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Patterns and correlates of tobacco and cannabis co-use by tobacco product type: Findings from the Virginia Youth Survey

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Abstract

Background: Cannabis use is more common among tobacco users than non-users, and co-use (i.e., use of both substances individually) may be increasing. Better understanding of patterns and correlates of co-use is needed. The current study aimed to compare rates and correlates of tobacco and cannabis co-use by tobacco product among youth.

Methods: High school students who completed the 2013 Virginia Youth Survey and reported past 30-day tobacco use (cigarette, smokeless tobacco, cigar) were included ($n=1390$). Prevalence of past 30-day tobacco-only and cannabis co-use was calculated. Demographic, tobacco, and other substance use characteristics were compared by co-use status. Multivariate logistic regression models examined correlates of co-use overall and by tobacco product.

Results: Over half of tobacco users were co-users. Poly-tobacco use, particularly combusted tobacco, was more prevalent among co-users. Past 30-day alcohol use and lifetime other illegal drug use/prescription drug misuse were common correlates of co-use. Black NH race/ethnicity was associated with co-use when restricted to cigarette users. “Other” race/ethnicity was associated with co-use in the overall model and when restricted to cigar users. Past 30-day cigarette smoking was associated with co-use in all models except among cigar smoking co-users.

Conclusions/Importance: Rates and correlates of tobacco and cannabis co-use were not uniform and differed by tobacco product type. Concurrent tobacco and cannabis users may be at greater risk for negative health effects associated with inhaled tobacco and other risky substance use. The efficacy of prevention efforts may be improved if risk factors associated with product-specific concurrent use are considered.

Keywords

tobacco; marijuana; adolescents; cannabis; smoking; correlates

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Declaration of Interest

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Introduction

Tobacco and cannabis (i.e., marijuana) are among the most widely used psychoactive substances among youth in the United States (US; Johnston, O'Malley, Miech, Bachman, & Schulenberg, 2015; Substance Abuse and Mental Health Services Administration, 2010; US Department of Health and Human Services, 2014), and their co-use is common (Ramo, Liu, & Prochaska, 2012). While rates of cigarette smoking in this age group have declined since 2007 (Centers for Disease Control and Prevention, 2016b), the use of alternative tobacco products (e.g., cigars, hookah, and electronic cigarettes) has increased (Jamal et al., 2017). However, youth cannabis use rates have remained relatively stable, despite increases in young adults (Center for Behavioral Health Statistics and Quality, 2015; National Institute on Drug Abuse, 2016). As a result, during 2014 past 30-day cannabis use exceeded that of cigarette smoking among US high school seniors (21% vs. 14%) and was still higher than all other alternative tobacco products assessed (electronic cigarettes, 17%; flavored little cigars, 12%; smokeless tobacco, 8%; Johnston et al., 2015). The health risks of using cannabis and tobacco products simultaneously (i.e., blunts, spliffs/joints) or independent of each other (i.e., co-use), specifically combusted tobacco and cannabis, include lung disease and related medical comorbidities (i.e., increased risk for lung cancer) as well as progression to substance dependence (Ameri, 1999; Cooper & Haney, 2009; Martinasek, McGrogan, & Maysonet, 2016; US Department of Health and Human Services, 2014; Yayan & Rasche, 2016). Hypothesized mechanisms related to the co-use of these substances includes likely synergistic effects when used simultaneously, the attenuation of each substance's negative effects, comparable combusted-based administration methods, and a similar range of predisposing factors underlying the likelihood for tobacco and cannabis use (Brook, Lee, Finch, & Brown, 2010; Jackson, Sher, & Schulenberg, 2008; Rabin & George, 2015).

While data on tobacco and cannabis use from youth populations are more limited, rates of tobacco and cannabis co-use among adults 18 years old and older from 2003–2014 appear to have increased, particularly for young adults (Schauer, Berg, Kegler, Donovan, & Windle, 2015). Many adult cannabis users report lifetime tobacco use (Agrawal & Lynskey, 2009) or past 30-day tobacco use (Schauer, Berg, Kegler, Donovan, & Windle, 2016), and tobacco and cannabis co-use is associated with younger age, Black race/ethnicity, other risky substance use patterns (e.g., heavy alcohol use and other illicit drug use), mental health problems, and adverse health effects (Cohn, Johnson, Ehlke, & Villanti, 2016; Ramo et al., 2012; Schauer et al., 2015). Results from a longitudinal study of related offspring found tobacco and cannabis co-use was associated with peer substance use, psychopathology, and increased risk for nicotine and cannabis abuse/dependence (Agrawal et al., 2011). In another longitudinal report of the ten most common past 30-day patterns of alcohol, cannabis, tobacco use among young adults, cannabis used in combination with tobacco and alcohol was one of the top six substance use patterns from 2011–2015, while exclusive cannabis use was much less common (Cohn, Johnson, Rath, & Villanti, 2016). A more complex trajectory-based approach (mixture modeling) has been used in several adolescent to young adult samples to explore the developmental course of concurrent use patterns of tobacco, cannabis, and other substances (Brook et al., 2010; Jackson et al., 2008; Passarotti, Crane, Hedeker, & Mermelstein, 2015). This method has indicated an increased likelihood of

tobacco and cannabis co-use across a variety of use trajectories (e.g., chronic tobacco and late onset marijuana use; chronic tobacco and chronic cannabis use; Brook et al., 2010) as well as common vulnerabilities across co-use trajectories. These data highlight the prevalence of tobacco and cannabis co-use and associations of this substance use pattern with negative health consequences/outcomes. Greater understanding of the factors and characteristics associated with tobacco and cannabis co-use will aid in the development of more targeted and effective prevention programs.

Previously, the relationship between tobacco use and cannabis use has often been examined broadly, where any tobacco use or only cigarette use is assessed as a potential correlate of cannabis use. This type of analysis limits the ability to determine if the association between tobacco use and cannabis use is uniform or differs by tobacco product type (Agrawal et al., 2011; Agrawal, Silberg, Lynskey, Maes, & Eaves, 2010; Passarotti et al., 2015; Ramo & Prochaska, 2012). However, there appears to be promise in using an exploratory approach that considers which tobacco products are used concurrently with cannabis. Among those that have analyzed rates of tobacco and cannabis co-use by tobacco product type, in an adult population co-use and cannabis use/dependence were highest among individuals who used both smoked and smokeless tobacco products (i.e., poly-tobacco use) relative to exclusive smoked tobacco use or exclusive smokeless tobacco use (Agrawal & Lynskey, 2009), and when examined simply by tobacco product type in a different adult population, cigarette smoking was the most common tobacco product used among cannabis users (60%) relative to cigar (21%), smokeless tobacco (6%), and pipe tobacco (4%) use (Schauer, Berg, et al., 2016). These product-specific analyses reveal potentially more risky substance use patterns (e.g., poly-tobacco use; combusted tobacco use) that may result in a greater likelihood or worsened negative health outcomes associated with tobacco and cannabis co-use (Martinasek et al., 2016; US Department of Health and Human Services, 2014; Yayan & Rasche, 2016). The lack of studies examining co-use with the wide range of tobacco products used among youth populations is especially striking in light of the recent prevalence trends observed for alternative tobacco products and poly-tobacco use patterns (Jamal et al., 2017).

The purpose of the current study was to examine prevalence and correlates of tobacco and cannabis co-use among youth tobacco users by tobacco product type (i.e., cigarettes, smokeless tobacco, and cigars). Results aim to inform prevention and intervention efforts to address the rising issue of cannabis and tobacco use among a rapidly changing US tobacco marketplace and regulatory framework for cannabis products by identifying risk factors unique to specific patterns of co-use differentiated by tobacco product type.

Methods

Study Design and Participants

A secondary data analysis was conducted using publicly available, de-identified data of 6935 high school students aged 12 or older from the 2013 Virginia Youth Survey (VYS; Virginia Department of Health, 2016; see Jones, Wiseman, & Kharitonova, 2016; Nasim, Blank, Berry, & Eissenberg, 2012; Sutter, Nasim, Veldheer, & Cobb, 2016) for other representative publications using this dataset mechanism). A two-stage cluster sample design was used to

obtain a representative student sample in grades 9–12. Weighting was used to adjust for non-response bias and the distribution of students by grade, gender, race/ethnicity in each jurisdiction. Respondents in the current study analyses included youth who were current (i.e., past 30-day) tobacco users of at least one tobacco product assessed (i.e., cigarettes, smokeless tobacco, or cigars for the past 30-day cannabis use item (original unweighted $n=1233$; imputed unweighted $n=1390$).

Measures

Demographics—Age was assessed on a 7-point scale from 12 years old or younger to 18 years or older. To capture any differences in tobacco and cannabis co-use between youth who had recently transitioned to high school versus older high school students (Centers for Disease Control and Prevention, 2016a), age was recoded to 14 years and 15 years. Gender was assessed as either male or female. Race was assessed with the following categories: American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, multiple races and/or ethnicities, and White. Hispanic or Latino status was assessed separately (yes, no). Due to sample size restrictions, race/ethnicity categories other than White Non-Hispanic (NH) and Black NH were recoded under one category of “Other.”

Tobacco product use—Participants reported past 30-day cigarette use in days on a 7-point scale (0 days, 1 or 2 days, 3 to 5 days, 6 to 9 days, 10 to 19 days, 20 to 29 days, and all 30 days). Past 30-day alternative tobacco product use frequency was assessed separately for cigars and smokeless tobacco (chew, snuff, dip) using the same 7-point scale with the following questions: “During the past 30 days, on how many days did you use chewing tobacco, snuff, or dip, such as Redman, Levi Garrett, Beechnut, Skoal, Skoal Bandits, or Copenhagen?” and “During the past 30 days, on how many days did you smoke cigars, cigarillos, or little cigars?”. Electronic cigarette and waterpipe/hookah use were not assessed in the survey. For the current analyses, past 30-day cigarette, cigar, and smokeless tobacco use were recoded to 4 categories (0 days, 1–2 days, 3–9 days, and 10 days) due to low frequency counts for some items and to keep product use frequency indices consistent across tobacco product types. These three tobacco product variables were also coded as binary (yes/no) to determine which products were used exclusively or in combination as well as the total number of tobacco products used over the past 30 days (1 products, 2 products, and 3 products).

Substance use—Frequency of past 30-day alcohol use was assessed using the same 7-point scale as for tobacco products and was recoded to the same 4 categories. Past 30-day use of cannabis (actual survey term was “marijuana”) was assessed on a 6-point scale (0 times, 1–2 times, 3–9 times, 10–19 times, 20–39 times, and 40 times). Historically “marijuana” is a US-based term for cannabis products while elsewhere in the world the scientific name, cannabis, is more widely accepted (Serrano, 2013). Within this manuscript, we utilize cannabis terminology to ensure consistency across audiences. Lifetime use of other illicit drugs (cocaine, heroin, methamphetamines, inhalants, and ecstasy) was assessed with five separate items using the same scale as cannabis use. Due to low sample sizes, these five items were collapsed into a single binary item (lifetime other illicit drug use; None, 1

drug). Lifetime use of steroid pills/shots and other prescription drugs (“such as OxyContin, Percocet, Vicodin, codeine, Adderall, Ritalin, or Xanax”) without a doctor’s prescription were assessed with two separate items using the same scale as cannabis use. Due to low sample sizes, these two items were combined into a single binary item (lifetime prescription drug misuse; None, 1 drug).

Data Analysis

Due to missing data among the primary variables of interest in this study (e.g., 5.7% for past 30-day cigarette use), multiple imputation was performed with the entire sample of 6935 cases for tobacco, substance use, and demographic variables. Variables were imputed using a fully conditional specification (FCS) method due to the arbitrary missing pattern and the nominal and ordinal nature of the variables (Berglund, 2015). Sample weights, stratum, and cluster (PSU) variables were included in the FCS method to account for complex survey data. All subsequent variable coding and data analyses were conducted with the 5 multiply imputed datasets. The SAS procedure MIANALYZE and combchi macro (Statistical Horizons, nd) were used to combine estimates across imputed datasets.

The sample was categorized first by past 30-day tobacco and cannabis co-use status: (1) tobacco-only user (reported at least one day of cigarette, smokeless tobacco, or cigar use and no cannabis use) or (2) tobacco and cannabis co-user (reported tobacco and cannabis use at least one day/time in the past 30 days). Then, weighted bivariate analyses by tobacco and cannabis co-use status were performed for all measures: age, race/ethnicity, gender, past 30-day cigarette use, past 30-day smokeless tobacco use, past 30-day cigar use, number of tobacco products used in past 30 days, past 30-day cannabis use, past 30-day alcohol use, lifetime other illegal drug use, and lifetime prescription drug misuse. Descriptive statistics were then used to determine past 30-day tobacco use rates by exclusive (e.g., cigarette-only) and combination use (e.g., cigarettes + cigars) status among tobacco-only users and tobacco and cannabis co-users. Next, four separate weighted multivariate logistic regression models were computed predicting tobacco and cannabis co-use status with tobacco-only users as the referent group. In keeping with an exploratory approach rather than stepwise, each model included age, race/ethnicity, gender, past 30-day cigarette use, past 30-day smokeless use, past 30-day cigar use, past 30-day alcohol use, lifetime illegal drug use, and lifetime prescription drug misuse as covariates. Number of tobacco products used in the past 30 days was excluded as a logistic regression model covariate due to its correlation with other past 30-day indices of tobacco use. The first logistic model (1) included the entire sample of tobacco users. To understand whether associations differed by tobacco product type used, three additional models were conducted (models 2 through 4). Model 2 included all individuals who reported smoking cigarettes in the past 30 days (regardless of other tobacco product use reported). Model 3 included all individuals who reported using smokeless tobacco in the past 30 days (regardless of other tobacco product use reported). Model 4 included all individuals who reported smoking cigars in the past 30 days (regardless of other tobacco product use reported). Samples examined in models 2–4 were not mutually exclusive; thus, because many of the participants reported poly-tobacco use, the same individuals may be included in models 2–4. All analyses utilized SAS 9.4.

Results

Overall Sample Characteristics and Differences by Cannabis Use Status

Table 1 displays demographic, tobacco use, and other substance use characteristics for the overall sample of tobacco-only users and tobacco and cannabis co-users. Across the sample, most were older than 14 years, over half identified as White NH and male. For past 30-day tobacco use, 62% reported cigarette smoking, 43% reported smokeless tobacco use, and 58% reported cigar smoking. In terms of poly-tobacco use, 47% reported using two or more tobacco products in the past 30 days. Over half (59%) reported using cannabis at least 1 time in the past 30 days (i.e., identified as tobacco and cannabis co-users). Alcohol was the most prevalent substance used in the past 30 days (75%), and lifetime other illegal drug use and prescription drug misuse were both reported by just under half of youth.

Bivariate comparisons (see Table 1) revealed significant differences between tobacco-only and tobacco and cannabis co-users by age and race/ethnicity but not gender. Co-users reported a higher frequency of cigarette, cigar, and alcohol use days in the past 30 days, and number of tobacco products used compared to tobacco-only users ($p < 0.001$). Compared to tobacco-only users, over twice as many co-users reported lifetime other illegal drug use and/or reported prescription drug misuse compared to tobacco-only users ($p < 0.001$).

Patterns of Tobacco Product Use by Cannabis Use Status

Tobacco-only users and tobacco and cannabis co-users were classified into tobacco product use sub-types based on any past 30-day use (yes/no) of cigarettes, smokeless tobacco, and cigars (see Table 2). Among tobacco-only users, the three highest frequency sub-types were smokeless tobacco-only use (28%) followed by cigarette-only use (21%) and cigar-only use (16%). Among tobacco and cannabis co-users, the three highest frequency sub-types were cigarette and cigar use (22%), cigarette-only use (21%), and use of all three products (21%).

Correlates of Tobacco and Cannabis Co-use By Tobacco Product Type

Table 3 shows results of the four logistic regression models predicting tobacco and cannabis co-use with identical covariates. Among all past 30-day tobacco users (model 1), significant positive associations with co-use were observed for “Other” race/ethnicity relative to White NH, frequent past 30-day cigarette smoking (3 to 10 days), frequent past 30-day cigar smoking (3 to 10 days), any frequency of past 30-day alcohol use, lifetime illicit drug use, and lifetime prescription drug misuse. Frequent past 30-day smokeless tobacco use (10 days) was negatively associated with co-use. When restricted to past 30-day cigarette users (model 2), positive associations with co-use emerged for Black NH relative to White NH, frequent past 30-day cigarette smoking (3 to 10 days), any frequency of past 30-day alcohol use, lifetime illicit drug use, and lifetime prescription drug misuse. Among smokeless tobacco users (model 3), there were no significant associations between co-use and race/ethnicity but any frequency of cigarette smoking, frequent alcohol use (10 days), lifetime illicit drug use, and lifetime prescription drug misuse were positively associated. Similar to model 1, in model 3, frequent smokeless tobacco use (10 days) was negatively associated with co-use. Among cigar users (model 4), “Other” race/ethnicity was positively associated with co-use as well as frequent past 30-day cigar smoking (3 to 10 days),

frequent past 30-day alcohol use (3 to 10 days), lifetime illicit drug use, and lifetime prescription drug misuse.

Discussion

In the current study of Virginia youth who reported past 30-day tobacco use, cigarette smoking was the most prevalent product reported (62%) followed by cigar (58%) and smokeless tobacco (43%) with 47% reporting use of two or more tobacco products. Among these adolescent tobacco users, 59% reported past 30-day cannabis use, with heavy use (40 times in the past 30 days) reported by 16% of respondents. Among tobacco-only users, exclusive use of smokeless tobacco or cigarettes were the most common tobacco user sub-types. For tobacco and cannabis co-users, exclusive and poly-tobacco user sub-types involving smoked tobacco products (cigarettes and cigars) were the most frequent. The high prevalence of smoked tobacco use among co-users may be due to the similarity of this route of administration to that of smoked cannabis and popularity of cannabis use methods involving combustion and combination with tobacco products (e.g., blunts, joints/spliffs; Schauer, King, Bunnell, Promoff, & McAfee, 2016). Consistent with adult data (Schauer, Berg, et al., 2016), past 30-day poly-tobacco use was higher among tobacco and cannabis co-users compared to tobacco-only-users (55% vs. 34%). Also consistent with previous work (Ramo et al., 2012; Schauer et al., 2015), logistic regression models indicated tobacco and cannabis co-use was associated with identifying as a racial/ethnic minority, past 30-day cigarette use, past 30-day cigar use, past 30-day alcohol use, and lifetime other substance use.

Several correlates differed across tobacco and cannabis co-users as a function of tobacco product type. Identifying as “Other” race/ethnicity was associated with tobacco and cannabis co-use among two of the models (tobacco users of any type; past 30-day cigar users). Due to the diverse make-up of this racial/ethnic category (e.g., Hispanic, more than one race), this finding is difficult to disentangle but with a larger sample may be better explored. Past 30-day cigarette use was not associated with tobacco and cannabis co-use among cigar users (unlike all other models) suggesting that co-use in this group did not differ as a function of cigarette smoking frequency. This finding seems in opposition to that observed in Table 2 where cigarette and cigar co-use was one of the most common tobacco use subtypes observed among tobacco and cannabis co-users (22%). Importantly, cigar-only use was also common (19%) among co-users indicating that cigar and cannabis co-users engage in various use patterns of these two substances. Importantly these logistic regression models, which account for additional covariates beyond tobacco use, illustrate that other factors impact associations between tobacco-only use and tobacco and cannabis co-use. One explanation for these findings is co-use among cigar smokers may be less likely to involve the use of cigarettes/joints (i.e., placing tobacco inside of a cigarette rolling paper) relative to cigars/blunts (i.e., placing cannabis inside a hollowed out cigar casing; Montgomery & Oluwoye, 2016). While research has identified that some Black young adults report using little cigars and cigarillos “only for weed” (Gonzalez, Cofie, & Trapl, 2017) and/or misreport their cigar use behavior (i.e., do not perceive blunts as tobacco use; Golub, Johnson, & Dunlap, 2005), here tobacco and cannabis co-use was associated with cigar smoking frequency in the overall model and among cigar smokers specifically. Importantly,

the overlap of cigar, cigarette, and cannabis use via the administration routes of joints and blunts challenges traditional assessments if co-use is not considered during questionnaire/item development. Lastly, the smokeless-only co-use groups had the lowest percentage of co-users (5%) compared to tobacco-only users (28%; see Table 2), and this tobacco type was the only form that was negatively associated with co-use. This effect may reflect sociodemographic and cultural differences for youth who primarily use smokeless tobacco, a product class often associated with rurality, White NH race/ethnicity, male gender, and use as form of expression of masculinity (Arrazola et al., 2014; Roberts et al., 2014). The infrequent use of smokeless tobacco among co-users strengthens the argument that combusted tobacco product use may be more important to target in prevention efforts.

Regardless of tobacco product type assessed, alcohol use in the past 30 days, lifetime illegal drug use, and lifetime prescription drug misuse were positively associated with tobacco and cannabis co-use (models 1–4). Previous work including longitudinal mixture models has identified a strong relationship between co-use and other substance use (Ramo et al., 2012), particularly alcohol (Cohn et al., 2016; Jackson et al., 2008; Schauer et al., 2015; Schauer, Berg, et al., 2016), but this study is the first to highlight a strong relationship between this substance use pattern and prescription drug misuse specifically among youth. At least two latent class analyses of young adults also have documented small classes of poly-substance users (including tobacco, cannabis, alcohol, and other substances; Evans-Polce, Lanza, & Maggs, 2016; Quek et al., 2013). Future work using latent class analysis methods could elucidate whether this same group of poly-substance users (inclusive of prescription drugs) exists among youth. Considering misuse of prescription drugs is the most highly abused category of drugs following marijuana among 12th graders (6.4% in 2014; Johnston et al., 2015), and the growth of prescription opioid abuse nationwide as well as in Virginia (Paulozzi, Jones, Mack, & Rudd, 2011), the current analysis supports strengthening efforts to intervene with this vulnerable group of youth who are likely abusing a range of other substances (Agrawal et al., 2011).

Taken together, it seems that tobacco prevention efforts should consider that some youth groups, such as combustible tobacco users, those who report alcohol or other substance use, and those identifying as non-White NH may also be at greater risk for cannabis use. As more states begin legalizing recreational cannabis use and cannabis use in general becomes a common topic of discussion nationally, tobacco prevention interventions may represent an opportunity to also address cannabis use prevention. Specifically, because combustible tobacco product use may be more of a risk factor for cannabis use, cannabis prevention may be incorporated into discussions on the risks of cigarettes or cigars. Additionally, health professions providing interventions in communities/settings with higher prevalence of racial/ethnic minority youth should note that these youth may be at greater risk for cannabis use than others. Consideration of these tobacco and cannabis co-use associations among subgroups of youth may assist in the creation of more tailored health messages which could improve the effectiveness of youth tobacco and cannabis prevention efforts.

There are several limitations to the current study. The data analyzed in the study are cross-sectional and geographically limited to the state of Virginia. Tobacco use groups examined (i.e., cigarette, smokeless tobacco, cigar) in the study were not mutually exclusive and

therefore unique patterns of tobacco and cannabis co-use associated with a specific type of tobacco product use may be affected by the inclusion of other tobacco product users in a single model. However, participants were allowed to be included in multiple groups because nearly half of tobacco users in the sample reported multiple tobacco product type use and creating exclusive tobacco product type groups would have limited the ability to detect differences between tobacco and cannabis co-use groups. The sample size limited the ability to conduct sub-group analyses such as by race/ethnicity or exclusive tobacco product sub-types (e.g., cigar-only vs. cannabis/cigar-only users). Additionally, the survey did not assess hookah/waterpipe or electronic cigarette use; both products have grown rapidly in use among US youth (Jamal et al., 2017; US Department of Health and Human Services, 2014) and may have unique associations with cannabis use. Simultaneous tobacco and cannabis use behaviors such as use of blunts or joints/spliffs and alternative cannabis consumption methods (e.g., bongs, edibles) were also not assessed (Akre, Michaud, Berchtold, & Suris, 2010; Cohn et al., 2015; Jolly, 2008). Use of a larger sample and more detailed cannabis use assessments could address these issues. Finally, the focus of the current analysis was on demographic and behavioral associations with tobacco and cannabis co-use. From a common liability perspective, certain genes have been identified as common risk factors for tobacco and cannabis use suggesting some individuals are predisposed to tobacco and cannabis co-use (Stringer et al., 2016). Future work may aim to investigate the genetic contribution of these relationships by tobacco product type.

Despite these limitations, several important conclusions can be drawn from these findings. Consistent with other work (Cohn et al., 2016; Schauer, Berg, et al., 2016), correlates of tobacco and cannabis co-use in the current study were not uniform across all types of tobacco products. While some correlates were consistent, certain demographic and behavioral characteristics had a stronger association with tobacco and cannabis co-use depending on the tobacco product reported. Approximately 95% of co-users reported use of a smoked tobacco product either exclusively or combination with smokeless tobacco vs. 72% of tobacco-only users. This difference suggests co-users may be at greater risk for negative health effects associated with inhaled tobacco use. Poly-tobacco use was also more prevalent among tobacco and cannabis co-users which places this group at risk for higher levels of nicotine dependence (Ali, Gray, Martinez, Curry, & Horn, 2016). Other illegal drug use and prescription drug misuse was also strongly correlated with tobacco and cannabis co-use across tobacco product types. Future research should continue to examine the relationship between tobacco and cannabis use among youth and whether other factors, such as peer influence or group identification, influence tobacco and cannabis co-use patterns. Just as certain peer crowds report higher rates of tobacco use (Lisha, Jordan, & Ling, 2016), peer crowd affiliation may be associated with differential risk for tobacco and cannabis co-use. A greater understanding of the factors that influence tobacco and cannabis co-use will aid health professionals in developing effective tobacco and cannabis prevention and cessation interventions that target those at greatest risk.

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REFERENCES

- Agrawal A, & Lynskey MT (2009). Tobacco and cannabis co-occurrence: does route of administration matter? *Drug Alcohol Depend*, 99(1–3), 240–247. Doi:10.1016/j.drugalcdep.2008.08.007 [PubMed: 18926646]
- Agrawal A, Scherrer JF, Lynskey MT, Sartor CE, Grant JD, Haber JR, . . . Xian H. (2011). Patterns of use, sequence of onsets and correlates of tobacco and cannabis. *Addict Behav*, 36(12), 1141–1147. Doi:10.1016/j.addbeh.2011.07.005 [PubMed: 21820810]
- Agrawal A, Silberg JL, Lynskey MT, Maes HH, & Eaves LJ (2010). Mechanisms underlying the lifetime co-occurrence of tobacco and cannabis use in adolescent and young adult twins. *Drug Alcohol Depend*, 108(1–2), 49–55. Doi:10.1016/j.drugalcdep.2009.11.016 [PubMed: 20047801]
- Akre C, Michaud PA, Berchtold A, & Suris JC (2010). Cannabis and tobacco use: where are the boundaries? A qualitative study on cannabis consumption modes among adolescents. *Health Educ Res*, 25(1), 74–82. Doi:10.1093/her/cyp027 [PubMed: 19515745]
- Ali M, Gray TR, Martinez DJ, Curry LE, & Horn KA (2016). Risk Profiles of Youth Single, Dual, and Poly Tobacco Users. *Nicotine Tob Res*, 18(7), 1614–1621. Doi:10.1093/ntr/ntw028 [PubMed: 26896162]
- Ameri A (1999). The effects of cannabinoids on the brain. *Prog Neurobiol*, 58(4), 315–348. [PubMed: 10368032]
- Arrazola RA, Neff LJ, Kennedy SM, Holder-Hayes E, Jones CD, Centers for Disease, C., & Prevention. (2014). Tobacco use among middle and high school students—United States, 2013. *MMWR Morb Mortal Wkly Rep*, 63(45), 1021–1026. [PubMed: 25393220]
- Berglund P. (2015). Multiple imputation using the fully conditional specification method: a comparison of SAS®, Stata, IVEware, and R. Retrieved from Cary, NC: <http://support.sas.com/resources/papers/proceedings15/2081-2015.pdf>
- Brook JS, Lee JY, Finch SJ, & Brown EN (2010). Course of comorbidity of tobacco and marijuana use: psychosocial risk factors. *Nicotine Tob Res*, 12(5), 474–482. Doi:10.1093/ntr/ntq027 [PubMed: 20231241]
- Center for Behavioral Health Statistics and Quality. (2015). Behavioral health trends in the United States: Results from the 2014 National Survey on Drug Use and Health (HHS Publication No. SMA 15–4927, NSDUH Series H-50). Rockville, MD: Substance Abuse and Mental Health Services Administration Retrieved from <http://www.samhsa.gov/data/sites/default/files/NSDUH-FRR1-2014/NSDUH-FRR1-2014.htm#idtextanchor009>.
- Centers for Disease Control and Prevention. (2016a). Child Development: Young Teens (12–14 years of age). Retrieved from <http://www.cdc.gov/ncbddd/childdevelopment/positiveparenting/adolescence.html>
- Centers for Disease Control and Prevention. (2016b). Trends in Current Cigarette Smoking Among High School Students and Adults, United States, 1965–2014. Retrieved from http://www.cdc.gov/tobacco/data_statistics/tables/trends/cig_smoking/
- Cohn A, Johnson A, Ehlke S, & Villanti AC (2016). Characterizing substance use and mental health profiles of cigar, blunt, and non-blunt marijuana users from the National Survey of Drug Use and Health. *Drug Alcohol Depend*, 160, 105–111. Doi:10.1016/j.drugalcdep.2015.12.017 [PubMed: 26803718]
- Cohn A, Villanti A, Richardson A, Rath JM, Williams V, Stanton C, & Mermelstein R (2015). The association between alcohol, marijuana use, and new and emerging tobacco products in a young adult population. *Addict Behav*, 48, 79–88. Doi:10.1016/j.addbeh.2015.02.005 [PubMed: 26042613]
- Cohn AM, Johnson AL, Rath J, & Villanti AC. (2016). Patterns and correlates of co-use of alcohol, marijuana, and emerging tobacco products in a national sample of young adults. *Am J Addict*. doi:doi:10.1111/ajad.12456
- Cooper ZD, & Haney M. (2009). Comparison of subjective, pharmacokinetic, and physiological effects of marijuana smoked as joints and blunts. *Drug Alcohol Depend*, 103(3), 107–113. doi:10.1016/j.drugalcdep.2009.01.023 [PubMed: 19443132]

- Evans-Polce R, Lanza S, & Maggs J. (2016). Heterogeneity of alcohol, tobacco, and other substance use behaviors in U.S. college students: A latent class analysis. *Addict Behav*, 53, 80–85. doi: 10.1016/j.addbeh.2015.10.010 [PubMed: 26476004]
- Golub A, Johnson BD, & Dunlap E (2005). The growth in marijuana use among American youths during the 1990s and the extent of blunt smoking. *J Ethn Subst Abuse*, 4(3–4), 1–21. doi:10.1300/J233v04n03_01
- Gonzalez SJK, Cofie LE, & Trapl ES (2017). “I just use it for weed”: The modification of little cigars and cigarillos by young adult African American male users. *J Ethn Subst Abuse*, 16(1), 66–79. doi: 10.1080/15332640.2015.1081117 [PubMed: 26643132]
- Jackson KM, Sher KJ, & Schulenberg JE (2008). Conjoint developmental trajectories of young adult substance use. *Alcohol Clin Exp Res*, 32(5), 723–737. doi:10.1111/j.1530-0277.2008.00643.x [PubMed: 18331376]
- Jamal A, Gentzke A, Hu SS, Cullen KA, Apelberg BJ, Homa DM, & King BA (2017). Tobacco Use Among Middle and High School Students - United States, 2011–2016. *MMWR Morb Mortal Wkly Rep*, 66(23), 597–603. doi:10.15585/mmwr.mm6623a1 [PubMed: 28617771]
- Johnston LD, O'Malley PM, Miech RA, Bachman JG, & Schulenberg JE (2015). Monitoring the Future national survey results on drug use: 1975–2014: Overview, key findings on adolescent drug use. Ann Arbor: Institute for Social Research, The University of Michigan Retrieved from <http://www.monitoringthefuture.org/pubs/monographs/mtf-overview2014.pdf>.
- Jolly DH (2008). Exploring the use of little cigars by students at a historically black university. *Prev Chronic Dis*, 5(3), A82. [PubMed: 18558032]
- Jones RM, Wiseman KP, & Kharitonova M. (2016). Association between high school students' cigarette smoking, asthma and related beliefs: a population-based study. *BMC Public Health*, 16(1), 913. doi:10.1186/s12889-016-3579-7 [PubMed: 27586515]
- Lisha NE, Jordan JW, & Ling PM (2016). Peer crowd affiliation as a segmentation tool for young adult tobacco use. *Tob Control*, 25(Suppl 1), i83–i89. doi:10.1136/tobaccocontrol-2016-053086 [PubMed: 27697952]
- Martinasek MP, McGrogan JB, & Maysonet A. (2016). A Systematic Review of the Respiratory Effects of Inhalational Marijuana. *Respir Care*. doi:10.4187/respcare.04846
- Montgomery L, & Oluwoye O (2016). The truth about marijuana is all rolled up in a blunt: prevalence and predictors of blunt use among young African-American adults. *Journal of Substance Use*, 21(4), 374–380. doi:10.3109/14659891.2015.1037365
- Nasim A, Blank MD, Berry BM, & Eissenberg T. (2012). Cigar use misreporting among youth: data from the 2009 Youth Tobacco Survey, Virginia. *Prev Chronic Dis*, 9, E42. [PubMed: 22261252]
- National Institute on Drug Abuse. (2016). DrugFacts—High School and Youth Trends. Retrieved from <https://www.drugabuse.gov/publications/drugfacts/high-school-youth-trends>
- Passarotti AM, Crane NA, Hedeker D, & Mermelstein RJ (2015). Longitudinal trajectories of marijuana use from adolescence to young adulthood. *Addict Behav*, 45, 301–308. doi:10.1016/j.addbeh.2015.02.008 [PubMed: 25792233]
- Paulozzi L, Jones C, Mack K, & Rudd R (2011). Vital Signs: Overdoses of Prescription Opioid Pain Relievers --- United States, 1999—2008. *MMWR Morb Mortal Wkly Rep*, 60(43), 1487–1492. [PubMed: 22048730]
- Quek LH, Chan GC, White A, Connor JP, Baker PJ, Saunders JB, & Kelly AB (2013). Concurrent and simultaneous polydrug use: latent class analysis of an Australian nationally representative sample of young adults. *Front Public Health*, 1, 61. doi:10.3389/fpubh.2013.00061 [PubMed: 24350230]
- Rabin RA, & George TP (2015). A review of co-morbid tobacco and cannabis use disorders: possible mechanisms to explain high rates of co-use. *Am J Addict*, 24(2), 105–116. doi:10.1111/ajad.12186 [PubMed: 25662704]
- Ramo DE, Liu H, & Prochaska JJ (2012). Tobacco and marijuana use among adolescents and young adults: a systematic review of their co-use. *Clin Psychol Rev*, 32(2), 105–121. doi:10.1016/j.cpr.2011.12.002 [PubMed: 22245559]
- Ramo DE, & Prochaska JJ (2012). Prevalence and co-use of marijuana among young adult cigarette smokers: An anonymous online national survey. *Addict Sci Clin Pract*, 7, 5. doi: 10.1186/1940-0640-7-5 [PubMed: 23186143]

- Roberts AL, Rosario M, Calzo JP, Corliss HL, Frazier L, & Austin SB (2014). Masculine boys, feminine girls, and cancer risk behaviors: an 11-year longitudinal study. *J Adolesc Health*, 55(3), 373–379. doi:10.1016/j.jadohealth.2014.02.020 [PubMed: 24746678]
- Schauer GL, Berg CJ, Kegler MC, Donovan DM, & Windle M (2015). Assessing the overlap between tobacco and marijuana: Trends in patterns of co-use of tobacco and marijuana in adults from 2003–2012. *Addict Behav*, 49, 26–32. doi:10.1016/j.addbeh.2015.05.012 [PubMed: 26036666]
- Schauer GL, Berg CJ, Kegler MC, Donovan DM, & Windle M (2016). Differences in Tobacco Product Use Among Past Month Adult Marijuana Users and Nonusers: Findings From the 2003–2012 National Survey on Drug Use and Health. *Nicotine Tob Res*, 18(3), 281–288. doi:10.1093/ntn/ntv093 [PubMed: 26009578]
- Schauer GL, King BA, Bunnell RE, Promoff G, & McAfee TA (2016). Toking, Vaping, and Eating for Health or Fun: Marijuana Use Patterns in Adults, U.S., 2014. *Am J Prev Med*, 50(1), 1–8. doi:10.1016/j.amepre.2015.05.027 [PubMed: 26277652]
- Serrano A (2013). Weed all about it: The origins of the word ‘marijuana’. Retrieved from <http://america.aljazeera.com/articles/2013/12/14/weed-all-about-ittheoriginsofthewordmarijuanaaintheus.html>
- Statistical Horizons. (nd) (Version SAS Macros. COMBCHI). Retrieved from <https://statisticalhorizons.com/wp-content/uploads/combchi.sas>
- Stringer S, Minica CC, Verweij KJ, Mbarek H, Bernard M, Derringer J, . . . Vink JM (2016). Genome-wide association study of lifetime cannabis use based on a large meta-analytic sample of 32 330 subjects from the International Cannabis Consortium. *Transl Psychiatry*, 6, e769. doi:10.1038/tp.2016.36 [PubMed: 27023175]
- Substance Abuse and Mental Health Services Administration. (2010). Results from the 2009 National Survey on Drug Use and Health: *Volume I* Summary of National Findings Rockville, MD.
- Sutter ME, Nasim A, Veldheer S, & Cobb CO (2016). Associations between unhealthy dieting behaviors and tobacco use among adolescents. *J Eat Disord*, 4, 39. doi:10.1186/s40337-016-0126-y [PubMed: 28018597]
- US Department of Health and Human Services. (2014). *The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General*: Atlanta, GA. Retrieved from <https://www.surgeongeneral.gov/library/reports/50-years-of-progress/full-report.pdf>.
- Virginia Department of Health. (2016). Virginia Youth Survey. Retrieved from <http://www.vdh.virginia.gov/livewell/data/surveys/youthsurvey/files.html>
- Yayan J, & Rasche K. (2016). Damaging Effects of Cannabis Use on the Lungs. *Adv Exp Med Biol*. doi:10.1007/5584_2016_71

Table 1.

Characteristics of Overall Sample of Virginia High School Past 30-day Tobacco Users and Comparisons by Past 30-day Cannabis Use Status

Characteristics	Overall Sample		Tobacco-Only Users		Tobacco/Cannabis Users		p
	n	Weighted %	n	Weighted %	n	Weighted %	
		n=1390		n=559		n=831	
Age							0.027
14 years old	203	11.7	97	14.3	106	9.8	
15 years old	1187	88.3	462	85.7	725	90.2	
Race/ethnicity							<0.001
White NH	725	57.9	348	67.5	376	51.2	
Black NH	290	22.9	90	17.4	200	26.8	
Other	375	19.1	121	15.1	255	21.9	
Gender							0.079
Male	828	61.2	352	65.2	476	58.4	
Female	562	38.8	207	34.8	356	41.6	
Past 30-day cigarette use							<0.001
0 days	507	38.0	279	51.1	228	28.8	
1–2 days	279	19.9	134	23.3	145	17.6	
3–9 days	213	15.4	63	10.2	150	19.0	
10 days	390	26.7	82	15.5	308	34.6	
Past 30-day smokeless tobacco use							0.015
0 days	797	57.5	276	51.1	520	61.9	
1–2 days	175	12.4	92	15.0	83	10.6	
3–9 days	167	12.3	74	13.1	93	11.7	
10 days	251	17.9	117	20.8	135	15.8	
Past 30-day cigar use							<0.001
0 days	611	42.5	324	55.3	287	33.6	
1–2 days	337	25.8	141	27.5	196	24.7	
3–9 days	260	17.2	65	10.5	194	22.0	
10 days	182	14.4	28	6.7	155	19.8	
Number of tobacco products used in past 30 days							<0.001
1 product	739	53.5	368	65.7	371	45.0	
2 products	437	31.0	145	26.1	292	34.5	
3 products	214	15.5	46	8.2	168	20.6	
Past 30-day cannabis use in times							
0 times	559	41.2	559	100.0	-	-	NA
1–2 times	194	13.3	-	-	194	22.6	
3–9 times	209	16.9	-	-	209	28.7	

		Overall Sample	Tobacco-Only Users (Weighted % = 41.2)		Tobacco/Cannabis Users (Weighted % = 58.8)		
		<i>n</i> =1390	<i>n</i> =559		<i>n</i> =831		
Characteristics	n	Weighted %	n	Weighted %	n	Weighted %	p
10–19 times	117	7.5		-	117	12.7	
20–39 times	76	5.0		-	76	8.6	
40 times	235	16.1		-	235	27.4	
Past 30-day alcohol use							<0.001
0 days	349	25.0	230	40.1	120	14.4	
1–2 days	366	27.1	163	30.0	203	25.1	
3–9 days	434	31.0	122	21.9	312	37.3	
10 days	241	17.0	43	7.9	197	23.3	
Lifetime other illegal drug use							<0.001
None	777	57.4	405	74.3	372	45.5	
1 drug	613	42.6	154	25.7	459	54.5	
Lifetime prescription drug misuse							<0.001
None	681	50.8	396	70.8	285	36.8	
1 drug	709	49.2	162	29.2	547	63.2	

Note: Items with a significant bivariate association are bolded. Significance is based on the adjusted F (Wald chi-square statistic) and its degrees of freedom. Frequencies are rounded to the nearest whole number and based on the frequency and standard deviation of the five imputed datasets.

Table 2.

Tobacco Use Sub-Types Among Past 30-day Tobacco-Only Users and Tobacco and Cannabis Co-Users

Tobacco Use Sub-type	Tobacco-Only Users		Tobacco/Cannabis Co-Users	
	(Weighted % = 41.2)		(Weighted % = 58.8)	
	<i>n</i> =559		<i>n</i> =831	
	n	Weighted %	n	Weighted %
Cigarette-only use	124	21.2	178	20.6
Smokeless tobacco-only use	161	28.4	40	5.2
Cigar-only use	83	16.1	153	19.2
Cigarette + smokeless tobacco use	40	5.7	68	7.8
Cigarette + cigar use	70	13.8	189	22.2
Smokeless + cigar use	35	6.6	35	4.5
Cigarette + smokeless tobacco + cigar use	46	8.2	168	20.6

Note: Tobacco use items assessed past 30-day use for each product or combination (yes/no). Tobacco/cannabis users reported cannabis use at least one time in the past 30 days. Frequencies are rounded to the nearest whole number and based on the frequency and standard deviation of the five imputed datasets.

Table 3.

Correlates of Past 30-day Cannabis and Tobacco Use Relative to Tobacco-Only Use (reference group) as a function of Tobacco Product Consumed

Characteristics	Logistic Model 1 Past 30-day Tobacco Users of Any Type <i>n</i> =1390			Logistic Model 2 Past 30-day Cigarette Users <i>n</i> =883			Logistic Model 3 Past 30-day Smokeless Tobacco Users <i>n</i> =593			Logistic Model 4 Past 30-day Cigar Users <i>n</i> =779		
	AOR	95% CI	LL	UL	AOR	95% CI	LL	UL	AOR	95% CI	LL	UL
Age												
14 years	Ref				Ref				Ref			
15 years	1.38	0.89	2.16		1.24	0.67	2.30		1.69	0.80	3.57	
Race/ethnicity												
White NH	Ref				Ref				Ref			
Black NH	1.90	0.94	3.86		2.62	1.15	5.96		1.35	0.42	4.34	
Other	1.62	1.01	2.57		1.57	0.90	2.76		1.31	0.73	2.35	
Gender												
Male	Ref				Ref				Ref			
Female	1.17	0.75	1.81		0.96	0.56	1.65		1.03	0.43	2.46	
Past 30-day cigarette use												
0 days	Ref				-				Ref			
1–2 days	1.08	0.69	1.68		Ref				2.94	1.30	6.66	
3–9 days	2.21	1.24	3.95		1.86	1.00	3.45		3.27	1.27	8.40	
10 days	2.13	1.20	3.80		1.76	1.04	2.98		3.91	1.55	9.89	
Past 30-day smokeless use												
0 days	Ref				Ref				-			
1–2 days	0.63	0.36	1.08		0.78	0.34	1.78		Ref			
3–9 days	0.59	0.31	1.13		0.82	0.36	1.86		0.90	0.42	1.90	
10 days	0.42	0.25	0.68		0.73	0.40	1.35		0.52	0.30	0.89	
Past 30-day cigar use												
0 days	Ref				Ref				Ref			
1–2 days	1.26	0.76	2.10		0.73	0.35	1.49		0.92	0.33	2.56	
									-			
									Ref			

Characteristics	Logistic Model 1 Past 30-day Tobacco Users of Any Type <i>n</i> =1390			Logistic Model 2 Past 30-day Cigarette Users <i>n</i> =883			Logistic Model 3 Past 30-day Smokeless Tobacco Users <i>n</i> =593			Logistic Model 4 Past 30-day Cigar Users <i>n</i> =779		
	95% CI			95% CI			95% CI			95% CI		
	AOR	LL	UL	AOR	LL	UL	AOR	LL	UL	AOR	LL	UL
3–9 days	2.24	1.42	3.54	1.47	0.82	2.65	1.79	0.91	3.51	1.84	1.01	3.34
10 days	2.40	1.25	4.62	1.39	0.67	2.90	2.36	0.96	5.85	2.33	1.02	5.32
Past 30-day alcohol use												
0 days	Ref			Ref			Ref			Ref		
1–2 days	2.05	1.12	3.74	2.86	1.27	6.47	1.79	0.68	4.71	1.58	0.78	3.17
3–9 days	3.87	2.22	6.75	4.66	2.30	9.42	2.53	0.82	7.82	4.70	2.08	10.60
10 days	4.94	2.39	10.22	5.67	2.21	14.52	5.54	1.53	20.00	5.02	1.68	14.93
Lifetime other illegal drug use												
None	Ref			Ref			Ref			Ref		
1 drug	2.00	1.37	2.90	2.06	1.30	3.27	2.56	1.52	4.31	1.93	1.14	3.27
Lifetime prescription drug misuse												
None	Ref			Ref			Ref			Ref		
1 drug	2.28	1.58	3.29	3.14	1.86	5.30	3.09	1.60	5.99	2.09	1.22	3.59

Note: AOR = adjusted odds ratio; CI = confidence interval; LL=Lower limit; UL=Upper limit; Ref = reference subgroup. All items listed were included in each model tested. Bolded items have a significant association in at least one model ($p<0.05$). Participants included in models 2–4 were not mutually exclusive; that is, all participants in model 2 reported cigarette smoking, all participants in model 3 reported smokeless tobacco use, and all participants in model 4 reported cigar smoking. AOR greater than 1 indicates greater likelihood of concurrent tobacco and cannabis use compared to tobacco-only use (reference subgroup). Frequencies are rounded to the nearest whole number and based on the frequency and standard deviation of the five imputed datasets.