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Transitions Across Tobacco Use Profiles Among Adolescents: Results from the Population Assessment of Tobacco and Health (PATH) Study Wave 1 and Wave 2

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Abstract

Background and Aims: To estimate progression to polytobacco use (PTU) over one year among a sample of US youth.

Design: Prospective survey with two waves one year apart: Wave 1 (2013-2014) and Wave 2 (2014-2015). We conducted latent transition analysis (LTA) to identify latent class transitions and examine sociodemographic predictors of transition types.

Setting: The USA.

Participants: 11,996 people who were aged 12-17 years at Wave 1.

Measurements: Publicly available data were used from the Population Assessment of Tobacco and Health (PATH) Study, a nationally representative sample of US civilian, non-institutionalized population aged 12 years and older. Tobacco use status was assessed and classified in terms of: never use, non-current (not in the past 30 days), and current (past-30-day) use of cigarettes, cigars, e-cigarettes, hookah, and smokeless tobacco. Other nicotine products were excluded because rates of use were either too low to model (e.g., pipe) or the product was not assessed in the PATH youth sample (e.g., nicotine replacement products).

Findings: We identified three distinct patterns: Class 1 - nonuse (Wave 1 prevalence = 86%; Wave 2 prevalence = 78%), Class 2 – ever use of cigarettes and e-cigarettes (Wave 1 prevalence = 11%; Wave 2 prevalence =14%), and Class 3 - current PTU (Wave 1 prevalence = 4%; Wave 2 prevalence = 7%). Probability of progression from nonuse to ever use of cigarettes and e-cigarettes

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was 0.06 and ever use of cigarettes and e-cigarettes to current PTU was 0.32. Nonusers were more likely to transition to ever use of cigarettes and e-cigarettes if they were older (vs. younger), white (vs. nonwhite), or if their parental education level was high school or less (vs. more than high school); and ever users of cigarettes and e-cigarettes to current PTU if they were older, male, or white.

Conclusions: US youth who had previously tried e-cigarettes and cigarettes at Wave 1 (2013-2014) had a 32% chance of transitioning to current use of two or more tobacco products within one year.

Keywords

Polytobacco; tobacco; youth; latent transition analysis

Introduction

In the United States (US), a tobacco product is defined as any product made or derived from tobacco that is intended for human consumption[1]. Tobacco product control efforts have reduced youth rates of cigarette use in the US, with past 30-day rates of cigarette use decreasing to 8.1% in 2018[2]. Of concern, from 2017 to 2018, current use of two or more tobacco products (i.e., polytobacco use [PTU]) increased by 22.0% (from 9.2% to 11.3%) among high school students[2]. During the same timeframe, past 30 day use of e-cigarettes increased by 77.8% [from 11.7% to 20.8%] among high school students[3,4]. The increased rates of e-cigarette use are relevant to increases in PTU because the US regulates e-cigarettes as tobacco products,[1] and e-cigarette use may contribute to PTU because e-cigarettes can be used discreetly in settings where tobacco use is prohibited [5]. A study using US nationally representative data from the Population Assessment of Tobacco Use and Health (PATH) explored patterns of PTU among youth and demonstrated that 47.2% of current adolescent (aged 12–17 years) tobacco users had engaged in PTU in the past 30 days[6]. Over 116 combinations of tobacco product use were identified, with cigarettes plus e-cigarettes being the most popular. PTU among youth is concerning because it increases risk for nicotine dependence and, thus, increases risk for nicotine-related negative consequences on the developing brain[7,8]. Hence, tobacco control policies are needed to prevent adolescent PTU. While research indicates that PTU is common, how use patterns progress over time is unclear.

The significant heterogeneity in youth PTU patterns indicates we should use a latent variable modeling approach for exploring PTU. Lanza et al. documented two fundamental limitations of using a manifest variable approach to analyze youth substance-use profiles: a) even simple models result in “insurmountable” mathematical challenges to predicting profiles (e.g., sparse contingency tables) and b) manually combined observed profiles (e.g., cigarettes + any alternative product) can be arbitrary and generate unreproducible results because profiles may be combined differently depending on the scientist [9]. Compared to a manifest variable approach, latent variable models systematically group individuals into meaningful, parsimonious groupings that allow the “big picture” to emerge [9] and facilitate interpretable predictions of group membership and transitions.

Additionally, understanding transition patterns could inform policy development to prevent transitions from nonuse to use and from less diverse (i.e., fewer products) to more diverse use profiles. We identified one study of California youth that used latent transition analysis (LTA) [10], a longitudinal extension of latent class analysis (LCA), to examine youth progressions across PTU classes. It demonstrated that youth use could be classified into 3 classes that were defined by low, intermediate, and high diversity (or number) of tobacco products used, and that 13-19% of youth were likely to progress to more diverse use profiles over a 6-month period.

Our study adds to this work by using PATH's US nationally representative adolescent sample to examine transitions across latent classes over one year. Specifically, we examined transitions across tobacco use (and nonuse) profiles and predictors of these transitions. We included age, race/ethnicity, sex, and parent education (a proxy for socioeconomic status) as covariates because previous work demonstrates that older adolescents, non-Hispanic whites, males, and youth whose parents have less than a high school education are more likely to engage in PTU[11].

Methods

Procedures

The Yale institutional review board approved a secondary data analysis of the PATH Study Public Use Files. The PATH study is representative of the US civilian, noninstitutionalized population aged 12 years and older and uses a longitudinal cohort design. Youth data were derived from parent and youth interviews via audio computer-assisted self-interviewing. The PATH study design details are published elsewhere [12].

Participants

We used Wave 1 (W1) and Wave 2 (W2) youth data and W2 adult data. In W1, youth were aged 12–17 years. Therefore, at W2, data for youth who turned 18 (n=1915) were available in the adult dataset. We performed analyses on the longitudinal sample (N=11,996 [88% of 13,651] responders at W2) interviewed at both waves.

Measures

Tobacco products.—Products of interest were cigarettes, cigars, e-cigarettes, hookahs, and smokeless tobacco. Other nicotine products were excluded because rates of use were either too low to model (e.g., pipe) or the product was not assessed in the PATH youth sample (e.g., nicotine replacement products). We created a three-category variable comprising of never use, noncurrent use (ever used, but not in the past 30 days), and current use (used in the past 30 days) for each tobacco product at W1 and W2. This definition of current use is consistent with the US Surgeon General's report and various US national surveys [2,13]. The three-category variable was created from survey items that asked adolescents if they had ever tried each product and the last time they had used it. We also created a variable describing the total number of products participants had tried and another describing the number of times participants had used a product. At W1, participants indicated the number of cigarettes, e-cigarette cartridges, or cigars they had used in their lifetime (coded as 0 = no use; 1 = 1 or more puffs but never a whole; 2 = 1, 3 = 2–10, 4 = 11–20, 5 = 21–50, 6 = 51–99, 7 = 100 or more) and the number of times they had smoked hookahs or used smokeless tobacco in their lifetime (as: 0 = no use, 1 = 1, 2 = 2–10, 3 = 11–20, 4 = 21–50, 5 = 51–99, 6 = 100 or more).

Covariates.—Covariates were measured in Wave 1. The PATH study team dichotomized age as 0 = 12–14 years and 1 = 15–17 years. Sex was coded 0 = "male" and 1 = "female." Parent education was indicated with a five-level variable ("less than high school," "high school graduate or equivalent," "some college (no degree) or associates degree," "bachelor's degree," or "advanced degree"). Race/ethnicity was indicated by a four-category variable ("non-Hispanic White," "Hispanic," "non-Hispanic Black" and "other"). Due to the small sample size of one of the class transitions, parent education was dichotomized (0 = "less than high school or high school education" and 1 = "more than high school education") as was race/ethnicity (0 = "non-Hispanic white" and 1 = "Nonwhite").

Data Analytic Approach

We conducted LTA to identify latent, homogenous groupings ("classes") of individuals at each time point and, simultaneously, examine latent class transitions across waves using Mplus Version 7 [14]. Multinomial logistic regressions were fit as part of LTA to examine whether demographics (W1) predicted transitions across classes from W1 to W2. Descriptive statistics describe demographics, number of products used, and lifetime quantity (or number of times a product was used) used by class.

We used the three-step approach for the LTA [15]:

(1) We fit an LTA model with no covariates, assuming independence across waves (i.e., class membership in W2 does not depend on W1 membership) and time invariance (classes in W1 and W2 have the same structure)[15]. The first assumption ensures that observed responses at one timepoint do not affect the class definition at other time points[15], and time invariance, a common assumption in LTA[15], ensures easier interpretation of class prevalences and transitions because classes maintain the same meaning across time. We selected the number of classes by examining fit statistics (i.e., Bayesian information criteria [BIC], Akaike information criteria [AIC], and the Vuong-Lo-Mendell-Rubin [VLMR] likelihood ratio test). Lower BIC and AIC indicate better models. The VLMR tests c-1 classes against c classes, with a significant p-value indicating that c-1 classes should be rejected in favor of c classes [16]. As measures of how confidently models assign participants to classes, we present the model entropy and average posterior probability of class membership for each class (both ranging 0–1; values higher than 0.7 are considered good for both [17,18]).

(2) We assigned each subject to their most likely class at each wave (based on the posterior membership probabilities from Step 1) and estimated the measurement/classification error of this assignment.

(3) We fit an LTA model with fixed measurement errors from Step 2 accounting for classification uncertainty. We also included covariates in the model and estimated their effect on class membership at W1 (results not shown) and transition probabilities.

Results were weighted using the W2 weights (unless otherwise specified) to account for the complex PATH survey design [12]. Regarding missing data, LTA uses a maximum likelihood estimation approach and all available data. As such, LTA assumes that missing data occurs at random.

Results

Descriptive Statistics

Weighted percentages and unweighted Ns are in Table 1. Overall 50.5% (N=6,217) of the sample was aged 12–14 years, 48.7% (N=5,858) were female, 54.6% were non-Hispanic white (N=5,806), and 17.9% (N=2,471) of parents had less than a high school education. Figures 1a and 1b demonstrate that current and noncurrent tobacco product use rates increased for all products over time. Rates of missing data for each tobacco product were low (range: 0.2% [N=29] for W1 hookah to 4.4% [N=536] for W2 cigar use).

Latent Transition Analysis

The goodness-of-fit criteria for LTA models in Step 1 are presented in Table 2. Although AIC and BIC continued to decrease until Class 6 and Class 5 (respectively), the VLMR likelihood ratio test favored three classes (p=0.0001). Relative to solutions with more classes, the three-class solution had better entropy (0.85) and better average posterior probabilities (all>0.82). Moreover, there was no clear conceptual interpretation for the models with more than three classes (e.g., the four-class solution contained two, non-distinguishable "nonuse" classes). Based on these considerations, we selected the more parsimonious three-class model.

We named the three classes "nonusers" (Class 1), "ever users of cigarettes and e-cigarettes" (Class 2) and "current polytobacco users" (Class 3) based on class-specific estimated probabilities of endorsing never, noncurrent, and current use of the products (Table 3). To facilitate interpretation, we examined the number of products noncurrently, currently, and ever (i.e., current + noncurrent use) used by class at W1 (Table 4), and the number of times participants had used cigarettes, cigars, e-cigarettes, hookah, and smokeless tobacco in their lifetime (Supplementary Table S1).

Class 1 comprised 86% (W1) and 78% (W2) of the sample, and very high probabilities (>0.97) of endorsing never use for all products were observed. Mean responses for number of products used at W1 indicated that this class reported noncurrent use of 0.1 products, current use of 0.0 products, and ever use of 0.1 products (Table 4).

Class 2 comprised 11% (W1) and 14% (W2) of the sample and had relatively high probabilities of noncurrent cigarette (0.51) and e-cigarette (0.45) use and low probabilities of current use (cigarette=0.14, e-cigarette=0.12). Adding probabilities for noncurrent and current use suggested the probabilities of ever use were 0.65 for cigarettes and 0.57 for e-cigarettes. Class 2 had high probabilities of never trying a cigar (0.66), a hookah (0.64), and smokeless tobacco (0.83). Mean responses for number of products used indicated noncurrent use of 2.2 products, current use of 0.4 products, and ever use of 2.60 products. Regarding number of times used (W1), median use was one cigarette per lifetime and was less than one e-cigarette cartridge per lifetime. For other products, the median reflected no use.

Class 3 comprised 4% (W1) and 7% (W2) of the sample and had relatively high probabilities of being current cigarette (0.71), e-cigarette (0.48), and cigar (0.46) users. Relatively high probabilities of never use for hookah (0.43) and smokeless tobacco (0.60) were observed. Mean responses for number of products used indicated noncurrent use of 1.4 products, current use of 2.3 products, and ever use of 3.65 products. Median use of cigarettes was 51–99 cigarettes, and 43% used 100 or more cigarettes. Median use of other products was 1 e-cigarette cartridge and 2–10 cigarillos. Hookah use was a median of 1 time. For other products, the median reflected no use.

Transitions across Tobacco Use Profiles and Predictors of Transitions

Table 5 presents estimated transitions across profiles from W1 to W2. Participants' latent class membership at W1 and W2 is shown in the rows and columns, respectively. Youth in Class 1 at W1 had a 94% chance of remaining in Class 1 at W2, a 6% chance of progressing to Class 2, and a 1% chance of progressing to Class 3. We observed a 32% chance that youth in Class 2 at W1 would progress to Class 3. Youth in Class 3 at W1 had an estimated 100% chance of remaining in Class 3 at W2.

Table 6 shows the multinomial regression results predicting transitions from W1 to W2. Overall, older youth were more likely to transition from Class 1 to 2 (adjusted OR for those aged 15–17 vs. 12–14 years was 2.99, 95% CI 2.10–4.25, $p<0.001$), but less likely to do so if they were nonwhite (OR=0.47, $p<0.001$) or had more educated parents (OR=0.56, $p=0.008$). Demographics were not significantly associated with transitions from Class 1 to 3. Youth were more likely to transition from Class 2 to 3 if they were older (OR=4.89, $p=0.004$) but less likely if they were female (OR=0.35, $p=0.004$) or nonwhite (OR=0.31, $p=0.001$).

Discussion

This study is the first to use nationally representative, longitudinal data to conduct LTA of youth polytobacco use (PTU) over one year. The classes demonstrate that use of multiple products is a significant feature of adolescent tobacco use[19]. Consistent with research examining tobacco use transitions among adults, membership in Class 1 (non-users) was relatively stable[20]. There was a 32% chance that youth from Class 2 (ever users of cigarettes and e-cigarettes) would transition to Class 3 (current PTU). Ever users of cigarettes and e-cigarettes were more likely to transition to current PTU if they were older, male, or white. Although we might expect youth to experiment with multiple tobacco products but eventually choose one, the observed transitions from ever use of cigarettes and e-cigarettes to current PTU suggest a significant number of youth who have tried multiple tobacco products will escalate their use to current use of multiple tobacco products. Thus, regulatory efforts to restrict the availability and appeal of products for youth experimentation may be needed to protect youth from progressing to current use of more products. Using price as a barrier to access (i.e., taxes or limits on minimum quantities that can be sold) and bans on flavored products to reduce youth appeal are examples of regulatory efforts applied to curb youth use of cigarettes that are not currently applied across all tobacco products[21,22].

Our identified classes are consistent with other studies among youth that have identified latent classes using never use, noncurrent use, and current use of tobacco products as class indicators[10,23,24]. Similar to the current study, these studies have shown that 1) cigarette, cigar, and e-cigarette us are important features of the current PTU class[10,23] and 2) ever use of tobacco often involves the use of two products[23,24]. Similar to Huh and Leventhal's latent transition analysis (LTA) among California youth, we identified 3 latent classes[10]. While Huh and Leventhal's classes were differentiated by number of products used, our classes were differentiated by current vs. ever product use and number of times used (in addition to number of products used). Thus, our study extends current research by using longitudinal data of nationally representative youth to show that multiple product use is distinguished by two primary characteristics: 1) ever trying cigarettes and e-cigarettes, with relatively small lifetime quantities of use (Class 2) or 2) current use of two or more products, mainly cigarettes, e-cigarettes, and cigars in quantities relatively higher than Class 2 (Class 3).

Regarding transitions across classes, we observed a 32% chance that ever users of cigarettes and e-cigarettes transitioned to current PTU. This likelihood of transition to current PTU could be monitored in future waves of the PATH data. Additionally, none of the participants transitioned from current PTU to ever use of cigarettes and e-cigarettes, which may be expected because current PTU may signal that youth are progressing to nicotine dependence. Lastly, although the probability of transition from nonuse to ever use of cigarettes and e-cigarettes was small, it represented a significant number of participants, highlighting the continued need for tobacco control efforts (e.g., messaging) to prevent nonusers from experimenting with tobacco use.

Our findings should be considered within the context of study limitations. First, selecting the best-fitting latent transition model depended on examining several indices of fit, some of which have documented biases for over and under extraction of classes [25]. Although we applied commonly used methods to identify the appropriate number of classes, there may be heterogeneity within classes. Second, rates of transition to some classes were low. Thus, our ability to examine predictors beyond the sociodemographic factors listed was limited. Third, our definition of current use as any use in the past 30 days may have influenced the patterns that emerged. For example, our latent class indicators were coded as never, noncurrent, and current use, and these states are asymmetrical measurements. Nevertheless, this study coded latent class indicators and defined current use in accordance with conventions in the field [2,1310,23,24]. Further research should examine the utility of these conventions for defining youth PTU and alternative categorizations of indicators for LCA and LTA because different classes could emerge if different indicators (e.g., frequency of use) were examined. Another definitional concern is that while e-cigarettes are included as tobacco products, other medicinal products containing nicotine, such as nicotine patch or gum were not assessed. However, this limitation should be considered in the context of the developmental period being studied; among US adolescents, ever use (i.e., current use + non-current use) of nicotine patch (1.5%) and gum (2.2%) is rare[26]. Lastly, the observed patterns were based on two waves of data collected over the course of one year, as such future research should examine how the observed trajectories unfold over time. Specifically, given the experimental nature of youth tobacco product use, it will be important for future research to determine whether multiple product use persists or whether single product use profiles eventually emerge.

Conclusion

Youth who had previously tried e-cigarettes and cigarettes only a few times had a 32% chance of transitioning to current use of two or more tobacco products within one year. Tobacco control efforts (e.g., increased pricing, flavor bans, counter marketing messaging) should be developed and tested to target youth who have previously used e-cigarettes and cigarettes before they transition to current use of two or more tobacco products.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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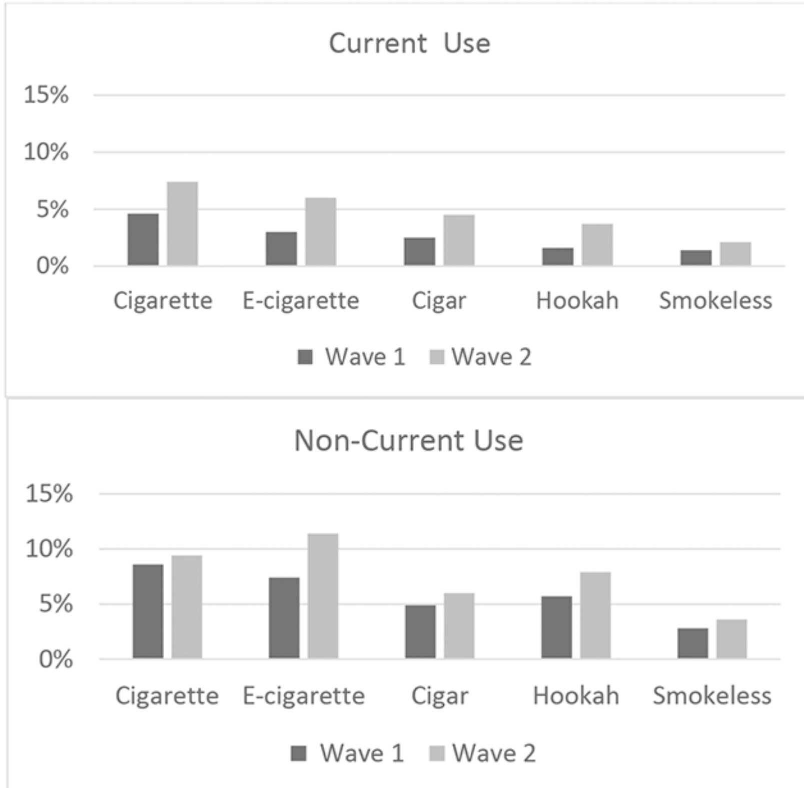

Figures 1a and 1b.
Rates of Current (Past 30 Days) and Non-Current Use (Ever, but not Past 30 Days) by Product (unweighted N = 11,996)

Table 1.

Descriptive statistics for Population Assessment of Tobacco and Health (PATH) study youth at Wave 1 (unweighted N=11996)

Age	**Weighted %**	**Unweighted N**
12 to 14 years old	50.5%	6217
15 to 17 years old	49.5%	5779
Sex		
Male	51.3%	6138
Female	48.7%	5858
Race/ethnicity		
Non-Hispanic White	54.6%	5806
Hispanic	22.3%	3453
Non-Hispanic Black	13.9%	1632
Other	9.2%	1105
Parent education *		
Less than high school	17.9%	2471
High school graduate or equivalent	17.8%	2217
Some college (no degree) or associates degree	31.8%	3794
Bachelor's degree	20.7%	2233
Advanced degree	11.8%	1198

This table shows descriptive statistics for covariates of interest. Percentages are weighted, whereas N's are unweighted.

*Parent education was missing for 83 subjects.

Table 2.

Fit indices of latent transition models of tobacco product use: Waves 1 & 2 (unweighted N=11996)

Number of Classes (C)	AIC	BIC	Entropy	VLMR p-value (test C-1 vs. C classes)	Average posterior probabilities in each class (across the two waves, in decreasing order)
1 class	93112.20	93186.12	NA	NA	1
2 classes	75940.70	76103.34	0.90	<0.0001	0.98; 0.95
3 classes	**75265.59**	**75516.93**	**0.85**	**0.0001**	**0.96; 0.83; 0.82**
4 classes	75049.58	75389.62	0.79	0.17	0.94; 0.82; 0.72; 0.68
5 classes	74939.14	75367.90	0.75	0.26	0.89; 0.75; 0.74; 0.71; 0.62
6 classes	74881.01	75398.47	0.64	0.45	0.81; 0.73; 0.72; 0.71; 0.61; 0.59

Note: These fit indices correspond to the LTA models fit in Step 1 of the 3-step LTA process. Text in bold indicates that the 3 class solution was the optimal solution according to statistical/theoretical criteria. Abbreviations: AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; VLMR, Vuong-Lo-Mendell-Rubin likelihood ratio test; NA, not applicable.

Table 3.

Estimated class prevalences at each wave and conditional response probabilities from three-step latent transition analysis (unweighted N = 11996)

		Class 1 – Nonusers	Class 2 – Ever Users of Cigarettes and E-cigarettes	Class 3 – Current Polytobacco Users
Wave 1 Prevalence		86% (N=10275)	11% (N=1263)	4% (N=458)
Wave 2 Prevalence		78% (N=9409)	14% (N=1705)	7% (N=882)
Cigarette	Never	0.98	0.36	0.08
	Non-current use	0.02	0.51	0.20
	Current	0.00	0.14	0.71
E-cigarette	Never	0.97	0.44	0.14
	Non-current use	0.02	0.45	0.39
	Current	0.01	0.12	0.48
Cigar	Never	0.99	0.66	0.22
	Non-current use	0.01	0.27	0.32
	Current	0.00	0.07	0.46
Hookah	Never	0.98	0.64	0.43
	Non-current use	0.02	0.29	0.32
	Current	0.01	0.07	0.25
Smokeless tobacco	Never	0.99	0.83	0.60
	Non-current use	0.01	0.13	0.21
	Current	0.00	0.04	0.19

Conditional response probabilities for use of cigarette, e-cigarette, cigar, hookah and smokeless tobacco are shown for the three classes that were identified during Step 1 of the latent transition analysis. Note. *Missing data for each product at each wave was as follows. Wave 1: Cigarette (weighted % = 0.2%; unweighted N = 30); E-cigarette (weighted % = 0.5%; unweighted N = 66); Cigar (weighted % = 2.8%; unweighted N = 332); Hookah (weighted % = 0.2%; unweighted N = 29); Smokeless tobacco (weighted % = 1.3%; unweighted N = 156); Wave 2: Cigarette (weighted % = 0.8%; unweighted N = 101); E-cigarette (weighted % = 3.4%; unweighted N = 418); Cigar (weighted % = 4.4%; unweighted N = 536); Hookah (weighted % = 0.9%; unweighted N = 117); Smokeless tobacco (weighted % = 3.0 %; unweighted N = 372).*

Table 4.

Descriptive statistics for number of products used at Wave 1 (N=11429)

		Class 1 (N=10130) – Nonusers		**Class 2 (N=909) – Ever Users of Cigarettes and E-cigarettes**		**Class 3 (N=390) – Current Polytobacco Users**	
		N	**%**	**N**	**%**	**N**	**%**
Number of products used: non-current use							
	0	9311	91.9%	19	2.2%	105	26.3%
	1	819	8.1%	159	17.8%	127	32.2%
	2	0	0.0%	466	50.9%	93	25.3%
	3 to 5	0	0.0%	265	29.1%	65	16.1%
Mean (SD)			0.1 (0.3)		2.2 (0.9)		1.4 (1.1)
Number of products used: current use							
	0	9960	98.2%	551	60.0%	0	0.0%
	1	170	1.8%	332	36.7%	43	10.6%
	2	0	0.0%	26	3.4%	217	56.4%
	3 to 5	0	0.0%	0	0.0%	130	33.0%
Mean (SD)			0.0 (0.1)		0.4 (0.6)		2.3 (0.8)
Number of products used: ever use (non-current use + current use)							
	0	9141	90.2%	0	0.0%	0	0.0%
	1	989	9.8%	0	0.0%	0	0.0%
	2	0	0.0%	502	54.9%	53	13.9%
	3 to 5	0	0.0%	407	45.1%	337	86.1%
Mean (SD)			0.1 (0.3)		2.6 (0.8)		3.7 (0.9)

This table shows the number of products (out of 5) for which participants reported non-current use, current use and ever use across the three latent classes identified. Participants are assigned to the class for which they have the highest posterior probability. Note: Current use=used in past 30 days; Non-current use =used in the lifetime, but not in past 30 days; Ever use = non-current use + current use. All results are weighted (excepted N's). N = 11429 because results are shown for participants with complete data on the use of all five products at Wave 1.

Table 5.

Transition probabilities (estimated frequencies) across latent classes of tobacco product use from Wave 1 to Wave 2 (unweighted N=11996)

		Wave 2 Class		
		Class 1 – Nonusers	**Class 2 – Ever Users of Cigarettes and E-cigarettes**	**Class 3 - Current Polytobacco Users**
Wave 1 Class	Class 1 – Nonusers	0.938 (N=9620)	0.056 (N=571)	0.006 (N=59)
	Class 2 – Ever users of Cigarettes and E-cigarettes	0.000 (N=0)	0.682 (N=864)	0.318 (N=403)
	Class 3 – Current Polytobacco Users	0.000 (N=0)	0.000 (N=0)	1.000 (N=478)

This table shows probabilities that were estimated from an LTA model without covariates fit in Step 3 of the 3-step LTA process.

Table 6.

Predictors of transitions across latent classes of tobacco product use from Wave 1 to Wave 2 (unweighted N=11913)

	Transition to Class 2 (Ever Users of Cigarettes and E-cigarettes) vs. Staying in Class 1 (Nonusers)				Transition to Class 3 (Current Polytobacco Users) vs. Staying in Class 1 (Nonusers)				Transition to Class 3 (Current Polytobacco Users) vs. Staying in Class 2 (Ever Users of Cigarettes and E-cigarettes)		
	OR	**95% CI**	**P**		**OR**	**95% CI**	**P**		**OR**	**95% CI**	**P**
Age 15 to 17 (vs. 12 to 14)	2.99	(2.10, 4.25)	<0.001		3.42	(0.71, 16.54)	0.126		4.89	(1.65, 14.55)	0.004
Female (vs. male)	1.05	(0.78, 1.43)	0.730		0.39	(0.07, 2.26)	0.295		0.35	(0.18, 0.72)	0.004
Non-white (vs. non-Hispanic white)*	0.47	(0.31, 0.69)	<0.001		1.75	(0.27, 11.28)	0.555		0.31	(0.16, 0.62)	0.001
More than high school parent education (vs. high school or less parent education)	0.56	(0.37, 0.86)	0.008		1.57	(0.21, 11.84)	0.660		0.87	(0.44, 1.75)	0.706

Note:

* Non-white includes Hispanic, non-Hispanic Blacks and others. These results were obtained from multinomial logistic regressions within an LTA model with covariates fit in Step 3 of the 3-step LTA process. N=11913 due to missing data on parent education.