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Co-occurring vulnerabilities and menthol use in U.S. young adult cigarette smokers: Findings from Wave 1 of the PATH Study, 2013–2014

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Abstract

This study incorporates intersectionality theory to address potential effects of age on other documented risk factors for current smoking and menthol cigarette use in young adults aged 18–34 using Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study (2013–2014). We explored known correlates of current cigarette and menthol cigarette smoking and interaction analyses by age group (18–24 vs. 25–34), accounting for survey weighting. Use of non-cigarette tobacco products and e-cigarettes was characterized among current cigarette smokers. Young adults experience multiple vulnerabilities to smoking beyond age and some of these known risk factors for smoking place those aged 18–24 at different risk of cigarette smoking compared to their 25–34 year old counterparts. These include lower odds of cigarette smoking by age for sex (female; AOR = 0.62 in those aged 18–24 vs. 0.72 in those aged 25–34) and Hispanic ethnicity (vs. White; AOR = 0.77 vs. 0.45), and higher odds of smoking among past 30-day alcohol users aged 18–24 vs. 25–34 (AOR = 1.62 vs. 1.32). Correlations between lower education and smoking were nearly two-fold higher in 25–34 than 18–24 year olds. Having any medical comorbidity had opposite effects on current smoking by age (18–24 positive correlation, AOR = 1.17; 25–34 negative correlation, AOR = 0.84). Lower education was correlated with menthol cigarette use among young adult smokers. This study suggests that higher smoking prevalence among young adults is associated with the intersection of multiple vulnerabilities to smoking.

Keywords

Socioeconomic factors; Health status disparities; Smoking; Tobacco use; Young adult

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Conflict of interest statement

The authors have no conflicts to declare.

1. Introduction

Despite historic declines in adult cigarette smoking prevalence in the U.S., reductions have not occurred equally throughout the population (Jamal et al., 2016; U.S. National Cancer Institute, 2017). As of 2015, one of the groups in which smoking prevalence estimated from the National Health Interview Survey (NHIS) remained higher was younger adults (Jamal et al., 2016). Findings from the 2013–2014 Population Assessment of Tobacco and Health (PATH) Study support differences in tobacco use by age with higher prevalence of most tobacco and e-cigarette product use in young adults aged 18–24 compared to adults aged 25 or older (Kasza et al., 2017). This coincides with recent changes in the timing of smoking onset with greater uptake of cigarette smoking occurring in young adulthood than in adolescence (Thompson et al., 2017).

Young adulthood is a distinct and important developmental period, typically spanning ages 18–29 (Arnett, 2000, 2001) marked by a period of heightened vulnerability to escalation and persistence of substance use (Arnett, 2005; Staff et al., 2010; Sussman and Arnett, 2014). It is also a period that often involves psychological distress and significant changes in social and environmental factors as young adults transition from living at home and attending school to living independently (Bonnie et al., 2014). As a result, young adults concurrently experience multiple known risk factors for cigarette smoking and these risk factors may coincide to produce greater risk for smoking among certain subgroups (U.S. National Cancer Institute, 2017). Additionally, the relationship between educational attainment and cigarette smoking may differ in young adults, as many are in the midst of completing their education (Williams et al., 2017).

Intersectionality theory posits that societies are defined by social divisions across multiple axes, including race, class, and gender, that influence each other (Collins and Bilge, 2016). Health disparities research, informed by intersectionality, may help to uncover how these axes of social identities co-occur to produce increased risk for given health behaviors or outcomes (López and Gadsden, 2016). Previous work has highlighted that education, race/ethnicity, and gender act summatively to increase smoking risk in vulnerable populations (Higgins et al., 2016). However, in line with standard biomedical approaches (Kelly, 2009), many population studies have largely focused on individual risk factors for smoking, identifying increased risk in young adults (Jamal et al., 2016; Kasza et al., 2017; Phillips et al., 2017) and within young adults, by sociodemographic characteristics (Green et al., 2007; Lariscy et al., 2013; Rath et al., 2013; U.S. Department of Health and Human Services, 2012; Villanti et al., 2017b). Studies in younger adults also identify relationships between medical comorbidities (e.g., cancer, Kaul et al., 2016), mental illness (Smith et al., 2014), substance use (Cohn et al., 2015) and smoking.

One potential reason for higher smoking prevalence in younger adults may be use of menthol cigarettes. Menthol cigarette consumption (Delnevo et al., 2014) and prevalence have remained largely stable over time in both young adults and adults (Giovino et al., 2015; Villanti et al., 2016) despite rapid declines in non-menthol cigarette consumption and prevalence. As a result, menthol cigarette use has eclipsed non-menthol use in young adults (Villanti et al., 2016). Risk factors for menthol cigarette use and cigarette smoking are

similar in youth adults (Cohn et al., 2016a; Rath et al., 2016). However, while males and white young adults have a higher prevalence of cigarette smoking (U.S. Department of Health and Human Services, 2012), correlates of menthol versus non-menthol cigarette use include being female and Black (Rath et al., 2016).

The goal of this study was to examine whether there were unique risk factors for cigarette smoking and menthol cigarette use in young adults aged 18–24 compared to 25–34 and how risk factors combine within these age classes. This approach incorporates intersectionality theory to underscore potential interaction effects of age on other documented risk factors for cigarette smoking and menthol cigarette use in young adults aged 18–34. It supplements traditional regression modeling with classification and regression tree (CART) analysis to examine the relative contribution of these factors in explaining risk for smoking by age group.

2. Methods

Data are from Wave 1 of the PATH Study conducted from September 12, 2013 to December 15, 2014. The PATH Study is a nationally-representative, longitudinal cohort study of 45,971 adults and youth in the US, ages 12 years and older. The National Institutes of Health, through the National Institute on Drug Abuse, is partnering with the Food and Drug Administration's Center for Tobacco Products to conduct the PATH Study under a contract with Westat. The PATH Study used Audio-Computer Assisted Self-Interviews (ACASI) available in English and Spanish to collect information on tobacco-use patterns and associated health behaviors. This analysis draws from the 32,320 Adult Interviews (ages 18 years and older), focusing on a subpopulation of young adults aged 18–34 ($n = 15,448$). Recruitment employed addressbased, area-probability sampling, using an in-person household screener to select youths and adults. Adult tobacco users, young adults ages 18 to 24 and African Americans were oversampled relative to population proportions. The weighting procedures adjusted for oversampling and nonresponse; combined with the use of a probability sample, the weighted data allow the estimates produced by Wave 1 of the PATH Study to be representative of the non-institutionalized, civilian US population. The weighted response rate for the household screener was 54.0%. Non-response analysis showed few differences with referent national surveys. Among households that were screened, the overall weighted response rate was 74.0% for the Adult Interview and 78.4% for the Youth Interview. Further details regarding the PATH Study design and methods are available elsewhere (Hyland et al., 2017); Wave 1 questionnaires and information on accessing the data are available at <https://doi.org/10.3886/ICPSR36231>. The PATH Study was conducted by Westat and approved by Westat's Institutional Review Board.

2.1. Measures

2.1.1. Cigarette use—Current smoking was defined as having ever smoked cigarettes and currently smoking cigarettes some days or every day. Current established smokers had also smoked at least 100 cigarettes in their lifetime; current experimental smokers did not meet that threshold. Similarly, former cigarette smokers were defined as having ever used the product and not smoking at the time of the survey. Former established smokers had also

smoked at least 100 cigarettes in their lifetime; former experimental smokers had smoked at least all or part of a cigarette but < 100 cigarettes. Never users were defined as those who reported never having smoked cigarettes, even one or two puffs. Westat-derived variables for each of these states were combined to create a single variable to describe cigarette smoking with five mutually-exclusive categories: never use, former experimental use, former established use, current experimental use, and current established use.

2.1.2. Menthol cigarette use—Current established smokers of manufactured and roll-your-own cigarettes were asked whether their regular brand was “flavored to taste like menthol or mint” (yes/no). Respondents answering yes were classified as current menthol cigarette smokers.

2.1.3. Risk factors for cigarette smoking—Sociodemographic variables used in these analyses included selfreported age group (18–24 and 25–34), gender, sexual orientation (heterosexual/straight and lesbian, gay, bisexual, or questioning (LGBQ)), race/ethnicity, educational attainment, poverty status, and region. Past 30-day substance use (alcohol, marijuana, heroin, cocaine, stimulants, prescription drugs) was also assessed. Respondents reporting any heart condition, any lung condition, diabetes, sugar diabetes, high blood sugar, or borderline diabetes, or cancer were classified as having medical comorbidities. Respondents also completed the Global Appraisal of Individual Needs -Short Screener (GAIN-SS; Dennis et al., 2006), which measures severity of symptoms of internalizing problems (e.g., depression, anxiety, trauma), externalizing problems (e.g., attention deficits, hyperactivity, impulsivity, conduct problems), and substance use problems (e.g., dependence) in the past year (i.e., 0–1 symptoms (low), 2–3 symptoms (moderate), and 4/4+ symptoms (high), depending on the scale).

2.2. Statistical analyses

Analyses were conducted using SVY procedures in Stata/MP version 15.1 using balanced repeated replication (BRR) replicate weights and Fay’s adjustment. Bivariate analyses, including crude logistic regression models, examined the correlation between smoking risk factors and age group, in addition to cigarette smoking status and age group. Next, multivariable logistic regression models were run stratified by age group to examine correlations between smoking risk factors and two outcomes: 1) current cigarette smoking (full sample) and 2) current menthol cigarette use (current established cigarette smokers). Post-hoc interaction models examined whether the magnitude of the correlation between each risk factor and smoking differed significantly by age group, controlling for all other variables in the model. All multivariable models included sex, sexual orientation, race/ethnicity, education, region, past 30-day alcohol, marijuana, and other drug use, any medical comorbidity, and the GAIN-SS subscales for internalizing and externalizing behavior and substance use problems. Poverty status was excluded from multivariable models due to the amount of missing data (9.3%), though sensitivity analyses examined the likely effect of this exclusion on study results.

Classification and regression tree (CART) analysis (Breiman et al., 1984; Lemon et al., 2003) was conducted to supplement regression modeling, using all smoking risk factors to

predict current smoking and menthol cigarette use as done in earlier work on the intersection of risk factors for smoking in the U.S. adult population (Higgins et al., 2016). CART analysis is a nonparametric procedure for dividing a population of interest into mutually exclusive subgroups (risk factor profiles) based on a dependent variable of interest (e.g., current smoking) and, in the process, identifying independent variables with the most explanatory power in accounting for that dependent variable within each subgroup. The tree was built using R's rpart package (R Core Team, 2017; Therneau et al., 2018) and the classification method, given the binary outcome. We included person-level survey weights, but could not utilize replicate weights as done in the multivariable models. Fully saturated trees were produced initially for each age group (18–24 and 25–34), and then pruned by selecting the complexity parameter that minimized cross-validation error to identify the risk factors with the greatest effect on smoking behavior.

3. Results

Participant characteristics are presented in Table 1. Approximately half of young adults aged 18–34 were male and 7.8% were lesbian, gay, bisexual or questioning (LGBQ). More than half (56.8%) were white, 39.1% had a high school education or less, and 36.8% lived below the poverty level. A quarter of young adults (24.6%) lived in the West, 37.3% in the Midwest, 21.4% in the South, and 16.8% in the Northeast. Prevalence of past 30-day substance use was 57.3% for alcohol, 13.4% for marijuana, and 5.8% for any other drugs; 21% (21.4%) were moderate or high on the GAIN-SS substance use scale. A larger proportion of young adults were moderate or high on the GAIN-SS internalizing behavior (40.2%) or externalizing behavior (43.1%) subscales. The prevalence of current cigarette smoking was 27.1% (25.5% in 18–24, 28.4% in 25–34) in young adults, with 40.9% reporting never cigarette use.

3.1. Correlation between smoking risk factors and age group

Bivariate analyses highlighted differences in the distribution of smoking risk factors by age group (18–24 vs. 25–34; Table 1). There were higher odds of being LGBQ (vs. heterosexual), black or other race (vs. white), having lower educational attainment, living below the poverty level (vs. above), and having higher internalizing and externalizing behaviors for 18–24 year olds compared to 25–34 year olds. Higher substance use scale scores and past 30-day marijuana use were positively correlated with being 18–24 as well, though past 30-day alcohol was negatively correlated with being in the younger age group. Having any medical comorbidity was also negatively correlated with being 18–24 versus 25–34. Former (experimental and established) and current established cigarette smoking were negatively correlated with younger age; however, the odds of current experimental smoking were higher in those aged 18–24 compared to those aged 25–34 (OR = 1.29).

3.2. Intersection of age group and smoking risk factors on current cigarette smoking

Table 2 presents correlates of current cigarette smoking, stratified by age group. In both age groups, males (vs. females), whites (vs. blacks and Hispanics), LGBQ respondents (vs. heterosexual), those with less than BA/Advanced degree (vs. BA/Advanced degree), past 30-day substance users (vs. non-users), and those with higher scores on the substance use and

internalizing behavior scales had higher odds of current smoking. There were three differences in correlates between age groups: first, residing in the Midwest was positively correlated with current smoking in 18–24 year olds but not 25–34 year olds while residing in the West was negatively correlated with smoking in 25–34 year olds but not 18–24 year olds. Second, having any medical comorbidity was positively correlated with smoking in 18–24 year olds and negatively correlated with smoking in 25–34 year olds. Third, higher externalizing behavior was negatively correlated with smoking in 18–24 year olds, but had no relationship in 25–34 year olds. Sensitivity analyses showed that poverty status was positively correlated with current cigarette smoking in both models, but it had minimal impact on the magnitude of most estimates.

Post-hoc analyses supported that the magnitude of the correlations between some risk factors and smoking differed by age group. There were significant interactions for sex (i.e., stronger negative correlation between being female and smoking in 18–24 year olds vs. 25–34 year olds; AOR = 0.83), being Hispanic (i.e., attenuated negative effect of Hispanic ethnicity on smoking in 18–24 year olds compared to 25–34 year olds; AOR = 1.68), education (i.e., smaller magnitude of correlations between lower education and smoking in 18–24 year olds vs. 25–34 year olds; AORs range from 0.53 to 0.54), past 30-day alcohol use (stronger positive correlation in 18–24 vs. 25–34 year olds; AOR = 1.27), medical comorbidities (cross-over effect in 18–24 vs. 25–34; AOR = 1.28), and internalizing behavior (i.e., smaller magnitude of correlation between internalizing behavior in 18–24 vs. 25–34 year olds; AOR = 0.74 for moderate, 0.70 for high).

Results from the CART analyses identified the relative contribution of risk factors associated with current smoking in each age group. The pruned tree for young adults aged 18–24 showed past 30-day marijuana use as the most important correlate of current smoking, followed by scoring high on the substance use scale, having a high school education or less, and scoring moderate or high on the internalizing behavior scale (Fig. 1). Smoking prevalence varied 3.5 fold from a low of 20% to a high of 70% across the five risk-factor profiles identified. Among young adults aged 25–34, the strongest correlate of current smoking was having less than a BA/Advanced degree, followed by past 30-day marijuana use, being non-white, living below the poverty level, and having higher internalizing behavior, externalizing behavior and substance use problems, with smoking prevalence varying 7.8 fold from a low of 9% to a high of 70% across 13 different risk-factor profiles (Fig. 2).

3.3. Intersection of age group and smoking risk factors on menthol use within current cigarette smokers

Current female smokers (vs. males), black and Hispanic smokers (vs. whites), and smokers with less than BA/Advanced degree (vs. having a BA/Advanced degree) had greater odds of menthol cigarette use compared to non-menthol use in both age groups (Table 3). Smokers residing in the West had lower odds of using menthol cigarettes in both age groups compared to smokers residing in the Northeast. There were two differences in correlates of menthol cigarette use by age group in young adult smokers: first, smokers residing in the Midwest (vs. Northeast) had lower odds of menthol use in the 25–34 age group. Second,

other race was positively correlated with menthol use in 25–34 year old smokers. Sensitivity analyses showed that poverty status was not correlated with menthol cigarette use among current smokers and had minimal effect on estimates in the original model.

The pruned tree from CART analyses in current smokers highlighted non-white race/ethnicity as the most important correlate of menthol cigarette use in 18–24 year olds, followed by being female, living in the Northeast, Midwest or South, and having less than a BA/Advanced degree (Supplemental Fig. 1). Among young adult smokers aged 25–34, the strongest correlate of menthol cigarette use was again being nonwhite, followed by having less than a BA/Advanced degree with no other predictors in the model (Supplemental Fig. 2).

Post hoc interaction analysis showed a significant interaction for black race (i.e., smaller magnitude of correlations between black race and menthol use in 18–24 year old smokers vs. 25–34 year old smokers; AOR = 0.42). Scoring moderate (vs. low) on the substance use scale was correlated with a lower odds of menthol cigarette use in 18–24 year old smokers and a higher odds of menthol cigarette use in 25–34 year old smokers; AOR = 0.68).

4. Discussion

As reported in national studies of adults (Higgins et al., 2016; Jamal et al., 2016; Phillips et al., 2017), being male, white, LGBTQ, having lower education, and reporting higher substance use, internalizing behavior and markers of psychological distress, were positively correlated with current cigarette smoking in the present subgroup of young adults aged 18–34. The present study also provides novel information on differences in the importance and magnitude of these correlates among those aged 18–24 versus 25–34. First, there are greater sex differences in smoking among young adults, with females aged 18–24 having significantly lower odds of smoking than females aged 25–34. Second, while Hispanic young adults are still less likely to smoke than whites in both age groups, this difference was attenuated in the younger age group. Both of these findings are consistent with data showing although there were declines in smoking uptake among white young adult males and females from 2006 to 2013, rates of smoking onset increased over this period among black and Hispanic young adult males and declined more slowly in black and Hispanic young adult females compared to whites (Thompson et al., 2017). Third, the magnitude of the positive correlation between lower education and current cigarette smoking was almost two-fold higher in the 25–34 year olds than the 18–24 year olds. This may be explained by the younger group being less likely to have completed their education (Williams et al., 2017), but was not previously reported in a study examining the relationship between education and smoking in young adults (Green et al., 2007). Educational attainment less than a BA was the strongest predictor and the only stand-alone risk profile in two prior studies in the overall U.S. adult population perhaps suggesting that its predictive utility grows in importance with age (Gaalema et al., in press; Higgins et al., 2016). Fourth, past 30-day alcohol use was more strongly correlated with cigarette smoking in those aged 18–24 than in those aged 25–34, in line with studies in this age group documenting the prevalence of alcohol and cigarette co-use (Cohn et al., 2015; Cohn et al., 2016b), as well as the relationship between alcohol use and social smoking (Lisha et al., 2015; Villanti et al., 2017c). Fifth, the magnitude of the

relationship between internalizing behavior and cigarette smoking was greater in the older age group than the 18–24 year olds. This may be attributable to later onset of mood disorders, like depression, though half of lifetime cases of psychiatric disorders start by adolescence and 7% by age 24 (Kessler et al., 2005). Finally, this study provides the first estimates of the relationship between any medical comorbidity and cigarette smoking in young adults, finding opposite effects in the two age groups.

Classification and regression tree analyses support the intersectionality of smoking risk factors in young adults, as seen in the general adult population (Higgins et al., 2016). The strength of this approach is its ability to illustrate how the risk factors of interest intersect corresponding to their relative strengths accounting for large differences in smoking risk, and the associated risk profiles that have the potential to guide targeted tobacco control and regulatory efforts. Past 30-day marijuana use, education, and internalizing behavior explained a large proportion of current smoking in both age groups. The substance use scale was identified as an important correlate of smoking in the 18–24 year olds and race/ethnicity and poverty status were identified as important correlates of smoking in the 25–34 year olds. The strength of the positive association between past 30-day marijuana use in predicting current smoking in both age groups but especially the 18–24 year olds warrants further monitoring in light of the liberalization of marijuana use laws in the U.S. and globally.

Menthol cigarette use is associated with smoking progression, increased nicotine dependence, and reduced smoking cessation and as such, poses a threat to public health (Villanti et al., 2017a). In this study, correlates of menthol cigarette use were largely consistent with previous studies (Rath et al., 2016), documenting higher odds of menthol use in female and non-White young adult smokers. They differed, however, in finding no correlation between being a sexual minority and menthol cigarette use (Rath et al., 2016) and no correlation between psychiatric symptoms and menthol cigarette use in young adult smokers (Cohn et al., 2016a). Novel findings from the current study document significantly higher odds of menthol use among young adult smokers with lower education and the emergence of region as a correlate of menthol cigarette use in young adults. Prior studies have shown no correlation between lower income and menthol cigarette use (Giovino et al., 2015; Villanti et al., 2016). The relationship between education and menthol cigarette use may remain confounded with race/ethnicity given differential exposure to targeted marketing of menthol cigarettes in low-income minority communities (Seidenberg et al., 2010; Widome et al., 2013; Yerger et al., 2007). Potential differences by region are consistent with Reynolds American's 2016 categorization of the Northeast and South as "core" markets, the Midwest as an "emerging" market, and the West as an "opportunity" market for Newport cigarettes, the country's leading menthol brand (Reynolds American Inc., 2016).

Limitations of this study include its cross-sectional nature, which precludes conclusions about the directionality of these correlations. Exclusion of poverty status from the multivariable models, while justified based on the proportion of missing data, may have resulted in overestimating the magnitude of the relationships between education and current cigarette smoking. On balance, this study has a number of strengths. It provides a comprehensive examination of smoking risk factors in a large, national sample, rarely included in a single dataset. The PATH Study's oversampling of young adults allows for

greater confidence in the stability of the estimated correlations between these risk factors and the smoking outcomes. Furthermore, the explicit focus on the intersection of age and smoking risk factors in young adults highlights differential effects of certain correlates among those 18–24, a group particularly vulnerable to smoking onset (Thompson et al., 2017) and targeted marketing by tobacco companies (Biener and Albers, 2004; Ling and Glantz, 2002).

5. Conclusions

Young adults experience multiple vulnerabilities to smoking beyond age and some of these known risk factors for smoking (i.e., being male, Hispanic, using alcohol, and having a medical comorbidity) place those aged 18–24 at greater risk of cigarette smoking compared to their 25–34 year old counterparts. In both age groups, smoking was concentrated in those with more than one risk factor and marijuana use, lower education, and internalizing behavior emerged as important correlates of smoking. These data also highlight education as a strong correlate of menthol cigarette use in young adults, which has not been documented in previous work in this age group (Rath et al., 2016). Findings support the importance of intervening on co-use with other substances, particularly alcohol and marijuana, to reduce tobacco use. The high proportion of young adult menthol cigarette users in this study reinforce that banning menthol in cigarettes could reduce tobacco use in this vulnerable group.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix A.: Supplementary data

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Young adults aged 18–24, Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study, 2013–2014. Pruned, weighted classification and regression tree (CART) model of associations between current cigarette smoking and the following risk factors: sex, LGBQ status, race/ethnicity, educational attainment, poverty status, census region, past 30-day alcohol use, past 30-day marijuana use, past 30-day any other drug use, any medical comorbidity, and the GAIN-SS internalizing, externalizing, and substance use scales. Results from a saturated model were “pruned” using CART analytic software to reduce complexity (R Core Team, 2017). Rectangles (nodes) represent smoking prevalence for the entire

population (top-most node) or population subgroups (all others nodes). Nodes also list the proportion of the adult population represented. Green nodes depict subpopulations where the majority of the population is non-smokers and blue nodes, subpopulations where the majority of the population is current smokers. Using the root node as an example, 75% of young adults aged 18–24 are non-smokers, 25% current smokers, and this node represents 100% of the U.S. young adults aged 18–24. Lines below nodes represent the binary branching around particular risk factors and risk-factor levels. The bottom row comprises terminal nodes (i.e., final partitioning for a particular subgroup). Terminal nodes contain the same information as the other nodes plus the percent of all adult current smokers represented by that node. Percent of current smokers represented is calculated by the following equation: $\% \text{ total population represented by a node} \times \text{smoking prevalence in that node} / \text{smoking prevalence in the entire study sample} \times 100$. Tallying % current smokers represented across all terminal nodes should equal 100% of smokers in the U.S adult population, save rounding error. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Fig. 2. Young adults aged 25–34, Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study, 2013–2014. Pruned, weighted classification and regression tree (CART) model of associations between current cigarette smoking and the following risk factors: sex, LGBTQ status, race/ethnicity, educational attainment, poverty status, census region, past 30-day alcohol use, past 30-day marijuana use, past 30-day any other drug use, any medical comorbidity, and the GAIN-SS internalizing, externalizing, and substance use scales. Results from a saturated model were “pruned” using CART analytic software to reduce complexity (R Core Team, 2017). Rectangles (nodes) represent smoking prevalence for the entire population (top-most node) or population subgroups (all others nodes). Nodes also list the proportion of the adult population represented. Green nodes depict subpopulations where the

majority of the population is non-smokers and blue nodes, subpopulations where the majority of the population is current smokers. Using the root node as an example, 72% of young adults aged 25–34 are non-smokers, 28% current smokers, and this node represents 100% of the U.S. young adults aged 25–34. Lines below nodes represent the binary branching around particular risk factors and risk-factor levels. The bottom row comprises terminal nodes (i.e., final partitioning for a particular subgroup). Terminal nodes contain the same information as the other nodes plus the percent of all adult current smokers represented by that node. Percent of current smokers represented is calculated by the following equation: $\% \text{ total population represented by a node} \times \text{smoking prevalence in that node} / \text{smoking prevalence in the entire study sample} \times 100$. Tallying % current smokers represented across all terminal nodes should equal 100% of smokers in the U.S adult population, save rounding error. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Characteristics of young adults aged 18–34, Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study, 2013–2014.

Table 1

	Aged 18–24 (n = 9110; 42.3%)		Aged 25–34 (n = 6338; 57.7%)		Total (n = 15,448)		Aged 18–24 vs. 25–34	
	%		%		%		OR	(95% CI)
Sex								
Male	50.2		50.5		50.4		Ref.	
Female	49.8		49.5		49.6		1.01	(0.97, 1.06)
Sexual orientation								
Heterosexual/straight	91.2		93.0		92.2		Ref.	
LGBQ	8.8		7.0		7.8		1.29	(1.12, 1.49)
Race/ethnicity								
White	54.8		58.2		56.8		Ref.	
Black	13.3		12.4		12.8		1.14	(1.02, 1.27)
Other	11.2		9.4		10.2		1.26	(1.04, 1.53)
Hispanic	20.7		19.9		20.2		1.10	(1.00, 1.22)
Education								
Less than high school	10.8		9.2		9.9		2.90	(2.55, 3.31)
High school graduate/GED	32.8		26.7		29.2		3.04	(2.74, 3.38)
Some college/associate's degree	43.2		31.5		36.4		3.40	(3.01, 3.84)
Bachelor's/advanced degree	13.2		32.7		24.5		Ref.	
Poverty status								
Below poverty level (< 100% of poverty guideline)	47.4		29.6		36.8		2.14	(1.95, 2.36)
At or above poverty level (≥ 100% of poverty guideline)	52.6		70.4		63.2		Ref.	
Region								
Northeast	17.2		16.5		16.8		Ref.	
South	20.6		21.9		21.4		0.90	(0.77, 1.04)
Midwest	37.8		36.9		37.3		0.98	(0.87, 1.10)
West	24.4		24.7		24.6		0.94	(0.82, 1.08)
Past 30-day alcohol use								
No	45.7		40.7		42.7		Ref.	

	Aged 18–24 (n = 9110; 42.3%)		Aged 25–34 (n = 6338; 57.7%)		Total (n = 15,448)		Aged 18–24 vs. 25–34	
	%		%		%		OR	(95% CI)
Yes	54.3		59.3		57.3		0.82	(0.74, 0.90)
Past 30-day marijuana use								
No	82.4		89.8		86.6		Ref.	
Yes	17.6		10.2		13.4		1.87	(1.65, 2.12)
Past 30-day use of any other drugs								
No	93.9		94.3		94.2		Ref.	
Yes	6.1		5.7		5.8		1.07	(0.93, 1.23)
Medical comorbidities								
No	76.1		71.9		73.7		Ref.	
Yes	23.9		28.1		26.3		0.80	(0.73, 0.88)
Internalizing behavior								
Low	53.7		64.3		59.8		Ref.	
Moderate	26.8		21.6		23.8		1.48	(1.34, 1.64)
High	19.5		14.1		16.4		1.65	(1.48, 1.84)
Externalizing behavior								
Low	49.2		62.5		56.9		Ref.	
Moderate	30.1		24.7		27.0		1.55	(1.41, 1.70)
High	20.8		12.8		16.2		2.07	(1.83, 2.34)
Substance use scale								
Low	76.0		80.5		78.6		Ref.	
Moderate	17.0		14.0		15.3		1.29	(1.16, 1.43)
High	7.0		5.5		6.1		1.35	(1.17, 1.55)
Cigarette smoking status								
Never	46.9		36.5		40.9		Ref.	
Former experimental	23.0		22.3		22.6		0.81	(0.71, 0.91)
Former established	4.6		12.8		9.3		0.28	(0.24, 0.33)
Current experimental	5.9		3.5		4.5		1.29	(1.10, 1.51)
Current established	19.6		24.9		22.6		0.62	(0.55, 0.68)

Missing: Sex (0.05%), sexual orientation (1.4%), race/ethnicity (0%), education (0.6%), poverty status (9.4%), region (0%), past 30-day alcohol use (3.6%), past 30-day marijuana use (1.0%), past 30-day any other drug use (0.1%), medical comorbidities (0.5%), internalizing behavior (0%), externalizing behavior (0%), substance use scale (0%), cigarette smoking status (0.3%).

Table 2

Intersection of age group and current cigarette smoking among young adults aged 18–34, Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study, 2013–2014.

	Current cigarette smokers, aged 18–24 (n=3236; 25.5%)		Current cigarette smoking vs. never/former cigarette smoking among 18–24year olds (n=9089)		Current cigarette smokers, aged 25–34 (n=2948; 28.4%)		Current cigarette smoking vs. never/former cigarette smoking among 25–34year olds (n=6320)	
	%	AOR	(95% CI)	%	AOR	(95% CI)		
Sex								
Male	59.9	Ref.		59.2	Ref.			
Female	40.1	0.62	(0.55, 0.69)	40.8	0.72	(0.61, 0.84)		
Sexual orientation								
Heterosexual/straight	86.9	Ref.		90.4	Ref.			
LGBQ	13.1	1.67	(1.38, 2.01)	9.6	1.42	(1.09, 1.86)		
Race/ethnicity								
White	59.6	Ref.		63.6	Ref.			
Black	12.1	0.68	(0.58, 0.81)	14.0	0.66	(0.54, 0.82)		
Other	8.9	0.86	(0.67, 1.11)	6.9	1.01	(0.71, 1.43)		
Hispanic	19.4	0.77	(0.66, 0.88)	15.5	0.45	(0.36, 0.56)		
Education								
Less than high school	15.3	4.56	(3.60, 5.78)	13.8	9.96	(7.76, 12.77)		
High school graduate/GED	39.3	3.58	(2.95, 4.34)	39.1	7.34	(5.95, 9.06)		
Some college/associate's degree	38.4	2.01	(1.69, 2.40)	34.7	3.89	(3.25, 4.65)		
Bachelor's/advanced degree	7.0	Ref.		12.4	Ref.			
Region								
Northeast	16.6	Ref.		17.0	Ref.			
South	21.8	1.16	(0.91, 1.47)	23.6	1.03	(0.85, 1.26)		
Midwest	40.1	1.24	(1.01, 1.53)	40.5	1.01	(0.82, 1.25)		
West	21.4	0.81	(0.63, 1.03)	18.9	0.55	(0.45, 0.67)		
Past 30-day alcohol use								
No	34.0	Ref.		35.8	Ref.			
Yes	66.0	1.62	(1.40, 1.87)	64.2	1.32	(1.11, 1.56)		
Past 30-day marijuana use								

	Current cigarette smokers, aged 18–24 (n=3236; 25.5%)		Current cigarette smoking vs. never/former cigarette smoking among 18–24year olds (n=9089)		Current cigarette smokers, aged 25–34 (n=2948; 28.4%)		Current cigarette smoking vs. never/former cigarette smoking among 25–34year olds (n=6320)	
	%	AOR	(95% CI)	%	AOR	(95% CI)		
No	62.8	Ref.		76.5	Ref.			
Yes	37.2	2.96	(2.55, 3.44)	23.5	3.87	(3.09, 4.86)		
Past 30-day use of any other drugs								
No	87.4	Ref.		88.0	Ref.			
Yes	12.6	1.65	(1.30, 2.09)	12.0	2.24	(1.68, 2.97)		
Medical comorbidities								
No	73.1	Ref.		69.5	Ref.			
Yes	26.9	1.17	(1.02, 1.35)	30.5	0.84	(0.73, 0.98)		
Internalizing behavior								
Low	45.5	Ref.		51.9	Ref.			
Moderate	25.7	1.03	(0.90, 1.17)	23.8	1.44	(1.19, 1.76)		
High	28.8	1.71	(1.48, 1.98)	24.2	2.64	(2.06, 3.39)		
Externalizing behavior								
Low	44.2	Ref.		69.4	Ref.			
Moderate	28.5	0.77	(0.68, 0.87)	19.6	0.82	(0.67, 1.01)		
High	27.3	0.79	(0.66, 0.95)	11.1	0.85	(0.66, 1.09)		
Substance use scale								
Low	58.9	Ref.		69.4	Ref.			
Moderate	25.3	1.46	(1.25, 1.69)	19.6	1.32	(1.05, 1.65)		
High	15.8	2.61	(2.16, 3.16)	11.1	1.61	(1.13, 2.29)		

Table 3

Intersection of age group and menthol cigarette smoking among young adult current smokers aged 18–34, Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study, 2013–2014.

	Current menthol cigarette use, aged 18–24 (n = 1316; 47.3%)		Current menthol vs. non-menthol use among 18–24 year old current established cigarette smokers (n = 2708)		Current menthol cigarette use, aged 25–34 (n = 1284; 44.7%)		Current menthol vs. non-menthol use among 25–34 year old current established cigarette smokers (n = 2801)	
	%	AOR	(95% CI)	%	AOR	(95% CI)		
Sex								
Male	53.0	Ref.		54.0	Ref.			
Female	47.0	1.79	(1.48, 2.17)	46.0	1.56	(1.29, 1.89)		
Sexual orientation								
Heterosexual/straight	84.6	Ref.		89.6	Ref.			
LGBQ	15.4	1.25	(0.94, 1.67)	10.4	1.07	(0.75, 1.53)		
Race/ethnicity								
White	57.7	Ref.		54.4	Ref.			
Black	16.1	5.01	(3.38, 7.42)	22.9	11.20	(7.47, 16.81)		
Other	7.0	1.12	(0.73, 1.73)	6.0	1.73	(1.19, 2.52)		
Hispanic	19.1	1.95	(1.49, 2.56)	16.7	2.63	(1.90, 3.65)		
Education								
Less than high school	16.6	2.38	(1.49, 3.81)	12.2	2.08	(1.32, 3.28)		
High school graduate/GED	39.1	1.69	(1.14, 2.52)	40.6	2.12	(1.44, 3.13)		
Some college/associate's degree	39.8	1.80	(1.19, 2.72)	39.6	2.27	(1.59, 3.23)		
Bachelor's/advanced degree	4.5	Ref.		7.6	Ref.			
Region								
Northeast	18.2	Ref.		19.1	Ref.			
South	22.6	0.84	(0.57, 1.24)	22.9	0.69	(0.48, 1.01)		
Midwest	42.9	0.91	(0.63, 1.33)	43.8	0.73	(0.55, 0.98)		
West	16.3	0.60	(0.42, 0.87)	14.3	0.44	(0.31, 0.64)		
Past 30-day alcohol use								
No	33.2	Ref.		36.2	Ref.			
Yes	66.8	1.10	(0.89, 1.36)	63.8	0.94	(0.77, 1.15)		

	Current menthol cigarette use, aged 18– 24 (n = 1316; 47.3%)	Current menthol vs. non-menthol use among 18–24 year old current established cigarette smokers (n = 2708)	Current menthol cigarette use, aged 25– 34 (n = 1284; 44.7%)	Current menthol vs. non-menthol use among 25– 34 year old current established cigarette smokers (n = 2801)		
	%	AOR	(95% CI)	%	AOR	(95% CI)
Past 30-day marijuana use						
No	64.6	Ref.		76.2	Ref.	
Yes	35.4	0.83	(0.67, 1.02)	23.8	0.93	(0.74, 1.16)
Past 30-day use of any other drugs						
No	87.8	Ref.		87.8	Ref.	
Yes	12.2	0.99	(0.72, 1.36)	12.2	1.03	(0.79, 1.34)
Medical comorbidities						
No	70.9	Ref.		68.0	Ref.	
Yes	29.1	1.13	(0.91, 1.40)	32.0	1.09	(0.89, 1.32)
Internalizing behavior						
Low	43.1	Ref.		51.9	Ref.	
Moderate	27.6	1.04	(0.79, 1.38)	23.1	0.90	(0.72, 1.13)
High	29.4	0.94	(0.72, 1.23)	25.0	1.11	(0.85, 1.46)
Externalizing behavior						
Low	44.5	Ref.		68.8	Ref.	
Moderate	29.1	0.88	(0.70, 1.10)	20.3	0.86	(0.69, 1.06)
High	26.4	0.92	(0.69, 1.25)	10.9	0.82	(0.62, 1.08)
Substance use scale						
Low	59.3	Ref.		68.8	Ref.	
Moderate	22.6	0.88	(0.71, 1.10)	20.3	1.26	(0.94, 1.68)
High	18.1	1.19	(0.91, 1.56)	10.9	1.07	(0.75, 1.53)