Original investigation

Patterns and Profiles of Adolescent Tobacco Users: Results From the Virginia Youth Survey

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Abstract

Background: Cigarette smoking has decreased to a record low among youth across the United States, including in Virginia. Rates of alternative tobacco use, however, are rising and polytobacco use is common. A better understanding of the shifting use patterns and associated risk factors is important for informing tobacco prevention, cessation, and policy efforts.

Methods: Weighted data from the 2013 Virginia Youth Survey were used. The sample was limited to 1168 youth who reported past 30-day tobacco use of ≥1 product (cigarettes, smokeless tobacco [smokeless], or cigars/little cigars/cigarillos [cigars]). Latent class analysis categorized individuals based on current tobacco use frequency/intensity. Multivariable multinomial logistic regressions compared classes on demographics, other tobacco-related factors, other substance use, and health/psychosocial factors.

Results: The five-class model indicated the best fit with classes characterized as "Chippers" (28.0%; high probability of low-frequency/intensity cigarette use), "Moderate Poly-Users" (23.6%; low- to high-frequency/moderate intensity cigarette use; moderate probability smokeless/cigar use), "Cigar Users" (20.9%; no–low-probability cigarette/smokeless use; high-probability cigar use), "Smokeless Users" (17.3%; no–low-probability cigarette/cigar use; moderate–high-probability smokeless use), and "Heavy Poly-Users" (10.4%; daily/high-intensity cigarette use, moderate–high-probability smokeless/cigar use). Classes differed significantly by demographics and inconsistently by other tobacco-related factors. Heavy Poly-Users were more likely to engage in other substance use behaviors, report suicidal ideation, and report being bullied because of gender.

Conclusions: Classes identified indicate that a large proportion of youth engage in polytobacco use and certain subgroups may be at greater risk for negative health consequences due to elevated psychosocial and behavioral risk factors.

Implications: These findings suggest distinct patterns of current tobacco use, including a high proportion of youth engaging in polytobacco use. Heavy polytobacco use co-occurs with other health risk behaviors and may be attributed to psychosocial risk factors. Results underscore the need for detailed monitoring of shifting youth tobacco use patterns as well as targeted prevention, cessation, and policy efforts.

Introduction

From 2011 to 2016, the United States observed significant decreases in current (past 30-day) cigarette smoking among high school (15.8%–8.0%) and middle school (4.3%–2.2%) students.[1] Comparable rates of decline were also reported among Virginian high school students from 2011 to 2015 (15.0%–8.2%) and middle school students from 2013 to 2015 (2.5%–1.6%).[2] Despite this decline in cigarette smoking, overall current use of any tobacco products has not significantly declined.[1] For instance, 22.7% of Virginian high school students in 2015[2] and 20.2% of US high school and 7.2% of middle school students in 2016 reported current use of any tobacco product.[1] Further, among those current tobacco users in 2016, 47.2% of US high schoolers and 42.4% of middle schoolers reported using more than one tobacco product.[1] These shifts reflect notable changes in the tobacco product marketplace and the resulting effects of various tobacco control efforts.[3] Moreover, these shifts may be particularly relevant for Virginian adolescents given that Virginia has the second lowest cigarette tax rate[4] and one of the lowest excise taxes on noncigarette products in the United States.[5] Monitoring patterns of youth tobacco use in regional populations such as Virginia can reveal important trends and associations that are influenced by differences in regional policy and geography. The significant public health burden and regional influence of tobacco use in adolescence[3,6] provide a strong impetus to examine the distinct patterns and risks of tobacco use among various youth populations.

The prevalence of concomitant tobacco use patterns among youth populations is of particular concern because of the increased risk of nicotine dependence and tobacco use persistence into adulthood.[7–9] Common use patterns among current tobacco users include consuming two tobacco products (eg, dual use: cigarettes and cigars) or three or more tobacco products (eg, polytobacco use: cigarettes, cigars, and smokeless tobacco). A nationwide sample of individuals aged 16–26 years from 2012 to 2013 examined patterns of single, dual, and polytobacco use.[10] The most common use patterns involved cigarettes: 49% of all single users smoked cigarettes, 69% of dual users combined cigarettes and another tobacco product, and most polytobacco users smoked cigarettes in combination with two or more tobacco products.[10] These results[10] and others[8,11–13] highlight the sizeable youth population that engages in concomitant tobacco use (dual and polytobacco) and unique risk factors associated with these consumption patterns.

As an alternative to researcher-driven definitions of polytobacco use,[14,15] several recent studies have used latent class analysis (LCA) to identify unobserved (ie, latent) groups based on tobacco product consumption.[8,13,16,17] This approach allows for the inclusion of variables related to tobacco use frequency (ie, number of days per month) and intensity (ie, use episodes per day), which may result in a more fine-grained understanding of tobacco use patterns. An LCA utilizing data from the 2012–2013 US National Youth Tobacco Survey (NYTS) among middle and high school current tobacco users identified nine classes defined by tobacco product type only: cigarette smokers, cigar smokers, smokeless tobacco users, hookah smokers, tobacco smokers/chewers, tobacco/hookah smokers, tobacco/snus/e-cigarette users, e-cigarette users, and polytobacco users.[8] Another LCA performed using NYTS data restricted to high school cigarette smokers from 2009 resulted in six latent classes that differed in cigarette frequency/intensity and use of alternative tobacco products: nondaily light smokers (≤5 cigarettes/day [cpd], ≤5 days/

month), chippers (1–5 cpd, <30 days/month), chippers-indulgent (1–5 cpd, <30 days/month, concurrent alternative tobacco product use), intermittent smokers (2–10 cpd, <30 days/month), daily smokers (≥11 cpd, all 30 days), and daily smokers-indulgent (≥11 cpd, all 30 days, concurrent alternative tobacco product use).[16] Youth in the daily smokers-indulgent class were more likely to report nicotine dependence (70%) compared to daily smokers (44%), as well as the chippers-indulgent class (18%),[16] suggesting patterns and types of tobacco use may contribute to persistence of tobacco use. Polytobacco use also has been linked to more marijuana and alcohol consumption in at least one LCA-based analysis among young adults,[13] but few have examined a comprehensive set of demographics, tobacco/substance use, and psychosocial covariates as part of this approach. With greater numbers of youth reporting polytobacco use patterns and the likelihood of negative consequences for youth who engage in concomitant tobacco use, more research is needed to characterize the profiles of youth tobacco users and their correlates.

Given the documented association between mental health and cigarette smoking among youth,[18,19] identifying potential psychosocial and physical health factors associated with changing patterns of tobacco use can help inform the development of tailored intervention and policy efforts. Adolescents' initiation of smoking, smoking intensity, and subsequent depression and suicidality (ie, ideation or attempts) share common social influences, such as a history of bullying[19] and adverse childhood experiences (eg, emotional/physical abuse, neglect, parental substance use[20,21]). Early exposure to social stressors has been shown to increase risk for use of substances (eg, alcohol, tobacco, illicit drugs) for coping as well as greater depressive symptoms that, in turn, increase risk for suicide during adolescence and adulthood.[22] Moreover, cigarette smoking has been shown to increase reports of depressive symptoms among adolescents,[23] as well as increase risk for suicidal ideation and suicide deaths among adults,[24] particularly as smoking frequency increases.[25] These findings highlight important and often overlooked areas for consideration in the examination of adolescent tobacco use, including psychosocial and physical health.

Policy, prevention, and cessation efforts targeted toward at-risk subgroups (ie, dual or polytobacco users) may prevent poor outcomes associated with tobacco use and other comorbid psychosocial or physical health factors among the most vulnerable adolescents. Identifying patterns of tobacco use that are associated with mental health problems may highlight a need for screening programs in schools or a need to target strategies for coping with stressors/mental health problems more broadly within tobacco cessation programs. The current study aimed to identify latent classes of adolescent tobacco users and determine predictors of class membership, including tobacco-related factors, alcohol, and other illicit substance use, psychosocial functioning, and physical health markers.

Methods

Participants

The present study was conducted using publically available, de-identified secondary data from a representative statewide sample of 6935 high school students from the 2013 Virginia Youth Survey (VYS). This study included 1168 students who indicated past 30-day tobacco use and had data available on all four tobacco use variables (past 30-day cigarette, smokeless tobacco, and cigar use, and daily cigarette intensity).

Measures

Adolescents responded to questions on the VYS about their demographics, tobacco product use, psychosocial factors, other substance use behaviors, and physical health.

Demographics

Sex was assessed as binary (male/female). Continuous age was dichotomized as "less than 15" and "15 years or older." Racial/ethnic groups in this study were recoded to White (non-Hispanic), Black (non-Hispanic), and "Other," which incorporated all other races/ethnicities.

Tobacco Product Use

Respondents indicated tobacco use frequency via how many days in the past 30 days they (1) smoked cigarettes, (2) used smokeless tobacco (ie, chewing tobacco, snuff or dip), and/or (3) smoked cigars (ie, cigars, cigarillos, or little cigars). Smoking intensity was assessed by how many cigarettes they smoked per day on average. Categories of days of tobacco use were collapsed into a 5-point scale (0 days, 1–2 days, 3–5 days, 6–29 days, all 30 days) for each tobacco type, and cigarette intensity was collapsed into a 4-point scale (none, <1–1 cpd, 2–5 cpd, 6–20+ cpd).

Tobacco-Related Factors

Students were asked about smoking rules in the home where they live and the vehicle they drive or ride in the most on a 3-point scale (never allowed, sometimes allowed, always allowed). Participants also indicated whether they believed smokers have more friends which was coded as yes (definitely/probably yes) and no (definitely/probably no). Harm perceptions of smoking flavored cigarettes and cigars were both assessed on a 3-point scale (very dangerous, somewhat dangerous, not at all dangerous).

Other Substance Use

Lifetime alcohol use (at least one drink of alcohol) and marijuana use (at least one time) were coded as yes/no. Current alcohol use in the last 30 days was coded as yes/no for at least one drink of alcohol and ≥5 drinks of alcohol in a row within a couple of hours. Current marijuana use was coded as yes/no for using marijuana at least 1 day in the last 30 days. If students had ever used any form of cocaine, huffed/inhaled substances such as glue, heroin, methamphetamines, or ecstasy, they were coded as having used illicit drugs (yes) versus if they had never used illicit drugs (no). Likewise, lifetime nonmedical use of prescription drugs (NMUPD) or steroids were combined into one yes/no variable: NMUPD.

Health and Psychosocial Factors

Students reported if they ever felt "so sad or hopeless almost every day for two weeks or more in a row that [they] stopped doing some usual activities?" and if they ever "seriously considered attempting suicide?" (yes/no) in the past 12 months. Participants also indicated in the past 12 months if they had been "bullied on school property," "electronically bullied," or "the victim of teasing or name calling because of [their] gender?" (yes/no). Participants indicated whether a doctor or nurse ever told them they had asthma (yes/no/not sure; not sure responses were excluded from present analyses).

Procedure

The VYS is an ongoing behavioral surveillance survey developed to monitor health risk behaviors of youth in Virginia and is funded by the Centers for Disease Control and Prevention, the Virginia Department of Health in collaboration with the Virginia Foundation for Healthy Youth, with support from the Department of Education.[2] The VYS is executed in a two-stage cluster sample design to obtain a representative student sample in grades 9–12. Sample weighting adjusts for nonresponse bias and the distribution of students by grade, sex, and race/ethnicity in each jurisdiction. The full description of the survey and methodology are available elsewhere.[26]

Data Analyses

Latent Gold 5.1 was used to classify adolescents based on current cigarette, smokeless tobacco, and cigar use frequency, as well as cigarette use intensity (Statistical Innovations, 2015). A successive-class model-building approach was utilized to identify the best-fitting number of clusters. The first criterion was a nonsignificant chi-square statistic for the overall model. Then, the Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC), Consistent AIC (CAIC), and entropy R^2 were used to determine adequate model fit. Entropy values closer to 1 signify distinction between classes.[27] As guiding principles, parsimony and interpretability also were used in final model selection. Data were weighted by stratum, primary sampling unit, and individual weight and used with replacement at first state method per Youth Risk Behavior Surveillance System guidelines.[28]

Descriptive statistics were computed to describe the overall sample, as well as by latent class–derived tobacco use cluster membership. A series of weighted bivariate and multivariable analyses were conducted following estimation of the final latent class model to determine correlates of cluster membership. IBM SPSS 24 (IBM Corporation, 2016) was used to examine bivariate cluster differences based on demographics, tobacco-related factors, other substance use, and health and psychosocial factors. Multinomial multivariable logistic regression analyses were computed using Stata 14.1 (StataCorp, College Station, TX).

Results

Descriptive Statistics

Among the analytical sample of current tobacco users (n = 1168), 63.3% of adolescents smoked cigarettes, 38.8% used smokeless tobacco, and 53.9% smoked cigars, little cigars, or cigarillos at least 1 day in the past 30 days. Of the 739 adolescents who smoked cigarettes, 46.6% smoked 1 cigarette or less per day, 33.7% smoked 2–5 cpd, and 19.8% smoked 6–20+ cpd.

Latent Class Model

A series of latent class models were estimated to identify underlying latent tobacco use profiles using the four measures of tobacco use. Following model estimation, the five-class model was selected as the best-fitting model. First, the five-class model was the first successive model to reach a nonsignificant chi-square statistic. Next, the BIC improved from the one-class model to the five-class solution, but fit reduced substantially when estimating successive models. The best models for the AIC and CAIC were the four- and eight-class solutions, respectively (Table 1). Considering together the chi-square *p*-value, BIC, entropy, interpretability, and parsimony, the five-class model demonstrated strong evidence for the best-fitting model.

Overall Sample

Table 2 displays the cluster labels, factor loadings for all model indicators, as well as the parameters for the four indicators (eg, cigarette/

Table 1. Model Fit Information for Latent Class Analyses With 1–11 Latent Classes

Classes	*df*	AIC	BIC	CAIC	Entropy R^2	Classification errors	*p*
1	15	12597.6	12673.6	12688.6	1.00	0.00	<.001
2	31	10981.3	11138.2	11169.2	1.00	0.00	<.001
3	47	10603.1	10841.0	10888.0	0.91	0.04	<.001
4	63	10239.5	10558.5	10621.5	0.91	0.05	<.001
5	**79**	**10499.8**	**10499.8**	**10578.8**	**0.90**	**0.07**	**.60**
6	95	10544.4	10544.4	10242.7	0.90	0.07	.99
7	111	10621.1	10621.1	10268.6	0.86	0.10	>.99
8	127	10695.8	10695.8	10292.4	0.87	0.10	>.99
9	143	10775.1	10775.1	10918.1	0.88	0.09	>.99
10	159	10860.8	10860.8	10355.8	0.86	0.12	>.99
11	175	10953.1	10953.1	11128.1	0.84	0.14	>.99

Bold font indicates selected model. Classification errors represent the proportion of cases that were misclassified. AIC = Akaike information criterion; BIC = Bayesian information criterion; CAIC = consistent AIC.

Table 2. Probabilities of Five-Class Latent Class Model

Indicator	Loading	Chippers	Moderate poly-users	Cigar users	Smokeless tobacco users	Heavy poly-users
Latent class membership probabilities		0.28	0.24	0.21	0.17	0.10
		Probability means				
Cigarette days	0.80					
0 days		0.00	0.00	1.00	1.00	0.00
1–2 days		0.72	0.01	0.00	0.00	0.07
3–5 days		0.21	0.16	0.00	0.00	0.02
6–29 days		0.07	0.62	0.00	0.00	0.00
All 30 days		0.00	0.22	0.00	0.00	0.90
Cigarette frequency per day (cpd)	0.85					
0 cpd		0.00	0.00	1.00	1.00	0.00
< 1–1 cpd		0.87	0.20	0.00	0.00	0.02
2–5 cpd		0.13	0.68	0.00	0.00	0.11
≥ 6–20+ cpd		0.00	0.12	0.00	0.00	0.88
Smokeless tobacco days	0.46					
0 days		0.76	0.71	0.90	0.00	0.44
1–2 days		0.07	0.05	0.05	0.34	0.11
3–5 days		0.04	0.06	0.02	0.16	0.05
6–29 days		0.07	0.11	0.03	0.28	0.08
All 30 days		0.06	0.07	0.00	0.22	0.31
Cigar days	0.44					
0 days		0.50	0.49	0.00	0.91	0.37
1–2 days		0.26	0.14	0.61	0.02	0.16
3–5 days		0.09	0.13	0.18	0.02	0.07
6–29 days		0.11	0.22	0.15	0.04	0.05
All 30 days		0.03	0.03	0.06	0.01	0.35

cigar days) for each respective latent class. The first latent class (Chippers; 28.0%) was characterized by high probability (0.93) of using cigarettes 1–5 days at relatively low frequencies (<1–5 cpd), low probability (0.24) of using smokeless tobacco, and moderate probability (0.50) of using cigars at various frequencies (highest probability for 1–2 days). The second latent class (Moderate Poly-Users; 23.6%) was characterized by high probability (0.84) of using cigarettes from 6 to 30 days at a moderate frequency (2–5 cpd), low probability (0.29) of using smokeless tobacco, and moderate probability (0.51) of cigar smoking (highest probability for 6–29 days). The third latent class (Cigar Users; 20.9%) was characterized by no cigarette use, low probability (0.10) of smokeless tobacco use, and high probability of cigar use (highest probability for 1–2 days; 0.61).

The fourth latent class (Smokeless Tobacco Users; 17.3%) was characterized by no cigarette use, high probability of smokeless tobacco use with similar probabilities for 1–2 days (0.34) and 6–29 days (0.28), and low probability (0.09) of cigar use. Finally, the fifth and smallest latent class (Heavy Poly-Users; 10.4%) was characterized by high probability (0.90) of using cigarettes daily at high intensity (6–20+ cpd), and moderate probability of smokeless tobacco (0.56) and cigar (0.63; highest probabilities for daily use of both products).

Bivariate Analyses

Weighted chi-square analyses were computed for all covariates to determine the differences between classes. Results for tobacco-related factors, other substance use, and health/psychosocial factors

are presented in Table 3. For demographics, there were significant differences by class membership for age, sex, and race/ethnicity ($p < .05$). Youth older than 14 years had the highest weighted percentage within all classes, including Heavy (92.4%, *SE* = 2.7) and Moderate Poly-Users (92.3%, *SE* = 1.8), Cigar Users (91.0%, *SE* = 2.2), Chippers (86.2%, *SE* = 2.6), and Smokeless Users (83.6%, *SE* = 3.5). Males were more prevalent among Smokeless Users (85.3%, *SE* = 3.0) and Heavy Poly-Users (67.5%, *SE* = 5.0) than females, but sex was more equally distributed for the Moderate Poly-Users (56.6%, *SE* = 3.2 male), Cigar Users (53.2%, *SE* = 4.2 male), and Chippers (43.2%, *SE* = 3.3 male). White adolescents were more prevalent in four of the latent classes with the highest proportion among Smokeless Users (81.7%, *SE* = 3.4), Heavy Poly-Users (67.5%, *SE* = 4.7), Moderate Poly-Users (52.7%, *SE* = 4.2), and Chippers (56.7%, *SE* = 4.6), followed by Other races/ethnicities for those four classes (Smokeless: 10.1%, *SE* = 2.0; Heavy: 17.5%, *SE* = 3.0; Moderate: 24.0%, *SE* = 4.4; Chippers: 23.5%, *SE* = 3.2). Cigar Users were approximately evenly split between White (45.5%, *SE* = 4.9) and Black (43.5%, *SE* = 5.1) adolescents.

The distribution of responses for all tobacco-related factors (ie, perceiving smokers have more friends, harm perceptions of flavored cigarettes and cigars, and rules about smoking in the home and car) were significantly different between classes. For other substance use, ever illicit drug use, ever NMUPD, marijuana use (both ever and current), and current alcohol use (light and heavy drinking) were significantly different between classes, but not ever drinking alcohol ($p = .23$; overall = 92.0%). Finally, being teased because of gender, feeling sad/hopeless, and suicidal ideation differed between classes, but not asthma diagnosis status ($p = .27$; overall = 24.1%), being bullied at school ($p = .42$; overall = 26.6%), or being electronically bullied ($p = .09$).

Multinomial Multivariable Analyses

Four weighted multinomial multivariable logistic regression models were conducted and described in detail below. Class membership served as the outcome in all models (reference group = Heavy Poly-Use). The first model determined the demographics that significantly differed by class. The three subsequent models assessed class differences in tobacco-related factors, other substance use, and health/psychosocial factors, while controlling for demographics (Table 4). Variables that were at least marginally significant ($p < .10$) at the bivariate level were included in each model.

Model 1: Demographics

A multinomial logistic regression was performed with age, sex, and race/ethnicity as predictors. Females were more likely than men to be Chippers (adjusted odds ratio [AOR] = 2.80, 95% CI = 1.64 to 4.78) and Cigar Users (AOR = 1.86, 95% CI = 1.03 to 3.37) and less likely than men to be Smokeless Users (AOR = 0.33, 95% CI = 0.16 to 0.70) versus Heavy Poly-Users. Black adolescents were more likely than White adolescents to be Moderate Poly-Users (AOR = 2.20, 95% CI = 1.17 to 4.14) and Cigar Users (AOR = 4.75, 95% CI = 2.36 to 9.55) versus Heavy Poly-Users. Adolescents from the Other race/ethnicity group were less likely than White adolescents to be Smokeless Users (AOR = 0.46, 95% CI = 0.26 to 0.82) versus Heavy Poly-Users. Adolescents <15 years old were less likely than older adolescents to be Heavy Poly-Users (AOR = .37, 95% CI = 0.15 to 0.90) versus Smokeless Users.

Model 2: Tobacco-Related Factors

After controlling for demographics, believing smokers have more friends increased the likelihood of being a Heavy Poly-User versus a Moderate Poly-User, Cigar User, or Smokeless User; there was no difference in the likelihood of being a Heavy Poly-User versus Chipper (Table 4). Across all classes, believing flavored cigarettes are "not at all dangerous" increased the likelihood of being a Heavy Poly-User. Believing cigars are only "somewhat" or "not at all dangerous" increased the likelihood of membership in the Cigar User class and the Smokeless User class (for "somewhat dangerous" only). For those where smoking is always allowed in the car, adolescents were more likely to be Heavy Poly-Users across all classes, although rules about smoking in the home had no significant class differences.

Model 3: Other Substance Use

Controlling for age, sex, and race/ethnicity, adolescents who belonged to the Heavy Poly-User class were more likely to have used illicit drugs than all other classes (Table 4). Compared to Smokeless Users, Heavy Poly-Users were more likely to have reported NMUPD as well as ever using marijuana, but no differences emerged between the other classes. Heavy Poly-Users were more likely to have reported drinking more heavily in the past 30 days when compared to Chippers, Cigar Users, and Smokeless Users. No differences were found across classes for current marijuana use or lighter alcohol use.

Model 4: Health and Psychosocial Factors

Controlling for demographics, adolescents in the Heavy Poly-Use class were more likely to have been teased about their gender in the past year than those in the Moderate Poly-User and Smokeless User classes (Table 4). In addition, adolescents in the Heavy Poly-User class were more likely to report suicidal ideation than Cigar and Smokeless Users. No class differences were observed for depressive symptoms or being bullied electronically.

Discussion

Consistent with other LCAs among youth populations, results presented here identified five classes of tobacco users that were differentiated by primary tobacco product used, cigarette use intensity (Chippers [cigarettes], Cigar Users, and Smokeless Users), and frequency of polytobacco use (Moderate and Heavy Poly-Users).[8,13,16] Unique to this examination are findings related to a broad range of demographics, tobacco-related factors, other substance use, and health/psychosocial correlates.

In comparison with previous LCAs using the NYTS, latent classes identified in the present study are consistent with subgroups identified using 2009 data, including the finding of a Chipper class that had a high probability of using cigarettes at a low frequency/intensity, as well as a Moderate Poly-User class that used cigarettes and alternative tobacco products at a lower intensity than a Heavy Poly-User group.[16] The current analysis also identified two classes defined specifically by alternative tobacco use, Cigar and Smokeless Users, which is in line with a more recent LCA using NYTS data from 2012 to 2013.[8] The identified Heavy Poly-User class reflects other data suggesting a rise in polytobacco use among youth.[10] The current study findings, however, may be an underestimation of poly use prevalence given that other novel tobacco products were not accounted for (eg, e-cigarette, hookah/waterpipe use) as reflected in Harrell et al. (2017).[8]

Table 3. Bivariate Comparisons by Latent Class Membership for Tobacco-Related, Other Substance Use, and Health/Psychosocial Covariates

Characteristic		Overall sample		Chippers		Moderate poly-users		Cigar users		Smokeless tobacco users		Heavy poly-users	
Overall *n*		1168		309		308		236		193		122	
	n	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE
Tobacco-related factors													
Smokers have more friends													
Yes	387	64.3	2.3	40.3	4.7	35.6	3.5	25.9	4.5	25.6	4.2	63.2	5.8
No	699	35.7	2.3	59.7	4.7	64.4	3.5	74.1	4.5	74.4	4.2	36.8	5.8
Harm perceptions—flavored cigarettes													
Very dangerous	495	46.0	1.8	42.0	2.9	44.2	2.9	53.4	3.9	51.4	4.6	36.8	6.1
Somewhat dangerous	487	44.2	1.7	51.6	2.7	43.8	3.2	39.3	3.8	46.0	4.6	33.5	4.8
Not at all dangerous	106	9.7	1.1	6.4	1.8	12.0	2.2	7.4	1.9	2.6	1.1	29.7	5.5
Harm perceptions—cigars													
Very dangerous	434	40.7	2.2	40.9	3.9	40.9	3.8	33.6	4.5	53.6	4.6	33.5	6.4
Somewhat dangerous	541	47.4	2.2	50.6	4.3	44.2	3.8	56.4	4.9	39.8	4.8	39.8	6.5
Not at all dangerous	119	11.9	1.0	8.5	2.1	14.9	3.1	10.0	2.5	6.5	2.6	26.7	6.0
Smoking rules—home													
Never allowed	767	69.9	1.9	76.1	3.0	63.1	3.7	75.0	3.4	80.6	3.2	42.3	6.1
Sometimes/places	175	13.7	1.4	12.5	2.8	17.4	3.0	13.2	2.7	10.3	2.4	14.8	3.3
Always allowed	199	16.4	1.4	11.4	2.2	19.5	2.7	11.8	2.3	9.1	2.4	42.8	5.5
Smoking rules—car													
Never allowed	541	48.1	2.5	52.5	3.6	40.5	4.7	55.3	5.1	65.3	4.6	12.3	4.6
Sometimes/places	258	22.0	1.6	26.5	2.7	19.7	3.0	27.7	4.5	16.7	4.3	13.1	3.2
Always allowed	334	29.9	2.2	21.0	2.5	39.8	4.1	17.0	2.6	18.1	3.2	74.6	5.0
Other substance use													
Ever illicit drug use													
Yes	452	37.4	1.9	35.3	3.2	47.4	3.4	24.0	3.7	24.3	3.9	67.9	5.7
No	696	62.6	1.9	64.7	3.2	52.6	3.4	76.0	3.7	75.7	3.9	32.1	5.7
Ever NMUPD													
Yes	565	49.0	1.8	43.2	3.5	58.3	3.7	47.2	3.7	28.8	4.1	77.8	4.2
No	583	51.0	1.8	56.8	3.5	41.7	3.7	52.8	3.7	71.2	4.1	22.2	4.2
Ever marijuana use													
Yes	849	77.0	1.9	77.0	3.8	90.5	2.6	80.3	3.8	44.0	4.1	93.0	2.8
No	234	23.0	1.9	23.0	3.8	9.5	2.6	19.7	3.8	56.0	4.1	7.0	2.8
Past 30-day marijuana use													
Yes	643	57.5	1.9	54.3	3.0	72.9	3.3	62.7	4.3	22.8	4.1	76.7	5.0
No	444	42.5	1.9	45.7	3.0	27.1	3.3	37.3	4.3	77.2	4.1	23.3	5.0
Past 30-day ≥1 drink													
Yes	719	74.5	1.6	74.5	3.2	83.8	2.9	69.0	3.7	59.7	3.9	90.0	3.7
No	246	25.5	1.6	25.5	3.2	16.2	2.9	31.0	3.7	40.3	3.9	10.0	3.7
Past 30-day ≥5 drinks													
Yes	507	47.8	2.0	44.0	4.0	62.0	4.1	37.7	3.5	32.9	4.6	72.5	4.6
No	553	52.2	2.0	56.0	4.0	38.0	4.1	62.3	3.5	67.1	4.6	27.5	4.6
Health and psychosocial factors													
Teased about gender													
Yes	113	10.3	2.0	11.4	2.8	7.3	2.0	10.9	4.2	5.0	1.8	21.2	6.2
No	1037	89.7	2.0	88.6	2.8	92.7	2.0	89.1	4.2	95.0	1.8	78.8	6.2
Feel sad/hopeless													
Yes	459	38.7	2.1	39.4	4.6	44.9	3.7	36.5	5.2	23.6	3.2	50.8	5.7
No	686	61.3	2.1	60.6	4.6	55.1	3.7	63.5	5.2	76.4	3.2	49.2	5.7
Suicidal ideation													
Yes	303	24.1	1.6	26.4	2.9	26.0	3.4	21.1	4.1	12.3	2.8	38.5	6.1
No	839	75.9	1.6	73.6	2.9	74.0	3.4	78.9	4.1	87.7	2.8	61.5	6.1
Bullied electronically													
Yes	250	21.2	2.0	27.0	3.1	19.7	2.8	18.8	4.7	13.6	3.5	26.9	5.5
No	900	78.8	2.0	73.0	3.1	80.3	2.8	81.2	4.7	86.4	3.5	73.1	5.5

SE = standard error; NMUPD = nonmedical use of prescription drugs. All *p* values < .014 except being bullied electronically (*p* = .088). Results for alcohol ever use, asthma diagnosis status, and bullied at school items not displayed (*p* > .10).

Table 4. Multinomial Logistic Regression Results

	Heavy poly-users vs chippers			Heavy poly-users vs moderate poly-users			Heavy poly-users vs cigar users			Heavy poly-users vs smokeless users		
	AOR	95% CI		AOR	95% CI		AOR	95% CI		AOR	95% CI	
Tobacco-related factors												
Smokers—friends[a]												
Yes	0.48	0.21	1.06	**0.36**	**0.18**	**0.73**	**0.19***	**0.09**	**0.41**	**0.30***	**0.13**	**0.69**
Harm perceptions—flavored cigarettes[b]												
Somewhat dangerous	1.11	0.46	2.67	1.00	0.48	2.09	0.50	0.22	1.13	1.64	0.75	3.62
Not at all dangerous	**0.11**	**0.02**	**0.65**	**0.24***	**0.07**	**0.82**	**0.06***	**0.02**	**0.24**	**0.11***	**0.01**	**0.91**
Harm perceptions—cigars[b]												
Somewhat dangerous	1.07	0.43	2.68	0.94	0.44	2.01	**2.72***	**1.16**	**6.37**	**0.43***	**0.20**	**0.92**
Not at all dangerous	1.79	0.36	8.96	1.37	0.38	4.92	**4.18***	**1.02**	**17.11**	0.57	0.08	4.30
Smoking rules—home[c]												
Sometimes allowed	0.61	0.24	1.54	0.77	0.36	1.67	0.62	0.24	1.57	1.01	0.34	2.98
Always allowed	0.52	0.20	1.32	0.60	0.28	1.27	0.68	0.30	1.52	0.57	0.24	1.36
Smoking rules—car[c]												
Sometimes allowed	0.69	0.26	1.80	0.75	0.28	2.01	0.76	0.31	1.84	**0.25***	**0.09**	**0.73**
Always allowed	**0.08***	**0.03**	**0.20**	**0.19***	**0.08**	**0.44**	**0.06***	**0.02**	**0.14**	**0.07***	**0.03**	**0.17**
Other substance use												
Ever illicit drug use[a]												
Yes	**0.44***	**0.23**	**0.82**	**0.54***	**0.31**	**0.96**	**0.22***	**0.11**	**0.44**	**0.37***	**0.18**	**0.76**
Ever NMUPD[a]												
Yes	0.58	0.31	1.07	0.55	0.27	1.10	0.51	0.25	1.03	**0.42***	**0.18**	**0.99**
Ever marijuana use[a]												
Yes	0.41	0.13	1.32	0.73	0.20	2.62	0.65	0.21	2.08	**0.24***	**0.07**	**0.86**
Past 30-day marijuana use[a]												
Yes	0.88	0.38	2.01	1.38	0.59	3.22	1.45	0.60	3.48	0.50	0.20	1.23
Past 30-day ≥1 drink[a]												
Yes	0.85	0.30	2.41	1.05	0.38	2.89	0.78	0.27	2.20	0.93	0.28	3.07
Past 30-day ≥5 drinks[a]												
Yes	**0.41***	**0.18**	**0.91**	0.56	0.27	1.14	**0.26***	**0.13**	**0.50**	**0.24***	**0.10**	**0.57**
Health and psychosocial factors												
Teased about gender[a]												
Yes	0.41	0.15	1.09	**0.28***	**0.11**	**0.73**	0.53	0.21	1.30	**0.25***	**0.08**	**0.81**
Feel sad/hopeless[a]												
Yes	0.66	0.28	1.53	1.11	0.53	2.33	0.79	0.35	1.79	0.56	0.23	1.36
Suicidal ideation[a]												
Yes	0.64	0.29	1.42	0.61	0.26	1.43	**0.45***	**0.21**	**0.95**	**0.42***	**0.18**	**0.94**
Bullied electronically[a]												
Yes	1.11	0.50	2.44	0.82	0.41	1.65	0.80	0.34	1.88	0.97	0.40	2.35

*Bold values were significantly associated (p < .05). AORs with an asterisk (*) were significantly associated (*p* < .05). Age, gender, and race/ethnicity are included as control variables. LC = latent class; AOR = adjusted odds ratio; CI = confidence interval; NMUPD = nonmedical use of prescription drugs.

[a]Reference = no.

[b]Reference = very dangerous.

[c]Reference = never allowed.

The patterns of tobacco use may reflect unique demographic and policy characteristics of Virginia. The LCA of Virginia adolescent tobacco users classified about 17% of the sample as Smokeless Users and almost 21% as Cigar Users. In comparison, an LCA of tobacco use patterns among a US Midwest state-based sample of young adults classified 10% of their sample as smokeless/snus/snuff users.[13] This difference may be related to regional differences in tobacco control policy and the proportion of urban versus rural areas between the Midwest and Virginia.[29] For example, the rates of smokeless tobacco (10–15%) use among Virginian adolescents from more rural areas (Southwest and Northwest) are higher than urban areas (4%–8%; Central and Eastern).[2] Increased rates of tobacco use among rural youth have been linked to greater exposure to tobacco advertising in these areas.[29] Notably, the tax on cigarettes in Virginia ranks 50 of 51[4] with $0.30 per pack of cigarettes versus the federal rate of $1.01 per pack[30] and has one of the lowest tax rates for noncigarette tobacco products.[5] State-level policies targeted at regulating tobacco advertising (eg, near schools and retail point-of-sale[31]) and increased tobacco taxes for cigarette and noncigarette products remain an underutilized tool to prevent and reduce youth tobacco use in Virginia. Patterns of tobacco use observed in this study demonstrate that policy measures must be inclusive of all types of tobacco products in order to reach the range of youth tobacco users.

Class differences in demographics, tobacco-related factors, and other substance use behaviors point to at-risk subgroups for different patterns of tobacco use as well as concurrent substance use problems. Females were more likely than males to be classified as Chippers and Cigar Users and less likely than males to be Smokeless Users versus Heavy Poly-Users in the multivariable model, consistent with other studies.[13,16] The current study also found that White adolescents were more likely to be Heavy Poly-Users than Moderate Poly-Users or Cigar Users versus Black adolescents, and more likely than Other races/ethnicities to be Smokeless versus Heavy Poly-Users, which is consistent with prior research.[16] The Heavy Poly-Users were generally more likely to use illicit drugs, as well as NMUPD, and report ever using marijuana. This finding is consistent with previous research that has linked poly-users with higher rates of marijuana use as compared to smokeless tobacco use.[13] Heavy Poly-Users were also more likely to have reported drinking more heavily in the past 30 days compared to Chippers, Cigar Users, and Smokeless Users. Previous research has similarly found that poly-users are the most likely group to report binge drinking.[13] In fact, in the present study, no differences were found across classes for current light alcohol use. Harm perceptions and social norms may influence these risk factors, as Heavy Poly-Users were more likely to report smoking always being allowed in the car they use most frequently, believing that smokers have more friends and that flavored cigarettes were not harmful; however, this group was less likely to believe cigars were harmful compared to the Cigar Users class. Findings are consistent with prior research that has shown dual users have lower harm perceptions of tobacco products.[32]

In extending previous research, this study included assessments of health-related and psychosocial correlates of the tobacco user latent class membership. Heavy Poly-Users were more likely to have been teased about their gender in the past year compared to youth in the Moderate Poly-User and Smokeless User classes; this subgroup also was more likely to report suicidal ideation than both Cigar and Smokeless Users. Youth who have reported bullying are more likely to initiate smoking[19] and report current tobacco use.[33] Interestingly, there were no class differences in depressive symptoms or being bullied electronically in the multivariable model even though depressive symptoms were reported more frequently among Heavy Poly-Users at the bivariate level. Although adolescents with more depressive symptoms have been more likely to initiate smoking,[17] these symptoms, as well as bullying, may not influence youths' product choice or patterns of tobacco use. Alternatively, the shared variance between bullying, depressive symptoms, and suicidal ideation may have overshadowed the association with tobacco use given the correlation between bullying and mental health, and that Heavy Poly-Users were more likely to experience suicidal ideation and to be teased about their gender. Previous research has linked suicidal behaviors with cigarette smoking among adolescents,[33–35] which highlights potential benefits of screening for mental health problems in schools as well as promoting positive coping strategies in the context of tobacco use prevention and cessation programs.

Interestingly, asthma diagnosis was not a correlate of class membership at the bivariate level although higher levels of cigarette smoking have been observed among individuals with asthma.[36] The high asthma rate among Virginians as a whole may have influenced the assessment of this covariate.[37]

Limitations

The current study had several limitations including lack of generalizability. Although the population was restricted to tobacco-using high school students living in Virginia, the use of analytic approaches that are replicable and measures found in other surveillance tools (Global Youth Tobacco Survey[38]) enhances the utility of this work. We did not include other novel tobacco products such as e-cigarettes and hookah/waterpipe because their use was not assessed in the VYS. Other important psychological factors that were not assessed in the VYS were also not included, such as whether students were verbally or physically bullied, how often they were bullied, or the severity or persistence of mental health problems. The current study was also cross-sectional in nature and casual pathways between psychosocial factors and tobacco use cannot be determined.

Conclusions

The present findings (1) validate previously identified classes of tobacco use among current adolescent tobacco users; (2) describe the demographics, tobacco-related factors, other substance use, and health/psychosocial factors associated with tobacco use patterns; and (3) highlight areas of concomitant risk with heavy polytobacco use. Given the shifting tobacco use patterns, state policy in Virginia should target increased taxation of all tobacco products, not just cigarettes, as well as regulation of tobacco advertising. Prevention and cessation programs for youth should target the overlapping use of multiple substances, social norms regarding tobacco use, and harm perceptions, targeting specific youth tobacco consumption patterns. Demographic subgroups that may be targeted for interventions are females for light smoking, White males for smokeless tobacco use and heavy poly use, and Black adolescents for cigar smoking and moderate poly use. Interventions may also consider integrating topics related to mental health promotion, coping with stress, and/or being bullied.

Declaration of Interests

None declared.

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