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Original investigation

Patterns of Tobacco Product Use and Correlates Among Adults in the Population Assessment of Tobacco and Health (PATH) Study: A Latent Class Analysis

George Kypriotakis PhD[1], Jason D. Robinson PhD[1], Charles E. Green PhD[1,2], Paul M. Cinciripini PhD[1]

[1]Department of Behavioral Science, The University of Texas MD Anderson Cancer Center, Houston, TX; [2]Center for Clinical Research and Evidence-Based Medicine, Department of Pediatrics, UTHealth, Houston, TX

Corresponding Author: George Kypriotakis, Department of Behavioral Science, The University of Texas MD Anderson Cancer Center, Houston, TX, USA. Telephone: 713-792-5079; Fax: 713-745-4286; E-mail: gkypriotakis@mdanderson.org

Abstract

Introduction: As the tobacco industry and market evolves, there is a growing need to understand the patterns of use of tobacco products and how they relate to demographics, dependency, withdrawal, and quit behavior.

Methods: We analyzed data from wave 1 of the PATH Study consisting of 14 856 individuals. Current users were defined as consuming at least 1 of 10 tobacco products. We performed a latent class analysis (LCA) to identify patterns of tobacco use. We used multinomial regression analysis to explore the association between these patterns with covariates representing socioeconomic status dependence/addiction, past quit attempts, and withdrawal severity.

Results: We identified four groups of current tobacco users with distinct profiles: (1) 61% of the sample were identified as cigarette-only users; (2) 9% were smokeless tobacco users; (3) 17% of the sample were characterized by being current users of all types of combustible tobacco including cigars, cigarillos, filtered cigars, and smoking a pipe (4) finally, 13% were e-cig and hookah users. All classes also shared a varying frequency of cigarette use. Exclusive cigarette users were more likely to be older and female, and experienced higher dependency and withdrawal. Users of e-cigs and hookah were the younger, most educated of all four subgroups, and presented the lowest dependency and withdrawal among the four groups.

Conclusions: FDA policy makers may want to discourage the use of tobacco products associated with higher tobacco dependency, and products that may contribute to experiencing higher levels of withdrawal symptoms by the user when trying to quit.

Implications: We identified four patterns of tobacco product use that are significantly related to demographic characteristics, dependency, and withdrawal. Policies should target users more likely to use tobacco products that increase dependency and withdrawal, making quitting more difficult.

Introduction

In May 2016, the US Food and Drug Administration (FDA) asserted regulatory authority over all tobacco products, including electronic cigarettes (e-cigs), cigars, hookah, pipe tobacco, and smokeless tobacco.[1] While cigarette smoking has the highest prevalence of use among all tobacco products (15.1%),[2] new tobacco products, such as e-cigs and snus, have been on the rise across the adult US

population, particularly among the young adult population. More traditional tobacco products such as cigars, chewing tobacco, and hookah are also becoming more popular.[3,4]

A recent study[5] found that 10% of the US population are polytobacco users. It is estimated that 38% of those who use tobacco are polytobacco users—76% are cigarette users, and 45% e-cig users. Although, cigarette use is declining in the United States,[6] there has been an enormous rise in the popularity of e-cigs in the US market. Market value is expected to increase from $3.5 billion to $10 billion by the end of 2018.[7] Awareness of e-cigs is also exponentially increasing, reaching approximately 90% for youth (12–17 years)[5] and 91% for adults who were current smokers in 2014.[8] E-cigs are also the tobacco product most frequently used in combination with combustible cigarettes with approximately 51% of current smokers having ever used it, and 21% of current smokers having used e-cigs in the past 30 days.[8] Hookah use has also been increasing among adults over the last 4 years[9] with approximately 19% of current cigarette users using hookah.[10] Similarly, dual use of cigarettes with other combustible tobacco products, such as cigars and cigarillos, has increased.[3,5] Approximately 30% of current cigarette smokers have used other combustible products.[11] Finally, the dual use of smokeless tobacco products in combination with cigarette use is now 41% among primary smokeless tobacco users,[12] while among those who primarily use cigarettes approximately 6% are dual users of cigarettes and smokeless tobacco products.[13]

Polytobacco use potentially increases the health risks associated with cigarette smoking. Compared to cigarette smoking, polytobacco use has been found to be associated with greater dependency,[14] greater difficulty quitting and increased incidence of disease.[15,16] Recent studies provide evidence that dual tobacco users of cigarettes and smokeless tobacco experience higher levels of nicotine dependency[17,18] and withdrawal[19] when trying to quit than cigarette smokers. Hookah use has also been associated with use of other tobacco products, although hookah users are less likely to be heavy smokers.[10] In addition, polytobacco use has been associated with past quit attempts when compared to cigarette-only use.[20]

The objective of this study is to identify patterns of tobacco use among adults in the United States and to explore the association between these patterns of use and socioeconomic status, dependence/addiction, past quit attempts, and withdrawal severity.

Method

Participants

We used data from the first wave of the adult file of the Population Assessment of Tobacco and Health (PATH) Study[21] (≥18 years; N = 32 320) to construct our sample. The PATH Study is a national study that used an area-probability sampling method, which, combined with the weighted data, produced a representative sample of all civilian, noninstitutionalized adults in the United States. The subsample of the PATH Study used in this study consists of 14 856 individuals who were *current established users* of at least 1 of the following 10 tobacco products: cigarettes, e-cigs, traditional cigars, cigarillos, filtered cigars, pipe tobacco, hookah, smokeless (loose snus, moist snuff, dip, spit, or chewing tobacco), snus pouches, and dissolvables. The subgroup *current established user* was defined in the PATH Study as "*the individual who has ever or fairly regularly used the product in the past, and that at the present the product is used daily or some days*." In addition to using the product at present, current cigarette use was also restricted to those having smoked more than 100 cigarettes in their lifetime. For hookah, current use is defined as *the individual has used the product in the past and at the present the product is used daily, some days, usually weekly, or usually monthly.*[21]

Measures

Demographic Variables

Examination of the effects of demographic characteristics on tobacco use patterns, included age, gender, race, education, and household income. Age was categorized into seven age groups: 18–24 (n = 3740; 25%), 25–34 (n = 3270; 22%), 35–44 (n = 2514; 17%), 45–54 (n = 2518; 17%), 55–64 (n = 1830; 12%), 65–74 (n = 769; 5%), 75+ (n = 214; 1%). There were 8517 (57%) males and 6339 (43%) females in the sample. We used two dichotomous race/ethnicity variables as predictors; African American (n = 2185; 15%) versus all others (n = 12 671; 85%), and Hispanic (n = 1922; 13%) versus all others (n = 12 729; 87%). Moreover, we used a six-category variable for education from "less than high school" to "advanced degree" with 51% (n = 7515) having a "high school graduate" degree. Finally, we use a dichotomous poverty variable to compare those below the poverty level (n = 5259; 39%) to those at or above (n = 8357; 61%) based on annual household income and following the 2015 poverty guideline issued by the Department of Health and Human Services.[22]

Tobacco Dependence Variables

To capture nicotine dependency we used nine different variables (questions). One question asked "Do you considered yourself addicted to tobacco?" with the responses: "No, not at all" (n = 3336; 23%), "Yes, somewhat addicted" (n = 5617; 38%), and "Yes, very addicted" (n = 5654; 39%). The remaining eight variables captured respondents level of agreement and ranged from 1 to 5 ("1 = not true of me at all" to "5 = extremely true of me"). Specifically, the respondents were asked to indicate the level of agreement with the following statements: "Frequently crave tobacco" (***$\bar{x}$ = 3.1; SD = 1.4), "My tobacco product use is out of control" ($\bar{x}$ = 2.13; SD = 1.4), "Usually want to use tobacco right after I wake up" ($\bar{x}$ = 3; SD = 1.7), "Using tobacco products really helps me feel better if I've been feeling down" ($\bar{x}$ = 2.72; SD = 1.5), "Using tobacco products helps me think better" ($\bar{x}$ = 2.8; SD = 1.5), "Find it really hard to stop using tobacco" ($\bar{x}$ = 3; SD = 1.5), "After not using tobacco for a while, I need to use in order to feel less restless and irritable" ($\bar{x}$ = 2.9; SD = 1.6), "After not using tobacco for a while, I need to use in order to keep myself from experiencing any discomfort" ($\bar{x}$ = 2.5; SD = 1.5).

Tobacco Product Quitting Variables

We used two variables to measure past tobacco product quit attempts and two variables to measure intention to quit. For the past quit attempts the respondent could select a list of items for the question: "In the past 12 months, have you tried to quit tobacco product(s)? Choose all that apply." Two of the responses were "Yes, I have tried to quit completely" (n = 4382; 31%) and "No, I have reduced or cut back instead of trying to quit" (n = 2537; 18%). We treated these two responses as separated variables to use as predictors for class membership. For intention to quit, for the first variable the respondent had to agree/disagree with the statement "Plans to quit smoking/using tobacco product(s) for good" (n = 8121;

89%). The second variable the respondents marked the "level of interest in quitting smoking/using tobacco products" measures on a scale of 1 = "not at all interested" to 10 = "extremely interested" ($\bar{x}$ = 6.9; SD = 2.9).

Withdrawal Variables

The five withdrawal variables were about how the respondent felt when he/she tried to quit in the last 12 months. Specifically, the question was: "Within days after stopping or cutting down on using tobacco products in the past 12 months, did you…." The responses were: "feel depressed" (n = 2570; 27%); "have difficulty concentrating" (n = 3216; 34%); "become easily irritated, angry, or frustrated" (n = 5704; 61%); "feel anxious or nervous" (n = 5026; 54%); "feel more restless than usual" (n = 4867; 52%).

Statistical Methods

Delineating unique patterns of tobacco use was undertaken using latent class analysis (LCA).[23] LCA identifies groups of individuals that share a similar response profile to categorical measured variables. Similar to factor analysis, LCA assumes that the covariation among directly measured variables is explained by a latent factor.[24] Following guidelines,[25] we began by specifying two latent classes and increased the number of classes until the increase in model fit and interpretability no longer merited the reduction in parsimony achieved by specifying another latent class. We examined six fit statistics to evaluate models: log likelihood (LL), Akaike information criterion (AIC), Bayesian information criterion (BIC) as recommended by Nylund et al.,[25] sample-size-adjusted BIC (SSA–BIC) as recommended by Henson et al.,[26] Lo–Mendell–Rubin likelihood ratio test (LMR)[27] as recommended by Nylund et al.,[25] and entropy. There are no cutoff scores for LCA fit statistics, but LL, AIC, BIC, and SSA–BIC values should be lower in comparison to other solutions, entropy should be larger in comparison to other solutions, and LMR should be significant (p < .05). Additionally, we considered the interpretation of solutions when selecting the best latent structure.[25]

We used Mplus v.7.11[28] for the latent class models and Stata v.15[29] for the descriptive statistics. We used the automatic three-step approach in Mplus to model auxiliary variables (covariates).[30]

All of the effects were reported as odds ratios. All the analyses presented were adjusted for oversampling and nonresponse by the use of weights (see supplement) provided with the PATH Study data set using balanced repeated replication with Fay's adjustment of 0.3.[28,29]

Results

Correlations among the 10 tobacco product variables are in Table 1, with their descriptive statistics in the last two columns. Current cigarette smokers were less likely to be current users of any of the other tobacco products, with smokeless tobacco products (r = −0.33, p < .001) and hookah (r = −0.23, p < .001) the least likely to be used. E-cig users were more likely to use hookah (r = 0.05, p < .001) and least likely to use smokeless tobacco products. Use of any of the combustible tobacco products other than cigarettes (cigars, cigarillos, filtered cigar, and pipe), was positively correlated with the use of another combustible tobacco product, with the strongest association observed between current use of cigar and current use of pipe (r = .18, p < .001).

Latent Classes

As seen in Figure 1, there were four distinguishable indicator response patterns for all four of the latent classes (see Supplementary Table S1 for model fit). We chose the 4 class solution because it exhibited lower LL, AIC, BIC, and SSA–BIC values, and a significant LMR likelihood ratio test in comparison with the two- and three-class solutions. Although the five-class solution had higher entropy and lower LL, AIC, BIC, and SSA–BIC, the LMR was nonsignificant. Thus, we retained the four-class solution structure shown in Figure 1. We reported the item–response probabilities, which indicate the likelihood that individuals in a given class reported using a particular tobacco product. These probabilities provided the basis for labeling the classes, although all four classes shared a certain level of cigarette use in combination with other tobacco products.

Class 1 (cigarette users; n = 9089, 61.2%)

This class represented a group of participants who reported being current exclusive users of combustible cigarettes and had very low to zero probability of being current users of any of the other tobacco products. The second highest probability of being a current user of another tobacco product in addition to cigarette was for e-cig (item–response probability = 0.06) followed by filtered cigar (item–response probability = 0.015).

Class 2 (smokeless users; n = 1263, 8.5%)

In the smokeless user class, everyone was a current user of a smokeless tobacco product. This class also had current cigarette smokers with an item–response probability of 0.23 and snus users with an item–response probability of 0.08.

Table 1. Correlations and Frequencies of All 10 Tobacco Products

Tobacco product	1	2	3	4	5	6	7	8	9	N = 14 856	%
1. Cigarette										11 402	76.79
2. E-cig	−0.11***									1575	10.62
3. Cigar	−0.17***	0.00								890	6.05
4. Cigarillos	−0.13***	0.03***	0.27***							1186	8.22
5. Filtered cigar	−0.04***	0.02	0.17***	0.16***						551	3.82
6. Pipe	−0.09***	0.03***	0.18***	0.08***	0.07***					318	2.14
7. Hookah	−0.23***	0.05***	0.04***	0.05***	0.02*	0.04***				1058	7.13
8. Smokeless	−0.33***	−0.05***	0.01	−0.02*	−0.01	0.02**	−0.04***			1597	10.90
9. Snus	−0.08***	0.01	0.05***	0.02**	0.03***	0.03***	0.00	0.21***		273	1.85
10. Dissolvables	−0.01	0.04***	0.04***	0.02*	0.00	0.09***	0.05***	0.01	0.01	19	0.13

*p < .05; **p < .01; ***p < .001.

Class 3 (poly-combustible user; *n* = 2508, 16.9%)

This class had the second highest probability of using cigarettes (item–response probability = 0.47), but it also had the highest probability of using cigars (item–response probability = 0.36), cigarillos (item–response probability = 0.33), filtered cigars (item–response probability = 0.16), and pipe smoking (item–response probability = 0.1). In addition, they were users of smokeless tobacco, e-cigs, and hookah with item–response probability of 0.1 for all three.

Class 4 (E-cig/hookah user; *n* = 1994, 13.4%)

The fourth class had the highest probability among all four classes of using e-cigs (item–response probability = 0.33) as well as of using hookah 9 (item–response probability = 0.28). This class also had an item–response probability of 0.33 of using cigarettes. All other products had a near zero or zero probability of being used by this group.

Correlates of Latent Classes

Demographics

We present the adjusted odds ratios in Table 2. Individuals in the cigarette user class were older and had the highest proportion of female users among the classes. Users in the smokeless class were more likely to be male, least likely to be African American or Hispanic, and have the lowest proportion of participants below the poverty line compared to the other classes. Poly-combustible tobacco users were more likely to be African American and to receive income below the poverty line compared with all other classes. E-cig/hookah users reported the highest level of education, had the highest proportion of Hispanic users, and were the youngest tobacco users among the four tobacco user groups (Supplementary Figure S1).

Dependence

For dependency predictors of latent class membership, the cigarette user class had the highest level of dependency compared with all other classes (Figure 2). The differences in dependency were most pronounced when cigarette users were compared with e-cig/hookah users. Four out of the nine dependency variables were higher for cigarette users than e-cig/hookah users. Specifically, exclusive cigarette users were more likely to report that they were addicted to tobacco (OR = 2.47, $p < .001$), that tobacco helped when feeling down (OR = 1.15, $p < .05$), that it was hard to stop using tobacco (OR = 1.32, $p < .05$), and that they felt irritated when not using tobacco (OR = 1.32, $p < .01$) when compared to e-cig/hookah user group. Users of smokeless tobacco were more likely to crave tobacco (OR = 1.5, $p < .001$) and to report that tobacco helped with thinking (OR = 1.10, $p < .001$) than the cigarette-only user group. In contrast, smokeless tobacco users were less addicted to tobacco (OR = 0.74, $p < .001$), were less likely to report out of control tobacco use (OR = 0.83, $p < .001$), and less likely to use tobacco immediately after they wake up (OR = 0.85, $p < .001$). Moreover, the poly-combustible tobacco user group was less likely to be addicted to tobacco than cigarette users (OR = 0.39, $p < .001$), less likely to use tobacco right after waking up (OR = 0.93, $p < .05$), and less likely to report that it is hard to stop tobacco use (OR = 0.85, $p < .001$). However, the poly-combustible tobacco user group was more likely to report using tobacco when feeling down (OR = 1.11, $p < .05$), that tobacco helped with their thinking (OR = 1.16, $P < .001$), and that they felt discomfort when not using tobacco (OR = 1.12, $p < .001$) as compared to cigarette user group. Supplementary Figure S2 presents the descriptive (weighted) standardized values of the dependence variables.

As compared to e-cig/hookah group, poly-combustible users were more likely to use tobacco when feeling down (OR = 1.27, $p < .001$) and feel more irritated when not using tobacco a (OR = 1.28, $p < .05$). Dependence behaviors among poly-combustible users with smokeless tobacco users were equivocal. Although, poly-combustible users were less likely to report being addicted to (OR = 0.53, $p < .001$) and less likely to crave (OR = 0.71, $p < .001$) tobacco, they were more likely to report out-of-control tobacco use (OR = 1.21, $p < .01$), tobacco use immediately after waking up (OR = 1.10, $p < .05$) and tobacco use as a mood enhancer (OR = 1.18, $p < .001$). Finally, smokeless tobacco users were more likely to be dependent to tobacco than e-cig/hookah users. The smokeless user group reported that they were more likely to be addicted to tobacco (OR = 1.81, $p < .01$), to crave tobacco (OR = 1.51, $p < .001$) and to feel irritated when not using tobacco (OR = 1.36, $p < .01$).

Quit Attempts

Participants in the cigarette user group were less likely to have tried to quit completely using tobacco in the past as compared e-cig/hookah group (OR = 0.59, $p < .01$). Similarly, smokeless users were less likely to have tried to quit completely in the past compared to e-cig/hookah group OR = .39, $p < .001$) as was the case when comparing

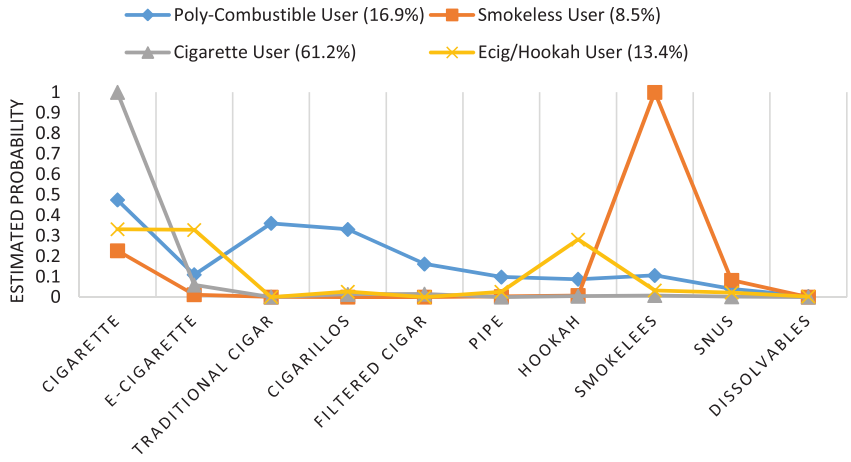

Figure 1. Four-class solution based on 10 tobacco products ($N = 14856$).

Table 2. Results of the Effects (Odds Ratios) of Covariates on the Tobacco Use Latent Classes

Variable	Cigarette vs. e-cig/hookah	Smokeless vs. e-cig/hookah	Poly-combustible vs. e-cig/hookah	Smokeless vs. cigarette	Poly-combustible vs. cigarette	Poly-combustible vs. smokeless
Demographics						
Age	2.07***	1.78***	1.63***	0.86***	0.79***	0.91*
Female	0.76	0.01***	0.16***	0.01***	0.21***	37.52***
African American	3.56***	0.31*	7.00***	0.09***	1.96***	22.56***
Hispanic	1.24	0.17***	0.87	0.14***	0.70***	5.06***
Education	0.87*	0.90	1.03	1.04	1.18***	1.14**
Poverty	1.01	0.65*	1.15	0.64***	1.13	1.78***
Dependency						
Addicted to tobacco	2.47***	1.81**	0.95	0.74**	0.39***	0.53***
Crave tobacco	1.01	1.51***	1.07	1.50***	1.06	0.71***
Out of control tobacco use	1.20	1.00	1.21	0.83***	1.01	1.21**
Use tobacco right after waking up	1.14	0.96	1.06	0.85***	0.93*	1.10*
Help feeling down	1.15*	1.07	1.27***	0.94	1.11**	1.18***
Help thinking	0.93	1.03	1.08	1.10*	1.16***	1.05
Hard to stopping using tobacco	1.32*	1.23	1.13	0.93	0.85***	0.92
Irritated when not using tobacco	1.32**	1.36**	1.28*	1.03	0.97	0.94
Feeling discomfort when not using tobacco	0.82	0.81	0.91	0.99	1.12*	1.13*
Quit attempts						
Tried to quit completely	0.59**	0.39***	0.48***	0.66***	0.82*	1.23
Tried to quit by cutting back	1.03	0.93	0.82	0.90	0.7*	0.88
Quit withdrawal symptom						
Depression	1.39*	0.61*	1.43	0.72*	1.69***	2.34***
Concentration	0.83	1.23	1.42	1.20	1.39*	1.15
Irritation	1.02	1.93***	1.22	0.98	0.62***	0.63*
Anxiety	1.31	1.10	1.22	0.76	0.85	1.11
Restless	0.99	1.25	1.15	1.01	0.93	0.92
Intention to quit						
Plan to quit for good	1.47	1.26	0.61	0.86	0.41***	0.48**
Interest in quitting	1.12***	1.03	1.05	0.92***	0.94**	1.03

*$p < .05$; **$p < .01$; ***$p < .001$.

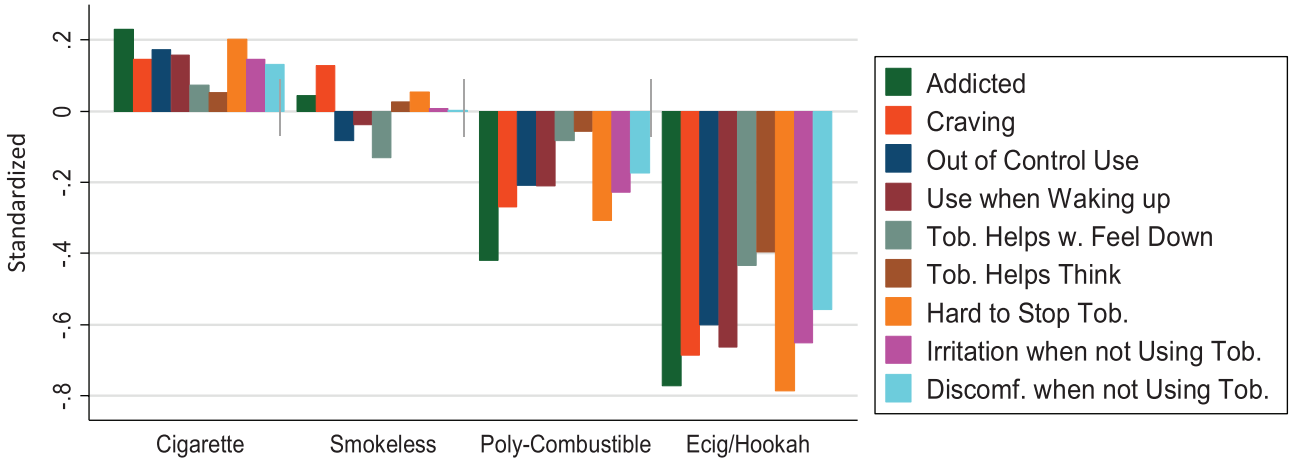

Figure 2. Standardized values of all dependence variables. Zero represents standardized mean of a continuous variable, or the standardized proportion of a dichotomous variable.

poly-combustible users with e-cig/hookah users (OR = 0.48, $p < .001$). In addition, smokeless and poly-combustible users were less likely to have tried to quit completely as compared to cigarette users (OR = 0.66, $p < .001$ and OR = 0.82, $p < .05$ respectively) (Supplementary Figure S3).

Withdrawal Symptoms

Among those who tried quitting in the past 12 months (n = 9080; 63.5%), the e-cig/hookah group experienced the least amount of withdrawal symptoms, with the exception of the symptom of depression, which was lowest for the smokeless group. Cigarette-only users were more likely to experience depression when trying to quit compared to e-cig/hookah users (OR = 1.39, p = .05). In addition, poly-combustible users were more likely to experience depression in withdrawal compared to cigarette-only (OR = 1.69, p < .001) and smokeless (OR = 2.34, p < 0.001) users. Although, smokeless users experienced less depression compared to e-cig/hookah users (OR = 0.61, p < .05), they were more likely to experience irritation than e-cig/hookah users (OR = 1.93, p < .001; Supplementary Figure S2).

Intention to Quit

The cigarette-only subgroup was more likely to plan to quit for good and reported higher interest in quitting (Supplementary Figure S3) more so than any other subgroup. Poly-combustible users were less likely to plan to quit for good as compared with cigarette users (OR = 0.41, p < .001) and smokeless users (OR = 0.48, p < .01). Poly-combustible users also reported lower level of interest in quitting compared to cigarette users (OR = 0.94, p < .01). Finally, cigarette-only users reported higher levels of interest in quitting than e-cig/hookah users, and when comparing smokeless users to cigarette users, smokeless users reported lower levels of interest in quitting (OR = 0.92, p < .001).

Discussion

One major contribution of the current article is that the classes identified provide a soft (probabilistic) classification of individuals into typologies of tobacco product use as opposed to a binary user/no user classification. The probabilistic classification may more realistically reflect how individuals use different tobacco products (not only in use/no use but also in terms of frequency) captured by the item–response probability that each class has for each product. Specifically, we found two classes that are not particularly dominated by one product (the e-cig/hookah and poly-combustible classes), and two classes that are dominated by the primary use of one product (cigarette class and smokeless class).

Our results also highlight how the four classes of tobacco use differ as a function of demographics and tobacco use-related characteristics. Consistent with previous research,[10,31,32] age was associated with tobacco product use. Older individuals were more likely to be members of the cigarette user class while the e-cig/hookah user class was more likely to be the youngest among the four classes. Race was also a strong differentiator of our classes, with African American users more likely to be poly-combustible users, congruent with previous studies.[33,34] Although being a Hispanic has been associated with polytobacco use,[31,34] the finding reported here that Hispanics were most likely to be associated with e-cigs and hookah use has not been reported before. Gender, education, and poverty level were also important predictors of class membership.

Research on dependency and withdrawal of polytobacco use is scarce. A recent study by Strong et al.[14] that used the same data as ours found that multiple product users reported higher than average tobacco dependence, similar to those reported by cigarette-only users. Our results on dependency and withdrawal diverge from previous studies that presented evidence of higher dependency and withdrawal for polytobacco users,[17,18,35] as compared to single product use. We found the cigarette user class to be the most dependent followed by the smokeless user class, results that validate the findings of Strong et al.[14] Poly-combustible users were the third highest in dependency and the e-cig/hookah class the least dependent out of all four classes. Withdrawal symptoms reflected the pattern observed in dependency where higher withdrawal was reported by the cigarette user class and the lowest withdrawal symptomatology was reported by the e-cig/hookah user class. However, the poly-combustible user class reported higher levels of depression and lack of concentration than did the smokeless class. Finally, variables related to quit history and intention to quit were not as consistent across classes as dependency and withdrawal. Although the e-cig/hookah group had the highest probability of having tried to quit completely they were the least likely to show interest in quitting. The cigarette class presented the highest probability of planning to quit and the highest level of interest in quitting. Thus, there appears to be a striking difference between these groups in actual quitting behavior (attempts) and future intentions. Cigarette/e-cig/hookah users may be those who attempted to quit in the past but have now settled into a poly use pattern with less intention to quit, whereas interest in quitting persists among current cigarette-only users.

Several practical recommendations emerge from the current research. In general, it may be useful for policy makers to be informed about which combination of tobacco products use are the least harmful for individuals and create conditions that discourage the most harmful constellations of tobacco product use among current tobacco users. Decision makers may want to discourage the use of tobacco products that produce high levels of tobacco dependency and result in the user experiencing high levels of withdrawal symptoms when trying to quit. From a selection standpoint, this may involve identifying tobacco products use patterns and transitions that lead to lower dependency, milder experience of withdrawal symptoms and potentially easier transition to cessation.

As with any research, our study has limitations. First, we only considered "current" users of a tobacco product and other types of use of products not meeting the current definition were not considered. Second, the structure of the data is cross-sectional so we cannot make cause and effect claims regarding the estimated effects, although future waves of the PATH Study will allow for testing of hypotheses and the evaluation of the predictive validity of the classes we identified. Third, the sets of measures we used to predict class membership were not exhaustive and confounding remains possible. Fourth, although LCA may provide a parsimonious grouping, unless this grouping is replicated and validated and given an exact definition, formulation of effective policies and treatment may be hindered. Finally, the conclusions pertaining to e-cig/hookah and poly-combustible user groups are limited by the estimated low item response probabilities of using each product.

We were able to demonstrate (1) the presence of four distinct groups of tobacco use, and (2) group membership of tobacco use can be predicted by demographics and tobacco-related characteristics. Our results demonstrate that that there is significant variation of demographic characteristics among the four groups of tobacco use, and that users of e-cigs and hookah were experiencing the least amount of dependency and past withdrawal symptoms than any other tobacco use group. Significant effects were also found in quitting behavior between cigarette-only users and e-cig and hookah users. Our results also show the benefits of adopting a latent class approach to better explicate the complexity of use of several tobacco products.

Supplementary Material

Supplementary data are available at *Nicotine and Tobacco Research* online.

Declaration of Interest

None declared.

Supplement Sponsorship

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