



HHS Public Access

Author manuscript

Addict Behav. Author manuscript; available in PMC 2020 August 27.

Published in final edited form as:

Addict Behav. 2015 March ; 42: 119–125. doi:10.1016/j.addbeh.2014.11.011.

Patterns of combustible tobacco use in U.S. young adults and potential response to graphic cigarette health warning labels

Andrea C. Villanti^{a,b,*}, Jennifer L. Pearson^{a,b}, Jennifer Cantrell^{b,c}, Donna M. Vallone^{b,c}, Jessica M. Rath^{b,c}

^aThe Schroeder Institute for Tobacco Research and Policy Studies, Legacy, Washington, DC, USA

^bDepartment of Health, Behavior and Society, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

^cDepartment of Research and Evaluation, Legacy, Washington, DC, USA

Abstract

In the evolving landscape of tobacco use, it remains unclear how tobacco control efforts should be designed and promoted for maximum impact. The current study links the identification of latent classes of young adult combustible tobacco users with anticipated responses to graphic health warning labels (HWLs). Data were collected in January 2012 using an online address-based panel as part of the Legacy Young Adult Cohort Study, and analyses were conducted in 2013. Latent class analyses identified five groups of tobacco users in a national sample of 4,236 young adults aged 18–34 years: (1) little cigar/cigarillo/bidi (LCC) and hookah users (4%); (2) nonusers, open to smoking (3%); (3) daily smokers who self-identify as “smokers” (11%); (4) nondaily, light smokers who self-identify as “social or occasional smokers” (9%); and (5) nonusers closed to smoking (73%). Of the nonusers closed to smoking, 23% may be better characterized as at risk for tobacco initiation. Results indicate differences in the potential effectiveness of HWLs across classes. Compared to the daily “smokers,” LCC and hookah users (RRR = 2.35) and nonusers closed to smoking (RRR = 2.33) were more than twice as likely to report that new graphic HWLs would make them think about not smoking. This study supports the potential of graphic HWLs to prevent young nonusers from using tobacco products. It suggests that the extension of prominent HWLs to other tobacco products, including LCCs and hookah tobacco, may also serve a prevention function.

Keywords

Models; Statistical; Population surveillance; Smoking/epidemiology; Tobacco

*Corresponding author at: The Schroeder Institute for Tobacco Research and Policy Studies, Legacy, 1724 Massachusetts Ave NW, Washington, DC 20036, United States. Tel.: +1 202 454 5751; fax: +1 202 454 5785. avillanti@legacyforhealth.org (A.C. Villanti).
Contributors

A.C. Villanti conceived the study. J.L. Pearson and A.C. Villanti conducted the data analysis. A.C. Villanti wrote the initial draft of the manuscript. J.L. Pearson, J. Cantrell, D.M. Vallone, and J.M. Rath aided in article conceptualization and writing. All authors contributed to and have approved the final manuscript.

Conflict of interest

All other authors declare that they have no conflicts of interest.

1. Introduction

Young adults are an important target for tobacco industry marketing efforts (Biener & Albers, 2004; Centers for Disease Control, Prevention, 2005; Ling & Glantz, 2002), and studies have shown increases in the rates of cigarette smoking initiation and transition to regular smoking in young adulthood (Foldes et al., 2010; Hammond, 2005; Lantz, 2003; Rath, Villanti, Abrams, & Vallone, 2012). Young adults have high rates of dual use of cigarettes and other tobacco products (Rath et al., 2012), particularly little cigars/cigarillos (Richardson, Rath, Ganz, Xiao, & Vallone, 2013) and hookah (Barnett et al., 2013; Cobb, Ward, Maziak, Shihadeh, & Eissenberg, 2010; Grekin & Ayna, 2012; Jarrett, Blosnich, Tworek, & Horn, 2012). Since young adulthood is a developmental period in which people establish lifelong health behaviors (Arnett, 2000), the use of combustible tobacco products by young adults is of great concern (U.S. Department of Health and Human Services, 2014).

As part of the 2009 Family Smoking Prevention and Tobacco Control Act, Congress required that the U.S. Food and Drug Administration (FDA) issue regulations requiring graphic label statements depicting the negative health consequences of smoking (H.R., 1256-111th Congress: Family Smoking Prevention and Tobacco Control Act, 2009) In April 2014, in its proposed “deeming rule,” FDA proposed to require the display of health warnings on tobacco products covered in the proposed rule (Food and Drug Administration, 2014), including cigars, hookah, and electronic cigarettes. FDA also proposed that all tobacco products carry an addiction warning and requested information on whether different warnings should be placed on different categories of products. Studies from other countries have demonstrated that the regulatory intervention of placing graphic health warning labels (HWLs) on cigarettes prevents smoking and encourages cessation in young people (O’Hegarty, Pederson, Yenokyan, Nelson, & Wortley, 2007; O’Hegarty et al., 2006; Vardavas, Connolly, Karamanolis, & Kafatos, 2009). In the current landscape of alternative tobacco use and multiple product use among young adults (Lee, Hebert, Nonnemaker, & Kim, 2014), it remains unclear how these types of warnings may affect different groups of tobacco users and how HWLs could be designed and promoted for maximum impact in this group.

Several studies have identified subgroups of cigarette smokers among adolescents and young adults (Rose et al., 2007; Sutfin, Reboussin, McCoy, & Wolfson, 2009) or polysubstance use, including tobacco (Conway et al., 2013; Quek et al., 2013; White et al., 2013). Other studies have focused on smokeless product use among U.S. adults (Timberlake & Huh, 2009) and multiple tobacco product use in a national sample of adolescents (Nasim, Blank, Cobb, & Eissenberg, 2012) and a Midwestern sample of young adults (Erickson, Lenk, & Forster, 2014). None of these studies, however, have linked the identification of latent classes of young tobacco users with actual or anticipated responses to tobacco control efforts. The current study was developed to characterize patterns of smoking cigarettes and other combustible tobacco products among young adults and to identify subgroups in which graphic HWLs may be more or less effective.

2. Methods

2.1. Participants

The current study uses cross-sectional data from the Wave 2 survey of the Legacy Young Adult Cohort Study, which was collected in January 2012 ($N = 4,236$). The detailed methods of this study have been described elsewhere (Rath et al., 2012). The cohort is composed of a nationally representative sample of young adults ages 18–34 years drawn from GfK's KnowledgePanel®, which is recruited via address-based sampling to provide statistically valid representation of the U.S. population, including cell phone-only households. African American and Hispanic young adults were oversampled to ensure sufficient sample sizes for subgroup analyses, and the survey was administered online in English and Spanish. The household recruitment rate for the Wave 2 survey was 14.9%. In 64.6% of these households, one member completed a core profile survey in which the key demographic information was collected. For the Legacy Young Adult Cohort Study, only one panel member per household was selected at random to be part of the study sample, and no members outside the panel were recruited. The study completion rate was 68.4%, and thus, the cumulative response rate was 6.6%. Observations were excluded for respondents where data were missing on the item assessing ever tobacco use ($N = 40$). This study was approved by the Independent Investigational Review Board, Inc., and online consent was collected from participants before survey self-administration.

2.2. Measures

2.2.1. Sociodemographics—As part of the KnowledgePanel® routine data collection, participants provided information on age at study entry (grouped as 18–24 and 25–34), gender, race/ethnicity (White, non-Hispanic; Black, non-Hispanic; Other, non-Hispanic; and Hispanic), and educational attainment (less than high school, high school, and some college or greater).

2.2.2. Combustible tobacco variables in the latent class model—Eight combustible tobacco behavior or attitude variables were assessed to include the full sample, not only tobacco users: (1) current use of cigarettes; (2) current use of little cigars/cigarillos/bidis (LCC); (3) current use of hookah; (4) cigarette smoking frequency (daily vs. nondaily); (5) smoking intensity (number of cigarettes on days smoked); (6) intention to quit smoking; (7) self-identified smoking status; and (8) susceptibility to smoking cigarettes. Cigarette, LCC, and hookah use were selected for inclusion in the latent class model due to increased prevalence among young adults, particularly in combination with cigarettes (Grekin & Ayna, 2012; Rath et al., 2012; Richardson et al., 2013), while smoking frequency, intensity, intention to quit, and self-identified smoking status were selected to better characterize cigarette users. Susceptibility to smoking cigarettes was selected to identify possible underlying patterns among nonsmokers.

Current use of cigarettes, LCC, or hookah was defined as having used the product on 1–30 days of the past 30 days. Unlike adult surveys of tobacco use, participants did not have to meet a threshold (e.g., 100 cigarettes) to be considered a current user. Among cigarette smokers, smoking behavior was characterized by frequency and intensity of smoking. Daily

smoking was defined as smoking on all 30 of the past 30 days, and nondaily smoking was classified as smoking on 1–29 of the past 30 days. Smoking intensity was assessed as mean number of cigarettes per day on days smoked; due to a programming error in the survey, the upper bound for this value was 30 cigarettes. Light smoking was defined as smoking 1–10 cigarettes per day (Husten, 2009; Okuyemi, Ahluwalia, Richter, Mayo, & Resnicow, 2001), and heavier smoking was defined as 11–30 cigarettes per day on days smoked. Nonusers were defined as those who used these products on 0 days of the past 30 days, had never used a tobacco product, reported having tried a tobacco or nicotine product only once, reported never having used a tobacco or nicotine product monthly, or reported having smoked 0 combustible tobacco products in their lifetime (including cigarettes, cigars, pipes, little cigars, and hookah).

Current cigarette smokers also provided information on intention to quit smoking cigarettes. Response choices for the intention to quit item followed stage of change theory (Prochaska & DiClemente, 1983) and included “Within the next 30 days,” “Within the next six months,” “Longer than six months,” “I don’t plan on quitting,” with nonsmokers coded as “I don’t smoke now.” This variable was dichotomized into intention to quit within the next 6 months (i.e., “within the next 30 days” or “within the next six months”), or not (i.e., “longer than six months” or “I don’t plan on quitting” or “I don’t smoke now”).

Self-identified smoking status was defined as a categorical variable with “Ex-smoker,” “Someone who tried smoking,” and “Nonsmoker” grouped as the reference category, “Social” and “Occasional” smokers collapsed into a single category, and “Smoker” as its own category.

Susceptibility to smoking was assessed with a measure validated in previous adolescent studies (Evans, Farkas, Gilpin, Berry, & Pierce, 1995; Mowery, Farrelly, Haviland, Gable, & Wells, 2004; Pierce, Choi, Gilpin, Farkas, & Merritt, 1996; Pierce, Farkas, Evans, & Gilpin, 1995). Susceptibility to smoking was defined as a categorical variable with three levels: (1) nonusers closed to smoking, (2) nonusers open to smoking, and (3) current tobacco users. In line with earlier studies, those defined as “open to smoking” were either never cigarette smokers or had ever smoked cigarettes (but not in the past 30 days) and answered “definitely yes,” “probably yes” or “probably no” to either (1) “Will you smoke a cigarette any time in the next year?” or (2) “If one of your friends or somebody close to you offered you a cigarette or other tobacco product, would you smoke/use it?” The reference category was those “closed to smoking” that reported never using tobacco and responded “definitely no” to both questions.

2.2.3. Noncombustible tobacco use variables—Current use of e-cigarettes, chewing tobacco, dip/snuff, snus, and nicotine products (e.g., gum, patches, lozenges) was defined for each product as use on 1–30 days of the past 30 days. Nonusers were defined as those who used these products on 0 days of the past 30 days or had never used these tobacco products.

2.2.4. Health warning label items—Binary measures regarding cigarette health warning labels were obtained from a National Cancer Institute-funded study of adolescents

and young adults (2P01CA098262–06A1; PI: Robin Mermelstein). They included the following: awareness of new graphic HWLs (“Have you heard about or seen new warning labels which include graphic pictures (i.e., pictures of disease or death caused by smoking?)”) and potential response related to graphic HWLs (“Do you think that new warning labels with graphic pictures would make you think about not smoking?”). Participants were not exposed to images of current cigarette HWLs or the FDA’s nine graphic HWLs as part of this study.

2.3. Data analysis

Latent class analyses were conducted in 2013 using Mplus 7.0 (www.statmodel.com) to identify subgroups based on combustible tobacco use patterns in the full sample of young adults. Selection of tobacco behavior variables was informed by previous analyses (Villanti, Cantrell, Pearson, Vallone, & Rath, 2014) and data on LCC and hookah use. The optimal number of classes was determined by running models with a successive number of classes from two to eight and comparing model fit indices, the odds of correct classification, entropy, and interpretability. Model fit indices included the log likelihood (–2LL), the Akaike Information Criterion, the Bayesian Information Criterion (BIC), and the sample size adjusted BIC, as well as Pearson and likelihood ratio chi-square statistics (Collins & Lanza, 2010). The optimal model was selected with the number of classes that (1) minimized BIC, based on evidence showing that BIC outperformed other model fit indices in a simulation study (Nylund, Asparouhov, & Muthen, 2007); (2) had nonsignificant *p* values for both Pearson and likelihood ratio chi-square statistics; (3) retained entropy greater than 0.9; and (4) demonstrated odds of correct classification greater than five across all classes (Nagin, 2005). The unweighted probabilities of tobacco behaviors by class were derived in MPLUS.

After the best-fitting latent class model was selected, class membership and probability of class membership were exported from MPLUS for each participant and merged with the full data set in Stata IC 11.0 (www.stata.com). Post-stratification weights were used to offset any nonresponse or noncoverage bias using Stata’s svy commands. Bivariate analyses were conducted to estimate the prevalence of the eight combustible tobacco variables in the latent class model, demographic characteristics, responses to the two warning label items in each class, and past 30-day use of noncombustible products by latent class. Multinomial logistic regression compared potential response related to graphic HWLs using Class 3 (daily “smokers”) as the reference class, adjusted for all sociodemographic variables and awareness of graphic HWLs.

3. Results

Sample characteristics are presented in Tables 1 and 2. The study sample was composed of 41% young adults aged 18–24 years, with an even balance of males and females. Nearly 60% of the sample was white and 59% had completed some college or greater. Overall, 22% of the sample reported current cigarette use, 4% reported current little cigar/cigarillo/bidi use, and 3% reported current hookah use. Fifty-five percent of participants were classified as nonusers closed to smoking and 19% as nonusers open to smoking in the full sample.

Slightly more than half of young adults reported awareness of new warning labels that include graphic pictures (54%) and endorsed that warning labels with graphic pictures would make them think about not smoking (53%).

3.1. Selection of the latent class model

In the latent class analyses based on the eight measures of combustible tobacco behaviors, we examined the fit statistics and interpretability of models ranging from two to eight classes. The five-class solution was chosen as the best model because it minimized BIC, was the last model for which the odds of correct classification remained greater than five across all classes, and was interpretable.

3.2. Identification of latent classes

Table 1 provides the weighted prevalence of combustible tobacco behaviors included in the model by latent class, the unweighted probability of class membership, and class size. The latent class model revealed five distinct patterns of tobacco behaviors: (1) current users of LCCs and/or hookah (Class 1, 4%); (2) nonusers open to smoking (Class 2, 3%); (3) daily cigarette users who self-identified as “smokers” (Class 3, 11%); (4) nondaily cigarette users who were light smokers and considered themselves “social smokers” (Class 4, 9%); and (5) nonusers closed to smoking (Class 5, 73%). Mean latent class probabilities for most likely latent class membership were 88% (Class 1), 98% (Class 2), 94% (Class 3), 95% (Class 4), and 96% (Class 5).

Of note, LCC and hookah users in Class 1 did not report using cigarettes, yet there was increased use of LCCs and hookah in both the daily “smokers” (Class 3) and the nondaily light “social smokers” (Class 4) compared to the full sample. Post hoc analysis indicated that 67% of the LCC and hookah users in Class 1 would be classified as open to smoking cigarettes using the two susceptibility items if current tobacco use was ignored as a separate category.

3.3. Other characteristics by latent class

Table 2 presents the bivariate analyses of sociodemographic characteristics, response to the HWL items, and noncombustible tobacco use by latent class. There were significant differences in gender, race/ethnicity, and education across the five latent classes, with daily “smokers” (Class 3) being the most likely to be white and of lower education and LCC and hookah users (Class 1) being more likely to be male and college-educated. There were also significant differences in response to one of the HWL items. Daily “smokers” were equally likely to be aware of new graphic HWLs but less likely to endorse that new graphic HWLs would influence intention to smoke compared to the other groups.

Noncombustible tobacco use varied by group as well, with nonusers closed to smoking (Class 5) and nonusers open to smoking (Class 2) reporting no use of e-cigarettes, chewing tobacco, dip/snuff, snus, or nicotine products in the past 30 days. Compared to daily “smokers” (Class 3), nondaily, light “social smokers” (Class 4) were more likely to have used e-cigarettes, chewing tobacco, and dip/snuff in the past 30-days. Current users of LCCs and/or hookah (Class 1) were also more likely to have used dip/snuff and significantly less

likely to have used nicotine products (e.g. nicotine replacement therapy) in the past 30 days compared to daily “smokers” (Class 3).

3.4. Multivariable analysis of potential response to graphic HWLs by latent class

Controlling for sociodemographics and awareness of new graphic HWLs, LCC, and hookah users (Class 1; RRR = 2.35) and nonusers closed to smoking (Class 5; RRR = 2.33) were more than twice as likely to report that new graphic HWLs would make them think about not smoking compared to the daily “smokers” (Class 3, Table 3). Positive response to new graphic HWLs was higher among nonusers open to smoking (Class 2) and nondaily, light “social smokers” compared to the daily “smokers,” but these differences were not significant.

Multivariable analyses also highlighted remaining demographic differences between the latent classes, even after controlling for all other variables in the model. Compared to the daily “smokers,” all other classes were more highly educated. Nonusers closed to smoking (Class 5) were significantly more likely to be younger (aged 18–24 vs. 25–34 years) and of other race or Hispanic compared to daily “smokers” (Class 3). Nonusers who were open to smoking (Class 2) did not differ from daily “smokers” (Class 3) with respect to age or gender but were significantly more likely to be non-White (RRR range: 3.73–6.25). The LCC and hookah users (Class 1) were twice as likely to be 18–24 years old, more than twice as likely to be Hispanic, and 68% less likely to be female compared to daily “smokers.” in Class 3. Nondaily, light “social smokers” (Class 4) were also almost twice as likely to be younger and more than three times as likely to be non-White (RRR range: 3.01 – 3.94).

4. Discussion

The current study confirms and extends previous findings on patterns of combustible tobacco use in U.S. young adults, while providing new insight into how subgroups defined by these patterns of tobacco use may respond to the future implementation of HWLs on tobacco products. Similar to Erickson et al.’s (2014) study, the majority of our sample (76%) did not report any combustible tobacco smoking in the past 30 days. Our study adds to the literature by providing further insight into young adult nonsmokers: the majority (96%) of nonsmokers ages 18–34 years was characterized as closed to smoking (Class 5), with 4% characterized as open to smoking (Class 2). In Class 2, 71% identified as a “social smoker” and 17% as a “smoker” despite not having smoked in the past 30 days; this class may be better defined as experimenters or highly intermittent smokers. In contrast, the 23% of Class 5 (nonusers closed to smoking) who report being susceptible to smoking may be better characterized as the cigarette-naïve nonsmokers at risk of tobacco use initiation. Further exploration of this subgroup showed that they were similar in age and gender, but significantly more likely to be non-White and of lower education compared to the rest of Class 5. Of particular import, they were equally likely to endorse that new graphic HWLs would make them think about not smoking as other Class 5 members. Identification of this subgroup, which comprises 17% of the sample, a group larger than Classes 1 through 4, highlights the potential role of graphic HWLs to prevent smoking in a vulnerable subpopulation of at-risk young adults.

Our results provide novel support for LCC and hookah users as a unique class based on current use behaviors and not only defined by experimentation with these products as in previous studies (Erickson et al., 2014). Text-only HWLs have been required on most cigar products since 2000 (Federal Trade Commission, 2000), which was partially driven by common misperceptions of cigars as less harmful than cigarettes—a perception that still exists (O'Connor et al., 2007; Steinberg & Delnevo, 2010). Similar confusion exists regarding the health risks of hookah (Cobb et al., 2010; Nuzzo et al., 2013; Wray, Jupka, Berman, Zellin, & Vijaykumar, 2012). Findings support the extension of warnings to other tobacco products such as LCCs and hookah tobacco as proposed in FDA's deeming regulations, or making existing warnings more prominent and noticeable as a prevention strategy. Findings that cigarette smokers were the least likely to report that graphic HWLs would affect their smoking behavior are consistent with previous research among young adults (Cameron, Pepper, & Brewer, 2013). However, this study provides new information on the potential effectiveness of graphic HWLs within other subgroups of young adults, specifically: nonusers closed to smoking (Class 5) and the LCC and hookah users (Class 1) were nearly twice as likely to endorse that new warning labels with graphic pictures on cigarettes would make them think about not smoking compared to the daily "smokers."

This study has several limitations. First, the analyses focus on a single wave of data collection; therefore, latent classes derived from combustible tobacco use behaviors reported at a single time point may not appropriately characterize the rapid changes in tobacco use in this age group. Second, the outcome variable is limited to a single item on anticipated response to graphic HWLs. Third, the items related to awareness of and response to new graphic HWLs did not specify that they would be on cigarette packaging. Additionally, to the extent that several of the groups (i.e., LCC and hookah users and the two classes of nonusers) may be unaware of the current text warning labels on cigarettes, results regarding future intention related to new graphic HWLs on cigarettes must be interpreted with caution. Finally, the response rate for this survey was 6.6%. While evidence indicates that probability-based Internet samples like the KnowledgePanel do not suffer from notable declines in sample representativeness with declines in response rates (Chang & Krosnick, 2009), low response must be considered when generalizing the study findings to the broader population. These limitations are balanced by the strength of the survey methodology used to recruit a large, nationally representative cohort of young adults, typically identified as hard-to-reach.

5. Conclusions

The current study links membership in latent subgroups of combustible tobacco-using young adults with anticipated responses to graphic HWLs on cigarette packages. It supports the potential of graphic HWLs to prevent tobacco use, given the positive responses to graphic HWLs among nonusers closed to smoking. Evidence also suggests that extending prominent HWLs to other combustible tobacco products, including LCCs and hookah tobacco, may prevent young people from smoking. Future research is needed to explore how this type of classification could be used to inform the targeted development of warning label messages or accompanying educational efforts to prevent uptake and facilitate cessation of tobacco products.

Acknowledgments

The authors would like to acknowledge Conrad Choiniere (FDA), Kevin Frissell (Westat), Elizabeth Lambert (NIH/NIDA), and Laura Shay (FDA) for their participation in this project and contributions to the manuscript.

Role of funding sources

This project has been funded in whole or in part with federal funds from the National Institute on Drug Abuse (NIDA), the National Institutes of Health, and the Food and Drug Administration (FDA), Department of Health and Human Services under contract no. HHSN271201100027C. Funding for the primary data collection was provided by the American Legacy Foundation. The views and opinions expressed in this presentation are those of the authors only and do not necessarily represent the views, official policy or position of the US Department of Health and Human Services, or any of its affiliated institutions or agencies. NIDA and FDA had no role in the study design, collection, or analysis of the data or the decision to submit the paper for publication. Representatives from NIDA and FDA contributed to the interpretation of the data and reviewed and commented on earlier versions of the manuscript.

References

- Arnett JJ (2000). Emerging adulthood. A theory of development from the late teens through the twenties. *American Psychologist*, 55(5), 469–480. [PubMed: 10842426]
- Barnett TE, Smith T, He Y, Soule EK, Curbow BA, Tomar SL, et al. (2013). Evidence of emerging hookah use among university students: A cross-sectional comparison between hookah and cigarette use. *BMC Public Health*, 13,302, 10.1186/1471-2458-13-302. [PubMed: 23560649]
- Biener L, & Albers AB (2004). Young adults: Vulnerable new targets of tobacco marketing. *American Journal of Public Health*, 94(2), 326–330. [PubMed: 14759950]
- Cameron LD, Pepper JK, & Brewer NT (2013). Responses of young adults to graphic warning labels for cigarette packages. *Tobacco Control*, 10.1136/tobaccocontrol-2012-050645.
- Centers for Disease Control, Prevention (2005). Cigarette smoking among adults—United States, 2003. *MMWR. Morbidity and Mortality Weekly Report*, 54(20), 509–513 (doi:mm5420a3 [pii]). [PubMed: 15917735]
- Chang L, & Krosnick JA (2009). National surveys via RDD telephone interviewing versus the Internet: Comparing sample representativeness and response quality. *Public Opinion Quarterly*, 73(4), 641–678, 10.1093/poq/nfp075.
- Cobb C, Ward KD, Maziak W, Shihadeh AL, & Eissenberg T (2010). Waterpipe tobacco smoking: An emerging health crisis in the United States. *American Journal of Health Behavior*, 34(3), 275–285. [PubMed: 20001185]
- Collins LM, & Lanza ST (2010). *Latent class and latent transition analysis with applications in the social, behavioral, and health sciences*. Hoboken, NJ: John Wiley & Sons, Inc.
- Conway KP, Vullo GC, Nichter B, Wang J, Compton WM, Iannotti RJ, et al. (2013). Prevalence and patterns of polysubstance use in a nationally representative sample of 10th graders in the United States. *Journal of Adolescent Health*, 52(6), 716–723, 10.1016/j.jadohealth.2012.12.006. [PubMed: 23465320]
- Erickson DJ, Lenk KM, & Forster JL (2014). Latent classes of young adults based on use of multiple types of tobacco and nicotine products. *Nicotine & Tobacco Research*, 10.1093/ntr/ntu024.
- Evans N, Farkas A, Gilpin E, Berry C, & Pierce JP (1995). Influence of tobacco marketing and exposure to smokers on adolescent susceptibility to smoking. *Journal of the National Cancer Institute*, 87(20), 1538–1545. [PubMed: 7563188]
- Federal Trade Commission (2000, 6 26). FTC announces settlements requiring disclosure of cigar health risks. Retrieved Apr 9, 2014, from <http://www.ftc.gov/news-events/press-releases/2000/06/ftc-announces-settlements-requiring-disclosure-cigar-health-risks>
- Foldes SS, An LC, Rode P, Schillo BA, Davern M, Alesci NL, et al. (2010). The prevalence of unrecognized tobacco use among young adults. *American Journal of Health Behavior*, 34(3), 309–321, 10.5555/ajhb.2010.343.309. [PubMed: 20001188]
- Food and Drug Administration (2014, 4 25). *Deeming Tobacco Products To Be Subject to the Federal Food, Drug, and Cosmetic Act, as Amended by the Family Smoking Prevention and Tobacco*

Control Act; Regulations on the Sale and Distribution of Tobacco Products and Required Warning Statements for Tobacco Products. Retrieved Jun 11, 2014, from <https://www.federalregister.gov/articles/2014/04/25/2014-09491/deeming-tobacco-products-to-be-subject-to-the-federal-food-drug-and-cosmetic-act-as-amended-by-the>

- Grekin ER, & Ayna D (2012). Waterpipe smoking among college students in the United States: A review of the literature. *Journal of American College of Health*, 60(3), 244–249, 10.1080/07448481.2011.589419.
- H.R. 1256-111th Congress: Family Smoking Prevention and Tobacco Control Act, 2012. (2009). C.F.R.
- Hammond D (2005). Smoking behaviour among young adults: Beyond youth prevention. *Tobacco Control*, 14(3), 181–185, 10.1136/tc.2004.009621. [PubMed: 15923468]
- Husten CG (2009). How should we define light or intermittent smoking? Does it matter? *Nicotine & Tobacco Research*, 11 (2), 111–121, 10.1093/ntr/ntp010. [PubMed: 19246425]
- Jarrett T, Blossnich J, Tworek C, & Horn K (2012). Hookah use among U.S. college students: Results from the National College Health Assessment II. *Nicotine & Tobacco Research*, 14(10), 1145–1153, 10.1093/ntr/nts003. [PubMed: 22318687]
- Lantz PM (2003). Smoking on the rise among young adults: Implications for research and policy. *Tobacco Control*, 12(Suppl. 1), i60–i70. [PubMed: 12773786]
- Lee YO, Hebert CJ, Nonnemaker JM, & Kim AE (2014). Multiple tobacco product use among adults in the United States: Cigarettes, cigars, electronic cigarettes, hookah, smokeless tobacco, and snus. *Preventive Medicine*, 62C, 14–19, 10.1016/j.ypmed.2014.01.014.
- Ling PM, & Glantz SA (2002). Why and how the tobacco industry sells cigarettes to young adults: Evidence from industry documents. *American Journal of Public Health*, 92(6), 908–916. [PubMed: 12036776]
- Mowery PD, Farrelly MC, Haviland ML, Gable JM, & Wells HE (2004). Progression to established smoking among US youths. *American Journal of Public Health*, 94(2), 331–337. [PubMed: 14759951]
- Nagin D (2005). *Group-based modeling of development*. Cambridge, MA: Harvard University Press.
- Nasim A, Blank MD, Cobb CO, & Eissenberg T (2012). Patterns of alternative tobacco use among adolescent cigarette smokers. *Drug and Alcohol Dependence*, 124(1–2), 26–33, 10.1016/j.drugalcdep.2011.11.022. [PubMed: 22209307]
- Nuzzo E, Shensa A, Kim KH, Fine MJ, Barnett TE, Cook R, et al. (2013). Associations between hookah tobacco smoking knowledge and hookah smoking behavior among US college students. *Health Education Research*, 28(1), 92–100, 10.1093/her/cys095. [PubMed: 22987864]
- Nylund KL, Asparouhov T, & Muthen BO (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling*, 14(4), 535–569.
- O'Connor RJ, McNeill A, Borland R, Hammond D, King B, Boudreau C, et al. (2007). Smokers' beliefs about the relative safety of other tobacco products: Findings from the ITC collaboration. *Nicotine & Tobacco Research*, 9(10), 1033–1042, 10.1080/14622200701591583. [PubMed: 17943619]
- O'Hegarty M, Pederson LL, Nelson DE, Mowery P, Gable JM, & Wortley P (2006). Reactions of young adult smokers to warning labels on cigarette packages. *American Journal of Preventive Medicine*, 30(6), 467–473, 10.1016/j.amepre.2006.01.018. [PubMed: 16704939]
- O'Hegarty M, Pederson LL, Yenokyan G, Nelson D, & Wortley P (2007). Young adults' perceptions of cigarette warning labels in the United States and Canada. *Preventing Chronic Disease*, 4(2), A27. [PubMed: 17362618]
- Okuyemi KS, Ahluwalia JS, Richter KP, Mayo MS, & Resnicow K (2001). Differences among African American light, moderate, and heavy smokers. *Nicotine & Tobacco Research*, 3(1), 45–50, 10.1080/14622200020032097. [PubMed: 11260810]
- Pierce JP, Choi WS, Gilpin EA, Farkas AJ, & Merritt RK (1996). Validation of susceptibility as a predictor of which adolescents take up smoking in the United States. *Health Psychology*, 15(5), 355–361. [PubMed: 8891714]

- Pierce JP, Farkas AJ, Evans N, & Gilpin E (1995). An improved surveillance measure for adolescent smoking? *Tobacco Control*, S47–S56.
- Prochaska JO, & DiClemente CC (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology*, 51(3), 390–395. [PubMed: 6863699]
- Quek LH, Chan GC, White A, Connor JP, Baker PJ, Saunders JB, et al. (2013). Concurrent and simultaneous polydrug use: Latent class analysis of an Australian nationally representative sample of young adults. *Frontiers in Public Health*, 1, 61, 10.3389/fpubh.2013.00061. [PubMed: 24350230]
- Rath JM, Villanti AC, Abrams DB, & Vallone DM (2012). Patterns of tobacco use and dual use in US young adults: The missing link between youth prevention and adult cessation. *Journal of Environmental and Public Health*, 2012, 679134, 10.1155/2012/679134. [PubMed: 22666279]
- Richardson A, Rath J, Ganz O, Xiao H, & Vallone D (2013). Primary and dual users of little cigars/cigarillos and large cigars: Demographic and tobacco use profiles. *Nicotine & Tobacco Research*, 15(10), 1729–1736, 10.1093/ntr/ntt053. [PubMed: 23645607]
- Rose JS, Chassin L, Presson C, Sherman SJ, Stein MD, & Col N (2007). A latent class typology of young women smokers. *Addiction*, 102(8), 1310–1319, 10.1111/j.1360-0443.2007.01889.x. [PubMed: 17624981]
- Steinberg MB, & Delnevo CD (2010). Tobacco smoke by any other name is still as deadly. *Annals of Internal Medicine*, 152(4), 259–260, 10.7326/0003-4819-152-4-201002160-00011. [PubMed: 20157140]
- Sutfin EL, Reboussin BA, McCoy TP, & Wolfson M (2009). Are college student smokers really a homogeneous group? A latent class analysis of college student smokers. *Nicotine & Tobacco Research*, 11 (4), 444–454, 10.1093/ntr/ntp006. [PubMed: 19264866]
- Timberlake DS, & Huh J (2009). Demographic profiles of smokeless tobacco users in the U.S. *American Journal of Preventive Medicine*, 37(1), 29–34, 10.1016/j.amepre.2009.03.010. [PubMed: 19524142]
- U.S. Department of Health and Human Services (2014). *The health consequences of smoking—50 years of progress. A report of the surgeon general*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.
- Vardavas CI, Connolly G, Karamanolis K, & Kafatos A (2009). Adolescents perceived effectiveness of the proposed European graphic tobacco warning labels. *European Journal of Public Health*, 19(2), 212–217, 10.1093/eurpub/ckp015. [PubMed: 19218335]
- Villanti AC, Cantrell J, Pearson JL, Vallone DM, & Rath JM (2014). Perceptions and perceived impact of graphic cigarette health warning labels on smoking behavior among U.S. Young adults. *Nicotine & Tobacco Research*, 16(4), 469–477, 10.1093/ntr/ntt176. [PubMed: 24212476]
- White A, Chan GC, Quek LH, Connor JP, Saunders JB, Baker P, et al. (2013). The topography of multiple drug use among adolescent Australians: Findings from the National Drug Strategy Household Survey. *Addictive Behaviors*, 38(4), 2068–2073, 10.1016/j.addbeh.2013.01.001. [PubMed: 23403274]
- Wray RJ, Jupka K, Berman S, Zellin S, & Vijaykumar S (2012). Young adults' perceptions about established and emerging tobacco products: Results from eight focus groups. *Nicotine & Tobacco Research*, 14(2), 184–190, 10.1093/ntr/ntt168. [PubMed: 22110049]

HIGHLIGHTS

- Five classes of young adults were identified based on combustible tobacco use.
- Potential responses to graphic health warning labels (GWHLs) differed by class.
- Little cigar and hookah users and nonsmokers may be more receptive to GWHLs.
- Supports a potential prevention effect of GWHLs on cigarette packaging.

Table 1

Prevalence of combustible tobacco behaviors and attitudes in the five-class model and in the full sample, weighted.

	Class 1		Class 2		Class 3		Class 4		Class 5		Full sample	
	LCC and hookah users	%	Nonusers, open to smoking	%	Daily “smokers”	%	Nondaily, light “social smokers”	%	Nonusers, closed to smoking	%		%
Cigarette use, past 30 days	0		0		100		100		0		0	22
Little cigar/cigarillo use, past 30 days	22		0		9		23		0		0	4
Hookah use, past 30 days	22		0		28		13		0		0	3
Intention to quit within 6 months	15		19		39		37		1		1	10
Smoking frequency												
None	100		100		0		0		100		100	78
Nondaily	0		0		6		97		0		0	10
Daily	0		0		94		3		0		0	12
Smoking intensity												
None	100		100		0		12		100		100	79
Light (1–10 cigarettes per day)	0		0		42		85		0		0	13
Heavier (11–30 cigarettes per day)	0		0		58		3		0		0	7
Self-identified smoking status												
Nonsmoker/ex-smoker/someone who tried smoking	75		12		0		22		100		100	76
Social smoker	21		71		10		70		0		0	11
Smoker	3		17		89		8		0		0	12
Susceptibility to smoking												
Nonuser, closed to smoking	0		9		0		0		77		77	55
Nonuser, open to smoking	0		91		0		0		23		23	19
Current user	100		0		100		100		0		0	27
Pr(Class membership), unweighted (%)	4		3		11		9		73		73	
Class size, unweighted (<i>n</i>)	180		122		442		371		3081		3081	4,196

Source: Legacy Young Adult Cohort Study, Wave 2 (January 2012).

Table 2

Characteristics of the five latent classes and in the full sample, weighted.

	Class 1 LCC and hookah users (4%)	Class 2 Nonusers open to smoking (3%)	Class 3 Daily “smokers” (11%)	Class 4 Nondaily, light “social smokers” (9%)	Class 5 Nonusers closed to smoking (73%)	Full sample	p value
	%	%	%	%	%	%	
<i>Sociodemographics</i>							
Age							0.15
	18–24	40	35	46	41	41	
	25–34	60	65	54	59	59	
Gender							<.001
	Male	51	53	56	47	50	
	Female	49	47	44	53	50	
Race/ethnicity							0.0001
	White, non-Hispanic	40	74	51	59	60	
	Black, non-Hispanic	20	11	18	13	13	
	Other, non-Hispanic	8	4	9	8	7	
	Hispanic	32	12	22	20	20	
Education							<.0001
	Less than high school	23	23	11	11	13	
	High school	26	39	32	26	28	
	Some college or greater	52	38	57	63	59	
Response to warning label items							0.096
	Have you heard about or seen new warning labels which include graphic pictures?	60	54	62	52	54	
	Do you think that new warning labels with graphic pictures would make you think about not smoking?	55	36	45	57	53	<.0001
Noncombustible tobacco use, past 30 days							<.0001
	E-cigarette use	0	5	11	0	2	

	Class 1 LCC and hookah users (4%)	Class 2 Nonusers open to smoking (3%)	Class 3 Daily “smokers” (11%)	Class 4 Nondaily, light “social smokers” (9%)	Class 5 Nonusers closed to smoking (73%)	Full sample	p value
	%	%	%	%	%	%	
Chewing tobacco use	1	0	2	7	0	1	<0.001
Dip/snuff use	17	0	3	11	0	2	<0.001
Sinus use	2	0	4	8	0	1	<0.001
Nicotine product use	0	0	3	8	0	1	<0.001

Source: Legacy Young Adult Cohort Study, Wave 2 (January 2012).

Table 3

Multinomial logistic regression of potential response to graphic health warning labels by latent class (weighted $N = 4,125$).^a

	<u>LCC and hookah users</u>		<u>Nonusers, open to smoking</u>		<u>Daily "smokers"</u>		<u>Nondaily, light "social smokers"</u>		<u>Nonusers, closed to smoking</u>	
	Adjusted RRR, Class 1 vs. Class 3	Adjusted RRR, Class 2 vs. Class 3	Adjusted RRR, Class 1 vs. Class 3	Adjusted RRR, Class 2 vs. Class 3	Adjusted RRR, Class 1 vs. Class 3	Adjusted RRR, Class 2 vs. Class 3	Adjusted RRR, Class 4 vs. Class 3	Adjusted RRR, Class 4 vs. Class 3	Adjusted RRR, Class 5 vs. Class 3	Adjusted RRR, Class 5 vs. Class 3
Age (years)										
18-24	2.09	(1.22-3.55)	1.51	(0.82-2.78)	Ref.	1.95	(1.24-3.05)	1.59	(1.13-2.22)	
25-34	Ref.		Ref.		Ref.	Ref.		Ref.		
Gender										
Male	Ref.		Ref.		Ref.	Ref.		Ref.		
Female	0.32	(0.20-0.52)	1.10	(0.63-1.90)	Ref.	0.91	(0.61-1.34)	1.23	(0.92-1.63)	
Race/ethnicity										
White, non-Hispanic	Ref.		Ref.		Ref.	Ref.		Ref.		
Black, non-Hispanic	1.07	(0.47-2.46)	3.97	(1.66-9.50)	Ref.	3.01	(1.49-6.05)	1.68	(0.97-2.92)	
Other, non-Hispanic	1.14	(0.33-3.90)	3.73	(1.14-12.24)	Ref.	3.15	(1.42-6.97)	2.58	(1.34-4.97)	
Hispanic	2.64	(1.27-5.46)	6.25	(2.85-13.71)	Ref.	3.94	(2.12-7.32)	3.18	(1.91-5.29)	
Education										
Less than high school	0.12	(0.05-0.31)	0.39	(0.17-0.89)	Ref.	0.21	(0.10-0.41)	0.19	(0.12-0.30)	
High school	0.26	(0.15-0.46)	0.34	(0.16-0.71)	Ref.	0.40	(0.25-0.64)	0.30	(0.21-0.41)	
Some college or greater	Ref.		Ref.		Ref.	Ref.		Ref.		
Have you heard about or seen new warning labels which include graphic pictures?	0.93	(0.56-1.53)	0.98	(0.53-1.83)	Ref.	1.33	(0.87-2.02)	0.76	(0.56-1.02)	
Do you think that new warning labels with graphic pictures would make you think about not smoking?	2.35	(1.39-3.97)	1.70	(0.91-3.18)	Ref.	1.30	(0.85-1.98)	2.33	(1.71-3.18)	
Constant	1.63	(0.74-3.60)	0.14	(0.05-0.35)		0.63	(0.33-1.21)	4.05	(2.48-6.63)	

Source: Legacy Young Adult Cohort Study, Wave 2 (January 2012).

^a Bold typeface indicates $p < 0.05$.