

# UC Riverside

## UC Riverside Previously Published Works

### Title

Longitudinal latent class analysis of tobacco use and correlates among young adults over a 10-year period.

### Permalink

<https://escholarship.org/uc/item/27p774r8>

### Authors

Sutfin, Erin

Denlinger-Apte, Rachel

Ross, Jennifer

et al.

### Publication Date

2022-07-01

### DOI

10.1016/j.drugalcdep.2022.109474

Peer reviewed



Published in final edited form as:

*Drug Alcohol Depend.* 2022 July 01; 236: 109474. doi:10.1016/j.drugalcdep.2022.109474.

## Longitudinal Latent Class Analysis of Tobacco Use and Correlates among Young Adults Over a 10-Year Period

Erin L. Sutfin<sup>1</sup>, Rachel L. Denlinger-Apte<sup>1</sup>, Jennifer Cornacchione Ross<sup>1</sup>, Kimberly G. Wagoner<sup>1</sup>, Cynthia K. Suerken<sup>4</sup>, John Spangler<sup>2</sup>, Mark Wolfson<sup>3</sup>, Beth A. Reboussin<sup>4</sup>

<sup>1</sup>Department of Social Sciences and Health Policy, Wake Forest School of Medicine

<sup>2</sup>Department of Family and Community Medicine, Wake Forest School of Medicine

<sup>3</sup>Department of Social Medicine, Population, & Public Health, School of Medicine, University of California, Riverside

<sup>4</sup>Department of Biostatistics and Data Science, Wake Forest School of Medicine

### Abstract

**Introduction:** We assessed patterns and correlates, including demographic characteristics, psychological factors, and social role transitions, of young adults' tobacco use over time.

**Methods:** In the fall of 2010, we recruited a cohort of 3,146 students from 11 colleges in North Carolina and Virginia. Participants completed baseline and at least two survey waves between 2010 and 2019.

**Results:** The sample was 49.8% female, 15.7% non-white, and 6.6% Hispanic. Longitudinal latent class analysis revealed a five-class model with distinct patterns and correlates of tobacco use. Limited Use (52.6% of sample) had minimal use. College-Limited Combustible Tobacco Users (16.8%) had moderate probability of cigarette, cigar, and waterpipe smoking, which decreased to no use post-college. Experimental Users (10.9%) had low probability of use that continued post-college. College Polytobacco with Continued Cigarette and E-Cigarette Users (14.0%) had high probability of use of cigarette smoking and increasing probability of e-cigarette, both of which continued post-college. Sustained Polytobacco Users (5.7%) had moderate probability of use of tobacco products across all waves.

**Conclusions:** Patterns of tobacco use varied considerably. In most classes, tobacco use was highest during freshman year and in three classes, use continued post-college. Prevention activities should focus on first-year students and target those at risk for post-college tobacco use.

### Keywords

Risk for tobacco use; Youth tobacco use; Longitudinal research

---

**Corresponding Author:** Erin L. Sutfin, Ph.D., Professor & Vice Chair, Department of Social Sciences and Health Policy, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157, Phone: (336) 713-5282, ESutfin@wakehealth.edu.

**Declarations of Interest:** None.

## 1. Introduction

Emerging adulthood, spanning the ages of 18 through 25, is a distinct developmental period marked by social role transitions (Institute of Medicine & National Research Council, 2015). Many individual-level changes during emerging adulthood stem from social role transitions, which occur in educational, occupational, social, and family domains, such as graduating from college, starting employment, moving into a new home, or getting married (Tanner & Arnett, 2013). These transitions are thought to influence trajectories of the substance use, including tobacco (Bachman et al., 2002; Schulenberg, Bryant, & O'Malley, 2004; Schulenberg & Maggs, 2002). Emerging adulthood is a period of tobacco use experimentation and transition to regular use and dependence (Barrington-Trimis et al., 2020; Richardson, Williams, Rath, Villanti, & Vallone, 2014).

Nearly two thirds of individuals who graduated from high school in 2019 enrolled in college by the following fall, making institutions of higher education a popular destination for emerging adults (United States Bureau of Labor Statistics, 2021). The transition from high school to college can be a stressful experience for some, marked with new freedoms, added responsibilities, and a new living environment (Sussman & Arnett, 2014). Arria and colleagues found that the college environment is at least as risky as the non-college environment for substance use and does not provide a protective benefit for young adults. In their prospective study of over 1,200 college students, they found that by sophomore year, almost all students had the opportunity to try alcohol, and between 80–90% had the opportunity to try tobacco and marijuana (Arria et al., 2008), which is consistent with estimates from the general population (Schulenberg et al., 2019). In fact, the tobacco industry recognizes the transition to college as particularly stressful, and has targeted college campuses to encourage new smokers, solidify existing patterns of tobacco use (Ling & Glantz, 2002) and introduce new products (Katz & Lavack, 2002; Klein, 2007; Lee, Goldstein, Klein, Ranney, & Carver, 2012; Wagoner et al., 2014). In a review of industry documents, Ling and Glantz concluded that the tobacco industry believes the transition from first cigarette to established smoker progresses until age 25 (Ling & Glantz, 2002) making young adults an essential population from which to attract new users.

College students may also be the target for non-cigarette tobacco products, including waterpipe tobacco, e-cigarettes, and cigar products. Research suggests that conventional and novel tobacco products are frequently sold near college campuses (Barker, Schleicher, Ababseh, Johnson, & Henriksen, 2018; Dai & Hao, 2017). Our research shows that waterpipe café, vape shop, and traditional retailer (e.g., convenience stores, grocery stores) density were higher in areas with a higher percentage of people who were college-educated or college-enrolled (King et al., 2020). Moreover, recent data indicate that young adults have higher rates of use of non-cigarette tobacco products than adolescents and older adults (Wang et al., 2018) and for some types of tobacco, such as waterpipe, college students have higher rates of use than their non-college peers (Sidani, Shensa, Yabes, Fertman, & Primack, 2019). With the proliferation of novel tobacco products, understanding patterns of use is important for intervention and prevention efforts during emerging adulthood.

Given the developmental and social role transitions that occur during emerging adulthood *and* the rapidly expanding marketplace, examining tobacco product use over time calls for a dynamic analytic approach. Longitudinal latent class analysis (LLCA), which creates classes of individuals with similar patterns of responses over time, is ideal for exploring patterns of tobacco use over time (Collins & Lanza, 2010). Studies using this or a similar approach to identify distinct classes of adolescents, young adults, and adults typically find a non-user or low use group (representing the largest proportion of the sample), one or more poly-user groups, and an experimenter group (Clendennen, Loukas, Creamer, Pasch, & Perry, 2019; Huh & Leventhal, 2016; Kypriotakis, Robinson, Green, & Cinciripini, 2018). Few studies have assessed patterns of use of multiple tobacco products specifically among young adults and those that have been conducted have relied on short time periods ranging from 1.5 to 2.5 years and were limited in the inclusion of important correlates. We sought to understand how young adults' tobacco product use change over a 10-year period, and whether distinct patterns are associated with demographic characteristics, psychological factors, and social role transitions. Additionally, we examined the impact of social role transitions on patterns of use during the post-college period. Findings can be used to identify critical times within distinct tobacco use patterns that are ripe for intervention.

## 2. Methods

### 2.1 Participants

The data are from the *Assessment of the College Experience (ACE) Study*. We recruited participants from 11 colleges in North Carolina (n=7) and Virginia (n=4). Details about school recruitment can be found elsewhere (Spangler et al., 2014; Wolfson et al., 2014). To identify potential participants, we conducted a screener survey in fall 2010 among all enrolled first-year students (Spangler et al., 2014). The purpose of the screener survey was to identify students who used smokeless tobacco or cigarettes to participate in a longitudinal study to assess trajectories and correlates of smokeless tobacco use. All first year students at each of the participating 11 colleges were sent emails with information about the study and a link to participate in the 10-item screener survey. A total of 10,528 freshmen completed the screener survey (response rate of 35.6%). From this sample, we invited students to participate in the longitudinal study. We selected all ever users of smokeless tobacco and current cigarette smokers to participate in the cohort study; all other students were randomly sampled with oversampling of males. Two weeks after the screener, 4,902 eligible students were invited to participate in the longitudinal study, of which 3,146 (64.2%) completed the baseline fall 2010 survey (Wave 1). Participants were then re-surveyed twice a year from fall 2010 through spring 2012 and then annually through fall 2014. Through wave 6, we retained approximately 80% of the cohort. Wave 7 (fall 2014) was the first post-college wave for most participants (73.3% who completed Wave 7 had graduated from college). Renewal funding was received prior to Wave 8 (fall 2016), and is known as the *Assessment of post-College Experience (ACE II) Study*. We re-engaged 62% of the cohort and retained approximately 60% through Wave 14 (fall 2019). See Figure 1 for sample sizes and retention rates at each survey wave. For this study, we included participants who completed the baseline assessment, at least one additional college wave, at least one post-college wave, and reported past month tobacco use in at least one wave. Participants that did not have at least

one college follow-up assessment and post-college assessment were significantly more likely to be male, white, have college-educated mothers, and be binge drinkers, marijuana users, and illicit drug and tobacco users at college entry ( $p$ 's < 0.05).

Participants were emailed a secure survey link at each wave. Non-responders received up to five email reminders, a phone call, and a text reminder. Participants were provided with an incentive for completing each wave, incentive amounts varied across waves but were between \$10 and \$40. The study protocol was approved by the Wake Forest School of Medicine Institutional Review Board. Additional privacy protection was secured by the issuance of a Certificate of Confidentiality by the Department of Health and Human Services.

## 2.2 Measures

**Sample Characteristics.**—Characteristics measured at Wave 1 included sex, race (coded as White vs. Non-White), ethnicity (coded as Hispanic vs. non-Hispanic), mother's educational level (as a marker of socioeconomic status; measured as some college education or less vs. college degree or higher), and attendance at religious services (coded as going to church two or more times per month vs. less often or no attendance). Membership in Greek-letter organizations was assessed at Wave 2.

**Tobacco Use.**—We assessed past 30-day tobacco use of the following products at each wave: combustible cigarettes; traditional cigars, cigarillos or little cigars (categorized as cigars); e-cigarettes; waterpipe (hookah); and chewing tobacco, moist or dry snuff, snus, dissolvables (categorized as smokeless tobacco). Product descriptions and images were provided for each product, and respondents were instructed to only report use of tobacco, not other substances (e.g., marijuana).

**Cigarette Smoking by Friends and Family.**—At Wave 1, participants were asked: "How many of your four closest friends smoke cigarettes?" and "Not including yourself, does anyone in your family currently smoke cigarettes?"

**Other Substance Use.**—At Wave 1, we assessed past month marijuana use and other illicit drugs, including cocaine, methamphetamines, hallucinogens, rohypnol, ecstasy, heroin, opioids, salvia, and K2. We assessed past month binge drinking (4 or more drinks in a row for females and five or more drinks in a row for males).

**Sensation Seeking.**—Sensation seeking was measured at Wave 1 using an eight-item scale (e.g., "*I would like to explore new places and prefer friends who are exciting and unpredictable*") with a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002). Total sensation seeking scores were calculated from the average of all items for participants who answered a minimum of five questions on the scale. Higher scores indicate higher levels of sensation seeking,  $\alpha = 0.78$ .

**Depression.**—We measured depressive symptoms with 11 items added at Wave 2 (Carpenter et al., 1998; Kohout, Berkman, Evans, & Cornoni-Huntley, 1993). Participants

were asked to indicate how often they felt each way during the past week with response options rarely or none of the time (< 1 day), some or a little of the time (1–2 days), occasionally or a moderate amount of the time (3–4 days), and most or all of the time (5–7 days). We summed responses and reverse coded as appropriate. Higher scores represent greater depression,  $\alpha = 0.83$ .

**Stress.**—Cohen’s 10-item Perceived Stress Scale was used to assess past 30-day stress added at Wave 2 (Cohen, Kamarck, & Mermelstein, 1983). On a five-point response scale ranging from never to very often. We reverse coded where appropriate and summed responses, with higher scores indicating greater perceived stress,  $\alpha = 0.84$ .

**Life Events.**—To assess social role transitions, we used 23 items adapted from Allem and colleagues (2013) (e.g., got married, got engaged, lost a job, got extremely ill) (Allem, Lisha, Soto, Baezconde-Garbanati, & Unger, 2013). These items were assessed at each wave from Waves 8–14. Participants indicated whether they had experienced each life event in the past 6 months. For Wave 8, when these items were first added, we assessed whether participants experienced each life event over the past 2 years (time between Wave 7 and Wave 8). Related life events (e.g., got married, moved in with someone, got engaged) were combined based on preliminary analyses which found similar relationships to tobacco trajectory group membership.

**Statistical Analyses.**—We conducted a LLCA on five tobacco use behavior (cigarettes; cigars; e-cigarette, waterpipe, and smokeless) measured at Waves 1–14. We tested one through six classes to determine the number of classes that best fit the various patterns of tobacco use. Based on standard goodness of fit statistics, including the Bayesian Information criterion (BIC) where lower values indicate an improved model fit, and the Lo-Mendell-Rubin adjusted likelihood ratio test (Lo, Mendell, & Rubin, 2001), we decided on the number of classes. Entropy was also calculated to provide an indication of the overall degree of classification uncertainty in the solution, with values closer to 1 indicating better classification accuracy. To accommodate missing data, analyses were completed in Mplus using full-information maximum likelihood estimation (Muthén & Muthén, 1998–2017). Participants were then assigned to the tobacco trajectory class for which they had the highest probability of membership based on the estimated posterior probabilities. College-entry characteristics were compared across tobacco trajectory groups using chi-squared tests for categorical data and F-tests for continuous outcomes. Multinomial logistic regression models were fit to assess the impact of college-entry characteristics on tobacco trajectory membership in a multivariable model. Finally, the likelihood of experiencing a life-event was modeled as a function of tobacco trajectory group membership using a mixed-effects logistic regression model to account for the repeated assessment of life events (waves 8–14). Each life-event was modeled separately and models were adjusted for college-entry characteristics that were significantly different between tobacco trajectory groups. Survey sampling procedures implemented in Stata accounted for individuals being nested within schools by using the Taylor series linearization approach to standard error estimation. We used multiple imputations by chained equations to handle missing covariate data. Twenty imputed datasets were generated using MI IMPUTE in Stata Version 15.

### 3. Results

The sample included 1,519 participants who completed the baseline assessment, at least one additional college wave, and at least one post-college wave, and reported past month tobacco use on at least one wave. Participants were 49.8% female, 15.7% non-white, 6.6% Hispanic, and 61.8% had mothers with at least a college degree. As baseline, 25.2% of participants reported past month cigarette smoking, 21.3% reported past month waterpipe use, 19.7% reported past month cigar use, 7.3% reported past month smokeless use, and 1.3% reported past month e-cigarette use. Other sample characteristics are in Table 1.

#### 3.1 Description of Latent Classes of Tobacco Users

The best-fitting model based on goodness of fit statistics was a five-class model (Supplemental Tables). The estimated probabilities of reporting tobacco use in each class are displayed in Figure 2. Participants in Class 1 (Limited Users), which includes 52.6% of the sample, had minimal likelihood of use of any tobacco product at Wave 1, which decreased to almost no use by Wave 8 and was sustained through Wave 14. In multinomial logistic regression models, we present comparisons with the Limited Use class (reference group) in Tables 2 and 3. Comparisons between all classes are shown in Supplemental Tables 3 and 4.

Class 2 is comprised of Sustained Polytobacco Users and includes 5.7% of the sample. This class is characterized by moderate use of all tobacco products. The probability of smokeless tobacco use at Wave 1 was moderate and increased over the college years before leveling off and then decreasing between waves 13 and 14. The probability of cigarette use increased over the college years and steadily decreased during the post college years until Wave 12, when it began increasing again. The probability of cigar smoking increased over the first three waves, decreased over the remaining college years and then leveled off post-college. The probability of waterpipe use was highest at Wave 1 and decreased over the college years before leveling off at a very low level post-college. Finally, the probability of e-cigarette use was low during the first five waves but increased between Waves 5 and 6. It then leveled off until Wave 10 when a second increase began and continued until Wave 13.

Compared to the Limited Use class, those in the Sustained Polytobacco Use class were less likely to be female (OR = 0.02, CI = 0.01, 0.07) and Non-White (OR = 0.26, CI = 0.07, 0.88); but more likely to be engaged in a Greek-letter organization (OR = 2.73, CI = 1.33, 5.66), use marijuana (OR = 2.44, CI = 1.44, 4.14), and binge drink (OR = 3.73, CI = 2.00, 6.96). Compared to Limited Use, Sustained Polytobacco Use were more likely to have been arrested (AOR = 16.5, CI = 5.05, 54.2) (Tables 2, 3).

Class 3 is comprised of Experimental Users and includes 10.9% of the sample. This class is characterized by low to moderate probability of use of all tobacco products except smokeless tobacco, which was not used by members of this group. Cigar and waterpipe use remained relatively stable over time, while cigarette and e-cigarette use increased and then leveled off.

Compared to Limited Users, Experimental Users were more likely to have peers (OR = 1.86, CI = 1.15, 2.02) and family members (OR = 1.74, CI = 1.20, 2.53) who smoke, and had

higher sensation seeking scores (OR = 1.51, CI = 1.23, 1.85), as well as be more likely to be separated or divorced (AOR = 3.96, CI = 1.45, 10.8).

Class 4 is comprised of College Polytabacco with Continued Cigarette and E-Cigarette Users and includes 14.0% of the sample. Members of this class had a high probability of cigarette smoking at Wave 1, which increased at Wave 2 and then was consistent during the remaining college years before decreasing after college. E-cigarette use increased over time, and, by Wave 14, was as likely as cigarette smoking. Waterpipe and cigar use were moderate at Wave 1 but declined over time. Smokeless tobacco use was low at Wave 1 and decreased to almost no use by Wave 7.

Compared to Limited Users, College Polytabacco with Continued Cigarette and E-Cigarette Users were more likely to use marijuana (OR = 5.01, CI = 3.24, 7.75), have peers who smoke (OR = 3.99, CI = 2.41, 6.61), have higher sensation seeking scores (OR = 1.78, CI = 1.27, 2.50), and higher depression scores (OR = 1.06, CI = 1.02, 1.12). Compared to Limited Users, College Polytabacco with Continued Cigarette and E-Cigarette Users were more likely to have lost a baby (miscarriage or pregnancy termination) (AOR = 4.43, CI = 1.67, 11.7), started providing care for a parent or relative (AOR = 1.97, CI = 1.02, 3.78), had or overcome a serious illness (AOR = 2.35, CI = 1.12, 4.94), been addicted to drugs or treated for addiction (AOR = 8.60, CI = 2.10, 35.2), started a new job (AOR = 1.43, CI = 1.15, 1.78), lost a job, been demoted, or unemployed (AOR = 2.33, CI = 1.50, 3.61), and been arrested (AOR = 8.08, CI = 2.99, 21.8).

Class 5 is comprised of College-Limited Combustible Users and includes 16.8% of the sample. Participants in this class had a moderate probability of cigarette, cigar, and waterpipe smoking at Wave 1, which decreased through college and was virtually non-existent for cigars and waterpipe by Wave 7 and cigarettes by Wave 10. Compared to Limited Users, College-Limited Combustible Users were less likely to attend religious services two or more times per month (OR = 0.55, CI = 0.39, 0.77), more likely to use marijuana (OR = 2.74, CI = 1.52, 4.95), binge drink (OR = 2.76, CI = 1.78, 4.28), have peers who smoke (OR = 2.61, CI = 1.79, 3.81), and have higher sensation seeking scores (OR = 1.48, CI = 1.11, 1.99). There were no differences in life events experienced between Limited Users and College-Limited Combustible Users.

#### 4. Discussion

In this sample of young adults, the longitudinal latent class analysis identified five classes with distinct patterns of tobacco use and correlates. More than half (52.6%) were in the Limited Use class, which showed minimal tobacco product use at college entry as well as over time, with no progression to regular use. Clendennen and colleagues identified a similar non-user class representing 30% of the sample of Texas college students (Clendennen et al., 2019). The college years are a high-risk period for experimentation with substance use, including tobacco, alcohol, and marijuana (Fromme, Corbin, & Kruse, 2008). Thus, it is not surprising that over half of the sample used tobacco products only briefly, primarily during college. Members of this class reported several protective factors, including more participation in religious activities, lower participation in Greek-letter organizations, less use



of other substances, low sensation seeking scores, and exposure to fewer smoking peers and family members, which may have contributed to their minimal use.

The other four classes (50% of the sample) had moderate to high prevalence of tobacco product use at college entry, highlighting the widely observed pattern of tobacco use often beginning before college (Services, 2012) and underscoring the need for prevention efforts aimed at teens. Additionally, transitioning from high school to college is a critical life event, with stressors such as separation from friends and family, increased independence, and adapting to a new social environment. College campuses should consider tailored programs for first-year students to help with the transition period (Purdie & Rosser, 2011; Upcraft, Garner, & Barefoot, 2005).

Members of the College Limited-Combustible Use (16.8%) class smoked waterpipe tobacco, cigars, and cigarettes, but did not continue tobacco use post-college. These participants were less likely than Limited Users to attend religious services, but were more likely to report binge drinking, marijuana use, and having peers who smoke cigarettes, and had significantly higher sensation seeking scores than Limited Users. This group may have used tobacco products socially during college when they were in environments that facilitated use, including peer use and lack of smoke-free policies. However, post-college environments may have little to no peer use and policies that discourage use, such as workplace bans. This is consistent with the concept of “maturing out” which suggests that role incompatibility and social control are two potential drivers of this phenomenon (Umberson, 1987; Yamaguchi & Kandel, 1985). One recent longitudinal study of tobacco use among young adults in Texas found statistically significant declines in e-cigarettes, waterpipe, and cigar use, but cigarette smoking and smokeless tobacco use remained stable (Loukas, Marti, & Perry, 2019). In our study, use of all tobacco products declined post-college among members of this class. Our study covered a longer period of time than the Texas study, which included only 2.5 years. Perhaps with a longer follow-up period, a similar reduction in cigarette smoking and smokeless tobacco use would have been observed.

The Sustained Poly tobacco, Experimental, and College Poly tobacco with Continued Cigarette and E-Cigarette classes were more likely to engage in marijuana use, binge drinking, and sensation seeking than Limited Users. Clendennen and colleagues found that young adults who were heavy drinkers and used marijuana were more likely to be poly tobacco versus single product users and were associated with membership in the tobacco use versus non-use groups (Clendennen et al., 2019). Incorporating tobacco treatment modules into existing campus curricula for students with problematic alcohol or drug use could be one option for reaching those who may be at-risk for tobacco use during college and beyond (Paschall, Antin, Ringwalt, & Saltz, 2011). Further, adding questions about family and friend tobacco use to student health intake forms could be a way of identifying students vulnerable to tobacco use and providing brief prevention or treatment counseling. Moreover, screening for marijuana use, along with assessing tobacco use in student health clinics could further identify students in need of treatment. In addition, they had moderate to high prevalence of use post-college, highlighting the need for tobacco prevention and cessation programming both during and post-college. During college, student health centers can serve as a point of intervention for students who use tobacco. However,

implementation of tobacco treatment services in student health centers has been limited. We found that just over half of 71 student health centers from 10 Southeastern states reported screening for tobacco use at every visit (Sutfin et al., 2015), despite recommendations from the US Preventive Services Task Force on prevention and cessation of tobacco use among children and adolescents (Sargent, Unger, & Leventhal, 2020). Most (80%) providers reported offering tobacco cessation counseling and 77% reported offering pharmacotherapy to students to those who wish to quit. Few (13%) reported having computerized reminders to encourage providers to advise patients to quit, yet 54% reported that the clinic offers health care provider training in effective smoking cessation interventions (Sutfin et al., 2015). Future research should focus on increasing screening and implementation of tobacco treatment services in student health centers. Because over 83% of the sample reported part or full time employment post-college (Wave 8), the workplace is a potential environment to reach young adults with health promotion and disease prevention efforts. Comprehensive tobacco-free workplace policies and programs can reduce employees' tobacco use (Castellan et al., 2015).

The College Polytabacco with Continued Cigarette and E-Cigarette Use class is largely characterized by waterpipe, cigar, and cigarette smoking during college with ongoing cigarette smoking and increasing likelihood of e-cigarette use. Members of this class also had the highest prevalence of marijuana and illicit drug use, friends who smoke cigarettes, and the highest levels of sensation seeking and depression. These findings are comparable to recent evidence indicating that co-use of marijuana and tobacco is increasing, with almost a quarter of young adults reporting current use of marijuana and at least one tobacco product (Cohn, Abudayyeh, Perreras, & Peters, 2019). Reasons for co-use reported by college students include prolonging marijuana's effects (Ramo & Prochaska, 2012) and tempering undesirable effects (i.e., withdrawal symptoms) (Budney, Vandrey, Hughes, Thostenson, & Bursac, 2008; Vandrey, Budney, Hughes, & Liguori, 2008). Thus, tobacco cessation programs for this population of dual-users should consider strategies that address cessation of marijuana use as well. Given the high depression scores, nicotine and marijuana may also be used for self-medication. College counseling and student health centers that are treating or screening college students for depression may want to consider adding tobacco prevention or treatment interventions as part of their standard care plans. Efforts are also needed post-college, through workplace health promotion and primary health care, to coordinate services for those experiencing negative life events so that they do not use nicotine to self-medicate.

Membership in Greek-letter organizations was associated with some classes, suggesting that it may be a risk factor. These organizations are social networks that offer young adults opportunities to select peers based on shared preferences (Cheney, Harris, Gowin, & Huber, 2014). These groups have social norms related to tobacco and other substance use that can either encourage or discourage use among their members. Our findings are consistent with a recent survey of college students that reported higher rates of tobacco use among fraternity and sorority members compared to non-Greek affiliated students (Soule, Rossheim, Cavazos, Bode, & Desrosiers, 2019). Additionally, a systematic review found that members of Greek-letter organizations were more like to smoke than those who were not members of these organizations (Cheney et al., 2014). More recent studies have documented higher rates of e-cigarette use among members of Greek-letter organizations (Marion,

Strand, & Baldrige, 2021). Tobacco prevention and cessation programs specifically tailored for Greek-letter organizations could be beneficial for reducing tobacco use during college and early adulthood, including strong tobacco-free policies in the housing and at all sponsored events.

E-cigarette use increased over time in three out of the five class, including all three classes in which tobacco use continued post-college. This is not surprising, given that the study period coincided with the proliferation of e-cigarette products, large increases in marketing, and a huge upsurge in popularity (Fadus, Smith, & Squeglia, 2019). E-cigarettes entered the U.S. market in 2007, followed by a period of sustained growth. Between September 2014 and May 2020, sales of e-cigarettes in the U.S. increased by 122.2% (Ali et al., 2020). This study was conducted during the time when high school students rates of e-cigarette use increase from 1.5% in 2011 to 27.5% in 2019 (Wang et al., 2019). Less drastic increases were seen among adults, with young adults, ages 18–24, having the highest prevalence of e-cigarette use compared to any other adult age group (Creamer et al., 2019).

We also examined social role transitions within tobacco use classes. Most classes had few, if any, differences in social role transitions compared to Limited Use. However, College Poly tobacco with Continued Cigarette and E-Cigarette Users were more likely to have experienced several social role transitions, including losing a baby, caring for a parent or relative, having or overcoming an illness, being addicted to or treated for drugs, losing a job, starting a new job, and being arrested. Schulenberg and Maggs (Schulenberg & Maggs, 2002) posit that increased instability during young adulthood, marked by multiple social role transitions, could result in increased stress and mental health problems. Although this College Poly tobacco with Continued Cigarette and E-Cigarette Users did not report significantly more stress than Limited Users, they did report more depressive symptoms. Young adults experiencing many social role transitions may benefit from targeted interventions aimed at addressing mental health problems (Patrick et al., 2020) during times of multiple transitions.

#### 4.1 Limitations

The primary limitation of this study is the geographically restricted sample. We recruited students from colleges in two states: North Carolina and Virginia. Both states have a history of tobacco farming and manufacturing and are home to the two largest tobacco companies in the U.S. Prior to the study, both North Carolina (January 2, 2010) and Virginia (December 1, 2009) had implemented smoking prohibitions in bars and restaurants. Cigarette taxes were not raised in either North Carolina or Virginia during the duration of the study. Both states provide limited funding to tobacco control programs. In fiscal year 2018, North Carolina funded the state tobacco control program at 5.4% and Virginia 12% of the CDC recommended levels. Both states have relatively weak tobacco laws, taxes, and prevention and findings from this study may not generalize to young adults from other states. Participants were recruited from four year colleges; results may not generalize to young adults who attended two year colleges or to those who did not attend college. The cohort is predominantly comprised of non-Hispanic white young adults, further limiting generalizability. However, the strategies recommended to reduce tobacco use are systematic

interventions aimed at the broad population of young adults, rather than individually-focused interventions.

## 5. Conclusion

Patterns of tobacco use varied considerably over time, with increases in the prevalence of e-cigarette use in three of five classes. In most classes, the likelihood of tobacco use was highest during freshman year. Prevention activities should focus on first-year students who are at high risk for certain kinds of tobacco products. In three classes, tobacco use continued after the college years. Student health centers have the opportunity to screen for tobacco use and provide brief intervention for tobacco users, yet over a third of college students who have visit their student health center were not asked about tobacco use, and among those who reported tobacco use, only half received any form of brief intervention (Sutfin et al., 2012). Student health centers may be an important ally in providing cessation services and encouraging tobacco use prevention. Similarly, post-college tobacco interventions are needed. Primary care providers and workplace health promotion programs hold promise for addressing tobacco use among young adults.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Funding:

Research reported in this publication was supported by the National Cancer Institute of the National Institutes of Health under Award Number R01CA141643. Dr. Denlinger-Apte was supported by funding from the National Cancer Institute under Award T32CA122061. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

## REFERENCES

- Ali FRM, Diaz MC, Vallone D, Tynan MA, Cordova J, Seaman EL, Trivers KF, Schillo BA, Talley B, King BA, 2020. E-cigarette unit sales, by product and flavor type - United States, 2014–2020. *M.M.W.R. Morb. Mortal. Wkly. Rep.*, 69(37), 1313–1318. doi:10.15585/mmwr.mm6937e2
- Allem JP, Lisha NE, Soto DW, Baezconde-Garbanati L, Unger JB, 2013. Emerging adulthood themes, role transitions and substance use among Hispanics in Southern California. *Addict. Behav.*, 38(12), 2797–2800. doi:10.1016/j.addbeh.2013.08.001 [PubMed: 24018219]
- Arria AM, Caldeira KM, O’Grady KE, Vincent KB, Fitzelle DB, Johnson EP, Wish ED, 2008. Drug exposure opportunities and use patterns among college students: results of a longitudinal prospective cohort study. *Subst. Abuse*, 29(4), 19–38. doi:10.1080/08897070802418451
- Bachman JG, O’Malley PM, Schulenberg JE, Johnston LD, Bryant AL, Merline AC, 2002. Why substance use declines in young adulthood: Changes in social activities, roles, and beliefs. Mahwah, NJ: Lawrence Erlbaum Associates.
- Barker DC, Schleicher NC, Ababseh K, Johnson TO, & Henriksen L, 2018. ENDS retailers and marketing near university campuses with and without tobacco-free policies. *Tob Induc Dis*, 16, 47. doi:10.18332/tid/94600 [PubMed: 30687532]
- Barrington-Trimis JL, Braymiller JL, Unger JB, McConnell R, Stokes A, Leventhal AM, Sargent JD, Goodwin RD, 2020. Trends in the age of cigarette smoking initiation among young adults in the US from 2002 to 2018. *JAMA Netw. Open*, 3(10), e2019022. doi:10.1001/jamanetworkopen.2020.19022 [PubMed: 33021650]

- Budney AJ, Vandrey RG, Hughes JR, Thostenson JD, Bursac Z, 2008. Comparison of cannabis and tobacco withdrawal: severity and contribution to relapse. *J. Subst. Abuse Treat*, 35(4), 362–368. doi:10.1016/j.jsat.2008.01.002 [PubMed: 18342479]
- Carpenter JS, Andrykowski MA, Wilson J, Hall LA, Rayens MK, Sachs B, Cunningham LL, 1998. Psychometrics for two short forms of the Center for Epidemiologic Studies-Depression Scale. *Issues Ment. Health Nurs*, 19(5), 481–494. doi:10.1080/016128498248917 [PubMed: 9782864]
- Castellan RM, Chosewood LC, Trout D, Wagner GR, Caruso CC, Mazurek J, McCrone SH, Weissman DN, 2015. Current intelligence bulletin 67: promoting health and preventing disease and injury through workplace tobacco policies. (Publication No. 2015–113). Morgantown, WV: Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Retrieved from <https://www.cdc.gov/niosh/docs/2015-113/>.
- Cheney MK, Harris LW, Gowin MJ, & Huber J, 2014. Smoking and membership in a fraternity or sorority: a systematic review of the literature. *J Am Coll Health*, 62(4), 264–276. doi:10.1080/07448481.2014.891595 [PubMed: 24527968]
- Clendennen SL, Loukas A, Creamer MR, Pasch KE, & Perry CL, 2019. Longitudinal patterns of multiple tobacco and nicotine product use among Texas college students: a latent transition analysis. *Prev Sci*, 20(7), 1031–1042. doi:10.1007/s1121-019-01031-3 [PubMed: 31302841]
- Cohen S, Kamarck T, Mermelstein R, 1983. A global measure of perceived stress. *J. Health Soc. Behav*, 24(4), 385–396. [PubMed: 6668417]
- Cohn AM, Abudayyeh H, Perras L, Peters EN, 2019. Patterns and correlates of the co-use of marijuana with any tobacco and individual tobacco products in young adults from Wave 2 of the PATH Study. *Addict. Behav*, 92, 122–127. doi:10.1016/j.addbeh.2018.12.025 [PubMed: 30623805]
- Collins LM, Lanza ST, 2010. Latent class analysis and latent transition analysis: with applications in the social, behavioral, and health sciences. New York, NY: Wiley.
- Creamer MR, Wang TW, Babb S, Cullen KA, Day H, Willis G, Jamal A, Neff L, 2019. Tobacco product use and cessation indicators among adults - United States, 2018. *MMWR Morb. Mortal. Wkly. Rep*, 68(45), 1013–1019. doi:10.15585/mmwr.mm6845a2
- Dai H, & Hao J, 2017. Geographic density and proximity of vape shops to colleges in the USA. *Tob Control*, 26(4), 379–385. doi:10.1136/tobaccocontrol-2016-052957 [PubMed: 27302700]
- Fadus MC, Smith TT, Squeglia LM, 2019. The rise of e-cigarettes, pod mod devices, and JUUL among youth: factors influencing use, health implications, and downstream effects. *Drug Alcohol Depend*, 201, 85–93. doi:10.1016/j.drugalcdep.2019.04.011 [PubMed: 31200279]
- Fromme K, Corbin WR, Kruse MI, 2008. Behavioral risks during the transition from high school to college. *Dev. Psychol*, 44(5), 1497–1504. doi:10.1037/a0012614 [PubMed: 18793080]
- Hoyle RH, Stephenson MT, Palmgreen P, Lorch EP, Donohew RL, 2002. Reliability and validity of a brief measure of sensation seeking. *Pers. Individ. Differ*, 32(3), 401–414. doi:10.1016/S0191-8869(01)00032-0
- Huh J, & Leventhal AM (2016). Progression of poly-tobacco product use patterns in adolescents. *Am J Prev Med*, 51(4), 513–517. doi:10.1016/j.amepre.2016.04.004 [PubMed: 27211895]
- Committee on Improving the Health, Safety, and Well-Being of Young Adults; Board on Children, Youth, and Families; Institute of Medicine; National Research Council; Bonnie RJ, Stroud C, Breiner H, editors, 2015. Investing in the health and well-being of young adults. Washington, DC: National Academies Press.
- Katz SK, Lavack AM, 2002. Tobacco related bar promotions: insights from tobacco industry documents. *Tob. Control*, 11 Suppl 1(0964–4563 (Print)), I92–I01. doi:10.1136/tc.11.suppl\_1.i92 [PubMed: 11893819]
- King JL, Wagoner KG, Suerken CK, Song EY, Reboussin BA, Spangler J, Walker S, Ross JC, Wolfson M, Sutfin EL, 2020. Are waterpipe café, vape shop, and traditional tobacco retailer locations associated with community composition and young adult tobacco use in North Carolina and Virginia? *Subst Use Misuse*, 55(14), 2395–2402. doi:10.1080/10826084.2020.1823417 [PubMed: 32969275]

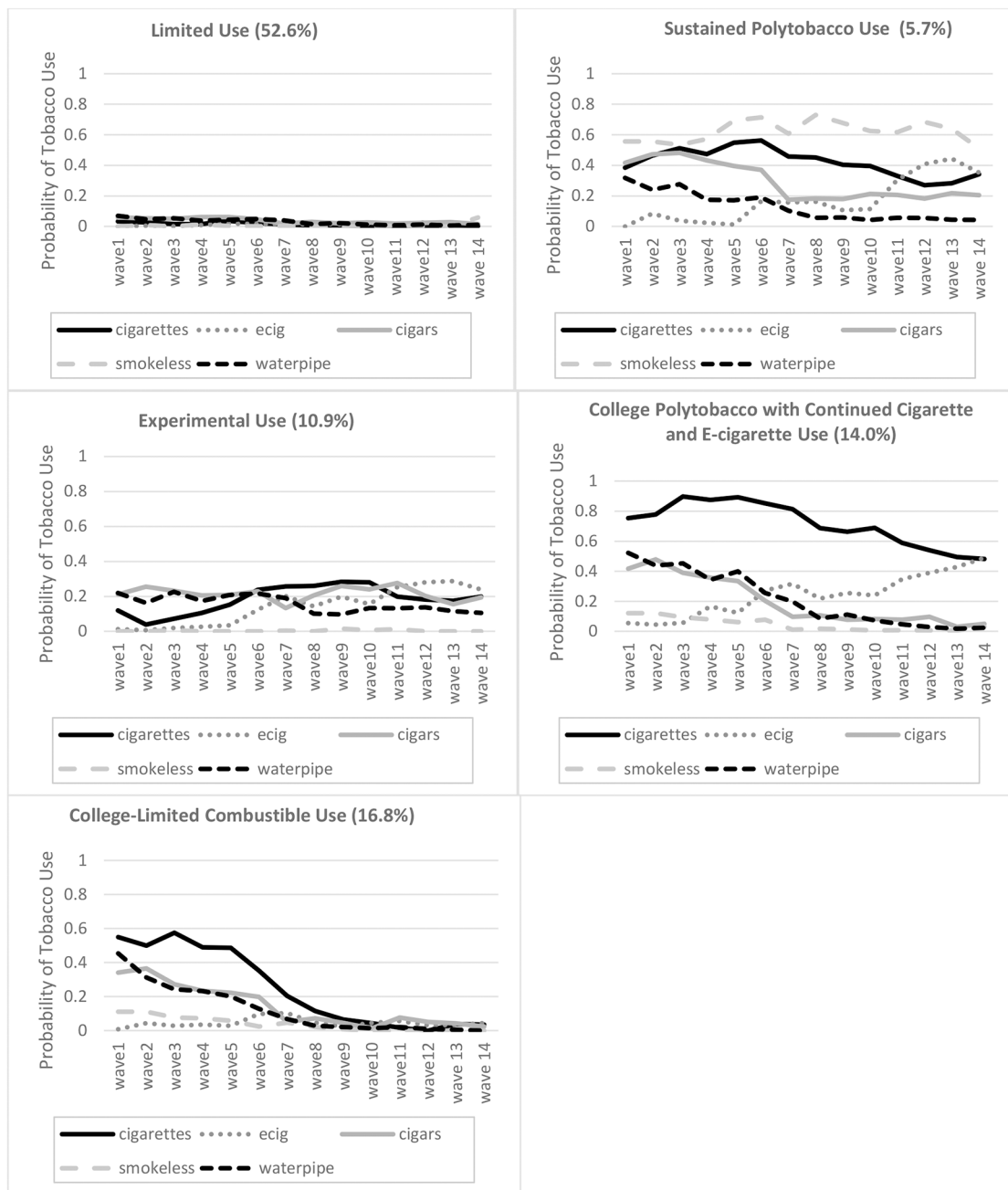
- Klein J, 2007. Tobacco targets: students concerned about free smokeless tobacco offered in bars. *Monterey County Herald*. Accessed on 11/17/21, <https://www.montereyherald.com/2007/05/08/tobacco-targets-students-concerned-about-free-smokeless-tobacco-offered-in-bars/>.
- Kohout FJ, Berkman LF, Evans DA, Cornoni-Huntley J, 1993. Two shorter forms of the CES-D (Center for Epidemiological Studies Depression) depression symptoms index. *J. Aging Health*, 5(2), 179–193. doi:10.1177/089826439300500202 [PubMed: 10125443]
- Kypriotakis G, Robinson JD, Green CE, & Cinciripini PM, 2018. Patterns of tobacco product use and correlates among adults in the Population Assessment of Tobacco and Health (PATH) study: a latent class analysis. *Nicotine Tob Res*, 20(suppl\_1), S81–s87. doi:10.1093/ntr/nty025 [PubMed: 30125013]
- Lee JG, Goldstein AO, Klein EG, Ranney LM, Carver AM, 2012. Assessment of college and university campus tobacco-free policies in North Carolina. *J. Am. Coll. Health*, 60(7), 512–519. doi:10.1080/07448481.2012.690464 [PubMed: 23002799]
- Ling PM, Glantz SA, 2002. Why and how the tobacco industry sells cigarettes to young adults: evidence from industry documents. *Am. J. Public Health*, 92(6), 908–916. doi:10.2105/ajph.92.6.908 [PubMed: 12036776]
- Lo Y, Mendell NR, & Rubin DB, 2001. Testing the number of components in a normal mixture. *Biometrika*, 88(3), 767–778. doi.org/10.1093/biomet/88.3.767
- Loukas A, Marti CN, & Perry CL, 2019. Trajectories of tobacco and nicotine use across young adulthood, Texas, 2014–2017. *Am J Public Health*, 109(3), 465–471. doi:10.2105/ajph.2018.304850 [PubMed: 30676800]
- Marion JW, Strand A, & Baldrige E, 2021. Changes in student behaviors and policy opinion regarding E-cigarettes at a Kentucky University from 2014 to 2018. *Prev Med Rep*, 22, 101364. doi:10.1016/j.pmedr.2021.101364 [PubMed: 33868903]
- Muthén LK, Muthén BO, 1998–2017. *Mplus User's Guide*. Eighth Edition. Los Angeles, CA: Muthén & Muthén.
- Paschall MJ, Antin T, Ringwalt CL, Saltz RF, 2011. Effects of AlcoholEdu for college on alcohol-related problems among freshmen: a randomized multicampus trial. *J. Stud. Alcohol Drugs*, 72(4), 642–650. doi:10.15288/jsad.2011.72.642 [PubMed: 21683046]
- Patrick ME, Rhew IC, Duckworth JC, Lewis MA, Abdallah DA, Lee CM, 2020. Patterns of young adult social roles transitions across 24 months and subsequent substance use and mental health. *J. Youth Adolesc*, 49(4), 869–880. doi:10.1007/s10964-019-01134-8 [PubMed: 31588973]
- Purdie J, Rosser VJ, 2011. Examining the academic performance and retention of first-year students in living-learning communities and first-year experience courses. *Coll. Stud. Aff. J*, 29(2), 95–112.
- Ramo DE, Prochaska JJ, 2012. Prevalence and co-use of marijuana among young adult cigarette smokers: An anonymous online national survey. *Addict. Sci. Clin. Pract*, 7(1), 5. doi:10.1186/1940-0640-7-5 [PubMed: 23186143]
- Richardson A, Williams V, Rath J, Villanti AC, Vallone D, 2014. The next generation of users: prevalence and longitudinal patterns of tobacco use among US young adults. *Am. J. Public Health*, 104(8), 1429–1436. doi:10.2105/AJPH.2013.301802 [PubMed: 24922152]
- Sargent JD, Unger JB, & Leventhal AM, 2020. Recommendations from the USPSTF for prevention and cessation of tobacco use in children and adolescents. *JAMA*, 323(16), 1563–1564. doi:10.1001/jama.2019.22312 [PubMed: 32343315]
- Schulenberg JE, Bryant AL, O'Malley PM, 2004. Taking hold of some kind of life: how developmental tasks relate to trajectories of well-being during the transition to adulthood. *Dev. Psychopathol*, 16(4), 1119–1140. doi:10.1017/s0954579404040167 [PubMed: 15704830]
- Schulenberg JE, Johnston LD, O'Malley PM, Bachman JG, Miech RA, Patrick ME, 2019. Monitoring the future national survey results on drug use, 1975–2018: Volume II, College students and adults ages 19–60. Retrieved from Ann Arbor: Institute for Social Research, The University of Michigan.
- Schulenberg JE, Maggs JL, 2002. A developmental perspective on alcohol use and heavy drinking during adolescence and the transition to young adulthood. *J. Stud. Alcohol Suppl*, Mar(14), 54–70. doi:10.15288/jsas.2002.s14.54 [PubMed: 12022730]

- Sidani JE, Shensa A, Yabes J, Fertman C, Primack BA, 2019. Waterpipe tobacco use in college and non-college young adults in the USA. *Fam. Pract*, 36(2), 103–109. doi:10.1093/fampra/cmy037 [PubMed: 29741621]
- Soule EK, Rossheim ME, Cavazos TC, Bode K, Desrosiers AC, 2019. Cigarette, waterpipe, and electronic cigarette use among college fraternity and sorority members and athletes in the United States. *J. Am. Coll. Health*, 69(5): 463–469. doi:10.1080/07448481.2019.1680555 [PubMed: 31702957]
- Spangler J, Song E, Pockey J, Sutfin EL, Reboussin BA, Wagoner K, Wolfson M, 2014. Correlates of smokeless tobacco use among first year college students. *Health Educ. J*, 73(6), 693–701. doi:10.1177/0017896913513746 [PubMed: 25484378]
- Sussman S, Arnett JJ, 2014. Emerging adulthood: developmental period facilitative of the addictions. *Eval. Health Prof.*, 37(2), 147–155. doi:10.1177/0163278714521812 [PubMed: 24492245]
- Sutfin EL, McNamara RS, Blocker JN, Ip EH, O'Brien MC, Wolfson M, 2012. Screening and brief intervention for tobacco use by student health providers on college campuses. *J. Am. Coll. Health*, 60(1), 66–73. doi:10.1080/07448481.2011.572325 [PubMed: 22171731]
- Sutfin EL, Swords DC, Song EY, Reboussin BA, Helme D, Klein E, Wolfson M, 2015. Screening and counseling for tobacco use in Student Health Clinics: reports of health care providers. *Am. J. Health Promot*, 30(1), e41–49. doi:10.4278/ajhp.130820-QUAN-436 [PubMed: 25372237]
- Tanner JL, Arnett JJ, 2013. Approaching young adult health and medicine from a developmental perspective. *Adolesc. Med. State Art Rev*, 24(3), 485–506. [PubMed: 24654544]
- Umberson D (1987). Family status and health behaviors: social control as a dimension of social integration. *J Health Soc Behav*, 28(3), 306–319. [PubMed: 3680922]
- United States Bureau of Labor Statistics, 2021. College enrollment and work activity of recent high school and college graduates summary. Washington, DC: United States Government. Retrieved on 11/17/2021 from <https://www.bls.gov/news.release/hsgc.nr0.htm>.
- United States Department of Health & Human Services, 2012. Preventing tobacco use among youth and young adults: a report of the Surgeon General. Atlanta, GA: U. S. Department of Health & Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. Retrieved on 11/17/2021 from <http://www.surgeongeneral.gov/library/reports/preventing-youth-tobacco-use/exec-summary.pdf>.
- Ucraft ML, Garner JN, Barefoot BO, 2005. Challenging & supporting the first-year student: a handbook for improving the first year of college. San Francisco, CA: Jossey- Bass.
- Vandrey RG, Budney AJ, Hughes JR, Liguori A, 2008. A within-subject comparison of withdrawal symptoms during abstinence from cannabis, tobacco, and both substances. *Drug Alcohol Depend*, 92(1–3), 48–54. doi:10.1016/j.drugalcdep.2007.06.010 [PubMed: 17643868]
- Wagoner KG, Song EY, Egan KL, Sutfin EL, Reboussin BA, Spangler J, Wolfson M, 2014. E-cigarette availability and promotion among retail outlets near college campuses in two southeastern states. *Nicotine Tob. Res*, 16(8), 1150–1155. doi:10.1093/ntr/ntu081 [PubMed: 24847099]
- Wang TW, Asman K, Gentzke AS, Cullen KA, Holder-Hayes E, Reyes-Guzman C, Jamal A, Neff L, King BA, 2018. Tobacco product use among adults - United States, 2017. *MMWR Morb. Mortal. Wkly. Rep*, 67(44), 1225–1232. doi:10.15585/mmwr.mm6744a2 [PubMed: 30408019]
- Wang TW, Gentzke AS, Creamer MR, Cullen KA, Holder-Hayes E, Sawdey MD, Anic GM, Portnoy DB, Hu S, Homa DM, Jamal A, Neff LJ, 2019. Tobacco product use and associated factors among middle and high school students - United States, 2019. *MMWR Surveill. Summ*, 68(12), 1–22. doi:10.15585/mmwr.ss6812a1
- Wolfson M, Pockey JR, Reboussin BA, Sutfin EL, Egan KL, Wagoner KG, Spangler JG, 2014. First-year college students' interest in trying dissolvable tobacco products. *Drug Alcohol Depend*, 134, 309–313. doi:10.1016/j.drugalcdep.2013.10.025 [PubMed: 24309296]
- Yamaguchi K, & Kandel DB, 1985. On the resolution of role incompatibility: A life event history analysis of family roles and marijuana use. *Am J Sociol*, 90(6), 1284–1325. doi:10.1086/228211



**Figure 1.**  
Flow of Study Participants, Retention Rates, and Mean Age at Each Wave.





**Figure 2.**  
Latent Class Profiles.

Table 1.

College Entry Characteristics by Tobacco Trajectory Group (N=1519).

College Entry Characteristics	Full Analytic Sample N=1519 % or Mean (SE)	Limited Use N=799 % or Mean (SE)	Sustained Polytobacco Use N=87 % or Mean (SE)	Experimental Use N=165 % or Mean (SE)	College Polytobacco with Continued Cigarette and E- Cigarette Use N=212 % or Mean (SE)	College-Limited Combustible Use N=256 % or Mean (SE)	p-value <sup>1</sup>
Female Sex	49.8	56.9	3.4	43.6	49.5	46.1	<0.001
Non-White Race	15.7	19.0	4.6	22.8	9.2	13.8	0.012
Hispanic Ethnicity	6.6	6.8	2.3	7.4	5.2	7.5	0.202
Mothers with College Education	61.8	65.3	75.4	60.4	60.6	67.3	0.168
Religious Service Attendance (2+ times/month)	42.3	46.7	45.3	35.8	31.1	26.7	<0.001
Greek-letter organizations <sup>2</sup>	16.8	15.1	40.1	15.3	17.9	22.7	0.007
Marijuana Use	23.8	10.5	42.2	23.9	55.7	43.0	<0.001
Illicit Drug Use	4.5	1.1	6.0	4.0	14.5	8.4	0.010
Binge Drinking	45.8	35.2	77.9	42.2	68.9	75.0	<0.001
At least one close friend smokes	51.8	39.0	52.9	57.9	80.0	69.0	<0.001
At least one family member smokes	40.1	33.5	34.5	47.9	45.5	34.6	0.008
Sensation Seeking	3.2 (0.01)	3.1 (0.02)	3.4 (0.08)	3.3 (0.06)	3.6 (0.04)	3.5 (0.04)	<0.001
Depression <sup>2</sup>	6.8 (0.11)	6.5 (0.19)	6.0 (0.61)	6.1 (0.40)	8.1 (0.42)	7.0 (0.34)	0.010
Stress <sup>2</sup>	15.2 (0.14)	15.3 (0.24)	14.4 (0.73)	14.1 (0.56)	15.8 (0.52)	15.3 (0.42)	0.187

<sup>1</sup> p-value is for an overall test of any difference between classes.<sup>2</sup> These variables were measured in Wave 2 (spring 2011)

**Table 2.**

Multinomial Logistic Regression of College Entry Characteristics Predicting Membership in Tobacco Trajectory Groups with Limited Use as the Reference Group (N=1519).

College Entry Characteristics	Sustained Polytobacco vs. Limited Use Adjusted OR (CI)	Experimental vs. Limited Use Adjusted OR (CI)	College Polytobacco with Continued Cigarette and E-Cigarette vs. Limited Use Adjusted OR (CI)	College-Limited Combustible vs. Limited Use Adjusted OR (CI)
Female Sex	<b>0.02 (0.01, 0.07)</b>	0.64 (0.41, 1.02)	0.79 (0.46, 1.35)	0.69 (0.44, 1.08)
Non-White Race	<b>0.26 (0.07, 0.88)</b>	1.25 (0.80, 1.94)	0.50 (0.22, 1.16)	0.89 (0.48, 1.67)
Hispanic Ethnicity	0.34 (0.06, 1.79)	1.16 (0.41, 3.23)	0.81 (0.36, 1.85)	1.23 (0.61, 2.49)
Mothers with College Education	0.99 (0.43, 2.27)	0.92 (0.49, 1.73)	0.76 (0.52, 1.11)	0.97 (0.60, 1.56)
Religious Service Attendance (2+ times/month)	1.15 (0.61, 2.14)	0.71 (0.49, 1.02)	0.78 (0.52, 1.17)	<b>0.55 (0.39, 0.77)</b>
Greek-letter organizations*	<b>2.74 (1.33, 5.66)</b>	1.17 (0.64, 2.15)	1.15 (0.60, 2.18)	1.35 (0.81, 2.34)
Marijuana Use	<b>2.44 (1.44, 4.14)</b>	2.02 (0.95, 4.31)	<b>5.01 (3.24, 7.75)</b>	<b>2.74 (1.52, 4.95)</b>
Illicit Drug Use	1.80 (0.48, 6.74)	1.40 (0.44, 4.47)	2.40 (0.59, 9.82)	1.84 (0.65, 5.20)
Binge Drinking	<b>3.73 (2.00, 6.96)</b>	0.88 (0.48, 1.62)	1.47 (0.88, 2.46)	<b>2.76 (1.78, 4.28)</b>
At least one close friend smokes	1.60 (0.89, 2.88)	<b>1.86 (1.15, 3.02)</b>	<b>3.99 (2.41, 6.61)</b>	<b>2.61 (1.79, 3.81)</b>
At least one family member smokes	1.47 (0.73, 2.93)	<b>1.74 (1.20, 2.53)</b>	1.55 (0.92, 2.62)	1.08 (0.79, 1.46)
Sensation Seeking	0.98 (0.59, 1.64)	<b>1.51 (1.23, 1.85)</b>	<b>1.78 (1.27, 2.50)</b>	<b>1.48 (1.11, 1.99)</b>
Depression*	1.00 (0.93, 1.06)	1.00 (0.95, 1.05)	<b>1.06 (1.02, 1.12)</b>	1.02 (0.97, 1.08)
Stress*	1.02 (0.96, 1.08)	0.97 (0.91, 1.04)	0.97 (0.92, 1.03)	0.99 (0.95, 1.03)

\* These variables were measured in Wave 2 (spring 2011).

**Table 3.**

Longitudinal Logistic Regression Models of Tobacco Trajectory Groups Predicting Life Event Outcomes in Young Adulthood with Limited Use as the Reference Group (N=1415).

Outcome: Life Events in Young Adulthood <sup>1</sup>	Sustained Polytobacco vs. Limited Use Adjusted OR <sup>2</sup> (CI)	Experimental vs. Limited Use Adjusted OR <sup>2</sup> (CI)	College Polytobacco with Continued Cigarette and E-Cigarette vs. Limited Use Adjusted OR <sup>2</sup> (CI)	College-Limited Combustible vs. Limited Use Adjusted OR <sup>2</sup> (CI)
<b>Personal/Relationship</b>				
Married, engaged, or moved in with significant other	0.74 (0.49, 1.13)	0.82 (0.62, 1.09)	0.94 (0.71, 1.24)	1.03 (0.81, 1.33)
Had a baby	1.87 (0.49, 7.09)	0.42 (0.14, 1.33)	0.95 (0.36, 2.49)	1.71 (0.76, 3.87)
Lost a baby	2.46 (0.37, 16.2)	2.34 (0.84, 6.53)	<b>4.56 (1.72, 12.1)</b>	0.97 (0.29, 3.21)
Started caring for a parent or relative	0.80 (0.25, 2.52)	1.33 (0.67, 2.64)	<b>1.95 (1.01, 3.74)</b>	1.00 (0.52, 1.93)
Death of parent, sibling, spouse or significant other	0.45 (0.15, 1.41)	1.16 (0.62, 2.16)	0.87 (0.46, 1.66)	0.77 (0.41, 1.43)
Had an illness or overcame an illness	2.49 (0.83, 7.49)	1.91 (0.90, 4.08)	<b>2.40 (1.14, 5.02)</b>	1.40 (0.68, 2.90)
Got separated or divorced	3.48 (0.77, 15.7)	<b>3.95 (1.44, 10.8)</b>	2.07 (0.69, 6.21)	0.84 (0.26, 2.70)
Addicted to or treated for drugs	2.24 (0.24, 20.8)	1.40 (0.24, 8.06)	<b>10.1 (2.43, 42.0)</b>	0.91 (0.16, 5.21)
<b>Financial/Legal</b>				
Started college or new school or classes	0.82 (0.46, 1.46)	0.94 (0.63, 1.39)	1.07 (0.73, 1.57)	1.04 (0.73, 1.47)
Started a new job	1.18 (0.87, 1.62)	1.23 (0.99, 1.53)	<b>1.43 (1.15, 1.77)</b>	1.14 (0.94, 1.39)
Lost job, demoted, or unemployed	1.14 (0.58, 2.24)	1.42 (0.90, 2.24)	<b>2.34 (1.51, 3.64)</b>	0.88 (0.56, 1.36)
Arrested	<b>15.9 (4.84, 52.4)</b>	2.64 (0.88, 7.94)	<b>8.59 (3.19, 23.2)</b>	2.84 (0.99, 8.17)

<sup>1</sup>Each life event is modeled separately.

<sup>2</sup>Models adjust for significant covariates in Table 2.