small percentage of individuals (9.2%) who smoked or chewed in the period before their first use of e-cigarettes, but did not use conventional products in the period after their first use. For these individuals, e-cigarettes may have served as a cessation aid, because use of conventional products was reduced during and following initial use of e-cigarettes. A similar proportion (Group 2; 7.6%) had not smoked cigarettes or used chewing tobacco 3 months prior to this period, but used these products following the e-cigarette use period, supporting a sequential association between e-cigarette use and conventional product use. Group 3 (12.6%) only used e-cigarettes, and apparently reduced their use over time. A relatively large proportion (Group 4; 53.8%) used e-cigarettes for a period, but did not continue their use of this product. They reduced their conventional product use slightly during the period of e-cigarette use, but e-cigarette use was not sustained, and their conventional cigarette use appeared to return to pre-e-cigarette use levels. In the last group (Group 5: 16.8%), participants were heavier smokers than in the other groups. They appear to add e-cigarettes to their tobacco use repertoire, without reducing their use of conventional tobacco products.



## DISCUSSION

The prevalence of e-cigarette use is high among emerging adults, and, as predicted from the increase in sales,<sup>10</sup> appears to be increasing rapidly over time. By the second assessment, conducted in 2014, 40% of this representative sample of emerging adults within the OYSUP study had at least tried e-cigarettes. Further, this is likely an underestimate, as a small proportion of emerging adults in this sample did not report using e-cigarettes, but did report using e-hookah. Recent marketing of electronic nicotine delivery systems under new names, such as e-hookah, vape pen, or hookah stick, suggests that new products and new product terminology should be incorporated into prevalence estimates.

Until 2014, the prevalence of e-cigarette use was the highest among emerging adults, as compared to adolescents or older adults. However, the present data, in addition to the data from the 2014 Monitoring the Future Study, suggest that relatively fewer emerging adults than adolescents report current use of e-cigarettes, as measured by use in the last 30 days. In addition, unlike adolescents, the prevalence of e-cigarettes among emerging adults is much lower than that of cigarettes. Whereas the current prevalence (last 30 days) of e-cigarettes in the present sample almost doubled between the 2 assessments, representing an 11-month period, the current prevalence of cigarette smoking increased slightly between these 2 assessments, rather than decreased. These estimates of current prevalence, along with findings from the TLFBS, suggest that most emerging adults who tried to quit smoking, with the aid of e-cigarettes, did not succeed.

Similar to adults,<sup>15–17</sup> but dissimilar to adolescents, approximately 85% of individuals who were lifetime e-cigarette users were also lifetime smokers. However, this association between cigarettes and e-cigarettes is less strong when examining 12-month and 30-day prevalence, showing that approximately one-third of emerging adults who are current e-cigarette users do not concurrently smoke conventional cigarettes. These prevalence estimates suggest that, in emerging adulthood, former cigarette smokers are more likely to use e-cigarettes, than are current smokers. This interpretation is supported by findings from a large sample of former and current smoking adults (ranging from age 18 to age 64)<sup>9</sup> that showed that former smokers were more likely than current smokers to be established e-cigarette users (current users and reported using greater than 50 times over their life).

Our findings showing that more men than women use e-cigarettes replicate previous studies conducted with emerging adults.<sup>12,19,34</sup> However, to our knowledge, ours is the first study to show a greater prevalence of e-cigarette use among emerging adults who have not progressed beyond high school in their education, as compared to those who had completed some college or who were still in school. These non-college-attending emerging adults were also more likely than college students to initiate e-cigarette use across the 11-month period. The finding that non-college emerging adults are at particular risk is important as many studies of emerging adults are based only on college students.<sup>14,19</sup> Of note, we did not find a difference in use by marital status.

E-cigarette users, compared to non-e-cigarette users, perceived e-cigarettes as less risky to health than cigarettes and perceived e-cigarette users more favorably, replicating

research with smokers regarding perceptions of smoking.<sup>35</sup> These findings also suggest that aggressive marketing strategies, with claims of health benefits and as users as “cool” may have guided these individuals toward e-cigarette use. The prospective prediction of onset of e-cigarette use from perception of relative harm and favorable social images provides further support for this premise. In addition, the perception that e-cigarettes are not addictive predicted onset of use between assessments. This inaccurate perception may have driven ex-smokers to try e-cigarettes to satisfy the contextual effects of smoking (ie, holding a cigarette, putting a cigarette to their mouths, taking a “smoke break” with friends) that they miss.

The pros and cons of e-cigarette use have been recently debated in the tobacco control literature.<sup>36–40</sup> Our findings from the TLFB interview suggest that the risks and/or benefits associated with e-cigarettes may vary at an individual level. For a relatively large proportion, e-cigarette use appeared to be primarily experimental, in that a large proportion of smokers and/or chewers maintained their conventional product use over time, but did not continue their e-cigarette use. For these individuals, and for those relatively few non-smokers and chewers who used e-cigarettes briefly, but apparently did not continue, the regulation of e-cigarettes is not central to their use of this product, as their experimental use is likely neither harmful nor helpful.

However, for a relatively small number of smokers or chewers, our findings from the TLFB interview suggest that e-cigarette use may have aided cessation, as use of conventional products did not occur in the interval following e-cigarette use. This finding supports other research showing that e-cigarettes can be an effective cessation aid, as compared to NRT, a placebo, and no aid.<sup>41,42</sup> However, of note, whereas these trials define cessation as 6 months without smoking, we only assessed conventional product use for 3 months.

In contrast, the TLFB data also suggest that some individuals are using e-cigarettes in conjunction with cigarettes, thereby increasing their nicotine intake, and potentially raising their level of addiction. This dual use of cigarettes and e-cigarettes is fairly common among adults.<sup>18</sup> This finding in conjunction with the finding that the frequency of e-cigarette use by dual users is higher than that of solo users suggests that e-cigarettes may be used to satisfy nicotine cravings when and where cigarette smoking is prohibited. Another relatively small proportion of e-cigarette users did not use conventional tobacco products in the interval prior to their initial use of e-cigarettes, but did use conventional products in the interval following first e-cigarette use, suggesting that e-cigarettes were their entry (or re-entry) into nicotine dependence. Thus, for these 2 groups of individuals, e-cigarettes do not serve a harm-reduction<sup>43</sup> purpose, as either use of conventional products continues or is initiated.

Although the primary motive reported for using e-cigarettes was as a cessation aid, the interview data suggest that a majority of e-cigarette users are not replacing their use of conventional products with e-cigarettes. The majority of e-cigarette users in the interview sample only used e-cigarettes experimentally and maintained their conventional product use. The second-largest group was comprised of dual users, continuing with their cigarette use and adding e-cigarettes to their tobacco use repertoire. These findings suggest that conventional tobacco use among emerging adults will be maintained, and will not be

replaced by the use of e-cigarettes. Thus, prevention and cessation efforts with emerging adults targeting conventional tobacco use must continue.

## IMPLICATIONS FOR TOBACCO REGULATION

Importantly, findings from our interview suggested that participants did not think other devices, such as e-hookahs or vape sticks, were e-cigarettes, suggesting that marketing regulations guide the nomenclature used to describe e-cigarettes. Similarly, we recommend that all current surveillance studies include the use of all alternative forms of electronic devices to be able to accurately report on the prevalence, and quantity and frequency of use.

Further, our findings suggest that e-cigarette use among emerging adults may be different from that among older adults. For emerging adults, e-cigarettes may not be as useful as a cessation aid as it is for older adults. This suggests altering the potential recommendation to healthcare providers to advise the use of e-cigarettes as a cessation aid for emerging adults and limiting marketing e-cigarettes as a cessation aid for emerging adults. Whereas some emerging adults do quit as a result of e-cigarette use, far more continue to use both products, and, for some, e-cigarette use is followed by conventional smoking.

Results from this study also suggest targeted counter-advertising for emerging adults. This counter-advertising needs to be directed to men and those without a post-high school education to prevent the initiation and maintenance of e-cigarette use. These counter-advertisements need to include the lack of knowledge regarding the health effects of e-cigarettes, that e-cigarettes contain nicotine and can lead to dependence, and counter the image that youth, including emerging adults, who use e-cigarettes are cool or exciting.

Our findings suggest that smokers may be using e-cigarettes in places where smoking is other-wise prohibited. Several studies have suggested that bystanders exposed to second-hand smoke from e-cigarettes are exposed not only to nicotine, but to potentially dangerous particles with the emitted vapor.<sup>44–46</sup> This suggests extending smoke-free policies beyond conventional cigarettes to e-cigarettes. This would not only protect non-smokers from the second-hand vapor from e-cigarettes, but would also encourage reduction in nicotine consumption.

Additional health warnings as well as age restrictions could be directed to emerging adults, as well as adolescents. As noted in the Surgeon General's Report, e-cigarette use could be particularly deleterious for adolescents as nicotine exposure in adolescence can have long-term consequences for brain development.<sup>47</sup> This warning could apply equally to emerging adults in their early twenties, as their brains are still developing until at least the mid-twenties.<sup>48</sup>

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Table 1

## Prevalence and Incidence of E-cigarette Use and Smoking

	T <sub>1</sub> Assessment (N = 862)		T <sub>2</sub> Assessment (N = 853)		Onset between T <sub>1</sub> and T <sub>2</sub> <sup>a</sup> (N = 831)	
	N	%	N	%	N	%
<b>Lifetime</b>						
Used e-cigarettes at least once	213	24.7	342	40.1 <sup>b</sup>	127	15.3
Used e-cigarettes 20 Times	57	6.6	135	15.8	78	9.4
Smoked cigarettes at least 100 times	296	34.3	321	37.6	28	3.4
Smoked cigarettes and e-cigarettes <sup>c</sup>	52	6.0	115	13.5	71	8.5
<b>Twelve-month</b>						
Used e-cigarettes	130	15.1	213	25.0	--	--
Smoked cigarettes	273	31.7	264	31.1	--	--
Smoked cigarettes and e-cigarettes	101	11.7	148	17.4	--	--
<b>30-day Prevalence</b>						
Used e-cigarettes	60	7.0	116	13.6	--	--
Smoked cigarettes	227	26.4	226	27.5	--	--
Smoked cigarettes and e-cigarettes	45	5.2	75	8.9	--	--

Note.

<sup>a</sup> = Onset between T1 and T2 is based on the subsample that completed both assessments.<sup>b</sup> = An additional 6.7% did not report that they had used an e-cigarette at T2, but reported using an e-hookah at T2.<sup>c</sup> = Smoked 100 cigarettes and 20 e-cigarettes in lifetime

**Table 2**

## Motives for Using E-cigarettes

<b>Motive</b>	<b>M</b>	<b>SD</b>
<b>Social</b>	1.51	.80
<b>Self enhancement</b>	1.34	.63
<b>Boredom relief</b>	1.83	1.12
<b>Affect regulation</b>	1.76	.87
<b>Cessation aid</b>	2.61	1.41

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Association between E-cigarette Use and Smoking and Chewing before and after Targeted 3-month Interval Using both T<sub>1</sub> and T<sub>2</sub> TLFB Data (N = 119)

**Table 3**

Group Description	N	%	Product/Use	Interval Before			Interval			Interval After		
				N	M	SD	N	M	SD	N	M	SD
<b>1 Smoked or chewed before/Did not after</b>												
Cigarettes	11	9.2	Cigarettes	10			3			0		
Frequency			Frequency	2.82	1.94	1.00	2.00			---		---
Quantity			Quantity	2.36	1.43	.91	1.64			---		---
Chew			Chew	3	0	0	0			0		0
Frequency			Frequency	1.21	2.12	0	0			---		---
Quantity			Quantity	1.21	2.49	0	0			---		---
E-cigarettes			E-cigarettes	0		11	3					
Frequency			Frequency	---	---	3.45	1.21			.45		.82
Quantity			Quantity	---	---	1.73	1.19			.27		.44
<b>2 Did not smoke or chew before/Did after</b>												
Cigarettes	9	7.6	Cigarettes	0		3	9					
Frequency			Frequency	---	---	1.44	2.24			2.78		1.48
Quantity			Quantity	---	---	1.11	1.76			2.22		1.20
Chew			Chew	0	0	0	0			0		0
Frequency			Frequency	---	---	0	0			0		0
Quantity			Quantity	---	---	0	0			0		0
E-cigarettes			E-cigarettes	0		9	2					
Frequency			Frequency	---	---	3.44	1.42			.56		1.13
Quantity			Quantity	---	---	1.33	.50			.22		.44
<b>3 Did not smoke or chew before or after</b>												
Cigarettes	15	12.6	Cigarettes	0		0	0					
Frequency			Frequency	---	---	---	---			---		---
Quantity			Quantity	---	---	---	---			---		---
Chew			Chew	0	0	0	0			0		0
Frequency			Frequency	---	---	---	---			---		---
Quantity			Quantity	---	---	---	---			---		---
E-cigarettes			E-cigarettes	0		15	3					
Frequency			Frequency	---	---	2.87	1.06			.33		.82
Quantity			Quantity	---	---	1.27	1.03			.07		.26

Group Description	N	%	Product/Use	Interval Before			Interval			Interval After		
				N	M	SD	N	M	SD	N	M	SD
<b>4 Smoked or chewed before and after/ Did not use e-cigarettes after</b>												
	64	53.8	Cigarettes	61			44			61		
Frequency				4.11	1.49		3.03	2.29		3.97	1.66	
Quantity				3.16	1.28		2.08	1.68		2.95	1.42	
Chew												
	7						5			6		
Frequency				.24	.85		.30	1.12		.29	1.04	
Quantity				.08	.26		.09	.34		.21	.84	
E-cigarettes												
	0						64			0		
Frequency				---	---		3.97	1.13		---	---	
Quantity				---	---		2.11	1.27		---	---	
<b>5 Smoked or chewed before and after/Used e-cigarettes after</b>												
	20	16.8	Cigarettes	20			18			19		
Frequency				4.45	1.28		4.25	1.71		3.80	1.67	
Quantity				3.20	.95		2.80	1.28		2.70	1.30	
Chew												
	2						1			2		
Frequency				.20	.70		.15	.67		.35	1.09	
Quantity				.10	.31		.05	.22		.45	1.79	
E-cigarettes												
	0						20			20		
Frequency				---	---		4.00	1.21		2.45	1.28	
Quantity				---	---		1.55	.83		1.05	.83	

Note.

Cigarettes. Frequency: 1 = 1/month; 2 = 2 – 3/month; 3 = 1 – 2 days/ week; 4 = 3 – 6/week; 5 = used daily; Quantity: 1 = <1/day; 2 = 1 – 3/day; 3 = 4 – 9/day; 4 = 10 – 20/day; 5 = 21 – 30/day; 6 = 31 – 40 day; 7 = >41/day.

E-cigarettes. Frequency: 1 = once; 2 = more than 1x/mo; 3 = 1 – 2 days/week; 4 = 3 – 6 days/week; 5 = daily; Quantity: 1 = 0 – 20 puffs/day; 2 = 21 – 80 puffs/day; 3 = 81 – 120 puffs/day; 4 = 121 – 200 puffs/day; 5 = 201+ puffs/day.

Chewing tobacco. Frequency: 1 = 1 time /month; 2 = 2 – 3 times /month; 3 = 1 – 2 days/ week; 4 = 3 – 6 days/week; 5 = used daily; Quantity: 1 = 1 tin/> 1 week; 2 = 1 tin/6 days; 3 = 1 tin/5 days; 4 = 1 tin/4 days; 5 = 1 tin/3 days; 6 = 1 tin/2 days; 7 = 1 tin/1 day.