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Date

# The Gateway Drug in Young Adult College Students: The Tobacco or Marijuana Products They Start With and Subsequent Use Profiles

By

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Master of Public Health

Epidemiology

_____

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# The Gateway Drug in Young Adult College Students: The Tobacco or Marijuana Products They Start With and Subsequent Use Profiles

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2016

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## Abstract

The Gateway Drug in Young Adult College Students: The Tobacco or Marijuana Products They Start With and Subsequent Use Profiles

By Amy Jung eun Park

**Background**: Little research has been done on the application of the gateway theory in relation to the current tobacco market, as well as in the current policy and social norms context regarding marijuana use. We examined: the extent to which first product used predicted subsequent use of tobacco and marijuana, specifically total number of products used in the lifetime, total number of products currently used, and current use of each product.

**Methods**: Data was from a two-year longitudinal study consisting of 3,418 U.S. young adult college student in Georgia. Correlates we examined were sociodemographic, psychosocial factors, and parental use of cigarettes, ATPs, and marijuana. Our outcomes were tobacco products, lifetime ever use, and past 30-day use.

**Results**: More products ever used was significantly associated with being older, male, other race, higher parental education, attending public school, living in an urban environment, experiencing more ACEs, more ADHD symptoms, and parental use of ATPs or marijuana, and SLT as first tobacco product. More products used in the past 30-days was significantly associated with being younger, other race, sexual minority, lower parental education, experiencing more ACEs, more ADHD and depressive symptoms, parental use of marijuana, and choosing SLT as first tobacco product. Predictors of past 30-day use of each are as follows: ***cigarettes***: first product used *not* being LCCs, e-cigarettes, hookah, or marijuana; first product used *not* being marijuana; ***smokeless tobacco***: first product used being smokeless tobacco; ***e-cigarettes***: no significant association with first product used; ***hookah***: first product used being hookah; and ***marijuana***: first product being used *not* being hookah but being marijuana.

**Conclusion**: The use of cigarettes as the first product used predicted more products ever used in the lifetime and in the past 30-days, compared to most other products as first product used (excluding SLT). Moreover, there is some specificity in terms of first product use and current product use, particularly for cigarettes, SLT, hookah, and marijuana. Thus, prevention efforts should be informed by this data. Specifically, cigarette use as first product can be considered as an indicator of overall subsequent use risk and recognize the specificity in relation to use trajectories for some products.

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# LITERATURE REVIEW

## Cigarettes, Alternative Tobacco Products, and Marijuana Use

Smoking is the leading cause of preventable disease and premature death in the world. According to the World Health Organization, tobacco kills more than 7 million people annually (1). In the United States (U.S.), more than 480,000 Americans died each year from smoking cigarettes from 2005 to 2009 according to Center for Disease Control and Prevention (CDC) (2). Though 2017 Morbidity and Mortality Weekly Report (MMWR) stated that the nationwide smoking prevalence declined from 20.9% in 2005 to 14.0% in 2017, nearly 34.3 million adult Americans are still smoking cigarettes (3). Of the U.S. adult smokers, according to 2019 Surgeon General, about 90% of daily smokers had their first cigarette by the age of 18, and 99% tried their first cigarette by the age of 26 (5). Indeed, adolescence is a critical period in initiation, with more than 2,000 adolescents (i.e., under the age of 18) trying their first cigarette each day (4).

Recently, use of alternative tobacco products (ATP), such as cigars/little cigars, smokeless tobacco (SLT), electronic cigarettes (e-cigarettes), and hookah, has become increasingly prevalent. While the prevalence of smoking cigarettes among high school students decreased from 10.8% in 2015 to 8.8% in 2017, ATP use increased from 7.3% in 2015 to 13.2% in 2017 according to 2015 and 2017 YRBS (6,7). 2017 National Health Interview Survey (NHIS) show that, among adults, cigarettes were the most popular product in 2017, with current use prevalence of cigarette smoking being 14.0%, followed by cigars (3.8%), e-cigarettes (2.8%), SLT (2.1%), and hookah (1.0%) (3). Data from the 2017 National Survey on Drug Use and

Health (NSDUH) show cigarettes, cigars, and SLT appear to be popular among young adults, with 22.3%, 9.1%, and 4.8% of young adults reporting use of cigarettes, cigars, and SLTs in 2017, respectively (72). As for adolescents (specifically 12th grade students), 2018 Monitoring the Future (MTF) data indicates that past 30-day prevalence of use of tobacco products was 7.6% for cigarettes, 5.2% large cigars (8.9% in flavored little cigars and 5.8% in regular little cigars), 4.2% SLT, 20.9% nicotine vape, and 4.4% hookah (56). Of particular note, the prevalence of e-cigarette use is increasing rapidly. For example, the National Youth Tobacco Survey (NYTS) data among U.S. middle and high school students, there was a 48% increase in middle school students and 78% increase of use among high school students from 2017 to 2018 (9).

Additionally, the most commonly used federally illicit drug is marijuana (57). In 2017, past-month use prevalence was 9.5% in adults, marking a 35% increase in the past decade (57,58). In 2017, adolescent use demonstrated the first significant increase in 7 years, with 24% reporting past-year use and 6.5% past-month use (79,59). 2018 MTF data indicates that past 30-day prevalence of marijuana use was 22.2% among 12th graders (57). Of note, the highest prevalence of use is in those 18-25 (21.5% in the past month), and the 20s are a critical period in marijuana use trajectories (57,60,61).

**The Gateway Theory**

The gateway theory was formulated originally in the 1970s to explain the frequently observed sequence in licit and illicit drug use (64,69,70) The gateway theory is controversial as it might discount alternative explanations, for example, characteristics of users that may predispose people to use (70). According to Bell and his colleagues, the gateway theory is problematically based on a predictive modeling instead of studying the causal associations (64). Regardless, in more recent years, the gateway theory has been applied to the range of ATPs as well as

marijuana use in relation to subsequent use of this range of substances as well as others (62,63,64,65,66).

For example, **Figure 1** represents the modern assumption of how use of e-cigarette will predict the use of cigarette in the future, according to Bell et al. Bell notes that there needs to be longitudinal studies that document sequence of product use, increased risk of choosing one product based on the first product, and causation (70).

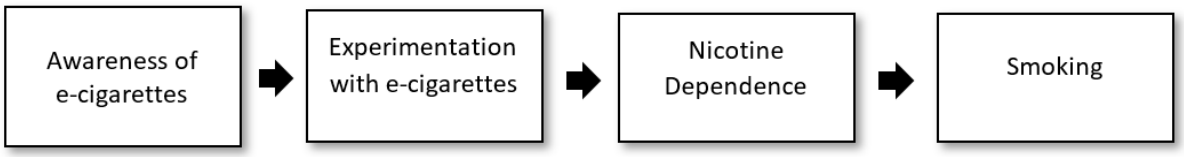


Figure 1: Modern perception of "gateway potential" of e-cigarettes and cigarette use (64).

Current literature on first tobacco and marijuana use is very limited. In 2015, a cross-sectional study by Suftin and colleagues with 3,146 college students found that 38% chose cigarettes as their first product, while 29% chose cigars, 25% chose hookah, and 6% chose SLT as their first tobacco product (31). Earlier research documented different statistics, indicating cigarettes being used first more commonly. For example, the 2012 Legacy Young Adult Cohort study involving a nationally representative sample of 4,201 young adults found that 73% started with cigarettes first, 11% with cigars, 5% with little cigars, and 4% with hookah (32). Additionally, 2012 NYTS data indicated that 20.3% of middle school students and 7.2% of high school students indicated using e-cigarettes as their first tobacco product (2).

Suftin and colleagues found that those who initiated with cigarettes or cigar products were more likely to be current cigarette smokers compared to those who initiated with other tobacco products (31). Other research has indicated that first using cigarettes increased the likelihood of initiating marijuana by four times (45) In another study, they found that women

who smoked cigarettes before entering college did not predict the use of hookah or marijuana use during college (53). Additionally, those who initiated with SLT were more likely to be current dual or poly tobacco users and twice more likely to initiate cigarettes (31,41). As for adolescents who use e-cigarettes, they were more willing to try cigarettes compared to those who were never users (47). Other studies have found that e-cigarette users were six times more likely to initiate cigarettes (42). Just like e-cigarettes, those who initiated with hookah have been shown to have higher odds of subsequent initiation of combustible tobacco products and ENDS (30). In addition, use of e-cigarettes or hookah was associated with increased risk of initiation of marijuana use (45). Lastly, one study on the "reverse gateway" found that use of marijuana during teens and young adulthood increased the risk of tobacco initiation (54). Also, using marijuana before attending college among women predicted initiation of hookah in college (53).

Cumulatively, these findings indicate that cigarettes are decreasingly being the first products tried, that trying any single product increased the risk of trying other products, that profiles of subsequent use are likely different depending on which product was used first, and that subsequent product use risk may be specific to the first product used, particularly in regard to cigarette use. However, longitudinal studies accounting for the diverse tobacco market and evolving social norms regarding marijuana are limited.

**Sociodemographic Correlates of Use of Tobacco and Marijuana Products**

A range of sociodemographic factors have been associated with tobacco and marijuana use, in terms of both first product used and current use. Data has indicated higher odds of using cigarettes as the first tobacco product among those younger than 17, females, Hispanics/Latinos, and those with a mother with more than four-year degree, relative to their counterparts (8,31).

However, correlates of current (past 30-day) cigarette smoking include low maternal education but not household income (80).

Cigars as first product used has been associated with being younger at age of initiation and being male (2,31,48). Among young adults, prevalence of cigar use was by Whites and Blacks, while among adults age 18 and up, American Indian and Alaskan Natives (AI/AN) and Black adults had higher prevalence of cigar use (2). Current use of LCC was correlated with being younger, Black, and non-Hispanics whereas large cigars were correlated with being male and Hispanic (78).

Like cigars, those who chose SLT as their first product were more likely to be male and younger than 17 years old in respect to females and older than 18 (31). In both youth and young adult population, White males were more likely to choose SLT as their first product than of Black, Hispanic, or "Other" youth (2,34,37). High prevalence of SLT was also seen in AI/AN and those who did not graduate from colleges from national and state surveys (38,39,40). A study looking at U.S. adult population in 2016 found that current SLT was correlated with being male and having less than a college degree (82).

In terms of e-cigarettes, a longitudinal study with 24-colleges in Texas found that young adult never smokers who perceived less harm using e-cigarettes were more likely to initiate use of e-cigarettes (46). 2013 Population Assessment of Tobacco ad Health (PATH) found that young adults with psychological problems and rebelliousness had increased susceptibility of starting e-cigarette use (48). Also, young adults who ever used alcohol, marijuana, and other substances, and exposure to secondhand smoking at home increased the risk of young adults smoking e-cigarettes (48). National Adult Tobacco Survey (NATS) found high current e-

cigarette use was seen in males, Whites (compared to “Other” race), and less than college degree (81).

Choosing hookah as first product was associated with being female, non-Hispanic African Americans, higher SES adolescents, and having a mother with more than four-year degree (8,31,35) In a study with 832 undergraduate students in New York who ever used a tobacco product, hookah was reported as first tobacco product used by 25.4% of the students (35). In the same study, approximately 50% of students reported hookah as their first product among never cigarette users (35). However, current use of hookah in adult population was correlated with being male, non-Hispanics of other races, and LGBT (83).

As for marijuana, there was a lack of literature on correlation between choosing marijuana as first product and any predictors. However, CDC’s 2017 national Youth Risk Behavior Surveillance System (YRBSS) show the highest use among high school students was seen in Blacks (42.8%), Hispanics (42.4%), and multiracial (40.4%) and non-Hispanic AI/AN had highest prevalence of marijuana initiation before the age of 13 (10). Also, female high school students were more likely to ever use a marijuana product whereas male students were more likely to initiate marijuana before the age of 13 (10). Past 30-day use of marijuana was correlated with being non-Hispanic multiracial and having a mother with at least a college degree (84).

In a 4,215 young adult cohort study, high prevalence of dual use was also seen in females, non-Hispanic Blacks, homosexual/bisexual, and low SES population (75,76,77). Among college students, those who were heavy polytobacco users were less likely to be Black, where as light polytobacco users were older and more likely to have parents using tobacco (74). 2011-2015 NYTS and TIYAC show that two most popular combination of tobacco among young

adult population were dual use of cigarettes and e-cigarettes, and cigarettes and cigars (73). 2014 NSDUH with 176,245 youths found that 5.4% youth co-use of tobacco and marijuana product (79)

**Psychosocial Correlates of Use of Tobacco and Marijuana**

There is limited literature on association between first tobacco and marijuana product used and psychosocial factors. Some literature indicates associations between first use of different tobacco products and adverse childhood experiences (ACEs), depression, and attention-deficit/hyperactivity disorder (ADHD).

*Adverse Childhood Experience*. ACEs are defined as "all types of abuse, neglect, and other potentially traumatic experiences that occur to people under the age of 18 (11)." The National Survey of Children's Health includes physical, sexual, and emotional abuse, physical and emotional neglect, and parental separation or divorce as examples of ACEs (11,12). Regardless of children's demographic background, children with more ACEs had higher odds of early substance initiation, daily tobacco and marijuana use, past 30-day marijuana use, and current SLT use (13,50,51). Experiencing more than five ACEs significantly increases the likelihood of cigarette smoking initiation, and ever, current, and heavy smoking (14,19). However, there is limited research on correlations between ACEs and using cigars, hookah, and e-cigarettes.

*Depression*. 2017 NSDUH data reports that approximately 17.3 million adults and 3.2 million adolescents, had at least one major depressive episode in their lifetime (16). Regardless of age, those living with depression are more likely to use and be dependent on nicotine compared to those who were not depressed (29). Those with higher depression score were more likely to initiate cigarette smoking among high school boys and young college adult population

and more likely to initiate e-cigarette among young college adult population (17,33). Based on 2010-2014 NSDUH study, major depressive episode was linked to marijuana initiation (71). Other than cigarette, e-cigarette, and marijuana use, there was lack of literature on association between depression and using cigars, SLT, e-cigarettes, and hookah.

*Attention-Deficit/Hyperactivity Disorder*. According to the 2016-2017 National Survey of Children's Health, about 6 million children of 3 to 17 years old are currently diagnosed with either Attention Deficit Disorder (ADD) or ADHD (18). Based on a longitudinal study following adolescents to young adulthood, being diagnosed with ADHD was associated with smoking tobacco or marijuana (49). Adolescents with ADHD were more likely to initiate cigarettes and e-cigarettes but not hookah (19,20,21,22,23). For cigars and SLTs, there was lack of literature on any associations with ADHD. As for marijuana, adolescents with ADHD smoked marijuana more frequently (21,22).

*Parental Influence on Use of Tobacco Products*. Parental tobacco use has been shown to influence the use of tobacco among their children. One longitudinal and one cross-sectional study with 3,012 and 2,417 children, respectively, found that having one parent smoker, in reference to neither parents smoking, increased the odds of ever smoking and risk of daily smoking (25,27). When both parents smoke, middle and high school students were more likely to be a current smoker (28). Maternal cigarette smoking increased the odds of adolescent cigarette smoking, whereas paternal SLT use increased the odds of adolescent boys initiating and using SLT (36,43,44). Similarly, parental e-cigarette use increases the odds of e-cigarette use (47). Interestingly, a cross-sectional survey of 7$^{th}$ graders found those who use of hookah have also been shown to be less likely to have parents who are cigarette smokers (52). Based on a cross-

sectional study with 3418 college students, having a parent who uses ATP or marijuana increased the level of ATP or marijuana use of students (26).

### Research Aims

In summary, the literature regarding the "gateway" phenomenon in the context of the current tobacco and marijuana market and social norms landscape is limited, with additional research needed to more fully characterize who is most likely to initiate use overall using distinct products and the subsequent use patterns that evolve based on which product was first used. This paper aims to contribute to the literature by examining tobacco and marijuana use outcomes (i.e., number of products ever used or currently used) in relation to first product used among ever users of tobacco or marijuana, as well as characterizing those who initially use the distinct tobacco products or marijuana.

## METHODS

### Procedure and Participants

Participants were sampled from a two-year cohort study, Project DECOY (Documenting Experiences with Cigarettes and Other Tobacco in Youth), which surveyed 3,418 young adults with diverse background from seven Georgia colleges or universities. The seven schools that participated in this study included two public universities, two private college/universities, two community/technical schools, and one HBCU (historically black college and university) from both rural and urban areas. The participants of this study were followed for two years and assessed every 4 months (totaling six waves of data).

Eligible participants included those between 18 and 25 years old and able to read English. Emails of students were obtained through the school's registrar's office. For schools with greater than 3,000 student enrollees, emails of 3,000 eligible students were randomly selected. If the

school had fewer than 3,000 students, then all the students who met the criteria were included in the study. The response rates from technical schools ranged from 15.4% to 27.6%, public schools ranged from 12.0% to 19.2%, private schools from 18.8% to 59.4%, and 23.1% at the HBCU.

The total response rate for the baseline survey was 22.9% (N=3,574/15,607), where wave five had a retention rate of 78.7% (2,689 completes) and wave six had 70.3% (2,403 completes). All participants had to confirm their participation by clicking "confirm button" on the confirmation email. The confirmation rate was 95.6% (N=3,418/3,574). Those who did not confirm via email were excluded from the study. For waves two to six, assessment survey was sent out quarterly. Participants had approximately three weeks to finish each wave, with reminders sent every 3 days. Participants were compensated for completing the survey on a graduate compensation schedule: $30 for wave two, $40 for waves three and four, $50 for waves five and six, and additional $100 was compensated for finishing all six waves. The incentives were sent via participant's preferred email addresses.

Current analyses focus on participants who participated at Wave 6 (N=2403, 70.3% of baseline sample) and reported any lifetime use of any tobacco product or marijuana (N=1451, 60.4% of Wave 6 participants).

## Measures

### *First Product Used*

*First product used* was assessed at Wave 6 by asking, "For each of the following tobacco product, indicate the order in which you tried them in your lifetime." Participants ranked the order of the following products: cigarettes, large cigars, little cigars or cigarillos, chewing tobacco, snus, e-cigarettes or vapes, hookah, marijuana, or chose "I have never tried any of these." Large cigars and little cigars were grouped together as cigars and chewing tobacco and

snus were grouped as smokeless for analysis. We also calculated *number of products ever used* based on this question.

### *Current Tobacco Product or Marijuana Use*

The use of tobacco products at Wave 6 was assessed by asking, "In the past 4 months, how many days have you smoked cigarettes/cigars/smokeless tobacco/hookah/e-cigarettes?" Answer choices ranged from 0 to 120 days. If participants reported use for 1 or more days, they were asked to indicate the number of days they used the tobacco product, respectively, in the past 30 days. Similarly, the use of marijuana at Wave 6 was assessed by asking, "In the past 4 months, how many days have you used marijuana?" Answer choices ranged from 0 to 120 days. If participants reported use for 1 or more days, they were asked to indicate the number of days they used marijuana in the past 30 days. Participants had the option to refuse to answer assessments of marijuana use.

### *Sociodemographic Measures*

Sociodemographic covariates were assessed at Wave 1 and included age, sex, sexual orientation (heterosexual or sexual minority), race (White, Black, Asian, or Other), ethnicity (Hispanic or non-Hispanic), and (as a proxy for socioeconomic status) parental education.

### *Setting*

Setting was characterized by the school type (private, public, technical college, and HBCU) and whether the school was in a rural or urban setting.

### *Psychosocial Measures*

ACEs were measured at Wave 2 using a 10-item scale developed by the CDC (12). ADHD was measured at Wave 2 utilizing the Adult ADHD Self-Report Scale Symptom Checklist (a 6-item scale) (67). Cronbach's alpha in the current study was .74. Depression was

assessed at Wave 5 using the PHQ-9 (a 9-item scale) that indicated major depressive disorder if more than 5 of the 9 depressive symptoms was present more than half the days of the last two weeks (68). Cronbach's alpha in the current study was .87.

Parental substance use was assessed by asking participants at Wave 1: "Does any one of your parental figures use…" and listed options (select all that apply): cigarettes, cigars/cigarillos/little cigars, smokeless tobacco, e-cigarettes, smoke tobacco using hookah or pipe, marijuana, or none of these. Report of parental use of any tobacco product was coded as parental use of tobacco.

**Data Analysis**

Bivariate analysis was performed to examine the correlation between participant characteristics (e.g., age, parental tobacco or marijuana use, ADHD symptoms) and first smoking product used (e.g., cigarettes, e-cigarettes, marijuana). We then examined outcomes of number of products ever used (including the various tobacco products and marijuana) and number of products used in the past 30 days at wave 6, first using bivariate analyses and then using multivariable linear regressions, respectively. We also examined correlates of each specific product used in the past 30 days.

**RESULTS**

Participant characteristics and bivariate association between participant characteristics and first smoking product used at wave 6 are presented in **Table 1**. Significant correlates included age, sex, race, parental education, school type (all p's<.001), rural/urban setting (p=.002), ACEs (p<.001), depressive symptoms (p=.006), and parental use of cigarettes (p<.001), ATPs (p=.007), and marijuana (p=.015).

**Number of Products Ever Used**

Bivariate analyses (**Table 2**) indicated that more products ever used was associated with being older, male, "Other" race, attending public school, living in an urban environment, and choosing SLT as first tobacco product ($p<.001$), experiencing more ACEs ($p=.001$), having a parent with higher education and parental use of marijuana ($p=.013$), parental use of ATP ($p=.023$), and having more ADHD symptoms ($p=.037$).

Multivariable regression analysis (**Table 3**) indicated that being male and choosing cigarettes as first product (compared to choosing cigars, e-cigarettes, hookah, and marijuana as first product) ($p<.001$), being White (compared to being Asian) ($p=.001$), having a parent who uses marijuana ($p=.006$), experiencing more ACEs ($p=.011$), being older ($p=.012$), and being White (compared to being "Other" race) ($p=.038$). Adding the first product used to the regression model increased the R-squared value from 0.107 to 0.176 ($p<.001$; not shown in tables).

**Number of Products Used in the Past 30 Days**

Bivariate analyses (**Table 2**) indicated that more products used in the past 30 days was associated with having parents who uses marijuana ($p<.001$), having more depressive symptoms ($p=.001$), other sexual orientation and choosing SLTs as first tobacco product ($p=.003$), being younger ($p=.007$), having more ADHD symptoms ($p=.021$), experiencing more ACEs ($p=.032$), having a parent with less than Bachelor degree ($p=.039$), and being "Other" race ($p=.048$).

Multivariable regression analysis (**Table 3**) indicated that having a parent who uses marijuana ($p<.001$), being younger and choosing cigarettes as first tobacco product (compared to choosing e-cigarettes) ($p=.003$), being male ($p=.006$), choosing cigarettes compared to choosing cigars ($p=.011$), being depressed ($p=.014$), and choosing cigarettes compared to hookah as first

tobacco product (p=.036). Adding first product used to the regression model increased the R-squared value from 0.035 to 0.044 (p<.001; not shown in tables).

**Past 30-Day Use of Each Product**

We also examined past 30-day use of each tobacco product and marijuana at Wave 6 to determine the extent to which first product used predicts current use of each product. Controlling for all other covariates, predictors of past 30-day use of each are as follows: ***cigarettes*** (N=201, 13.9%): first product used *not* being LCCs (OR=0.44, CI: 0.27, 0.72, p<.001), e-cigarettes (OR=0.20, CI: 0.06, 0.67, p=.009), hookah (OR=0.35, CI: 0.18, 0.69, p=.002), or marijuana (OR=0.47, CI: 0.30, 0.75, p=.001), Nagelkerke R-Square=.128; ***LCCs*** (N=102, 7.0%); first product used *not* being marijuana (OR=0.47, CI: 0.24, 0.92, p=.027), Nagelkerke R-Square=.176; ***smokeless tobacco*** (N=51, 3.5%): first product used being smokeless tobacco (OR=4.32, CI: 1.58, 11.79, p=.004), Nagelkerke R-Square=.404; ***e-cigarettes*** (N=79, 5.4%): no significant association with first product used, Nagelkerke R-Square=.081; ***hookah*** (N=96, 6.6%): first product used being hookah (OR=2.45, CI: 1.22, 4.92, p=.012), Nagelkerke R-Square=.126; and ***marijuana*** (N=263/1384, 19.0%; Note: N=67 refused): first product being used *not* being hookah (OR=0.54, CI: 0.30, 0.99, p=.044) but being marijuana (OR=1.90, CI: 1.29, 2.80, p=.001), Nagelkerke R-Square=.136.

## DISCUSSION

This study examined: the extent to which first product used predicted subsequent use of tobacco and marijuana, specifically total number of products used in the lifetime (as an indicator of experimentation); total number of products currently used (as an indicator of risk); and current use of each product (as an indicator of specificity). This study is critical, as longitudinal studies

accounting for the diverse tobacco market and evolving social norms regarding marijuana are limited. In brief, study findings indicated that the use of cigarettes as the first product used predicted more products ever used in the lifetime and in the past 30 days, compared to most other products as first product used. Moreover, there is some specificity in terms of first product use and current product use, particularly for cigarettes, SLT, hookah, and marijuana.

Of all the tobacco products, cigarette (31.8%) was the most prevalent first tobacco product chosen compared to other products followed by cigars (21.8%), marijuana (26.8%), hookah (11.5%), e-cigarettes (4.2%), and SLT (3.8%). This finding was consistent with prior research indicating that cigarette was the popular first product compared to other tobacco products (31,32). Interestingly, if we were to only look at nicotine products, our findings were consistent with previous research with cigar and hookah being the second and the thirst most frequent first tobacco choices (31,32).

The literature on marijuana being the first product was lacking. However, prevalence of adolescents was 6.5%, 12$^{th}$ graders were 22.2%, and adults were 9.5% (56,57,58,59). If we were to make a graph looking at the prevalence trend of marijuana use, from adolescents to 12$^{th}$ graders to adults, it would look like a bell curve. If we were to assume this prevalence is similar to frequency of marijuana being the first product, this shows that young adults are a critical period in marijuana trajectory (57,60,61).

Previously, I mentioned that in order to satisfy gateway potential, there needs to be studies that document sequence of product used, increased risk of choosing one product based on the first product, and causation (70). Our study clearly shows all three factors to confirm that use of cigarettes can predict the use of other tobacco product in the future. On average, those who chose cigarettes as first tobacco or marijuana product predicted more products ever used in their

lifetime and in past 30-day, with exception of SLT. For example, average predicted number of products used by those who chose cigarettes as first product was 2.54 for lifetime and 0.61 for past-30day use, where as those who chose e-cigarettes as first product averaged 1.15 for lifetime and 0.33 for past 30-day use. Looking at these findings, cigarettes pose a greater overall risk as a gateway product compared to other tobacco and marijuana products.

Also, there was some specificity in terms of first product use and current product use. Some our study's profile of subsequent use depending on the first product of choice was not consistent with previous studies. Our study found: 3) those whose first product was not SLT were likely to use SLTs in the past 30 days; 4) those whose first product was hookah were likely to report past 30-day use of hookah. The evidence on 1) those whose first product was not LCC or e-cigarettes were likely to use cigarettes in the past 30-days, and 5) those who first product was not hookah were more likely to report past 30-day use of marijuana were inconsistent with past research. For example, Sutfin et al and Barrington-Trimis et al. reported those initiating with LCC or e-cigarettes were more likely to initiate cigarette and be a current cigarette user (42,31). Our findings on: 1) those whose first product was not hookah or marijuana were likely to use cigarettes in the past 30-days, and 2) those whose first product was not marijuana were likely to use LCC in the past 30-days, was supported by the literature with general terms (i.e. combustible tobacco product) (24,54). The possible reason behind these differences may be due different sample population.

Age, race, and parental education was consistently a significant sociodemographic correlate in both ever use and past 30-day use. Other significant sociodemographic correlate for lifetime use was sex, school type, and living in a rural/urban environment, and past 30-day was sexual orientation. For lifetime use, our study found being older, male, "Other" race, having a

parent with high parental education, attending public school, being in an urban environment were a significant correlate. However, there were inconsistencies with: being younger for cigarette, cigar, and SLT, being female for cigarette, SLT, hookah, and marijuana, being White for SLT, and being Black for hookah (2,8,31,35,48). For lifetime use, our study found being younger, being a sexual minority, "Other" race, and having a parent with less than a four-year degree were the significant correlates. As for past 30-day use, inconsistencies were: being Black for cigar, being White for e-cigarettes (78,81).

As for psychosocial correlates, experiencing more ACEs, having more ADHD symptoms, and having a parent who uses marijuana were common correlates of lifetime use and past 30-day use. Significant psychosocial correlates for lifetime use were experiencing more ACEs, having more ADHD symptoms, and having a parent who uses ATPs and marijuana. Moreover, our significant psychosocial correlates for past 30-day use were experiencing more ACEs, having more depressive and ADHD symptoms, and having a parent who uses marijuana.

Studies by Duck et al., Alcala et al., and others supported the idea of experiencing more ACEs and found that those who had experienced more ACEs had higher odds of ever cigarette use, and current cigarette, SLT, and marijuana use (13,14,16,50,51) Similar to our findings, current literature also concurred on more depressive and ADHD symptoms leading to tobacco and marijuana use. For example, Glasheen et al. and Breyer et al., reported those who experience more major depressive episodes and ADHD symptoms were more likely to initiate marijuana (49,71). Lastly, like findings of our study, Windle et al. reports that parental use of ATP or marijuana increase the likelihood of ATP or marijuana use of students (26). Unlike the prior research, our study did not find any significant linking parental use of cigarettes to young

adults using cigarettes. Theoretically, for ACEs, depressive and ADHD symptoms, it maybe that people are using cigarettes, SLTs, and marijuana to cope with their ACEs and symptoms.

These findings have implications for interventions seeking to target those at risk for higher number of products used. These findings suggest that by observing first tobacco or marijuana products can indicate subsequent use risk and recognize the specificity in relation to use trajectories for some products, specifically cigarettes. Additional research is needed to support and understand cigarette being a gateway potential to other tobacco or marijuana products. Future studies should oversample those who chose SLT, e-cigarettes, and hookah to examine the trajectories more closely. Moreover, future studies should focus on trajectory link between choosing e-cigarettes as first tobacco product and subsequent tobacco or marijuana products since e-cigarette use and co-use is growing rapidly among younger population (9,73).

**Limitations**

This study had several limitations that should be considered when interpreting the results. First, this was a cross-sectional study that obtained data through self-report. This led to possible recall bias. The generalizability of study findings to nationwide adult population may be limited because the study only incorporated young adults (age 18-25) who attended colleges and universities in the state of Georgia. Also, the study had a smaller proportion of males (39.0%) to females (61.0%), which may be problematic because men are more likely to smoke tobacco products compared to females (55). One of the main limitations for this study was sample size, specifically in regard to small cell sizes for variables related to first use of SLT, e-cigarettes, and hookah, as well as some correlates of interests (e.g., racial/ethnic minorities, sexual minorities).

Future studies should over sample or target those who are Asian, Other race, sexual minorities, and those who first used SLT, e-cigarettes and hookah. Future studies should also

note recent regulatory changes, i.e., FDA flavor ban and state-level laws regarding recreational marijuana use.

## CONCLUSIONS

The use of cigarettes as the first product used predicted more products ever used in the lifetime and in the past 30 days, compared to most other products as first product used (excluding smokeless tobacco for both outcomes and marijuana for past 30-day outcomes). Moreover, there is some specificity in terms of first product use and current product use, particularly for cigarettes, SLT, hookah, and marijuana. Thus, prevention efforts should be informed by this data. Specifically, cigarette use as first product used can be considered as an indicator of overall subsequent use risk and recognize the specificity in relation to use trajectories for some products.

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**TABLES**

**Table 1. Participant Characteristics and Bivariate Analyses Examining Correlates of First Product Used Among Ever Users of Tobacco and/or Marijuana**

| Variables | Total N=1451 (100.0%) N (%) or M (SD) | Cigarettes N=462 (31.8%) N (%) or M (SD) | Cigars N=317 (21.8%) N (%) or M (SD) | Smokeless N=55 (3.8%) N (%) or M (SD) | E-cigarettes N=61 (4.2%) N (%) or M (SD) | Hookah N=167 (11.5%) N (%) or M (SD) | Marijuana N=389 (26.8%) N (%) or M (SD) | p |
|---|---|---|---|---|---|---|---|---|
| ***Sociodemographics*** | | | | | | | | |
| Age (M, SD) | 20.72 (1.97) | 21.13 (2.06) | 20.62 (1.90) | 20.69 (1.96) | 19.54 (1.50) | 20.98 (1.93) | 20.38 (1.86) | <.001 |
| Sex (N, %) | | | | | | | | <.001 |
| Male | 566 (39.0) | 143 (31.0) | 169 (53.3) | 43 (78.2) | 22 (36.1) | 59 (35.3) | 130 (33.4) | |
| Female | 885 (61.0) | 319 (69.0) | 148 (46.7) | 12 (21.8) | 39 (63.9) | 108 (64.7) | 259 (66.6) | |
| Sexual Orientation (N, %) | | | | | | | | .166 |
| Heterosexual | 1298 (89.5) | 405 (88.6) | 292 (93.0) | 52 (94.5) | 55 (90.2) | 155 (92.8) | 339 (88.5) | |
| Other | 139 (9.6) | 52 (11.4) | 22 (7.0) | 3 (5.5) | 6 (9.8) | 12 (7.2) | 44 (11.5) | |
| Race (N, %) | | | | | | | | <.001 |
| White | 944 (65.1) | 324 (71.5) | 224 (70.9) | 52 (94.5) | 45 (73.8) | 93 (56.7) | 206 (54.1) | |
| Black | 303 (20.9) | 63 (13.9) | 63 (19.9) | 3 (5.5) | 8 (13.1) | 43 (26.2) | 123 (32.3) | |
| Asian | 94 (6.5) | 33 (7.3) | 8 (2.5) | 0 (0.0) | 4 (6.6) | 15 (9.1) | 34 (8.9) | |
| Other | 89 (6.1) | 33 (7.3) | 21 (6.6) | 0 (0.0) | 4 (6.6) | 13 (7.9) | 18 (4.7) | |
| Hispanic (N, %) | 123 (8.5) | 41 (8.9) | 24 (7.6) | 2 (3.6) | 4 (6.6) | 19 (11.4) | 33 (8.6) | .514 |
| Parental Education (N, %) | | | | | | | | <.001 |
| < Bachelors | 646 (44.5) | 240 (52.6) | 114 (36.2) | 21 (38.9) | 24 (39.3) | 69 (41.8) | 178 (46.1) | |
| ≥ Bachelors | 791 (54.5) | 216 (47.4) | 201 (63.8) | 33 (61.1) | 37 (60.7) | 96 (58.2) | 208 (53.9) | |
| School Type (N, %) | | | | | | | | <.001 |
| Private | 620 (42.7) | 152 (32.9) | 152 (47.9) | 17 (30.9) | 27 (44.3) | 84 (50.3) | 188 (48.3) | |
| Public | 435 (30.0) | 140 (30.3) | 107 (33.8) | 27 (49.1) | 22 (36.1) | 49 (29.3) | 90 (23.1) | |
| Technical college | 239 (16.5) | 144 (31.2) | 24 (7.6) | 9 (16.4) | 9 (14.8) | 16 (9.6) | 37 (9.5) | |
| HBCU | 157 (10.8) | 26 (5.6) | 34 (10.7) | 2 (3.6) | 3 (4.9) | 18 (10.8) | 74 (19.0) | |
| Rural/urban (N, %) | | | | | | | | .002 |
| Rural | 716 (49.3) | 201 (43.5) | 183 (57.7) | 22 (40.0) | 35 (57.4) | 83 (49.7) | 192 (49.4) | |
| Urban | 735 (50.7) | 261 (56.5) | 134 (42.3) | 33 (60.0) | 26 (42.6) | 84 (50.3) | 197 (50.6) | |
| ***Psychosocial Factors*** | | | | | | | | |
| ACEs (M, SD) | 1.42 (1.79) | 1.84 (1.94) | 1.09 (1.70) | 1.06 (1.86) | 1.14 (1.64) | 1.11 (1.38) | 1.45 (1.76) | <.001 |
| Depressive symptoms (M, SD) | 5.83 (5.41) | 6.37 (6.13) | 4.98 (5.75) | 4.37 (4.83) | 5.60 (5.32) | 4.84 (5.00) | 5.57 (5.50) | .006 |
| ADHD symptoms (M, SD) | 9.65 (4.24) | 9.98 (4.31) | 9.37 (4.03) | 10.21 (4.33) | 10.38 (4.27) | 9.29 (4.14) | 9.46 (4.35) | .124 |
| ***Parental Use*** | | | | | | | | |
| Cigarettes (N, %) | 339 (23.4) | 164 (35.5) | 49 (15.5) | 7 (12.7) | 13 (21.3) | 32 (19.2) | 74 (19.0) | <.001 |
| ATPs (N, %) | 494 (34.0) | 211 (45.7) | 95 (30.0) | 16 (29.1) | 21 (34.4) | 47 (28.1) | 104 (26.7) | .007 |
| Marijuana (N, %) | 116 (8.0) | 46 (10.0) | 12 (3.8) | 4 (7.3) | 3 (4.9) | 11 (6.6) | 40 (10.3) | .015 |

**Table 2. Bivariate Analyses Examining Tobacco Use Outcomes in Ever Users of Tobacco or Marijuana**

| | Number of Products Ever Used | | Number of Products Used, Past 30 Days | |
|---|---|---|---|---|
| **Variables** | **r or M (SD)** | **p** | **r or M (SD)** | **p** |
| ***Sociodemographics*** | | | | |
| Age (r) | 0.10 | <.001 | -0.07 | .007 |
| Sex (M, SD) | | <.001 | | .132 |
| Male | 2.51 (2.00) | | 0.58 (0.90) | |
| Female | 1.69 (1.47) | | 0.51 (0.84) | |
| Sexual Orientation (M, SD) | | .216 | | .003 |
| Heterosexual | 1.99 (1.74) | | 0.51 (0.86) | |
| Other | 2.19 (1.73) | | 0.75 (0.92) | |
| Race (M, SD) | | <.001 | | .048 |
| White | 2.20 (1.81) | | 0.50 (0.85) | |
| Black | 1.46 (1.32) | | 0.63 (0.93) | |
| Asian | 1.52 (1.73) | | 0.43 (0.78) | |
| Other | 2.48 (1.90) | | 0.66 (0.88) | |
| Ethnicity (M, SD) | | .741 | | .806 |
| Non-Hispanic | 2.01 (1.76) | | 0.54 (0.88) | |
| Hispanic | 2.07 (1.66) | | 0.52 (0.79) | |
| Parental Education (M, SD) | | .013 | | .039 |
| < Bachelors | 1.89 (1.63) | | 0.59 (0.90) | |
| ≥ Bachelors | 2.12 (1.83) | | 0.49 (0.83) | |
| School Type (M, SD) | | <.001 | | .056 |
| Private | 2.01 (1.74) | | 0.46 (0.82) | |
| Public | 2.26 (1.86) | | 0.59 (0.88) | |
| Technical college | 2.02 (1.71) | | 0.59 (0.97) | |
| HBCU | 1.32 (1.25) | | 0.58 (0.83) | |
| Rural/urban (M, SD) | | <.001 | | .731 |
| Rural | 1.82 (1.59) | | 0.54 (0.88) | |
| Urban | 2.20 (1.86) | | 0.53 (0.86) | |
| ***Psychosocial Factors*** | | | | |
| ACEs (r) | 0.09 | .001 | 0.06 | .032 |
| Depressive symptoms (r) | 0.05 | .070 | 0.09 | .001 |
| ADHD symptoms (r) | 0.06 | .037 | 0.06 | .021 |
| ***Parental Use*** | | | | |
| Cigarettes (M, SD) | | .203 | | .078 |
| No | 1.98 (1.76) | | 0.51 (0.85) | |
| Yes | 2.12 (1.69) | | 0.61 (0.85) | |
| ATPs (M, SD) | | .023 | | .151 |
| No | 1.96 (1.73) | | 0.52 (0.84) | |
| Yes | 2.24 (1.79) | | 0.61 (0.95) | |
| Marijuana (N, %) | | .013 | | <.001 |
| No | 1.98 (1.74) | | 0.50 (0.83) | |
| Yes | 2.40 (1.75) | | 0.92 (1.12) | |
| ***First Product Used (M, SD)*** | | <.001 | | .003 |
| Cigarettes | 2.54 (1.74) | | 0.61 (0.89) | |
| Cigars | 2.07 (1.64) | | 0.44 (0.78) | |
| Smokeless | 3.44 (2.15) | | 0.74 (1.09) | |
| E-cigarettes | 1.15 (1.24) | | 0.33 (0.71) | |
| Hookah | 1.48 (1.57) | | 0.40 (0.73) | |
| Marijuana | 1.48 (1.57) | | 0.58 (0.87) | |

**Table 3. Multivariate Analyses Examining Tobacco Use Outcomes in Ever Users of Tobacco or Marijuana**

| | Number of Products Ever Used | | | Number of Products Used, Past 30 Days | | |
|---|---|---|---|---|---|---|
| **Variables** | **B** | **CI** | **p** | **B** | **CI** | **p** |
| ***Sociodemographics*** | | | | | | |
| Age | 0.06 | 0.01, 0.11 | .012 | -0.04 | -0.06, -0.01 | .003 |
| Sex | | | | | | |
| Male | Ref | -- | -- | Ref | -- | -- |
| Female | -0.72 | -0.91, -0.52 | <.001 | -0.15 | -0.26, -0.04 | .006 |
| Sexual Orientation | | | | | | |
| Heterosexual | Ref | -- | -- | Ref | -- | -- |
| Other | 0.16 | -0.15, 0.46 | .305 | 0.10 | -0.07, 0.27 | .227 |
| Race | | | | | | |
| White | Ref | -- | -- | Ref | -- | -- |
| Black | -0.30 | -0.603, 0.00 | .051 | 0.15 | -0.02, 0.31 | .078 |
| Asian | -0.60 | -0.98, -0.22 | .002 | -0.03 | -0.24, 0.18 | .802 |
| Other | 0.41 | 0.02, 0.80 | .038 | 0.13 | -0.09, 0.34 | .243 |
| Hispanic | -0.09 | -0.42, 0.25 | .608 | -0.05 | -0.23, 0.14 | .621 |
| Parental Education | | | | | | |
| < Bachelors | Ref | -- | -- | Ref | -- | -- |
| ≥ Bachelors | 0.178 | -0.02, 0.38 | .079 | -0.03 | -0.14, 0.08 | .611 |
| School Type | | | | | | |
| Private | Ref | -- | -- | Ref | -- | -- |
| Public | 0.09 | -0.14, 0.31 | .448 | 0.05 | -0.07, 0.17 | .426 |
| Technical college | -0.15 | -0.45,0.16 | .344 | 0.08 | -0.08, 0.25 | .327 |
| HBCU | -0.05 | -0.46, 0.36 | .807 | 0.04 | -0.19,0.27 | .743 |
| Rural/urban | | | | | | |
| Rural | Ref | -- | -- | Ref | -- | -- |
| Urban | -0.08 | -0.28, 0.13 | .456 | 0.00 | -0.11, 0.12 | .946 |
| ***Psychosocial Factors*** | | | | | | |
| ACEs | 0.07 | 0.02, 0.13 | .011 | 0.00 | -0.03, 0.03 | .802 |
| Depressive symptoms | 0.00 | -0.01, 0.02 | .686 | 0.01 | 0.00, 0.02 | .014 |
| ADHD symptoms | 0.01 | -0.02, 0.03 | .500 | 0.01 | -0.01,0.02 | .408 |
| ***Parental Use*** | | | | | | |
| Cigarettes | -0.01 | -0.24, 0.22 | .948 | -0.03 | -0.15, 0.10 | .688 |
| ATPs | 0.02 | -0.22, 0.25 | .900 | 0.01 | -0.12, 0.14 | .836 |
| Marijuana | 0.47 | 0.13, 0.81 | .006 | 0.40 | 0.21, 0.58 | <.001 |
| ***First Product Used*** | | | | | | |
| Cigarettes | Ref | -- | -- | Ref | -- | -- |
| Cigars | -0.66 | -0.92, -0.41 | <.001 | -0.18 | -0.32, -0.04 | .011 |
| Smokeless | 0.47 | -0.01, 0.95 | .053 | 0.10 | -0.16, 0.36 | .458 |
| E-cigarettes | -1.33 | -1.78, -0.88 | <.001 | -0.37 | -0.62, -0.12 | .003 |
| Hookah | -0.99 | -1.29, -0.69 | <.001 | -0.18 | -0.34. -0.01 | .036 |
| Marijuana | -1.05 | -1.29, -0.80 | <.001 | -0.06 | -0.19, 0.08 | .396 |
| **Adjusted R-Squared** | | .176 | | | .044 | |