



Changes in use of cigarettes and non-cigarette alternative products among college students



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HIGHLIGHTS

- E-cigarette use increased to 25% among cigarette smokers and 3% for non-smokers.
- Cigarette smokers were 8.5 times more likely than non-smokers to use e-cigarettes.
- Hookah use increased among non-cigarette smokers, but declined among smokers.

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ABSTRACT

Introduction: The present study examined change in use of various smoked and smokeless non-cigarette alternative products in a sample of college students, stratified by current, or past 30-day, cigarette smoking status.

Methods: Participants were 698 students from seven four-year colleges in Texas. Participants completed two waves of online surveys regarding tobacco use, knowledge, and attitudes, with 14 months between each wave.

Results: The most prevalent products used by the entire sample at Wave 1 were cigarettes, followed by hookah, cigars/cigarillos/little cigars, and electronic cigarettes (e-cigarettes). At Wave 2, prevalence of e-cigarette use surpassed use of cigars/cigarillos/little cigars. Snus and chew/snuff/dip were relatively uncommon at both waves. Examination of change in use indicated that e-cigarette use increased across time among both current cigarette smokers and non-cigarette smokers. Prevalence of current e-cigarette use doubled across the 14-month period to 25% among current smokers and tripled to 3% among non-cigarette smokers. Hookah use also increased across time, but only among non-cigarette smokers, whereas it decreased among current cigarette smokers. Use of all other non-cigarette alternatives remained unchanged across time. Logistic regression analysis was used to examine the socio-demographic predictors of Wave 2 e-cigarette use, the only product that increased in use among both current cigarette smokers and non-cigarette smokers. Results indicated that Wave 1 current cigarette use and Wave 1 current e-cigarette use, but not gender, age, or race/ethnicity, were significantly associated with Wave 2 e-cigarette use.

Conclusions: Findings underscore the need to track changes in the use of non-cigarette alternatives and call for additional research examining the factors contributing to change in use.

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1. Introduction

While cigarette use in the United States (U.S.) declined between 2005 and 2012 (Agaku, King, and Dube, 2014), use of non-cigarette alternative products, such as little cigars, snus, and electronic cigarettes (e-cigarettes) became increasingly prevalent (Connolly and Alpert, 2008; King, Alam, Promoff, Arrazola, and Dube, 2013). In 2010, an estimated 13.6% of adults tried one of the following: snus, hookah,

dissolvable tobacco, or an e-cigarette (McMillen, Maduka, and Winickoff, 2012). By 2013, lifetime use of e-cigarettes alone was 9.4% among the general adult population (King, Patel, Nguyen, and Dube, 2015). Young adults have the highest rates of use of non-cigarette alternatives, with one study indicating that young adults were nine times more likely than older adults to have tried snus (Biener, McCausland, Curry, and Cullen, 2011). Yet, there is limited research on young adult's use of non-cigarette alternatives. The purpose of the present study was to examine trends in use of non-cigarette alternative products by young adult college students across approximately 14 months.

Non-cigarette alternatives are either smoked (e.g., hookah and cigars) or smokeless (e.g., snus and e-cigarettes). Cigarette smokers are more likely than non-cigarette smokers to use both smoked and

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smokeless non-cigarette alternatives (Biener and Bogen, 2009; McMillen et al., 2012). Using data from a national study of college students, Jarrett, Blossnich, Tworek, and Horn (2012) found that 28.5% of current cigarette smokers were current hookah users in comparison with 5.9% of non-cigarette smokers. Regarding smokeless products, Popova and Ling (2013) showed that 38% of current and former cigarette smokers tried loose or moist snuff, snus, dissolvable tobacco, or e-cigarettes, and 13.6% used one of these in the past 30 days. Popova and Ling also reported that among the products examined, e-cigarettes were the most commonly used non-cigarette alternatives, and the product that current and former cigarette smokers were most receptive to trying in the future.

Use of non-cigarette alternatives is concerning for several reasons. First, smoked non-cigarette alternatives, like hookah, contribute to serious health problems, such as heart disease and lung cancer (Cobb, Ward, Maziak, Shihadeh, and Eissenberg, 2010). Smokeless alternatives are believed to be safer than traditional cigarettes. However, most smokeless products are not regulated by the U.S. Food and Drug Administration (FDA); thus, their safety has yet to be determined. Second, non-cigarette alternatives are being used as smoking cessation aids (Etter, 2010), even though there is no empirical evidence that they help cigarette smokers permanently quit. Use of these products may therefore sustain addiction. Finally, because smokeless products are marketed for use in places where smoking is not allowed (Mejia and Ling, 2010), these products may be used concurrently with cigarettes, especially when and where smoking is not allowed. Concurrent use of two or more products may result in additive or even multiplicative negative health effects (Wetter et al., 2002) and lead to escalated use and addiction among intermittent cigarette smokers (White, Bray, Fleming, and Catalano, 2009), or prolong addiction and fewer quit attempts among addicted smokers (Parascandola, Augustson, and Rose, 2009). Consequently, use of non-cigarette alternatives has considerable public health risks.

Relatively little is known about trends in use of non-cigarette alternative products across time (King et al., 2013, 2015; McMillen, Gottlieb, Whitmore Schaefer, Winickoff, and Klein, in press). One exception is a study conducted by King et al. (2015), which examined e-cigarette use in representative samples of U.S. adults in 2010 and 2013. The researchers found that prevalence of ever use of e-cigarettes more than doubled across the three-year period from 3.3% in 2010 to 8.5% in 2013. Further findings indicated that current (i.e., past 30-day) cigarette smokers had the highest rate of current e-cigarette use and were more likely than their peers to have ever used this product. These results highlight the need to monitor trends in use of non-cigarette alternatives across time, particularly among cigarette smokers. However, King et al.'s study was limited to examination of only one type of non-cigarette alternative, e-cigarettes, and implications from their data are limited by potential cohort effects because different samples were assessed in 2010 and 2013. Rather, to assess changes in use of non-cigarette alternatives, it is necessary to examine prevalence in the same sample across time.

The present study extends existing research by examining change in use of smoked and smokeless non-cigarette alternatives (i.e., cigars/cigarillos/little cigars, hookah, chew/snuff/dip, snus, and e-cigarettes) by 18 to 35 year old college students over an approximately 14-month period of time. The sample was drawn from four-year colleges because they are over-represented by young adults who tend to have the highest rates of use of non-cigarette alternatives. Given that cigarette smokers are more likely than their peers to use these products (Biener and Bogen, 2009; McMillen et al., 2012; Sutfin, McCoy, Morrell, Hoepfner, and Wolfson, 2013), we examined change in use separately for current cigarette smokers and non-cigarette smokers. Finally, for non-cigarette alternative products that showed a significant increase in use across time, we assessed the role of Wave 1 current smoking status and various socio-demographic predictors in increased use across time.

2. Material and methods

2.1. Participants

Participants were a convenience sample of 698 students from seven urban four-year colleges within the University of Texas System. Students participated in the study at two waves, with approximately 14 months between each wave. Wave 1 occurred in spring 2012 and Wave 2 in spring 2013. Students were initially 18–35 years old (*mean age* = 22.98; *standard deviation* = 4.21), and 10.7% were freshmen, 18.5% were sophomores, 25.9% were juniors, 29.4% were seniors, and 15.5% were graduate students. Over half (56%) of the 698 students were female; 42.5% were non-Hispanic white, 43.3% were Hispanic/Latino, 2.6% were African-American/Black, 6.9% were Asian, and 4.8% reported another race/ethnicity.

2.2. Procedure

The University of Texas at Austin Institutional Review Board gave approval for the two waves of data collection. Students were recruited to participate in the study via their university provided email addresses, which were obtained through open records requests from each of the universities, made possible due to the Public Information Act. In fall 2011, undergraduate enrollment at the seven universities ranged from 3094 to 38,437, summing to a total of 120,280 students. Almost 86,000 (85,659) student emails were provided through the open records request. After removal of 871 bounce-backs and 604 unsubscribed students, the adjusted sampling frame was 84,184 students.

In early spring 2012, students received an email introducing the study and indicating that an electronic survey invitation would be distributed two to three days later. The invitation provided a brief survey description and the hyperlink to the survey. Students who did not participate in the survey were sent two reminders. Upon completion of the survey, students were asked if they would be willing to participate in the second wave of the study. Of the 84,184 students who received an e-mail invitation, 8904 agreed to participate. However, 63 students were under the age of 18 and 1092 did not report their age, and were subsequently removed from the sample. Thus, a total of 7749 students, 18 years of age and older participated in Wave 1 and of these, 3444 indicated they would be willing to participate in a future wave. Approximately 14 months after Wave 1, the 3444 students were sent another round of four emails, inviting and reminding them to participate in Wave 2 of the study. After removal of 104 emails that were undeliverable, 3340 students were invited to participate in Wave 2. Of the 3340 students who participated in Wave 1 and who were willing to participate in Wave 2, a total of 765 completed the online survey at Wave 2. Given our focus on young adults, only data from the 698 students who were 18–35 years old at Wave 1 were retained for this study. Note, however, that sample sizes for individual analyses varied due to missing data, which ranged from zero cases for student's age and race/ethnicity to 20 cases for Wave 2 current snus use.

2.3. Measures

2.3.1. Current tobacco and e-cigarette use

Current use of cigarettes, cigars/cigarillos/little cigars, hookah, chewing tobacco/snuff/ dip, snus and e-cigarettes was assessed with the same question at both study waves. The question, "During the past 30 days, on how many days did you use ____?" (Starr et al., 2005), had seven response options, including '0 days', '1 to 2 days', '3 to 5 days', '6 to 9 days', '10–19 days', '20–29 days' and 'all 30 days.' Responses for each product were recoded into a dichotomous variable (0 = 0 days and 1 = 1 to 2 days or more in the past 30 days).

2.4. Attrition analyses

Analyses were conducted to determine if students participating in both study waves ($n = 765$) varied in age, gender, and tobacco use behaviors from those who participated at Wave 1 ($N = 6984$) only. There were no significant differences on any of the assessed variables between the current sample of participants and those who participated at Wave 1 only. Specifically, students participating in both study waves did not vary from their counterparts on age [$t(7747) = .88$] and gender [$\chi^2(1) = 1.19$], or past 30-day use of any assessed tobacco product: cigarettes [$\chi^2(1) = 2.40$], cigars/cigarillos/little cigars [$\chi^2(1) = .18$], hookah [$\chi^2(1) = .27$], chew/snuff/dip [$\chi^2(1) = .96$], snus [$\chi^2(1) = .19$], and e-cigarettes [$\chi^2(1) = .21$].

3. Results

Change in prevalence of cigarette and non-cigarette alternative use across the 14-month period was examined using a series of McNemar tests, which are used to test differences between paired dichotomous variables. Analyses were conducted for the entire sample and separately for students who reported being current (past 30-day) cigarette smokers and non-cigarette smokers at Wave 1. As shown in Table 1, the most prevalent product used by the entire sample at both waves was cigarettes, followed by hookah and cigars/cigarillos/little cigars. Although use of e-cigarettes was lower than that of cigars/cigarillos/little cigars at Wave 1, e-cigarette use exceeded cigar/cigarillo/little cigar use at Wave 2. Snus and chew/snuff/dip were relatively uncommon, with both types of tobacco products being used by less than 2.2% of the entire study sample at either wave. Regarding change in prevalence for the entire sample, only e-cigarette use showed a significant change across time, with use increasing from 3.7% of the entire sample at Wave 1 to 7.7% at Wave 2.

Examination of non-cigarette alternative use among current cigarette smokers indicated that hookah was the most prevalent product used at Wave 1, followed by e-cigarettes and then cigars/cigarillos/little cigars. However, the pattern of findings changed at Wave 2. At Wave 2, e-cigarettes were the most prevalent product used by current cigarette smokers, followed by hookah and then cigars/cigarillos/little cigars (see Table 1). Additional findings indicated that only hookah and e-cigarettes showed significant changes in use across the 14-month period of time. Hookah use declined in prevalence from 30.9% to 17.3% among current cigarette smokers. In contrast, e-cigarette use increased from 14.5% to 25.4% among current cigarette smokers. Consistent with the entire sample, snus and chew/snuff/dip were relatively uncommon, and use of these products did not change across time, with both types of tobacco products being used by less than 4.3% of current cigarette smokers.

Use of non-cigarette alternatives was relatively uncommon among non-cigarette smokers. Nonetheless, the most prevalent non-cigarette alternatives used by non-cigarette smokers were hookah and cigars/

cigarillos/little cigars, both of which were used by less than 7% of this group at either wave. Moreover, fewer than 2.8% of non-cigarette smokers reported using any other non-cigarette alternative. Regarding change, both hookah and e-cigarette use showed significant increases in prevalence across time, with e-cigarette use tripling in prevalence from .8% at Wave 1 to 2.8% at Wave 2 and hookah use almost doubling from 4.3% to 7% (see Table 1).

Follow-up descriptive analyses were conducted to examine patterns of persistence and desistance of cigarette and non-cigarette alternative use across the two waves. In particular, we examined the proportion of students who were; 1) persistent non-users of the products at Wave 1 and Wave 2, 2) persistent current users of the products both at Wave 1 and Wave 2, 3) “new” users of the products, or those who used only at Wave 2, and 4) Wave 1 current users of the products who desisted use by Wave 2. These analyses were stratified by Wave 1 current smoking status.

As shown in Table 2, the majority of Wave 1 current cigarette smokers were persistent non-users of non-cigarette alternative products, ranging from 64.7% for hookah to 93.6% for snus. Although there were fewer persistent users, persistent use of non-cigarette alternative products ranged from .7% for chew/snuff/dip and snus to 12.9% for hookah. A sizable proportion of current smokers also reported desistance of use of alternative products by Wave 2, ranging from 2.9% for snus and 18.0% for hookah. Alternatively, some current smokers reported using the non-cigarette alternatives only at Wave 2. Use of non-cigarette alternatives only at Wave 2 ranged from 2.2% for chew/snuff/dip to 17.4% for e-cigarettes. Thus, although there was a considerable proportion of current smokers who desisted from current use of cigarette and non-cigarette alternatives at Wave 2, there was also a considerable proportion who reported use only at Wave 2, particularly e-cigarettes.

Regarding Wave 1 non-cigarette smokers, almost all students in this category were persistent non-users of the non-cigarette alternative products at Wave 1 and Wave 2 (see Table 2). Persistent non-use ranged from 91.0% of non-current smokers for hookah to 99.4% for snus. Alternatively, persistent current use at both waves ranged from 0% for snus to 2.3% for hookah. Fewer than 6.6% of non-cigarette smokers reported use of any one product for the first time in the study at Wave 2 (range = .4% for snus to 6.6% for cigarettes) and even fewer desisted use by Wave 2. Desistance among non-current smokers ranged from .2% for snus to 2.1% for hookah, although the low levels of desistance should be interpreted within the context of initially low levels of use of the products by non-current smokers.

Finally, one logistic regression analysis was conducted to examine if gender, age, race/ethnicity and Wave 1 current cigarette use contributed to the increased use of non-cigarette alternatives. Because e-cigarettes were the only product that showed increasing use across time, this analysis was conducted only for e-cigarettes, and Wave 1 e-cigarette use was included as a covariate. Results indicated that only Wave 1 cigarette use and Wave 1 e-cigarette use predicted Wave 2 e-cigarette use (see Table 3). Students reporting current cigarette and e-

Table 1
Prevalence and change in use of cigarette and non-cigarette alternatives for the entire sample and stratified by current cigarette use status.

	Total sample ($n = 671-676$)			Current cigarette smokers ($n = 138-140$)			Non-current cigarette smokers ($n = 530-533$)		
	Wave 1 %	Wave 2 %	McNemar <i>p</i> -value	Wave 1 %	Wave 2 %	McNemar <i>p</i> -value	Wave 1 %	Wave 2 %	McNemar <i>p</i> -value
Cigarettes	21.3	19.7	.266	NA	NA	NA	NA	NA	NA
^a Cigars	4.7	5.0	.885	11.5	11.5	1.00	2.6	3.4	.523
Hookah	9.8	9.1	.625	30.9	17.3	.001	4.3	7.0	.029
^b Smokeless	1.9	2.2	.804	4.3	2.9	.727	1.1	1.9	.289
Snus	0.9	1.0	1.00	3.6	3.6	1.00	0.2	0.4	1.00
E-cigarettes	3.7	7.7	.000	14.5	25.4	.014	0.8	2.8	.007

Note. Current cigarette smoker status based on Wave 1 past 30-day use of cigarettes. Sample sizes for each of the cigarette and non-cigarette alternative products vary due to missing data.

^a Includes cigars, little cigars, and cigarillos.

^b Includes chew, snuff, and dip.

Table 2

Patterns of persistence and desistence of current use of cigarettes and non-cigarette alternatives across the 14-month period between Wave 1 and Wave 2.

	Current cigarette smokers					Non-current cigarette smokers				
	<i>n</i>	Persist non-use	Persist use	New use at Wave 2	Desist use at Wave 2	<i>n</i>	Persist non-use	Persist use	New use at Wave 2	Desist use at Wave 2
Cigarettes	144	0	98 (68.1%)	0	46 (31.9%)	532	497 (93.4%)	0	35 (6.6%)	0
^a Cigars	139	111 (79.9%)	4 (2.9%)	12 (8.6%)	12 (8.6%)	533	506 (94.9%)	5 (0.9%)	13 (2.4%)	9 (1.7%)
Hookah	139	90 (64.7%)	18 (12.9%)	6 (4.3%)	25 (18.0%)	531	483 (91.0%)	12 (2.3%)	25 (4.7%)	11 (2.1%)
^b Smokeless	139	130 (93.5%)	1 (0.7%)	3 (2.2%)	5 (3.6%)	532	520 (97.7%)	4 (0.8%)	6 (1.1%)	2 (0.4%)
Snus	140	131 (93.6%)	1 (0.7%)	4 (2.9%)	4 (2.9%)	530	527 (99.4%)	0	2 (0.4%)	1 (0.2%)
E-cigarettes	138	94 (68.1%)	11 (8.0%)	24 (17.4%)	9 (6.5%)	531	514 (96.8%)	2 (0.4%)	13 (2.4%)	2 (0.4%)

Note. Current cigarette smoker status based on Wave 1 past 30-day use of cigarettes. Sample sizes for each of the cigarette and non-cigarette alternative products vary due to missing data.

^a Includes cigars, little cigars, and cigarillos.

^b Includes chew, snuff, and dip.

cigarette use at Wave 1 were significantly more likely (8.5 times and 6.6 times, respectively) than their non-using counterparts to report current e-cigarette use 14 months later at Wave 2.

4. Discussion

Non-cigarette alternatives are becoming increasingly prevalent among young adults, but relatively little is known about change in use of these products across time. Results from this study fill a critical gap, showing that e-cigarette use significantly increased across approximately 14 months, among both current cigarette smoking and non-cigarette smoking college students. Examination of the socio-demographic predictors indicated that Wave 1 cigarette use was the strongest predictor of increased e-cigarette use. Current cigarette smokers were 8.5 times more likely than their counterparts to show an increased prevalence in use across time. Hookah use also showed changes in prevalence across time. Hookah use increased across time among non-cigarette smokers, but declined among current cigarette smokers. Use of cigars/cigarillos/little cigars and of chew/snuff/dip and snus remained unchanged. Additional findings indicated that hookah, cigars/cigarillos/little cigars, and e-cigarettes were the most prevalent non-cigarette alternatives whereas chew/snuff/dip and snus were relatively uncommon in our sample of college students. Study findings highlight the need for additional research examining longitudinal changes in young adults' use of non-cigarette alternatives across multiple study waves. Research

examining factors contributing to increased use of e-cigarettes is particularly warranted.

Consistent with research indicating that cigarette smokers are more likely than their peers to use a variety of non-cigarette alternative products (Biener and Bogen, 2009; McMillen et al., 2012), findings indicated that current use of non-cigarette alternatives during at least one study wave ranged from 6% for snus to 35% for hookah among current cigarette smokers compared with .6% for snus to 9% for hookah among non-current smokers (see Table 2). While non-smoked alternatives, such as chew/snuff/dip and snus, are often marketed for use where smoking is not allowed (Mejia and Ling, 2010), these products are addictive and none are completely harmless (Foulds, Ramstrom, Burke, and Fagerstrom, 2003; Hatsukami, Lemmonds, and Tomar, 2004). Similarly, smoked alternatives, such as hookah, have known negative health effects including heart disease and lung cancer (Cobb et al., 2010). Concurrent use of cigarettes with other non-cigarette alternatives therefore may result in additive or even multiplicative negative health effects.

Hookah was the most prevalent non-cigarette alternative product used both by current cigarette smokers and non-cigarette smokers. Approximately 9% of sampled students reported using hookah in the past 30 days, which corroborates findings from a nationally representative sample of college students, indicating that 9.9% of the sample reported current hookah use in the 2008/2009 school year (Sidani, Shensa, and Primack, 2013). Moreover, 13% of current smokers and 2% of non-current smokers were persistent users of hookah, reporting past 30-day use at both study waves. Hookah use may be more prevalent among college students than other alternatives because it facilitates social interactions (Sharma, Beck, and Clark, 2013). However, it may also be more prevalent because college students believe it is more socially acceptable and less harmful than cigarettes (Heinz et al., 2013), even though it has many of the same negative health effects (Cobb et al., 2010).

Additional findings indicated that hookah use declined across the 14-month period among current cigarette users, whereas it increased among non-cigarette users. Compared with 18% of current smokers who desisted hookah use by Wave 2, only 2% of non-current smokers did the same. Evidence indicates that college student hookah users tend to be younger (Sidani et al., 2013). Thus, the decline in use as current smokers increased in age is not unexpected. However, the significant increase in use among non-cigarette smokers to 7% at Wave 2 is alarming given that hookah use has negative health consequences (Cobb et al., 2010) and has been associated with intention to try cigarettes among non-cigarette smokers (Heinz et al., 2013). The increased use across time in our sample of non-cigarette smokers may reflect later initiation of hookah use. However, because we were limited to two

Table 3Examining socio-demographic and Wave 1 current cigarette and e-cigarette use predictors of Wave 2 current e-cigarette use (*n* = 669).

	<i>B</i>	<i>S.E.</i>	<i>Odds ratio</i>	<i>95% CI</i>
Gender				
Female	REF	REF	REF	REF
Male	.24	.33	1.27	.66–2.44
Age				
18 to 25 years old	REF	REF	REF	REF
26 to 35 years old	−.31	.39	.74	.34–1.58
Race/ethnicity				
Non-Hispanic White	REF	REF	REF	REF
Hispanic	−.37	.35	.69	.35–1.38
Other	−.75	.56	.47	.16–1.41
Wave 1 current cigarette use	2.13***	.35	8.45	4.28–16.70
Wave 1 current e-cigarette use	1.88***	.49	6.58	2.52–17.16

Note. Pairwise deletion resulted in removal of data from 29 participants from the overall sample. REF = Reference category.

p* < .05; *p* < .01; ****p* < .001.

assessments separated by 14 months, and initiation may have occurred prior to Wave 1 or between Wave 1 and Wave 2, the current study could not determine when initiation of hookah use occurred. Additional research is therefore needed to examine patterns of initiation across time to understand not only when college students begin using hookah, but also the implications for subsequent and continued use of hookah, particularly among non-cigarette smoking students.

The most noteworthy finding of the current study is that current e-cigarette use increased across time among both current cigarette smoking and non-cigarette smoking students. Approximately one quarter of current cigarette smokers reported past 30-day use of e-cigarettes at Wave 2, and this represented a near doubling of the prevalence at Wave 1. The prevalence of e-cigarette use tripled to 3% at Wave 2 among non-current smokers. This finding is consistent with research indicating that e-cigarette use is a growing phenomenon (King et al., 2015), but also makes a unique contribution to the literature by demonstrating change in use across time in the same study sample. E-cigarettes currently lack FDA regulation and their level of safety has not yet been determined. Increasing use of these products among current smokers and non-smokers is therefore a public health concern that requires continued tracking and analysis to determine predictors of use.

E-cigarette use was relatively high among current cigarette smokers, with 32% reporting current use during at least one study wave, and Wave 1 current cigarette smoking predicted subsequent e-cigarette use 14 months later. Cigarette smokers may be at elevated risk for e-cigarette use because they are targeted with messages about using these products in places where smoking is not allowed (Mejia and Ling, 2010). Concurrent use of cigarettes with non-cigarette alternatives, such as e-cigarettes, may lead to escalated use and addiction of both products by intermittent users (White et al., 2009), or prolong addiction and fewer quit attempts among addicted smokers (Parascandola et al., 2009). Escalated use and addiction may be particularly relevant to the 8% of current cigarette smokers in our sample who were also persistent e-cigarette users, reporting current e-cigarette use at both waves.

The tripling of the prevalence of e-cigarette use among non-current smokers to 3% across the 14-month period is also worthy of discussion. E-cigarettes may be particularly appealing to non-cigarette smokers because they are available in various flavors ranging from fruit to candy and alcohol flavors (U.S. Department of Health and Human Services, 2012) and perceived to be lower in harm compared with conventional cigarettes (Smith, Curbow, and Stillman, 2007). Nonetheless, e-cigarette use may lead to nicotine addiction and there are concerns that these products may introduce young adults to other tobacco products (Grana, 2013). To date, however, no studies have examined trajectories and transitions of e-cigarette use either alone or concurrently with other products. Research examining longitudinal trends in e-cigarette use by college students is therefore warranted, particularly since the college years are a time when there is considerable change in tobacco use (Gilpin, White, and Pierce, 2005; Wetter et al., 2004).

The current study is unique in its examination of change across time in the use of alternative tobacco products, including e-cigarettes, in the same sample of college students. However, some limitations should be taken into consideration. First, the study was limited to two waves of data separated by approximately 14 months. Examination of tobacco use across three or more time periods would allow for examination of trajectories and transitions in use of the various products, either alone or concomitantly with other products. Second, our question on e-cigarettes was modeled after questions traditionally asked about cigarettes and other non-cigarette alternatives (i.e., past 30-day use) and is consistent with other surveillance studies on e-cigarettes (Sutfin et al., 2013). However, the typography of e-cigarette use is different from that of other products and therefore, measurement might also differ. Yet, very little research provides guidance on how best to ask questions about e-cigarette use to obtain a meaningful measure of current use. Future research examining the typography of e-cigarette use is needed. Finally, given that data were drawn from seven colleges in Texas, results

may not generalize to populations outside of the current sample. Future studies replicating study findings with larger, more representative samples are needed.

5. Conclusions

Notwithstanding the limitations, the current study provides valuable information on change in use of non-cigarette alternative products and highlights the need for additional research examining trends in use of e-cigarettes, the only product that increased in use across time among both current cigarette users and non-cigarette users. The near doubling in prevalence of e-cigarette use among current smokers to 25% across the 14-month period is particularly troubling, given that concurrent use of cigarettes with at least one other tobacco product is associated with escalated and prolonged use of cigarettes and with increased possibility of addiction or prolonged addiction (Parascandola et al., 2009; White et al., 2009). The tripling of e-cigarette use to 3% among non-smokers is also concerning because the health effects of these products are unknown, and use may lead to nicotine addiction and/or use of other tobacco products (Grana, 2013). Additional information on hookah and cigar/cigarillo/little cigar use is also needed, as these products were also highly prevalent among current cigarette users and hookah use increased across time among non-cigarette smokers. Findings from this research underscore the importance of including information about non-cigarette alternatives, particularly e-cigarettes, hookah, and cigars/cigarillos/little cigars in prevention programs aimed at college students. However, college cessation programs should also be aware of the concurrent use of more than one tobacco product among college students (Latimer, Batanova, and Loukas, 2014) and should develop programs to help these users quit using cigarettes and non-cigarette alternative products.

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Contributors

A Loukas conceptualized the study and led the writing and editing of the paper. M Batanova conducted the analyses, assisted with writing the results, and editing the paper. A Fernandez and D Agarwal assisted with writing and editing the paper.

Conflict of interest

All authors declare that they have no conflicts of interest.

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