Prevention Science (2019) 20:1031–1042
https://doi.org/10.1007/s11121-019-01031-3

Longitudinal Patterns of Multiple Tobacco and Nicotine Product Use Among Texas College Students: a Latent Transition Analysis

Stephanie L. Clendennen[1] · Alexandra Loukas[2] · MeLisa R. Creamer[1] · Keryn E. Pasch[2] · Cheryl L. Perry[1]

Published online: 13 July 2019

Abstract

Diverse tobacco and nicotine products have altered the terrain of tobacco use behaviors. Limited research has examined contemporary patterns of use among young adults. This study identified tobacco and nicotine product use groups and examined changes in young adults' use patterns, across a 1.5-year period. Participants were 5,482 18–29-year-old students (M age = 20.5, SD = 2.36; 63% female) from 24 Texas colleges who completed a four-wave bi-annual online survey. Latent transition analysis was used to identify groups from 10 items (ever and current use of cigarettes, cigars, smokeless tobacco, e-cigarettes, and hookah) and to examine probabilities of transitioning between groups over four waves. Five groups were identified: *Non-users* (30%), *Poly-experimenters* (26%), *Hookah experimenters* (18%), *E-cigarette & hookah experimenters* (15%), and *Poly-cigarette users* (11%). Few students transitioned between groups over time. *Poly-cigarette users* had the highest average probability of remaining stable over time (1.00), followed by *E-cigarette & hookah experimenters* (.97), *Non-users* (.94), *Poly-experimenters* (.93), and *Hookah experimenters* (.92). All groups became more stable over time except *Hookah experimenters* whose members were most likely to transition to *Poly-cigarette users* or other experimenter groups. The greatest transition was from *Poly-experimenters* to *Poly-cigarette users* with probabilities of .10, .08, and .03 for transitioning between waves one and two, two and three, and three and four, respectively. There was substantial poly-use and experimentation, which may explain little movement between groups over the 1.5-year time period and underscores the need for prevention programs targeting multiple product use among college students.

Keywords Latent transition analysis · Young adults · Tobacco use · Electronic cigarette use · Multiple tobacco product use

Tobacco use is a primary cause of morbidity and mortality in the United States (US) (U.S. Department of Health and Human Services 2012). Although the prevalence of cigarette smoking has declined substantially since the 1964 Surgeon General's report on smoking and health, rates of decline have stalled in recent years, and cigarettes remain the most commonly used tobacco product among adults in the US (Hu 2016). In addition, the emergence and appeal of alternative tobacco and nicotine products, such as electronic cigarettes (e-cigarettes) and hookah, have altered the terrain of tobacco use behaviors; thus, tobacco and nicotine product use remains a primary public health concern.

Young adults report the highest prevalence of tobacco and nicotine product use. According to the 2013–2014 National Adult Tobacco Survey, young adults in the US, ages 18–24, report using any combustible tobacco products (33.0%), hookah (20.2%), e-cigarettes (13.6%), cigars/cigarillos/filtered little cigars (8.9%), and smokeless tobacco (6.4%) at least occasionally (Hu 2016). Recent studies have shown that multiple tobacco and nicotine product use (concurrent use of two or more products) is more common than single product use, among young adults (Loukas et al. 2016; Yu et al. 2017).

✉ Stephanie L. Clendennen
Stephanie.L.Clendennen@uth.tmc.edu

Alexandra Loukas
alexandra.loukas@austin.utexas.edu

MeLisa R. Creamer
MeLisa.R.Creamer@uth.tmc.edu

Keryn E. Pasch
kpasch@austin.utexas.edu

Cheryl L. Perry
Cheryl.L.Perry@uth.tmc.edu

[1] Health Promotion and Behavioral Sciences, The University of Texas Health Science Center at Houston (UT Health) School of Public Health in Austin, Austin, TX 78701, USA

[2] Kinesiology and Health Education, The University of Texas at Austin, Austin, TX 78712, USA

Multiple tobacco and nicotine product use is concerning since other high risk behaviors such as alcohol use, binge drinking, and marijuana use often co-occur with tobacco and nicotine product use (Haardörfer et al. 2016; Windle 2003). In addition, concurrent use may expose users to increased levels of nicotine and other harmful chemicals like carbonyl compounds found in e-cigarettes (HHS, 2016).

The US Food and Drug Administration (FDA) has outlined research priorities to inform FDA regulation of the manufacturing, distribution, and marketing of tobacco and nicotine products. These priorities include understanding changes in tobacco and nicotine product use behaviors, including experimentation, initiation, multiple product use, and transitions in use, and employing innovative methods and measures to assess tobacco use behaviors (U.S. Food and Drug Administration 2017). Previous studies have used latent variable modeling approaches to characterize patterns of multiple tobacco and other substance use. Rather than relying on a single observed variable to define behavior, latent variable modeling uses several observed indicators to portray complex patterns of use (Collins and Lanza 2013). Several studies have used latent variable modeling approaches including latent class analysis (LCA) to identify latent classes of polysubstance use and latent transition analysis (LTA) to further model changes in class membership, longitudinally (Delk et al. 2019; Huh and Leventhal 2016; Lisha et al. 2019; Simon et al. 2017; Tomczyk et al. 2016; Yu et al. 2018).

A systematic review of peer-reviewed studies on LCA/LTA and adolescent polysubstance use identified 23 studies published through June 2015 (Tomczyk et al. 2016). All studies measured substance use via self-report, and the majority were conducted in the US with predominately white samples. Most studies (14/23) were cross-sectional, and nine were longitudinal. Sample sizes ranged from 450 to 419,698 participants, with most (13/23) ranging from 1,019 to 2,744. The number of latent classes of substance use ranged from three to seven, with most studies (17/23) identifying three or four latent classes. A "non-user"/"abstainer"/"low user" class was identified in all but four of the 23 studies, and most of the participants in any given study were classified in the non/low class. All 23 studies identified a poly-use class (i.e., a class characterized by concurrent use of at least two substances). Most studies included a single indicator of tobacco use, either cigarette or any tobacco use, and included other substance use indicators including use of alcohol, marijuana, and other drugs (Tomczyk et al. 2016).

Substantially fewer studies have used LCA/LTA to examine patterns of multiple tobacco and nicotine product use (i.e., studies utilizing multiple indicators of tobacco and nicotine product use). Kypriotakis et al. (2018) identified four latent classes of current tobacco users from ten indicators (current use of cigarettes, e-cigarettes, cigars, cigarillos, filtered cigars, pipe tobacco, hookah, smokeless tobacco, snus, and dissolvables). Among 14,856 adult current users, the largest class was "cigarette-only users," followed by "combustible users," "e-cigarette and hookah users," and "smokeless tobacco users." Huh and Leventhal (2016) is one of few studies to use latent variable modeling to examine longitudinal (i.e., two waves with 6 months between each) patterns of diverse tobacco and nicotine product use among 3,396 adolescents. A three-latent status model was identified from five indicators (past 6-month use of cigarettes, e-cigarettes, hookah, blunts, and cigars). The largest latent status was "non-users," followed by "e-cigarette/hookah users," and "poly-tobacco users" (characterized by high probabilities of using all five tobacco products). The latent groups remained stable across the 6-month period; the probabilities of adolescents remaining in the same group from baseline to 6-month follow-up were high (.81, .85, and .87). However, the largest transitions were from "non-users" to "e-cigarette/hookah users" and from "e-cigarette/hookah users" to "poly-tobacco users," demonstrating a trend towards multiple product use. While these studies extend our understanding of patterns of tobacco product use, additional research examining changes in patterns of use across longer periods of time and among young adults, the population with the highest prevalence of tobacco use, is needed (Kasza et al. 2017).

To date no study has examined longitudinal, contemporary patterns of diverse tobacco and nicotine product use among young adults. Similarly, few studies have examined the factors that predict these patterns, such as age, biological sex, race/ethnicity, and other substance use behaviors. Thus, little is known about the modern landscape of tobacco and nicotine product use, particularly how these behaviors cluster together, among individuals, over time. Identifying patterns of tobacco and nicotine product use and factors associated with them is key as these findings may inform regulatory policies and prevention programs for young adults. The aims of this study are (i) to identify the most parsimonious, adequate model of the longitudinal patterns of tobacco and nicotine product use among a cohort of Texas college students, and (ii) to determine whether race/ethnicity, age, sex, and other substance use including alcohol use, binge drinking, and marijuana use are associated with tobacco and nicotine product use behaviors at baseline. This study is novel in its use of LTA to examine diverse tobacco and nicotine product use patterns, with examination of the most commonly used products including cigarettes, cigars, smokeless tobacco, e-cigarettes, and hookah, over four waves of data (1.5 years), among a large, diverse sample of young adults. Based on previous research, we hypothesize identification of "non-user," "e-cigarette/hookah user," and "poly-user" groups. We hypothesize that groups will primarily remain stable over the 1.5-year period, and transitions will occur in the direction of "non-user" to "poly-user."

Methods

Participants

Data are from four waves of the Marketing and Promotions Across Colleges in Texas Project (Project M-PACT). Project M-PACT is a rapid response surveillance system of college students from 24 colleges in Texas. Our sample consists of 5,482 students (M age at wave one = 20.5, SD = 2.36; 63.4% female; 36.3% non-Hispanic white, 31.1% Hispanic/Latino, 16.9% Asian, 8.1% African American or black, and 7.5% another race/ethnicity or multi-racial/ethnic). The wave one survey was administered between fall 2014 and spring 2015, and three follow-up waves occurred every 6 months thereafter. There were two eligibility criteria for participating students. First, participants were full- or part-time degree- or certificate-seeking undergraduate students at a participating 4-year college or enrolled in a vocational/technical program at a 2-year college. Secondly, participants were 18–26 years old if they were a lifetime non-tobacco user or 18–29 years old if they were a lifetime tobacco user (ever smoked at least 100 cigarettes, or at least 20 cigars, or ever used smokeless tobacco/spit/chewing tobacco at least 20 times). Lifetime non-tobacco users over 26 years of age were excluded from participation because the study aimed to examine initiation and transitions in tobacco use, and initiation is unlikely to occur after age 26 (HHS, 2004). Users over the age of 26 were included to increase the probability that 2-year vocational students would be eligible to participate in our study since 2-year students are older and more likely to use tobacco products, compared to 4-year students (Biener et al. 2011; Loukas et al. 2008).

Procedure

Twenty-four colleges were recruited from five counties that included the four largest metropolitan areas in Texas (Austin, Dallas/Fort Worth, Houston, and San Antonio). Six colleges (three 4-year and three 2-year) were selected from each of these four areas in Texas. All 2-year colleges and nine of the 12 4-year colleges were public institutions. Eligible students attending the colleges were recruited to participate in the online survey via email invitation. The email addresses of students attending 15 colleges were obtained directly from the college through open records requests. Once obtained, project personnel sent students an invitation email via a secure server. The remaining nine colleges did not release email addresses. Rather, the nine colleges sent an email invitation on the project's behalf to eligible students through their own internal communication channel. Students who were emailed directly by project personnel received an introductory email invitation and two email reminders 5 days after the first invitation and again 6 days later (11 days after the first invitation). Students who were emailed through their respective colleges were sent at least one invitation email and students at three of these nine colleges received one additional reminder email.

The email invitation described the purpose of the study and included a link to an eligibility survey. A total of 15,336 students were assessed for eligibility. The eligibility survey confirmed potential participants' student status as degree/certificate-seeking undergraduates and contained questions on lifetime use of tobacco (i.e., lifetime cigarette, cigar, and smokeless tobacco) and age. Eligible students who wished to participate in the study provided informed consent and then completed the online survey. Upon completion of the survey, each student received a $10 electronic gift card for waves one and two and a $20 electronic gift card for waves three and four, and all students were entered into a drawing to win one of 20 $50 electronic gift cards at each wave. A total of 13,714 students were eligible to participate in the study and of these, 5,482 students (40%) provided consent and completed the survey. This reponse rate is similar to or exceeds that of similar online studies of college students (Berg et al. 2014; Velazquez et al. 2011). Retention rates were 79% at wave two, 79% at wave three, and 81% at wave four. Figure 1 is a flow diagram depicting study recruitment. Project M-PACT was reviewed and approved by the University of Texas at Austin Institutional Review Board (2013-06-0034).

Measures

Measures for Project M-PACT were modeled after existing surveys and reviewed by nine tobacco control experts. Final item modifications were conducted through an iterative process of cognitive interviewing (Willis 2004) with 25 young adults who were not Project M-PACT participants (Hinds III et al. 2016).

Indicators Ten dichotomous variables were used as indicators of tobacco and nicotine product use behavior: ever (lifetime) and current (past 30-day) use of cigarettes, cigar products, smokeless tobacco, electronic nicotine delivery system (ENDS) devices (i.e., e-cigarettes, vape pens, or e-hookah), and hookah/waterpipe. Each indicator variable was measured at each of the four waves. Ever use of cigarettes, cigars, smokeless tobacco, e-cigarettes, and hookah was assessed by asking, "Have you ever smoked/used [product], even one or two puffs?" and current use was assessed by asking, "On how many days of the past 30 days did you smoke/use [product]?" Students who reported use on at least 1 day in the past 30 days were coded as a "current user" and those that reported smoking cigarettes on zero days in the past 30 days were coded as a "non-user." For cigars, hookah, and e-cigarettes, language regarding using the product "as intended" was added to make it clear we were asking about use of the product with tobacco or nicotine, and not another substance like marijuana.

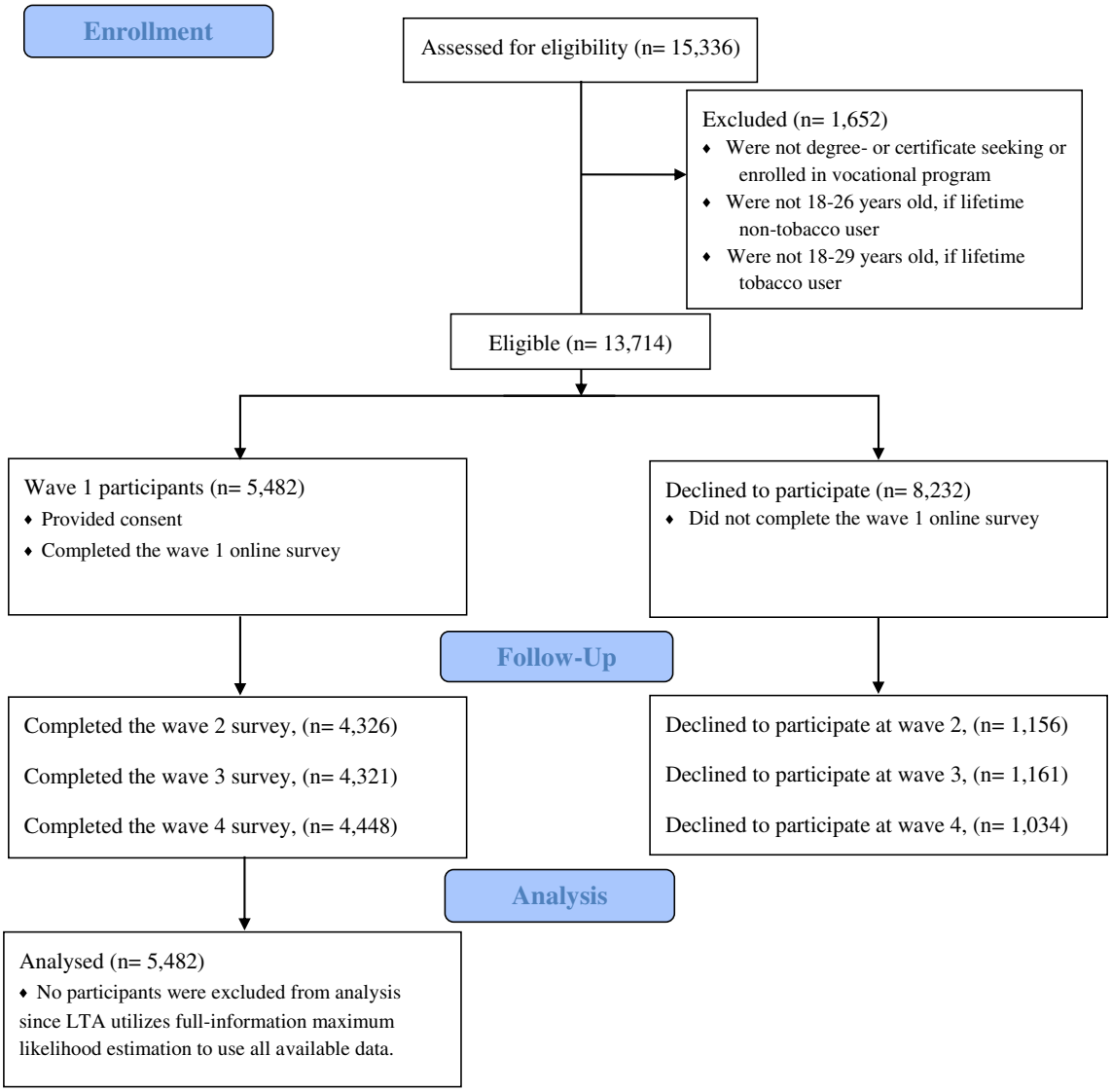

Fig. 1 Flow diagram for study recruitment (M-PACT, waves 1 through 4)

Covariates Six variables (measured at wave one) were used as covariates to predict latent class membership at wave one. These were race/ethnicity, age, sex, current alcohol use, current binge drinking, and current marijuana use. Current alcohol use was assessed by asking, "During the past 30 days, on how many days did you have at least one drink of alcohol?" Students who reported having at least one drink of alcohol on at least 1 day in the past 30 days were coded as "current users" and those that reported alcohol use on zero days in the past 30 days were coded as "non-users." Current binge drinking was assessed by asking, "During the past 14 days, on how many days did you have at least five or more drinks of alcohol in a row?" Students who reported having at least five drinks in a row at least once in the past 14 days were coded as "binge drinkers," and students who reported having five plus drinks on zero days in the past 30 days were coded as "non-users." Current marijuana use was assessed by asking, "During the past 30 days, how many occasions, or times, if any, have you used marijuana?" Students who reported using marijuana at least once in the past 30 days were coded as "current users," and students who reported marijuana use on zero days in the past 30 days were coded as "non-users." Descriptive statistics for all variables used in this study are provided in Table 1.

Attrition Analyses

Independent sample *t* tests and chi-square tests were conducted to determine whether students who were eligible to participate at the three follow-up waves but who did not participate, were significantly different from those who participated at follow-up waves. Results indicated students not participating were significantly more likely to use tobacco and nicotine products.

Table 1 Descriptive statistics (M-PACT, waves 1 through 4)

Variable	Wave 1 ($n = 5,482$)	Wave 2 ($n = 4,326$)	Wave 3 ($n = 4,321$)	Wave 4 ($n = 4,448$)
Indicators of latent status	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Ever cigarette use	2693 (50.8)	2117 (49.1)	2223 (51.4)	2347 (52.9)
Ever cigar use	2010 (36.6)	1740 (40.7)	1864 (43.2)	1990 (45.1)
Ever smokeless use	662 (12.1)	708 (16.8)	874 (20.5)	1023 (23.4)
Ever e-cigarette use	2636 (48.0)	2170 (50.4)	2307 (53.4)	2491 (56.3)
Ever hookah use	3021 (55.1)	2554 (59.6)	2712 (63.0)	2896 (65.7)
Current cigarette use	1161 (21.1)	749 (17.4)	756 (17.5)	758 (17.2)
Current cigar use	529 (9.6)	295 (6.9)	265 (6.1)	266 (6.0)
Current smokeless use	162 (2.9)	95 (2.2)	94 (2.2)	103 (2.3)
Current e-cigarette use	944 (17.2)	635 (14.8)	533 (12.3)	480 (10.9)
Current hookah use	919 (16.7)	579 (14.0)	548 (12.8)	493 (11.3)
Covariates				
Mean age (SD)	20.49 (2.36)			
Race/ethnicity	n (%)			
White	1992 (36.3)			
Hispanic/Latino	1707 (31.1)			
Asian	925 (16.8)			
Black/African American	446 (8.1)			
Other/multi-racial	412 (7.5)			
Sex	n (%)			
Male	1985 (36.2)			
Female	3493 (63.7)			
Current alcohol use[a]	3642 (66.4)			
Current binge drinking[b]	1625 (29.6)			
Current marijuana use[c]	1347 (24.6)			

SD standard deviation. Lifetime/ever use rates vary across waves due to attrition

[a] Current alcohol is having at least one drink of alcohol on at least 1 day in the past 30 days

[b] Current binge drinking is having at least five drinks in a row at least once in the past 14 days

[c] Current marijuana use is using marijuana at least once in the past 30 days

Statistical Analyses

Latent class analysis (LCA) and latent transition analysis (LTA) were used to identify the most parsimonious model of tobacco and nicotine product use profiles from 10 indicators: ever and current use of cigarettes, cigars, smokeless tobacco, e-cigarettes, and hookah and to examine changes in tobacco and nicotine product use profiles over four waves (1.5 years). LCA was used as a preliminary step in selecting a LTA model, which provided an understanding of the latent structure of the data at each wave. To select the optimal number of tobacco and nicotine product use groups, latent class models with two through seven latent classes were compared at each of the four waves. Five hundred different sets of random starting values were used to estimate each model to determine the most parsimonious model for a given number of latent classes. Model fit was assessed by comparing information criteria associated with each model, as well as model stability and interpretability. These included the likelihood-ratio G^2 statistic, degrees of freedom associated with G^2, Akaike information criterion (AIC), Bayesian information criterion (BIC), sample size adjusted BIC (ABIC), log-likelihood value, and entropy. Since there were a relatively large number of indicator variables, each with two response options, the degrees of freedom were large. Therefore, *p*-values were not produced, and we were not able to compare the G^2 obtained in each model. For this reason, we relied primarily on the AIC, BIC, and ABIC values to assess model fit. The AIC, BIC, and ABIC values continued to decrease as more latent classes were added to the model. However, these values began to level off at the five latent class solution. At each wave, the six and seven latent class models were not well identified since only a small percentage of the 500 sets of random starting values converged to the same solution, and these models had poor homogeneity and class separation compared to the five-class model. Thus, we determined the

five latent class model provided the best fit at each of the four waves. Fit statistics for each model at waves one through four are reported in Table 2.

A LTA model was applied to the five-class solution at all four time points simultaneously to model the probability of students' transitioning from one latent status to another, over time. Three sets of parameters were estimated. Latent status membership probabilities represent the prevalence of a latent status at a particular point in time. In LTA, latent class is often termed latent status since the groups are fluid over time. Item-response probabilities represent the probability of selecting a particular response (yes/no) to an observed indicator variable, conditional on membership in a latent status at a particular point in time. Item-response probabilities were constrained to be equal across the four waves since we found the meaning of the different latent groups remained relatively invariant across the four waves. Transitional probabilities represent the probability of transitioning to a latent status at a particular point in time, conditional on latent status at the previous wave.

Covariates were added to our selected LTA model to test whether race/ethnicity, age, sex, alcohol use, binge drinking, and marijuana use predicted class membership at wave one. We employed a multinomial logistic regression approach, where latent class membership was the dependent variable and the probability of class membership depended on the values of the covariates. Cases with missing data for a covariate were deleted. An omnibus test for the overall significance of each covariate on latent status membership is reported. All analyses were conducted in SAS, version 9.4. SAS macros; PROC LCA and PROC LTA were used to fit the LCA and LTA models (Version 1.3.2; Lanza et al. 2015).

Prior to fitting our models, an assessment of the distribution of missing data revealed a non-monotone pattern of missingness. Under the assumption of missing values to be

Table 2 Summary of information for selecting number of latent classes for college student tobacco and nicotine product use (M-PACT, waves 1 through 4; $n = 5{,}482$)

No. latent classes	Likelihood-ratio G^2	Degrees of freedom	AIC	BIC	ABIC	Log-likelihood	Entropy
Wave 1							
2	4055.02	1002	4097.02	4235.82	4169.09	− 21648.05	0.87
3	2682.40	991	2746.40	2957.89	2856.21	− 20961.73	0.78
4	2039.60	980	2125.60	2409.80	2273.16	− 20640.34	0.78
5	*1621.83*	*969*	*1729.83*	*2086.73*	*1915.14*	*− 20431.45*	*0.82*
6	1326.48	958	1456.48	1886.08	1679.53	− 20283.78	0.86
7	1104.65	947	1256.65	1758.95	1517.44	− 20172.86	0.88
Wave 2							
2	2521.50	1002	2563.50	2697.28	2630.55	− 16257.53	0.88
3	1543.64	991	1607.64	1811.49	1709.81	− 15768.60	0.78
4	1174.25	980	1260.25	1534.17	1397.53	− 15583.91	0.77
5	*916.60*	*969*	*1024.60*	*1368.60*	*1197.01*	*− 15455.08*	*0.80*
6	776.78	958	906.78	1320.85	1114.31	− 15385.17	0.83
7	640.22	947	792.22	1276.36	1034.86	− 15316.89	0.85
Wave 3							
2	2344.73	1002	2386.73	2520.52	2453.79	− 16342.82	0.87
3	1359.57	991	1423.57	1627.44	1525.76	− 15850.25	0.77
4	995.98	980	1081.98	1355.93	1219.29	− 15668.45	0.79
5	*765.31*	*969*	*873.31*	*1217.34*	*1045.75*	*− 15553.11*	*0.83*
6	643.47	958	773.47	1187.59	981.05	− 15492.20	0.85
7	507.39	947	659.39	1143.59	902.09	− 15424.16	0.83
Wave 4							
2	2181.27	1002	2223.27	2357.62	2290.89	− 16637.18	0.87
3	1245.93	991	1309.93	1514.64	1412.96	− 16169.51	0.75
4	915.26	980	1001.26	1276.34	1319.34	− 16004.17	0.75
5	*686.75*	*969*	*794.75*	*1140.20*	*968.61*	*− 15889.91*	*0.77*
6	574.69	958	704.69	1120.51	913.97	− 15833.89	0.83
7	476.14	947	628.14	1114.33	872.83	− 15784.61	0.79

AIC Akaike information criterion; *BIC* Bayesian information criterion; *ABIC* adjusted BIC using Rissanen's sample size adjustment. *p* values not reported because degrees of freedom too large. Italic font indicates the best-fitting model at each wave

missing at random, we employed a full-information maximum likelihood (FIML) approach in which missing data is handled within the analysis model. Using this approach, individuals with complete data and missing data were analyzed together, and model estimates were adjusted on the basis of all of the information provided by these individuals. To handle missing data across indicator variables, PROC LCA and PROC LTA automatically employ a FIML approach that requires no additional input from the user. In PROC LCA and PROC LTA, missing data across covariates predicting latent class membership are handled using casewise deletion. Data used in this study are not publically available at the time of the writing of this article.

Results

Item-response probabilities (shown in Table 3) were used to label the five latent statuses: *Non-users*, *Poly-cigarette users*, *Poly-experimenters*, *Hookah experimenters*, and *E-cigarette & hookah experimenters*. Students in the *Non-users* latent status have a zero probability of reporting any use of cigarettes, cigars, smokeless tobacco, e-cigarettes, and hookah. *Poly-cigarette users* have a high probability of reporting current cigarette use (.66) and ever cigarette use (.98). *Poly-cigarette users* are also highly likely to report ever using cigars (.85), smokeless tobacco (.98), e-cigarettes (.88), and hookah (.94). Students in the *Poly-experimenters* group are likely to report ever use of cigarettes (.99), cigars (.71), e-cigarettes (.93), and hookah (.89). *Poly-experimenters* are not likely to report any use of smokeless tobacco or current cigar use. Although defined by high experimentation with multiple products, *Poly-experimenters* are somewhat likely to report current use of cigarettes (.49), e-cigarettes (.37), and hookah (.34). *Hookah experimenters* are likely to report having ever tried hookah (.63). *Hookah experimenters* are somewhat likely to have ever smoked a cigarette (.52) or cigar (.35). *Hookah experimenters* are highly unlikely to have used any other tobacco and nicotine products. *E-cigarette & hookah experimenters* are highly likely to have ever used e-cigarettes (.94) and hookah (.71), and are unlikely to report using any other products.

The overall probability of membership in a status at each wave is shown in Table 3. The most common latent status at wave one was *Non-users* (30.3%), followed by *Poly-experimenters* (25.9%), *Hookah experimenters* (17.7%), *E-cigarette & hookah experimenters* (15.1%), and *Poly-cigarette users* (11.0%). At wave four, *Non-users* remained the most prevalent latent status (25.4%), followed by *Poly-experimenters* (23.1%), *E-cigarette & hookah experimenters* (17.6%), *Poly-cigarette users* (17.4%), and *Hookah experimenters* (16.5%).

The overall effects of alcohol use, binge drinking, and marijuana use on latent status membership at wave one were highly significant ($p < .0001$). Students who reported wave one alcohol use or binge drinking were approximately two to four times more likely to belong in the *Poly-cigarette users*, *Poly-experimenters*, *Hookah experimenters*, and *E-cigarette*

Table 3 Item-response probabilities for a five latent status model of college student tobacco and nicotine product use (M-PACT, waves 1 through 4; $n = 5{,}482$)

Latent status name	Non-users	Poly-cigarette users	Poly-experimenters	Hookah experimenters	E-cigarette & hookah experimenters
Class membership probabilities					
Wave 1	.3030	.1102	.2588	.1767	.1512
Wave 2	.2797	.1426	.2430	.1809	.1537
Wave 3	.2617	.1651	.2351	.1745	.1636
Wave 4	.2537	.1737	.2314	.1653	.1760
Item-response probabilities					
Ever cigarette use	.0000	*.9831*	*.9875*	.5218	.2287
Ever cigar use	.0000	*.8511*	*.7081*	.3546	.1749
Ever smokeless use	.0000	*.9806*	.0000	.0534	.0271
Ever e-cigarette use	.0000	*.8762*	*.9324*	.0000	*.9418*
Ever hookah use	.0000	*.9414*	*.8858*	*.6250*	*.7075*
Current cigarette use	.0000	*.6578*	.4923	.0717	.0024
Current cigar use	.0000	.2978	.1905	.0462	.0383
Current smokeless use	.0000	.2580	.0000	.0056	.0036
Current e-cigarette use	.0000	.4366	.3703	.0000	.1846
Current hookah use	.0000	.3398	.3385	.0779	.1862

Item-response probabilities were constrained to be equal across waves. Item-response probabilities > .6 in italics to facilitate interpretation of latent statuses. The probability of a "no" response can be calculated by subtracting the item-response probabilities from 1

& hookah experimenters statuses, relative to *Non-users*. Students who reported wave one marijuana use were over eight times more likely to be *Poly-cigarette users* (OR 8.33) and *Poly-experimenters* (OR 8.19), and two to four times more likely to be *Hookah experimenters* (OR 2.48) and *Hookah & e-cigarette experimenters* (OR 3.46) than *Non-users*. Alcohol use, binge drinking, and marijuana use did not substantially differentiate the four user groups from one another; however, there were some differences. Relative to *Hookah experimenters*, *Poly-cigarette users*, *Poly-experimenters*, and *E-cigarette & hookah experimenters* were more likely to report binge drinking and marijuana use. Compared to *E-cigarette & hookah experimenters*, *Poly-cigarette users* and *Poly-experimenters* were more likely to use marijuana.

Race/ethnicity, age, and sex were weaker predictors of product use profiles since the odds ratios for these covariates were close to one in many comparisons. However, the overall effects for Hispanic and Asian racial/ethnic categories, age, and sex were significant ($p < .0001$). The largest observed effects were for the comparison of *Poly-cigarette users* relative to other groups. Female students, relative to males, were four to five times more likely to be *Non-users*, *Poly-experimenters*, *Hookah experimenters*, and *E-cigarette & hookah experimenters* compared to *Poly-cigarette users*. Black, Asian, and other/multi-racial students, relative to white students, were approximately two times more likely to belong to other latent groups compared to *Poly-cigarette users*. Odds ratios for predictors of status membership at wave one, with each latent status serving as the reference group, are reported in Table 4.

Table 5 displays transition probabilities (i.e., the probability of transitioning from a given latent status to each of the five latent statuses from wave one to wave two, from wave two to wave three, and from wave three to wave four). Probabilities along the diagonal (in italics) of each probability matrix, reflect the probability of student membership in the same latent status across two consecutive waves. *Non-users* have a high probability of remaining *Non-users* from wave one to wave two (.92), from wave two to wave three (.94), and from wave three to wave four (.97). Likewise, *Poly-cigarette users* have a high probability of remaining *Poly-cigarette users* (1.00) across all three transitions. The probabilities of remaining *Poly-experimenters* across four waves were .90, .92, and .97; for *Hookah experimenters* .93, .90, and .92; and for *E-cigarette & hookah experimenters* .94, .97, 1.00. All groups became more stable over time except *Hookah experimenters* whose members were most likely to transition to *Poly-cigarette users*, *E-cigarette & hookah experimenters*, and *Poly-experimenters*. *Non-users* were most likely to transition to *Hookah experimenters* and *E-cigarette & hookah experimenters*. *E-cigarette & hookah experimenters* transitioned to *Poly-cigarette users* and *Poly-experimenters*. The greatest transition was from *Poly-experimenters* to *Poly-cigarette users* with probabilities of .10, .08, and .03 for transitioning between waves one and two, two and three, and three and four, respectively.

Discussion

This study identified five unique latent profiles of tobacco and nicotine product use behaviors among college students. Consistent with prior research and expectations, we identified a *Non-users* status, two "poly-user" statuses, *Poly-cigarette users* and *Poly-experimenters*, and one status that was characterized by high probabilities of both e-cigarette and hookah use. In addition, we identified a status that was characterized by hookah experimenters. The clustering of use into five statuses revealed college students' use of tobacco and nicotine products is characterized by experimentation and poly-use. Three of the five latent statuses were labeled as "experimenters" since each of these groups was best characterized by high probabilities of ever use and low probabilities of current use. Only one class, *Poly-cigarette users*, could be characterized by current use (i.e., had an item-response probability greater than .60 for a current use item) and was labeled *Poly-cigarette users* because members of this group were likely to be current cigarette users and experimenters of other tobacco and nicotine products. These findings are consistent with those of Haardörfer et al. (2016) who identified latent classes among college students characterized by poly-use. Our study extends previous research by examining these patterns longitudinally.

As hypothesized, profiles of use remained stable over 1.5 years since the greatest probability of transitioning from one latent status to another was .10 for transitioning from *Poly-experimenters* to *Poly-cigarette users* between waves one and two (6 months). Although small, this probability represents approximately 137 students (10% of *Poly-experimenters*) who transitioned from experimenting with multiple tobacco and nicotine products to becoming regular cigarette users, and over the 1.5-year study period, a total of 279 students transitioned from *Poly-experimenters* to *Poly-cigarette users*. Members of other experimenter groups, *Hookah experimenters* and *E-cigarette & hookah experimenters*, were also likely to transition to *Poly-cigarette users*. As such, the *Poly-cigarette users* status remained perfectly stable over time (1.00) and members of this group did not transition to other groups over time (.00). Consistent with Huh and Leventhal's research, these findings indicate that, when transitioning, young adults move to higher levels of tobacco use across time, especially from non-use or experimentation of one or more products to past 30-day cigarette use and other product use. There is concern about non-cigarette

Table 4 Odds ratios for predictors of status membership at wave 1 with each latent group serving as the reference group (M-PACT; $n = 5,482$)

Covariate	Non-users	Poly-cigarette users	Poly-experimenters	Hookah experimenters	E-cigarette & hookah experimenters
Race (White ref)					
Hispanic*	–	0.96	1.34	1.33	1.89
Asian*	–	0.36	0.53	0.78	1.17
Black	–	0.48	0.98	1.05	1.12
Other	–	0.84	1.24	0.84	1.96
Age*	–	1.34	1.18	1.20	1.00
Sex (male ref)*	–	0.19	0.08	1.04	1.15
Alcohol use*	–	2.81	3.82	2.77	3.30
Binge drinking*	–	3.62	2.69	1.61	2.08
Marijuana use*	–	8.33	8.19	2.48	3.46
Race (White ref)					
Hispanic*		–	1.39	1.37	1.96
Asian*		–	1.45	2.11	3.17
Black		–	2.02	2.16	2.30
Other		–	1.47	1.57	2.33
Age*		–	0.88	0.89	0.74
Sex (male ref)*		–	4.06	5.27	5.81
Alcohol use*		–	1.35	0.98	1.17
Binge drinking*		–	0.73	0.44	0.57
Marijuana use*		–	0.98	0.29	0.41
Race (White ref)					
Hispanic*			–	0.99	1.41
Asian*			–	1.45	2.17
Black			–	1.07	1.13
Other			–	1.06	1.57
Age*			–	1.01	0.84
Sex (male ref)*			–	1.29	1.42
Alcohol use*			–	0.72	0.86
Binge drinking*			–	0.60	0.77
Marijuana use*			–	0.30	0.42
Race (White ref)				–	
Hispanic*				–	1.42
Asian*				–	1.49
Black				–	1.06
Other				–	1.47
Age*				–	0.83
Sex (male ref)*				–	1.10
Alcohol use*				–	1.19
Binge drinking*				–	1.28
Marijuana use*				–	1.39

Dashes indicate the reference status

*$p < .0001$ for the omnibus test for overall significance of a covariate on latent status membership

use leading to cigarette use since previous research has provided evidence of this trend (Barrington-Trimis et al. 2016; Loukas et al. 2015; Loukas et al. 2018; Loukas et al. 2019; Primack et al. 2017; Soneji et al. 2017). Prevention programs are needed to educate young adults about the consequences of poly-use, including increased risk of nicotine dependence and substance use disorders (HHS, 2004).

The results of this study suggest that for some people, addiction may not be solidified until after young adulthood since

Table 5 Transition probabilities for a five latent status model of college student tobacco and nicotine product use (M-PACT, waves 1 through 4; n = 5,482)

	Non-users	Poly-cigarette users	Poly-experimenters	Hookah experimenters	E-cigarette & hookah experimenters
Probability of transitioning to …. Conditional on …					
… Wave 1 latent status	… Wave 2 latent status				
Non-users	*.9231*	.0024	.0028	.0525	.0192
Poly-cigarette users	.0000	*1.0000*	.0000	.0000	.0000
Poly-experimenters	.0000	.0986	*.9014*	.0000	.0000
Hookah experimenters	.0000	.0190	.0178	*.9333*	.0298
E-cigarette & hookah experimenters	.0000	.0188	.0380	.0000	*.9432*
… Wave 2 latent status	… Wave 3 latent status				
Non-users	*.9355*	.0014	.0011	.0407	.0214
Poly-cigarette users	.0000	*1.0000*	.0000	.0000	.0000
Poly-experimenters	.0000	.0802	*.9198*	.0000	.0000
Hookah experimenters	.0000	.0146	.0351	*.9020*	.0484
E-cigarette & hookah experimenters	.0000	.0000	.0318	.0000	*.9682*
… Wave 3 latent status	… Wave 4 latent status				
Non-users	*.9693*	.0004	.0000	.0173	.0130
Poly-cigarette users	.0000	*1.0000*	.0000	.0000	.0000
Poly-experimenters	.0000	.0312	*.9688*	.0000	.0000
Hookah experimenters	.0000	.0050	.0211	*.9211*	.0528
E-cigarette & hookah experimenters	.0000	.0016	.0000	.0000	*.9984*

Diagonal transition probabilities in italics to facilitate interpretation

experimentation with tobacco and nicotine products was more common than regular use among students in our sample. Although latent statuses remained relatively stable over time, transitions between groups over time occurred in the direction of experimentation to regular use of tobacco and nicotine products. Other recent research has shown initiation of tobacco and nicotine products may no longer begin in youth as widely believed, and young adults are more likely than youth to initiate tobacco use (Perry et al. 2018; Thompson et al. 2017). Previously, regulatory efforts and prevention programs have focused on reducing tobacco initiation among children and adolescents with little focus on young adults (Lantz et al. 2000). However, Villanti et al. (2018) identified a critical need to interrupt the escalation of risk behaviors occurring in young adulthood. Similarly, our findings support the need for more policies and programs focused on preventing young adult initiation of tobacco and nicotine products and preventing the transition from experimentation to regular use.

Finally, study findings may help to determine which individuals, defined by their latent statuses of use, are most likely to transition to heavier product use groups over time. Predictors of latent statuses may provide insight as to the risk factors associated with membership in latent statuses. Osibogun et al. (2017) found that young adults who are heavier drinkers and use marijuana are more likely to be poly-tobacco users, compared to single product users. This study revealed alcohol and marijuana use were significant factors related to membership in tobacco and nicotine product user groups compared to a non-user group, suggesting prevention programs that target multiple tobacco and nicotine product use, as well as other substance use, may be needed. Similar to Choi et al. (2018), our study revealed latent profiles of tobacco use vary by demographic characteristics. In our study, female students and students belonging to minority racial/ethnic groups were more likely to be non-users and experimenters, and not regular cigarette users. These findings may inform regulatory policies and prevention programs for young adults, especially as initiation of tobacco use becomes more prominent among young adults. Older students were also more likely to be tobacco and nicotine product users than non-users. However, age may be biased since older young adults (ages 26–29) were lifetime tobacco users, and those ages 18–25 were lifetime tobacco users and never users. More research is needed to delineate the relationship between age and membership in latent tobacco product use groups.

Limitations

Study findings should be considered in the context of some limitations. First, the study sample was drawn from 24 2- and 4-year Texas colleges, so findings are not generalizable to other samples. Second, our sample is limited to college students and does not include young adults who did not attend college. However, our sample includes both 4-year University and vocational students at 2-year colleges and is racially/ethnically diverse. This is an important distinction of our study since vocational students tend to have higher rates of tobacco use and are more likely to be racial/ethnic minorities (Biener et al. 2011; Loukas et al. 2008). Additionally, attrition analyses revealed students who were eligible to participate at the three follow-up waves but who did not participate were significantly more likely to use tobacco and nicotine products. This disproportionate drop-out suggests tobacco users may be underrepresented in the study.

Another limitation is the short span of our study (1.5 years), which may not be a long enough period of time to detect larger transitions in product use profiles. Since transition probabilities were small, we encountered estimation problems when examining associations between covariates and transitions between waves. For this reason, we were only able to examine predictors of latent class membership at wave one. In addition, we utilized dichotomous tobacco use indicators which may have resulted in a loss of information regarding levels of tobacco use. However, tobacco use is commonly dichotomized in seminal studies that examine tobacco and other substance use behavior patterns (Huh and Leventhal 2016; Simon et al. 2017; Tomczyk et al. 2016; Yu et al. 2018), and a more complex model (i.e., indicators with more than two categories) would produce model estimation problems. Future research might examine trends in levels of multiple tobacco and nicotine product use among larger young adult samples. Finally, a limitation of PROC LCA and PROC LTA is the inability to test the significance of each odds ratio. Instead, an omnibus test for the overall significance of each covariate is available.

Despite limitations, our study is one of few to examine transitions over a period greater than 6 months. Future research is needed to determine whether the high number of experimenters in our sample become regular product users, over a longer period of time. Additionally, future research might evaluate other potential risk factors for latent group membership that may inform regulatory policies and prevention programs. Given that young adults are transitioning from lower to higher use and membership in higher use groups are predicted by other substance use, prevention programs that target all types of substance use should be developed. These types of programs should be developed and applied in the college environment, given that the majority of young adults attend college and young people spend an extended period of time, up to 4 or more years, in college (U.S. Bureau of Labor Statisitcs 2017). Finally, from a policy perspective, communication campaigns should target young adults to educate them about the consequences of experimenting with tobacco use, which includes poly-product use.

Source of Funding Research reported in this presentation was supported by grant number (1 P50 CA180906) from the National Cancer Institute and the FDA Center for Tobacco Products (CTP).

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Disclaimer The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the Food and Drug Administration.

References

Barrington-Trimis, J. L., Urman, R., Berhane, K., Unger, J. B., Cruz, T. B., Pentz, M. A., ..., McConnell, R. (2016). E-cigarettes and future cigarette use. *Pediatrics, 138*(1).

Berg, C. J., Haardöerfer, R., Escoffery, C., Zheng, P., & Kegler, M. (2014). Cigarette users' interest in using or switching to electronic nicotine delivery systems for smokeless tobacco for harm reduction, cessation, or novelty: A cross-sectional survey of US adults. *Nicotine & Tobacco Research, 17*, 245–255.

Biener, L., McCausland, K., Curry, L., & Cullen, J. (2011). Prevalence of trial of snus products among adult smokers. *American Journal of Public Health, 101*, 1874–1876.

Choi, H. J., Yu, M., & Sacco, P. (2018). Racial and ethnic differences in patterns of adolescent tobacco users: A latent class analysis. *Children and Youth Services Review, 84*, 86–93.

Collins, L. M., & Lanza, S. T. (2013). Latent class and latent transition analysis: With applications in the social, behavioral, and health sciences (Vol. 718): John Wiley & Sons.

Delk, J., Carey, F. R., Case, K. R., Creamer, M. R., Wilkinson, A. V., Perry, C. L., & Harrell, M. B. (2019). Adolescent tobacco uptake and other substance use: A latent class analysis. *American Journal of Health Behavior, 43*, 3–14.

Haardörfer, R., Berg, C. J., Lewis, M., Payne, J., Pillai, D., McDonald, B., & Windle, M. (2016). Polytobacco, marijuana, and alcohol use patterns in college students: A latent class analysis. *Addictive Behaviors, 59*, 58–64.

Hinds III, J. T., Loukas, A., Chow, S., Pasch, K. E., Harrell, M. B., Perry, C. L., . . . Wackowski, O. A. (2016). Using cognitive interviewing to better assess young adult e-cigarette use. *Nicotine & Tobacco Research, 18*, 1998–2005.

Hu, S. S. (2016). Tobacco product use among adults—United States, 2013–2014. *MMWR. Morbidity and Mortality Weekly Report, 65*, 685–691.

Huh, J., & Leventhal, A. M. (2016). Progression of poly-tobacco product use patterns in adolescents. *American Journal of Preventive Medicine, 51*(4), 513–517.

Kasza, K. A., Ambrose, B. K., Conway, K. P., Borek, N., Taylor, K., Goniewicz, M. L., ..., & Kaufman, A. R. (2017). Tobacco-product use by adults and youths in the United States in 2013 and 2014. *New England Journal of Medicine, 376*, 342–353.

Kypriotakis, G., Robinson, J. D., Green, C. E., & Cinciripini, P. M. (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 & Tobacco Research, 20*, S81–S87.

Lantz, P. M., Jacobson, P. D., Warner, K. E., Wasserman, J., Pollack, H. A., Berson, J., & Ahlstrom, A. (2000). Investing in youth tobacco control: A review of smoking prevention and control strategies. *Tobacco Control, 9*, 47–63.

Lanza, S. T., Dziak, J. J., Huang, L., Wagner, A., & Collins, L. M. (2015). PROC LCA & PROC LTA user's guide (version 1.3. 2). University Park: The Methodology Center, Penn State. Retrieved October 1, 2017, from http://methodology.psu.edu.

Lisha, N. E., Thrul, J., & Ling, P. M. (2019). Latent class analysis to examine patterns of smoking and other tobacco products in young adult Bar patrons. *Journal of Adolescent Health, 64*, 93–98.

Loukas, A., Murphy, J. L., & Gottlieb, N. H. (2008). Cigarette smoking and cessation among trade or technical school students in Texas. *Journal of American College Health, 56*, 401–407.

Loukas, A., Batanova, M., Fernandez, A., & Agarwal, D. (2015). Changes in use of cigarettes and non-cigarette alternative products among college students. *Addictive Behaviors, 49*, 46–51.

Loukas, A., Chow, S., Pasch, K. E., Li, X., Hinds, I., Josephine, T., ..., Perry, C. L. (2016). College students' polytobacco use, cigarette cessation, and dependence. *American Journal of Health Behavior, 40*, 514–522.

Loukas, A., Marti, C. N., Cooper, M., Pasch, K. E., & Perry, C. L. (2018). Exclusive e-cigarette use predicts cigarette initiation among college students. *Addictive Behaviors, 76*, 343–347.

Loukas, A., Marti, C. N., & Perry, C. L. (2019). Trajectories of tobacco and nicotine use across young adulthood, Texas, 2014–2017. *American Journal of Public Health, 109*, 465–471 (0), e1-e7.

Osibogun, O., Jaber, R., Bahelah, R., Taleb, Z. B., & Maziak, W. (2017). Poly-tobacco use among young adults in the United States: Findings from the Population Assessment on Tobacco and Health study, 2013–2014. *Annals of Epidemiology, 27*, 535.

Perry, C. L., Pérez, A., Bluestein, M., Garza, N., Obinwa, U., Jackson, C., et al. (2018). Youth or young adults: Which group is at highest risk for tobacco use onset? *The Journal of Adolescent Health, 63*, 413–420.

Primack, B. A., Shensa, A., Escobar-Viera, C. G., Barrett, E. L., Sidani, J. E., Colditz, J. B., & James, A. E. (2017). Use of multiple social media platforms and symptoms of depression and anxiety: A nationally-representative study among US young adults. *Computers in Human Behavior, 69*, 1–9.

PROC LCA & PROC LTA (Version 1.3.2) [software]. (2015). Univeristy Park: The Methodology Center, Penn State. http://methodology.psu.edu. Accessed 1 Oct 2017.

Simon, P., Camenga, D. R., Kong, G., Connell, C. M., Morean, M. E., Cavallo, D. A., & Krishnan-Sarin, S. (2017). Youth e-cigarette, blunt, and other tobacco use profiles: Does SES matter? *Tobacco Regulatory Science, 3*, 115–127.

Soneji, S., Barrington-Trimis, J. L., Wills, T. A., Leventhal, A. M., Unger, J. B., Gibson, L. A., ..., Miech, R. A. (2017). Association between initial use of e-cigarettes and subsequent cigarette smoking among adolescents and young adults: A systematic review and meta-analysis. *JAMA Pediatrics, 171*, 788–797.

Thompson, A. B., Mowery, P. D., Tebes, J. K., & McKee, S. A. (2017). Time trends in smoking onset by sex and race/ethnicity among adolescents and young adults: Findings from the 2006–2013 National Survey on Drug Use and Health. *Nicotine & Tobacco Research, 20*, 312–320 ntx010.

Tomczyk, S., Isensee, B., & Hanewinkel, R. (2016). Latent classes of polysubstance use among adolescents—A systematic review. *Drug and Alcohol Dependence, 160*, 12–29.

U.S. Bureau of Labor Statistics. (2017). *69.7% of 2016 high school graduates enrolled in college in October 2016.* https://www.bls.gov/opub/ted/2017/69-point-7-percent-of-2016-high-school-graduates-enrolled-in-college-in-october-2016.htm. Accessed 28 Feb 2019.

U.S. Department of Health and Human Services. (2004). *The health consequences of smoking: A report of the Surgeon General*. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 62.

U.S. Department of Health and Human Services. (2012). *Preventing tobacco use among youth and young adults: A report of the Surgeon General*. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 3.

U.S. Department of Health and Human Services. (2016). *E-cigarette use among youth and young adults: A report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

U.S. Food and Drug Administration. (2017). Research priorities. Retrieved August 18, 2018, from https://www.fda.gov/TobaccoProducts/PublicHealthScienceResearch/Research/ucm311860.htm .

Velazquez, C. E., Pasch, K. E., Laska, M. N., Lust, K., Story, M., & Ehlinger, E. P. (2011). Differential prevalence of alcohol use among 2-year and 4-year college students. *Addictive Behaviors, 36*, 1353–1356.

Villanti, A. C., Niaura, R. S., Abrams, D. B., & Mermelstein, R. (2018). Preventing smoking progression in young adults: The concept of prevescalation. *Prevention Science, 20*, 377–384 1–8.

Willis, G. B. (2004). Cognitive interviewing: A tool for improving questionnaire design. Sage Publications.

Windle, M. (2003). Alcohol use among adolescents and young adults. *Population, 45*, 19–15.

Yu, E. S., Saddleson, M. L., Murphy, J. M., Giovino, G. A., & Mahoney, M. C. (2017). Patterns of polytobacco use among college students. *Health Behavior and Policy Review, 4*, 173–181.

Yu, M., Sacco, P., Choi, H. J., & Wintemberg, J. (2018). Identifying patterns of tobacco use among US middle and high school students: A latent class analysis. *Addictive Behaviors, 79*, 1–7.