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Predicting Tobacco Use across the First Year of College

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Abstract

Objective—The purpose of this study was to assess patterns of tobacco use across the first year of college, transitions in use, and associated predictors.

Methods—The frequency of tobacco use (cigarettes, cigars, smokeless tobacco, and hookah) during the fall and spring of 4073 college students' first year at college were used as indicators in latent class (LCA) and latent transition analyses (LTA).

Results—The LCA yielded 3 classes that represent levels of use frequency and not specific tobacco product classes: non-using, experimenting, and frequent using. The LTA results demonstrate stability in class membership from fall to spring. The most common transition was for the fall experimenters to transition out of experimentation. A series of demographic,

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Human Subjects Statement

The Virginia Commonwealth University institutional review board (HM13352) approved the original Spit for Science data collection. The current data analysis for this paper was exempt from IRB review.

Conflict of Interest Statement

The authors declare no conflicts of interest.

environmental, and intrapersonal predictors were found to influence both fall class membership, and transitions from fall to spring.

Conclusions—Students are likely to use multiple alternative tobacco products along with cigarettes. Their frequency of use of these products is fairly stable across the first year of college. Predictors reflecting experiences during the first year of college had the greatest impact on college tobacco use, demonstrating the importance of the college experience on young adult tobacco use.

Keywords

tobacco; college; transition; alternative tobacco

Tobacco use is a public health concern due to its potential to lead to addiction and cancer. Currently, tobacco use is highest in young adults aged 18–25.¹ Over 60% of college students have tried at least one tobacco product, with about one-third having used in the past 30 days.² Whereas the most commonly used tobacco product is cigarettes, young adults are also experimenting with other tobacco products including cigars, smokeless tobacco, and hookah. About half of all college students have tried alternative tobacco products, such as cigars and hookah, with about 20% using in the past 30 days.³ Although alternative tobacco users believe these products are less harmful than cigarettes,^{4–6} use of an alternative tobacco product has been shown to increase risk of nicotine dependence in adult current smokers,⁷ making them equally important to study in the college population. In addition to their high levels of tobacco use, young adults are also at greatest risk for progressing to regular tobacco use.⁸

The first year of college, with its associated developmental changes, is an essential period to study tobacco use.⁹ During this time, students experience new stressors and challenges^{10,11} putting them at increased risk for mental health problems and substance abuse including tobacco use.¹² Also during this time, college freshmen are developing new social groups. These peers have been shown to have a strong effect on a person's tobacco use.^{13,14} Additionally, it has been shown that college mental health symptoms are more predictive of future adult behavior than adolescent high school symptoms.¹² Taken together, the onset of these changes and new experiences with the potential for long term effects make studying tobacco use across the transitional first year of college an important area of research for selecting those most at risk of initiation or escalation in tobacco use.

Predictors of Young Adult Tobacco Use

The theory of Triadic Influence (TTI) seeks to provide an overarching framework for the influences on health behaviors.¹⁵ This framework has been used previously in the context of factors influencing youth substance use.^{16,17} The TTI proposes 3 streams of influence: intrapersonal, social/interpersonal, and cultural/environmental. In the current study we chose to focus on 2 predictors from each stream of influence due to their previous associations with young adult tobacco use.

Cultural/environmental influences represent broader societal level influences, which are often out of the individual's control and can also affect social/interpersonal and intrapersonal

factors. Sex and race/ethnicity can be viewed as cultural/ environmental influences and influence rates of tobacco use. Male cigarette smokers are more than 3 times as likely to use other tobacco products than female cigarette smokers.¹⁸ Whereas an equal number of men and women use cigarettes, men use more tobacco products overall due to their increased likelihood to use alternative tobacco products.^{2,18} Research also has demonstrated racial differences in frequency of cigarette and cigar use¹⁹ and racial differences in predictors/ indicators of alternative tobacco use (defined as cigars, smokeless tobacco, and hookah).²⁰ College students who are hookah or dual users (cigarette and hookah) differ demographically from both nonsmokers and cigarette only smokers.²¹ This further emphasizes that nicotine use among young adults shows variation with regard to sex, ethnicity/race, and type of tobacco products.

Additionally we focused on social/interpersonal factors such as peer substance use^{22,23} and stressful life events (SLEs),²⁴ and intrapersonal factors, such as anxiety and depression.²⁵ Each of these factors has been associated with a different stage in the progression of tobacco use. For example, peer use predicted smoking initiation and SLEs were associated with continuing smoking;²⁶ anxiety and depression predict more serious use such as daily cigarette use or nicotine dependence.²⁷ Morrell, Cohen, Bacchi and West²² demonstrated that peer use also predicts smokeless tobacco use in college students but little is known overall regarding how these factors affect alternative tobacco use.

Longitudinal Analyses of College Tobacco Use

Due to the high rates of use among these age groups¹ and their likelihood of progressing into regular use,⁸ it is important to understand how tobacco use patterns change across adolescence and young adulthood. Although the majority of longitudinal studies have focused on cigarette smoking,^{28–31} 2 studies examined tobacco use during the first year in college. Colder et al³² found that there was a general decrease in the number of cigarettes smoked and the percentage of the population that smoked over the course of their freshman year. With regards to alternative tobacco use, Fielder et al³³ found that pre-college hookah use predicted cigarette use during college, but pre-college cigarette use did not predict hookah use. This finding implies that there may be a hierarchy of tobacco products where some products act as gateway products to using other types of tobacco products. The current study builds on both of these studies by examining a variety of tobacco products and allowing for comorbid use.

Latent Class and Latent Transition Analysis

Latent class analysis (LCA) is a statistical method used to identify latent subgroups or classes within a sample based on individuals' responses to measured items. LCA differs from standard regression methods, in that it creates subgroups that are data driven rather than predetermined by the researcher. Determining subtypes of tobacco users is valuable as interventions may not be effective across all users.³⁴ Some studies have found a small class with high rates of endorsement across alternative tobacco products.^{7,35} In a LCA of predominantly high school students, Nasim et al³⁵ found a small latent class (6.5% of the sample) that endorse alternative tobacco use (cigars, bidis, and cloves). Similarly in a LCA

of college students, Timberlake⁷ found that the smallest latent class (4.3%) was defined by use of multiple alternative tobacco products (cigars, bidis, smokeless tobacco). These findings suggest a level of poly-substance use among alternative tobacco users. However, other studies show small classes indicated by specific alternative tobacco products.³⁶ Specifically, in an LCA of college students, Erickson et al³⁶ found specific tobacco product classes: a class indicated by cigarettes use only, a class indicated by cigarillo and hookah use, and a class indicated by snus and snuff use. This suggests that there is something distinct about users of specific tobacco products. Using LCA in a large, diverse, college sample, our study aims to provide further evidence as to whether college students engage in poly-tobacco use or there are specific subgroups of alternative tobacco product users.

Whereas LCA examines subgroups at a single time point, latent transition analysis (LTA) provides an opportunity to assess changes in an individual's pattern of tobacco use across time. LTA is the longitudinal version of LCA, in that it is used to categorize individuals into subgroups across time and describes how individuals transition among subgroups across time. Therefore, LTA is an essential tool for determining if there is heterogeneity in the trajectories of tobacco use across the freshman year of college, which has implications for predicting long-term substance use. Understanding how tobacco use changes among subgroups can help to identify early on who is at greatest risk to escalate use. To our knowledge, there are no previous studies that have focused exclusively on use of tobacco products and transitions using LTA.

Our study is among the first to examine patterns of tobacco use, including both cigarettes and alternative tobacco products, and their predictors across the transitional period of the first year of college. First, we used LCA to assess subgroups of alternative tobacco users at the fall and spring of the students' first year of college. Second, LTA was used to determine whether patterns of alternative tobacco use changes over the first year in college. Finally, we assessed predictors of alternative tobacco use in a longitudinal framework.

METHODS

Sample Description

The sample comes from the Spit for Science project,³⁷ an assessment of incoming freshmen at a large, public US university. Study data were collected and managed using REDCap (Research Electronic Data Capture) tools hosted at Virginia Commonwealth University.³⁸ The 4073 participants used in this study come from the incoming freshman classes of 2011 (Cohort 1) and 2012 (Cohort 2; 68% response rate across both cohorts). Data were collected at 2 time points during the participants' freshman year of college; once upon arriving on campus to capture their behavior before college, and then again in their spring semester of the freshman year to capture their early college behavior. Endorsement of tobacco use was comparable across the 2 cohorts (Appendix Table A1). Across the 2 cohorts, 1601 (39%) were men and 2466 (60.1%) were women. The ethnic breakdown was as follows: 21 (0.5%) American Indian/ Alaskan Native, 654 (15.9%) Asian, 746 (18.2%) black/African-American, 244 (5.9%) Hispanic/ Latino, 223 (5.4%) more than one race, 32 (0.8%) Native Hawaiian/other Pacific Islander, 18 (0.4%) unknown, and 2094 (51%) white. This racial/ ethnic breakdown is representative of the diversity at Virginia Commonwealth University.

Measures

Tobacco measures—In both the fall and spring semester, tobacco use was measured by 4 questions, asking how often students used cigarettes, cigars, smokeless tobacco, or hookah in the past 30 days. Smokeless tobacco was added to the survey in the spring of Cohort 1. Therefore, it was not assessed in the fall for Cohort 1 but was assessed at both time points for Cohort 2. Answer choices were “I did not use,” “Once or twice,” “A few days (3 to 4 days a month),” “A couple of days a week (5 to 11 days a month),” “3 times a week (12 to 14 days a month),” “most days of the week (15 to 25 days a month),” “daily or almost daily (26 to 30 days a month),” and “I choose not to answer.” Due to the low endorsement rates in some of the most frequent use categories, some response options were collapsed. For the cigar, smokeless tobacco, and hookah variables, a “few days” and “a couple days a week” were collapsed, and “3 times a week,” “most days of the week,” and “daily or almost daily” were collapsed. For the cigarette variable, “a few days” and “a couple days a week” were collapsed and “3 times a week” and “most days of the week” were collapsed. The “daily or almost daily” category was left separately for cigarettes due to the large number of students who endorsed this category and its previously noted strong association with nicotine dependence symptoms.³⁹

Predictors—Sex and race/ethnicity were measured in the fall semester of participants’ freshman year. Anxiety, depression, peer deviance and stressful life events (SLE) were measured in both the fall and spring semester of the participants’ freshman year. Anxiety and depression were measured using a subset of items from the Symptom Checklist-90 (SCL-90).⁴⁰ Both scales show high internal reliability ($\alpha = .81$ and $.80$, respectively) in the current study. Participants rated how much each symptom caused them discomfort (“Not at all,” “A little bit,” “Moderately,” “Quite a bit,” and “Extremely”) within the last 30 days. Peer deviance was assessed on high school friends in the fall and college friends in the spring. Peer deviance was measured by 6 questions asking how many of the student’s friends (“none,” “a few,” “some,” “most,” “all”) had smoked cigarettes, drunk alcohol, got drunk, had problems with alcohol, been in trouble with the law, and smoked marijuana. Both high school and college peer deviance measures show high internal reliability ($\alpha = .89$ and $.88$, respectively) in the current study. SLEs were measured by 12 questions⁴¹ asking whether the student had experienced a potentially stressful life event, related to interpersonal, economic, career, health, legal stress, or death of a loved one, in the past 12 months (fall assessment) or since starting college (spring assessment). Each endorsement of a SLE was summed to create the SLE score.

Statistical Methods

Latent class analysis (LCA) was run to classify individuals into unobserved subgroups, called latent classes, based on their observed response pattern for the 4 tobacco use questions. To determine the optimal number of classes, we followed guidelines for class enumeration described in Nylund et al.⁴² We first used the Akaike information criterion (AIC⁴³), Bayesian information criterion (BIC⁴⁴), and adjusted Bayesian information criterion (aBIC⁴⁵) to reduce the number of class solutions to compare, with lower values indicating better fitting models. From the 2–3 models determined by information criteria, we used the Vuong-Lo-Mendell-Rubin likelihood ratio test (LMR⁴⁶) and the bootstrapped

likelihood ratio test (BLRT⁴⁷) to determine the best fitting model. The LMR and BLRT compare the current k class solution to the k-1 solution, where a significant p-value indicates the additional class does not explain the data better.

Next, we used LTA to assess how students' patterns of tobacco use changed over their first year of college. LTA is the longitudinal extension of LCA in that it classifies individuals into tobacco use classes, but also allows for the examination of transitions among these classes. Using the number of classes from the best-fitting fall and spring LCAs, we fit 4 different latent transition models to test the equivalency of fall and spring classes. Specifically, these models were: a completely measurement invariant model where all classes were equal between fall and spring; a completely measurement non-invariant model where all classes were allowed to differ between fall and spring; and 2 partial measurement invariant models where one or 2 classes were held constant and the rest were allowed to differ across fall and spring. The best fitting model from these was determined using the lowest value of the AIC, BIC, and aBIC.

Finally, using the best fitting LTA model, we examined the effect of different predictors on class membership and the transition probabilities. Each predictor was entered into the LTA model separately to maximize power to detect effects and sample size due to models with multiple predictors excluding participants with missing data on any of the included predictors.⁴⁸ Race, sex, and other predictors that captured behavior before college using the initial survey were modeled to predict initial class membership in addition to transitions between classes. Due to the small sample sizes in some of the race categories (Native American/Alaskan Native, Hispanic/Latino, Native Hawaiian/ Other Pacific Islander, and more than one race) were combined into one category termed "Multiple ethnicities/races." Because the "Multiple ethnicities/races" category was created without a substantive meaning it was used solely for modeling purposes and is not to be interpreted. Predictors that were measured in the spring survey were modeled to predict only the transitions between classes. All analyses were performed using Mplus v7.1.⁴⁹

RESULTS

Sample Description

In the fall, 21.1% of incoming freshmen had smoked at least one cigarette in the past 30 days and 35.5% had tried at least one alternative tobacco product in the past 30 days. By the spring assessment, 22.8% of the freshmen had smoked at least one cigarette and 44% had tried at least one alternative tobacco product in the last 30 days. Table 1 shows the endorsement of the tobacco measures in the fall and spring. Depression and anxiety scores ranged from 4 to 20 with a mean of 8.49 (3.61) and 6.61 (2.96) respectively, in the fall, and 9.78 (3.88) and 6.89 (3.18) respectively, in the spring. Peer deviance scores ranged from 6 to 30 with a mean of 14.33 (5.21) for high school peers and a mean of 14.7 (5.09) for college peers. Students endorsed an average of 1.79 (1.67) SLEs in the fall and 1.94 (1.82) SLEs in the spring.

Latent Class Analysis (LCA) Results

The results of the LCA indicated a 3-class solution for both the fall and spring. Appendix Table A2 shows the fit statistics for the LCA models. In the fall, the 3-class solution had the lowest AIC and lowest aBIC. In addition, the nonsignificant p-values in the 4-class solution for the LMR LRT and BLRT indicated that the 3-class solution was the most parsimonious model. In the spring, the 3-class solution had the lowest BIC and aBIC. The LMR LRT and BLRT were both significant for the 3-class solution. The LMR LRT, but not the BLRT, was nonsignificant for the 4-class solution. In the fall, the classes represent a non-using class (76% of the sample), an experimenting class (18%), and a frequent use class (5%). In the spring, the classes also represent non-using (80%), experimenting (17%), and frequent use (2%) classes. In both the fall and the spring the non-using class reported low rates of any tobacco use and zero probability of being in the highest frequency categories across substances. The frequent use class had a high probability of any tobacco use and the highest probability of endorsing the most frequent use categories compared to the other 2 classes. Finally, the experimenting class had a moderate to high probability of endorsing any tobacco use (except smokeless tobacco) but a low or zero probability of endorsing the highest frequency of use. Figure 1 shows the probabilities of endorsement for any tobacco use and for the most frequent category for the fall and spring classes.

Latent Transition Analysis (LTA) Results

The measurement invariant model, where the interpretation of each class was constant from fall to spring, had the lowest values of the BIC and aBIC. In addition, there was not a statistically significant difference in model fit from the measurement variant to measurement invariant model ($\chi^2 = 45$, $df = 39$, $p = .24$). The 3 classes in the best-fitting LTA solution were similar to those found in the LCA model, with a large non-using class, a smaller experimenting class, and the fewest people in a frequent use class. Table 2 contains the latent transition probabilities between the fall and spring classes. Overall, individuals were most likely to stay in the same class from fall to spring. The probability of being a frequent user in the spring given that an individual was classified as a frequent user in the fall was 97%; the probability of being a non-user in the spring given that they were a non-user in the fall was 96%. The most common transition was for experimenters in the fall to transition to another class, usually to non-use (22%), though a smaller number transitioned to frequent use (5%).

Predictor Results

Table 3 shows the effect of the demographic, social/interpersonal (peer deviance, stressful life events [SLE]), and intrapersonal (depression, anxiety) predictors on initial class memberships. Men are more likely than women to be in either of the tobacco using classes in the fall (ORs = 2.32 frequent use, 2.36 experimenting). African Americans and Asians are less likely than Whites to be in either the experimenting class (ORs = 0.60 African Americans, 0.36 Asians) or the frequent use class (ORs = 0.16 African Americans, 0.24 Asians) in the fall. Higher scores on any of the social/interpersonal or intrapersonal predictors significantly increased the likelihood that a student would be in the frequent use class compared to the non-using class (ORs = 1.32 SLE, 1.49 peer deviance, 1.11 depression, 1.08 anxiety). Only peer deviance (OR = 1.24) and SLE (OR = 1.21) increased a

student's likelihood of being in the experimenting class in the fall compared to the non-using class.

Tables 4 and 5 show the latent transition probabilities by sex and race respectively. Overall, the transition probabilities are similar between men and women. Compared to women, men are less likely to transition out of the experimenting class. However, men who do transition out of the experimenting class are more likely to transition into the frequent use class than women. Across Whites/European Americans, Blacks/African Americans, and Asians the transition probabilities were similar. Asians were most likely to transition out of the frequent use class compared to the other 2 races and exclusively into non-use. However, for the experimenter class in the fall, Asians were most likely to transition into the frequent use class. Whites/European Americans were most likely to stay in the experimenter class from fall to spring.

Table 6 shows the effect of the social/interpersonal and intrapersonal predictors on the transition from fall to spring. Overall, predictors measured in the fall did not predict the transition between classes from fall to spring with the exception of having highly deviant peers in high school increasing the likelihood that a student would transition out of experimenting in the fall and into non-use. Additionally, high levels of depression and anxiety in the fall decreased the likelihood that non-users in the fall would transition into the experimenting class in the spring (ORs = 0.42 depression, 0.42 anxiety). Predictors measured in the spring predicted the transition from fall class membership to spring class membership. High levels of college peer deviance and SLE across the first year of college increased the likelihood that students would transition into either of the tobacco using classes (ORs = 1.30 to 1.42) while decreasing the likelihood that they would transition out of experimenting class and into non-use. High levels of depression (OR = 1.28) and anxiety (OR = 1.30) in the spring only significantly increased the likelihood that a student would transition from non-use to frequent use.

DISCUSSION

Whereas there has been an increase in the variety of tobacco products used by youth in recent years, there is still a limited amount of research examining (1) patterns of use across tobacco products, and (2) factors related to changes in patterns of use over time. Our study fills that gap by assessing both patterns of use and predictors of use over time in a college population.

Overall, we found that students used multiple tobacco products with the same frequency: students who were frequent cigarette smokers were likely to use other tobacco products frequently as well, and those who experimented with one tobacco product were likely to try others. This was in contrast to the LCA by Erickson et al³⁶ that found classes were indicated by specific tobacco products, such as cigarettes, snuff and snus, or cigarillos and hookah. However, Erickson et al³⁶ only assessed whether or not young adults used these products in the past month, and not how frequently they were used. In contrast, we provided a more comprehensive assessment of tobacco use by using ordinal variables, representing frequency of use.

In addition, we found that across the student's first year of college their tobacco use was fairly stable. The majority of those who began college as non-users continued to be non-users and those who entered college frequently using multiple tobacco products continued to do so in the spring. The exception is that about 27% of those who entered college experimenting with tobacco products either increased to frequent use (5.3%) or desisted to non-use (21.8%). Similarly, in a study of first-year college women, Fielder et al³³ found that pre-college hookah use predicted college cigarette use and pre-college cigarette use predicted college hookah use. Our study included more tobacco products but still found that tobacco use was consistent across product type. In a year-long study of young adults, Richardson et al²⁸ found that the percentage of the sample in each tobacco use group was static across a one-year period, paralleling our finding that individual tobacco use patterns are generally stable across a short time frame.

Our findings that men were more likely than women to be in the tobacco using classes and that Blacks/African Americans and Asians were less likely than Whites/European Americans to be in the tobacco using classes replicated previous findings.^{2,18} In addition, the transition patterns were fairly stable across sex and ethnicity/race. However consistent with previous research,⁵⁰ given that a student was an experimenter in the fall, men were more likely to transition into frequent use compared to women, and women were more likely to transition into non-use compared to men. With regard to different ethnic/racial groups in our study, we found that blacks/African-American experimenters were more likely to transition in general, and were more likely to transition to non-use compared to Whites/European Americans. This transition into non-use after experimenting follows research demonstrating that black/African-American adolescents are less likely to smoke cigarettes in the past month^{19,51} and less likely to try smoking in the future⁵² compared to white/European-American adolescents. In contrast, we found that Asians were more likely to become frequent users if they were experimenters in the fall; however, they were more likely to become non-users if they were frequent users in the fall compared to Whites/European Americans and Blacks/African Americans. This is a particularly interesting finding as little research has been conducted on tobacco use in Asian-American populations.

In general, predictors measured in the fall (which captured experiences prior to college), significantly predicted initial class membership but not the transition from fall to spring, and predictors measured in the spring (which captured experiences during college), significantly predicted the transition in tobacco use class from fall to spring. This is exemplified in the effects associated with stressful life events (SLEs). High school SLEs were associated with increased risk of being in either of the tobacco using classes in the fall, consistent with previous research.^{24,26} However, whereas high school SLEs were not associated with the transition in class membership from fall to spring, college SLEs were associated with transitioning to the tobacco using groups. Similarly, deviant high school peers had a significant effect on initial class membership but not the transition from fall to spring class, and deviant college peers had a significant effect on tobacco transitions. The stronger effect of spring predictors is consistent with previous research in this sample examining poly-substance transitions across the first year of college,⁵³ in which they found that first-year college experiences were better predictors of college substance use than pre-college factors.

These findings, along with our findings emphasize college as an ideal time to focus prevention and intervention efforts.

One exception is the effect of high school peers on the transition from experimenting in the fall to non-use in the spring. Students with more deviant peers in high school were more likely to transition from experimenting to non-use. *Post hoc* analyses demonstrated that experimenters who transitioned to non-use had a significant decrease ($M = -1.98$, $SD = 5.74$) in peer deviance than those who continued experimenting from fall to spring ($M = 0.88$, $SD = 4.77$, $t(148) = -4.90$, $p < .001$). This significant difference in peer group shows that individuals who transitioned from experimentation to non-use also changed from a more deviant peer group in high school to a less deviant peer group in college. This demonstrates that whereas *high school* peers are important in setting a student's incoming tobacco use, their influence declines over the time spent in college when they affiliate with less deviant peers. This strong, yet modifiable, effect of peer group on tobacco use could be targeted in prevention and intervention efforts.

An interesting pattern of results emerged with respect to the effect of anxiety and depression on tobacco class membership and transitions. Anxiety and depression symptoms prior to college were associated with the frequent use class during the fall semester but not associated with the experimenting class. Similarly, anxiety and depression symptoms during college were associated only with the transition from non-use to frequent use. These findings are consistent with research showing a prominent and cyclical role of negative emotions in substance abuse.⁵⁴ However, anxiety and depression symptoms were not associated with *experimentation*. Fall anxiety and depression were actually protective of fall non-users transitioning into experimentation in the spring. This may reflect the fact that a certain level of experimentation with tobacco is developmentally normative and associated with peer use. Therefore, those with high anxiety or depression in the fall may be less likely to select into deviant peer groups or spend much time with peers,^{55,56} and thus, are protected against experimenting with tobacco products. However, when individuals with depressive and anxious symptomology use, they use frequently.

Several limitations of the current study should be considered. Although this is one of the first studies to examine alternative tobacco use longitudinally, and we chose to focus here on the transitional period of starting college, it is possible that tobacco use could change more dramatically over the entire college experience and beyond. The participants in the Spit for Science sample are followed throughout all 4 years of college, enabling future studies to assess if and how these tobacco use patterns change over a longer period. Additionally, due to small sample sizes in the frequently using class, we were not able to examine factors that contribute to the small number of riskiest users who decreased their use or to the small number of experimenters who escalated their use. Unfortunately, we did not have information on e-cigarette use, which is increasing in popularity among youth.^{57,58} However, researchers should be cautious when including use of e-cigarettes in studies measuring more traditional nicotine products. The health consequences of e-cigarettes are not yet well understood,⁵⁹ whereas, the health consequences for the products included in our study are well documented.⁶⁰ Furthermore, e-cigarettes have been used as a smoking cessation product,^{61,62} a fact that potentially confounds those who are at various stages of

quitting with regular users or those escalating their use. Also, even though our sample was large and diverse, these findings may not be generalizable to all tobacco users. However, previous work in this sample has shown tobacco use rates to be comparable to nationally representative studies on young adults.³⁷ Finally, as with all survey data, there is the potential for recall bias leading to either inflated or deflated reports of tobacco use.

In conclusion, our study is among the first to examine concurrent frequency of tobacco product use and its predictors longitudinally. We found that college freshmen were more likely to use multiple tobacco products than a single product, and generally were consistent in their use patterns from fall to spring. Peer deviance, SLE, anxiety, and depression predicted frequent use in the fall but only peer deviance and SLE predicted experimenting. Predictors reflecting experiences during the first year of college generally had a stronger effect on transition than those reflecting pre-college experiences. This study reiterates the importance of assessing alternative tobacco products in addition to cigarettes, because many students use multiple products. In addition, our study demonstrates the need to educate students on healthy coping skills so they will be less likely to use tobacco as a means of dealing with anxiety, depression, or SLE.

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Appendix

Table A1

Endorsement Frequencies for Tobacco Products across Cohorts 1 and 2

	Cigarettes		Smokeless		Cigars		Hookah	
	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Cohort 1	390 (19.4%)	366 (24.2%)	N/A	78 (3.8%)	421 (21.1%)	428 (21.5%)	548 (27.6%)	587 (29.4%)
Cohort 2	462 (22.9%)	318 (21.4%)	56 (3.7%)	57 (3.8%)	271 (18.1%)	233 (15.9%)	342 (22.8%)	344 (23.5%)

Table A2

Latent Class Analysis Fit Statistics for Fall and Spring

Fall	Log-likelihood	# Free parameters	AIC	BIC	aBIC	LMR p-value	BLRT p-value
1 Class	−9763	13	19552	19634	19592	N/A	N/A
2 Classes	−8914	27	17882	18052	17966	< .001	< .001
3 Classes	−8872	41	17827	18085	17955	.002	< .001
4 Classes	−8860	55	17829	18176	18001	.738	.5
Spring	Log-likelihood	# Free parameters	AIC	BIC	aBIC	LMR p-value	BLRT p-value
1 Class	−7113	13	14252	14330	14289	N/A	N/A
2 Classes	−6532	27	13118	13280	13194	< .001	< .001
3 Classes	−6468	41	13018	13264	13134	.014	< .001
4 Classes	−6450	55	13011	13341	13166	.061	.013

Note.

AIC; Akaike information criterion, BIC; Bayesian information criterion, aBIC: adjusted Bayesian information criterion, LMR: Lo-Mendel-Rubin likelihood ratio test, BLRT: bootstrapped likelihood ratio test

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Figure 1.

The Probability of Tobacco Product Endorsement by Latent Tobacco Class

Note.

The top row shows the fall latent class solutions, and the bottom row shows the spring latent class solutions. The graphs on the left show the probability of each class endorsing any frequency of tobacco use. The graphs on the right show the probability of each class endorsing the highest frequency of tobacco use.

Table 1

Endorsement Frequencies for Tobacco Products in Fall and Spring of Students' First Year of College

	Fall				Spring			
	Cigarettes	Smokeless	Cigar	Hookah	Cigarettes	Smokeless	Cigar	Hookah
Did not use	3172 (78.8%)	1941 (96.1%)	3134 (78.7%)	2844 (71.5%)	2312 (77.2%)	2882 (96.2%)	2460 (83.0%)	2277 (76.8%)
Once or twice	280 (7.0%)	33 (1.6%)	486 (12.2%)	720 (18.1%)	236 (7.9%)	45 (1.5%)	276 (9.3%)	451 (15.2%)
3 to 11 days/month	231 (5.7%)	26 (1.3%)	284 (7.71%)	359 (9.0%)	168 (5.6%)	32 (1.1%)	165 (5.6%)	201 (6.8%)
12 to 25 days/month	126 (3.1%)	---	---	----	111 (3.7%)	---	---	---
26 to 30 days/month	215 (5.3%)	19 (0.9%)	79 (2.0%)	56 (1.4%)	169 (5.6%)	36 (1.2%)	63 (2.1%)	34 (1.1%)

Note.

Frequency of smokeless tobacco, cigar, and hookah use were collapsed over the 12 to 25 days per month and the 26 to 30 days per month categories. Ns differ due to missingness and attrition from fall to spring.

Table 2

Probability of First Year College Students Transitioning between Latent Tobacco Classes in the Fall and Spring

		Spring		
		Frequent	Experimenters	Non-users
Fall	Frequent	0.971 (484)	0 (0)	0.029 (14)
	Experimenters	0.053 (50)	0.728 (685)	0.218 (205)
	Non-users	0.015 (38)	0.029 (76)	0.956 (2520)

Note.

The numbers represent the probability of being in a spring class given their fall class membership. Numbers in the parentheses represent the number of participants in a given transition based on estimated posterior probabilities.

Table 3

Predictors of Latent Tobacco Class Membership in Fall Semester College Freshman

	Frequent vs Non-use		Experimenting vs Non-use	
	OR	p-value	OR	p-value
Men	2.32 (1.84, 2.92)	< .001	2.36 (1.85, 2.99)	< .001
Women	ref	ref	ref	ref
Asian	0.24 (0.16, 0.35)	< .001	0.36 (0.25, 0.52)	< .001
Black/African American	0.16 (0.10, 0.26)	< .001	0.60 (0.42, 0.86)	.006
White/European American	ref	ref	ref	ref
Stress	1.32 (1.25, 1.41)	< .001	1.21 (1.13, 1.3)	< .001
Peer Deviance	1.49 (1.43, 1.55)	< .001	1.24 (1.21, 1.28)	< .001
Depression	1.11 (1.08, 1.15)	< .001	1.00 (0.97, 1.04)	.94
Anxiety	1.08 (1.04, 1.12)	< .001	1.00 (0.95, 1.06)	.95

Table 4

Probability of First Year College Students Transitioning between Latent Tobacco Classes across the Fall and Spring for Men and Women

Men		Spring		
		Frequent	Experimenters	Non-using
Fall	Frequent	0.908	0.071	0.021
	Experimenters	0.102	0.727	0.171
	Non-using	0.021	0.038	0.942
Women		Spring		
		Frequent	Experimenters	Non-using
Fall	Frequent	0.974	0	0.026
	Experimenters	0.039	0.665	0.296
	Non-using	0.012	0.026	0.963

Table 5

Probability of First Year College Students Transitioning between Latent Tobacco Classes across the Fall and Spring for each Race Group

Asian		Spring		
		Frequent	Experimenters	Non-using
Fall	Frequent	0.877	0	0.123
	Experimenters	0.228	0.634	0.138
	Non-using	0.015	0.044	0.941
Black/African American		Spring		
		Frequent	Experimenters	Non-using
Fall	Frequent	0.971	0.029	0
	Experimenters	0.021	0.631	0.348
	Non-using	0.015	0.023	0.962
White		Spring		
		Frequent	Experimenters	Non-using
Fall	Frequent	0.967	0	0.033
	Experimenters	0.071	0.737	0.193
	Non-using	0.02	0.032	0.948
Multiple ethnicities/races		Spring		
		Frequent	Experimenters	Non-using
Fall	Frequent	0.863	0.112	0.025
	Experimenters	0.056	0.72	0.224
	Non-using	0.014	0.034	0.952

Table 6

Predictors of Transitioning between Latent Tobacco Classes across the Fall and Spring

Predictors measured in the Fall						
	Non-use to experimenting ^a		Non-use to frequent use ^a		Experimenting to non-use ^b	
	OR	p - value	OR	p - value	OR	p - value
Peer Deviance	N/A		N/A		1.21 (1.06, 1.38)	.004
Stress	0.90 (0.28, 2.90)	.862	0.59 (0.25, 1.43)	.246	0.92 (0.69, 1.22)	.556
Depression	0.42 (0.30, 0.59)	< .001	1.08 (0.95, 1.24)	.248	1.02 (0.90, 1.15)	.785
Anxiety	0.42 (0.31, 0.57)	< .001	1.18 (0.95, 1.46)	.141	0.96 (0.81, 1.14)	.651
Predictors measured in the Spring						
	Non-use to experimenting ^a		Non-use to frequent use ^a		Experimenting to non-use ^b	
	OR	p - value	OR	p - value	OR	p - value
Peer Deviance	1.35 (1.25, 1.47)	< .001	1.42 (1.27, 1.59)	< .001	0.79 (0.70, 0.89)	< .001
Stress	1.30 (1.10, 1.54)	.002	1.32 (1.12, 1.56)	.001	0.59 (0.32, 1.08)	.089
Depression	0.82 (0.45, 1.5)	.528	1.28 (1.14, 1.42)	< .001	0.88 (0.74, 1.06)	.175
Anxiety	-	-	1.30 (1.20, 1.42)	< .001	0.82 (0.66, 1.02)	.078

Note.

Fall predictors were measured at the fall assessment and spring predictors were measured at the spring assessment.

^aThe reference transition for these analyses is non-use in the fall to non-use in the spring.^bThe reference transition for these analyses is experimenting in the fall to experimenting in the spring.