



Published in final edited form as:

Drug Alcohol Depend. 2016 May 1; 162: 137–145. doi:10.1016/j.drugalcdep.2016.02.041.

Marijuana Use Trajectories and Academic Outcomes among College Students

Cynthia K. Suerken¹, Beth A. Reboussin^{1,2}, Kathleen L. Egan², Erin L. Sutfin², Kimberly G. Wagoner², John Spangler³, and Mark Wolfson²

¹Department of Biostatistical Sciences, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157

²Department of Social Sciences and Health Policy, Wake Forest School of Medicine, Medical Center Blvd, Winston-Salem, NC 27157

³Department of Family and Community Medicine, Wake Forest School of Medicine, Medical Center Blvd, Winston-Salem, NC 27157

Abstract

Background—Marijuana is the most commonly used illicit drug by college students. Prior studies have established an association between marijuana use and poor academic performance in college, but research on the frequency of marijuana use over the entire college career is limited. The study objective was to examine the association of marijuana use trajectories on academic outcomes, including senior year enrollment, plans to graduate on time, and GPA.

Methods—Data were collected from a cohort of 3,146 students from 11 colleges in North Carolina and Virginia at six time points across the college career. Group-based trajectory models were used to characterize longitudinal marijuana use patterns during college. Associations between marijuana trajectory groups and academic outcomes were modeled using random-effects linear and logistic regressions.

Results—Five marijuana trajectory groups were identified: non-users (69.0%), infrequent users (16.6%), decreasing users (4.7%), increasing users (5.8%), and frequent users (3.9%). Decreasing users and frequent users were more likely to drop out of college and plan to delay graduation when compared to non-users. All marijuana user groups reported lower GPAs, on average, than non-users.

Corresponding Author: Cynthia K. Suerken, Department of Biostatistical Sciences, Division of Public Health Sciences, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157, Phone: (336) 713-1348, Fax: (336) 713-5308, CSuerken@wakehealth.edu.

Contributors

Cynthia Suerken wrote the first draft of the manuscript and conducted the literature search and statistical analyses. Beth Reboussin oversaw the statistical analyses. Beth Reboussin, Kate Egan, Erin Sutfin, Kimberly Wagoner, John Spangler, and Mark Wolfson contributed to the study design. All authors reviewed and edited drafts of the manuscript and approved of the final version.

Conflict of Interest

All authors declare that they have no conflicts of interest.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conclusion—These results identify marijuana use patterns that put students at risk for poor academic performance in college. Students who use marijuana frequently at the beginning of the college career are especially at risk for lower academic achievement than non-users, suggesting that early intervention is critical.

Keywords

Marijuana; College students; Early intervention; Academic performance; Longitudinal study; Trajectory modeling

1. INTRODUCTION

Marijuana is the most commonly used illicit substance among college students, with 48.5% reporting lifetime use, 20.8% past month use, and 5.9% reporting daily use in 2013 (Johnston et al., 2015). Daily and past 30 day marijuana use among college students has risen steadily since 2007. Daily marijuana users exhibit more characteristics of dependence than less frequent users (Hammersley and Leon, 2006), which makes the increase in daily use particularly concerning. At the same time that daily use is increasing, perceptions of harm associated with regular marijuana use are declining; only 35.1% of young adults think smoking marijuana regularly places the user at great risk compared to 57.2% a decade ago (Johnston et al., 2015).

Prior research has found that college student marijuana users are more likely to be white, male, single, members of fraternities or sororities, non-athletes, not religious, cigarette smokers, and heavy episodic drinkers (Bell et al., 1997; Johnston et al., 2015; Buckman et al., 2011; Wechsler et al. 1997; Yusko et al., 2008; McCabe et al., 2005; Mohler-Kuo et al., 2003). Students who initiate marijuana prior to age 16 are more likely to continue to use marijuana in college and be regular users (Mohler-Kuo et al., 2003), and early age of initiation has been shown to be associated with problems later in life such as depression and drug dependence (Green and Ritter, 2000; Ellickson et al., 2005; Chen et al., 2009). In one study, initiation of marijuana use during freshman year was found to be associated with living on campus, using cigarettes or alcohol, and Hispanic ethnicity (Suerken et al., 2014).

Acute effects of marijuana use among college students include impaired driving (Whitehill et al., 2014) and engaging in risky sexual activity (Bell et al., 1997) as well other high risk behaviors (Shillington and Clapp, 2001; Kouri et al., 1995). Several studies have linked marijuana use with impaired mental functioning and reduced psychological well-being. College student marijuana use has been found to be associated with anxiety, depression, hostility, interpersonal sensitivity, paranoia, and psychoticism (Buckner et al., 2010). Marijuana use is associated with the impairment of many cognitive functions that affect academic performance, including attention, concentration, memory, verbal fluency, processing speed, planning, and decision making (Caldeira et al., 2008; Churchwell et al., 2010; Hermann et al., 2007; McHale et al., 2008; Ramaekers et al., 2006; Shillington and Clapp, 2001; Vadhan et al., 2007; Wadsworth et al., 2006). Marijuana use reduces brain volume, affects brain metabolism, alters brain circuitry, and restricts blood flow to the brain, thereby reducing cognitive performance (Battistella et al., 2014; Block et al., 2002;

Churchwell et al., 2010; Hermann et al., 2007; Verdejo-García et al., 2006; Yücel et al., 2008). Chronic marijuana use poses even more risks. Heavy and long-term marijuana users experience even greater difficulties with cognitive functioning, compared to light users and non-users (Block et al., 2002; Bolla et al., 2002; Kouri et al., 1995; Pope and Todd, 1996; Solowij et al., 1995, 2002, 2011; Verdejo-García et al., 2006; Whitlow et al., 2004; Yücel et al., 2008). Chronic marijuana users report higher levels of sensation seeking as well as more problems with self-control and externalizing behavior (Brook et al., 2011).

Especially relevant to college students is the immediate impact that marijuana use has been shown to have on academic performance. Marijuana use is associated with dropping out of college (Braun et al., 2000; Degenhardt et al., 2010; Fergusson et al., 2003; Fergusson and Boden, 2008; Fleming et al., 2012; Hunt et al., 2010; Schulenberg et al., 2005; Tucker et al., 2005, 2006), having a lower GPA (Arria et al., 2013a, 2015; Bell et al., 1997; Buckner et al., 2010), poorer performance on exams and projects (Shillington and Clapp, 2001), spending less time studying for classes (Bell et al., 1997), and lower class attendance (Caldeira et al., 2008; Arria et al., 2013a, 2015; Shillington and Clapp, 2001). Marijuana craving has been shown to be negatively associated with time spent studying and academic motivation in college, and more frequent marijuana use has been found to be negatively associated with college GPA (Phillips et al., 2015; Martinez et al., 2015). Another study found that the likelihood of earning a college degree declines with more frequent marijuana use (Horwood et al., 2010).

Patterns of frequency of marijuana use may vary over the course of the college career, so it is important to study the complete trajectory of marijuana use during those years. Several studies report the impact of any past year or past month marijuana use on college performance but do not measure how often students use marijuana (Bell et al., 1997; Braun et al., 2000; Shillington and Clapp, 2001). Several studies on the impact of marijuana trajectories on academic performance and educational aspirations follow a cohort of adolescents from adolescence into young adulthood but do not focus specifically on college students (Brook et al., 2011; Degenhardt et al., 2010; Fleming et al., 2012; Flory et al., 2004; Schulenberg et al., 2005; Tucker et al., 2005; Windle and Wiesner, 2004). Only one study has focused on college student frequency of marijuana use over time. Arria et al. (2013b) found that infrequent marijuana users, increasing users, and chronic/heavy users are more likely to have a gap in college enrollment compared to minimal users. They also found that increasing marijuana use over the college career was associated with a drop in GPA and that marijuana use frequency during the first year of college had an enduring effect on delaying graduation, via its influence on the path from skipping class to GPA at baseline (Arria et al., 2015). However, this study only included students at one college. More research is needed in order to understand the impact of the frequency of marijuana use across the college career on academic outcomes.

2. METHODS

2.1 Study Design

Data were obtained as part of the Smokeless Tobacco Use in College Students study. The objective of this study was to assess trajectories and correlates of smokeless tobacco use

among a cohort of college students by surveying them at multiple points during their college career (Wolfson et al., 2014). All first year students enrolled at 11 colleges in North Carolina and Virginia were recruited through school email to participate in a brief web-based screener survey in fall 2010 in order to determine study eligibility. Nine participating colleges are public schools, and two are private schools. Five colleges are located in rural areas, four colleges are located in suburban communities, and two colleges are in urban areas. Thirty-six percent (10,528) of eligible students participated in the screener survey (Spangler et al., 2014).

A random sample of eligible participants was selected two weeks after the screener survey. This sample was invited to participate in the longitudinal cohort study. Students were selected within each school with an objective of 285 completions per school in order to have sufficient power to detect differences in smokeless tobacco use for various predictors in the parent study. Due to the goal of the parent study, students at higher risk for using smokeless tobacco were oversampled, including lifetime smokeless tobacco users, current cigarette smokers, and males. Data were collected each semester of the students' freshman and sophomore year, and during the fall of the students' junior and senior years (Wolfson et al., 2014). Students had the opportunity to update their contact information at each wave. Students who did not initially complete the survey via the URL emailed to them received follow-up text messages and phone calls with reminders to complete the survey. Attempts were made to contact all students who participated at baseline, including participants who dropped out of college. Among the 4,190 students who were invited to participate, 3,146 (64%) eligible students completed the first survey. Of the students who participated in the first survey, 2,520 (80.1%), 2,459 (78.2%), 2,507 (76.7%), 2,516 (80.0%), and 2,500 (79.5%) students participated in the second, third, fourth, fifth, and sixth surveys, respectively. Almost two thirds of the sample (65.4%) participated in all 6 waves, another 10.1% participated in 5 waves, 5.6% participated in 4 waves, and 18.9% of the sample participated in fewer than 4 waves. Females ($p = 0.019$) and students whose mothers do not possess at least a college degree ($p = 0.041$) were more likely to be missing at least one wave of data.

There was a \$15 incentive for completing the first survey, and this incentive increased by \$5 for each subsequent survey. The Wake Forest School of Medicine Institutional Review Board approved study protocol. Several participating schools also had their own Institutional Review Board approvals. A Certificate of Confidentiality by the Department of Health and Human Services was obtained in order to protect the privacy of the participants (Wolfson et al., 2014).

2.2 Measures

2.2.1 Academic Outcomes—Three academic outcomes were measured during the fall semester of the participants' senior year (Wave 6): current enrollment in college, plans to graduate from college on time, and grade point average. All academic outcomes were self-reported. Students were considered to be still enrolled in college if they reported a college where they were enrolled or had already graduated from college (since this indicates that they did not drop out of college). They were considered to not be enrolled in college if they

reported taking a leave of absence or were no longer enrolled in an academic institution. Students were also asked to report the month and year that they planned to graduate from college. They were considered to be planning to graduate on time if they had already graduated or if their expected graduation date was May 2014 or earlier, since all participating schools hold spring commencement in May. The third college outcome that students reported was college grade point average. Grade point average was reported on a scale of 0–4, with any values over 4 being rounded down to 4.0.

2.2.2 Marijuana Use—During the first wave, students were asked if they had ever used marijuana. At each subsequent time point, students were asked if they had used marijuana within the past six months. If they answered affirmatively to either version of the question, then they were asked on how many days out of the past 30 days that they used marijuana, with the following response options: 0, 1–2, 3–5, 6–9, 10–19, 20–29, and all 30. Responses to this question were recoded to the midpoint of the category (i.e., a response of “6–9” was coded as “7.5”).

2.2.3 Demographics—Demographic characteristics measured during fall 2010 (Wave 1) include gender, race (white and non-white), ethnicity (Hispanic and non-Hispanic), and mother’s education (4 year college degree or higher vs. less than a 4 year college degree). Spending money available in an average month (at least \$100 per month vs. less than \$100 per month) was measured at Wave 6.

2.2.4 Social characteristics—Social characteristics were measured at Wave 6 and included participation in campus athletics (varsity, club, or intramural sports) within the past six months (yes vs. no); current membership or pledge status in a fraternity or sorority (yes vs. no); participation in religious activities at least twice per month over the past six months (yes vs. no); current residential status (on campus vs. off campus or studying abroad); and relationship status (steady partner or married vs. single, separated/divorced, or widowed). College graduates were not asked about their residential status and were assumed to be living off campus.

2.2.5 Other substance use—For cigarettes and hookah tobacco, students were considered a user if they reported using the substance at least once within the past 30 days at Wave 6. National Institute of Alcohol Abuse and Alcoholism guidelines (2004) were used to define heavy episodic drinking. Male and female students were denoted as heavy episodic drinkers if they drank at least five or four drinks in a row during the past 30 days, respectively. Illicit drug use was defined as using cocaine, methamphetamines, hallucinogens, rohypnol, ecstasy, or heroin at least once within the past six months at Wave 6.

2.2.6 Sensation Seeking and Perceived Stress—The Brief Sensation Seeking Scale (Hoyle et al., 2002) was administered at Wave 6. Sensation seeking scores were computed by averaging eight five-point Likert scale items (1= strongly disagree to 5 = strongly agree) for all participants who answered at least 5 items in the scale. Cronbach’s alpha for the Brief Sensation Seeking Scale was 0.82. Stress was measured at Wave 6 using the Perceived Stress Scale (Cohen and Williamson, 1988). Scores were computed by summing ten items

on a scale from 0=never to 4=very often. Two items were reverse coded. If only one or two items were missing, the mean of the remaining items was substituted for the missing items. Cronbach's alpha for the Perceived Stress Scale was 0.86.

2.3 Statistical Analysis

Group based trajectory modeling was used to identify the most common patterns of past-30-day marijuana use frequency during college (Nagin, 1999). Models used a zero-inflated Poisson distribution to account for the large number of students who did not use marijuana. Linear and quadratic terms for each trajectory group were included and compared. One- to eight-group models were considered. The best model was selected based on a combination of the Bayesian information criterion (BIC), group interpretability, and having reasonably large groups (at least 5% of the sample). Trajectory models were constructed using PROC TRAJ in SAS Version 9.4. Maximum likelihood estimation was used to estimate model parameters. Students were assigned to the marijuana trajectory group with the highest probability of membership.

Descriptive statistics on all demographic and social characteristics, substance use rates, and mental health and psychological factors are presented. The prevalence of being currently enrolled in college, graduating on time and the mean GPA were estimated by school to examine variation in academic outcomes. Bivariate associations between trajectory groups and all covariates were assessed via Chi square tests.

Random-effects linear and logistic regression models were fit in order to explore associations between marijuana trajectories and academic outcomes measured during the students' senior year of college. School was treated as a random effect to account for the inter-school correlation of academic outcomes (Donner et al., 1981; Murray and Short, 1995, 1996). Bivariate models were constructed for each covariate and academic outcome. Multivariable models predicting college outcomes from marijuana trajectory groups were estimated, adjusting for characteristics that had a marginal bivariate association ($p < 0.20$) with the outcomes. Covariates included basic demographic variables and factors shown to be associated with marijuana use in the literature (Bell et al., 1997, Johnston et al., 2015; Buckman et al., 2011; Wechsler et al. 1997; Yusko et al., 2008; McCabe et al., 2005; Mohler-Kuo et al., 2003). Adjusted and unadjusted odds ratios and 95% confidence intervals are presented for both dichotomous outcomes (enrollment in college and graduation on time). Regression coefficients, standard errors, and p-values are presented for the linear model for college grade point average. Models predicting graduation on time and college grade point average were restricted to only students who were currently enrolled or had graduated. Analyses for missing data were carried out using multiple imputation methods (Royston, 2009). First we assessed whether the sample with complete data differed from those with some missing data who additionally contributed to the multiple imputation analysis. This was done for each of the academic outcome models. Results revealed that the sample with full data were more likely to be white compared to those with missing data for the enrollment and GPA outcome models and were more likely to be enrolled in a public institution for the model for graduation on time. No differences were found with regards to gender, Hispanic ethnicity, mother's education or spending money for any of the academic

outcome models. We then conducted multiple imputation analysis on our regression models of marijuana trajectory group predicting academic outcomes. Models were estimated using the GLLAMM procedure and imputations were performed using the ICE procedure in Stata Version 13.1. All analyses use a 5% level of significance.

Since some groups of students were oversampled, all prevalence estimates, bivariate tests, and regression models use weights. Only univariate descriptive statistics on demographic and social characteristics are reported unweighted in order to describe the sample. Sampling weights reflect the inverse probability of selection from the screener survey and include a non-response adjustment. The weights were scaled using the approach of Pfefferman et al. (1998) to account for the students-within-schools design.

3. RESULTS

3.1 Sample characteristics

Almost half (48.6%) of the sample participating at Wave 6 was female (Table 1). About 16% were nonwhite, and 7% were Hispanic. Nearly 63% reported that their mother earned at least a four year college degree, and 82.6% had at least \$100 of spending money per month. Around one third (34.6%) of the sample participated in campus athletics, 26.0% were members or pledges of a sorority or fraternity, and 21.8% participated in religious services on at least a biweekly basis. About one-fourth of students lived on campus, and 45.3% were in a committed relationship. Fifteen percent_{wt} of students reported using cigarettes, 64.2%_{wt} reported heavy episodic drinking, and 8.8%_{wt} used hookah within the past month. In the past six months, 29.8%_{wt} of students used marijuana and 6.6%_{wt} used other illicit drugs. Mean sensation seeking and stress scores were 3.0_{wt} (SD = 0.8_{wt}) and 15.9_{wt} (SD = 6.9_{wt}), respectively.

Most students (97.2%_{wt}) were either enrolled in college or had graduated as of Wave 6. Among students who were still enrolled, 73.9%_{wt} planned to graduate on time. The mean GPA among students enrolled in college as of wave 6 was 3.29_{wt} (SD = 0.47_{wt}). Academic outcomes varied by school and ranged from 92.5%_{wt} to 99.6%_{wt} for college enrollment, 51.1%_{wt} to 92.8%_{wt} for graduating on time, and 3.15_{wt} to 3.39_{wt} for the mean GPA.

3.2 Trajectory modeling

The Bayesian Information Criteria statistic increased with the addition of each trajectory group (Table 2). As noted by Nagin and Tremblay (2001), in some applications, the BIC continues to improve, often resulting in the splitting of a large trajectory group into two smaller ones with parallel trajectories. In this instance, it is best to choose the best model based on interpretability and group sizes (no trajectory group significantly below 5% of the sample, though some weighted estimates may fall below 5%). We stopped at five groups because adding a sixth group would have split one of the groups in the five group model into two parallel groups that would not have improved interpretability.

The five group model trajectories are plotted in Figure 1. Among the 2,500 students who participated at Wave 6, 1,495 (69.0%_{wt}) were classified as non-users of marijuana throughout their college careers. The trajectory for non-users remained relatively flat, with

0.03 days of marijuana use, on average, at Wave 1, and 0.04 days of use by Wave 6. Infrequent users ($n=460$, 16.6%_{wt}) used marijuana occasionally over time. They averaged 0.9 days of marijuana use per month at Wave 1 and increased use slightly over time, to an average of 1.7 days per month by Wave 6. Decreasing users ($n=178$, 4.7%_{wt}) used marijuana more frequently during their first semester of college (8.9 days per month, on average), and their use declined over time to an average of 1.0 day per month by Wave 6. Increasing users ($n=196$, 5.8%_{wt}) used marijuana rarely during their first year of college (1.1 days per month, on average), and their use increased during their time in college to an average of 16.6 days per month by Wave 6. Frequent users ($n=171$, 3.9%_{wt}) used marijuana often throughout their entire college careers, averaging 15.7 days per month at Wave 1, steadily increasing to 21.3 days per month by Wave 5, and dropping slightly to 19.8 days per month, on average, at Wave 6.

3.3 Trajectory associations with covariates

Marijuana trajectory groups varied greatly across demographic groups (Table 3). Only 28.6% of frequent users were women, while 68.1% of non-users were female ($p < 0.001$). Non-users and increasing users had the highest percentages of nonwhites (17%–18%; $p=0.002$). Sixteen percent of frequent users were Hispanic, while the other four trajectory groups were 4%–8% Hispanic ($p=0.006$). Non-users were less likely to have more than \$100 per month in spending money than the other four groups (78% vs. 85%–89%, $p < 0.001$).

We also observed differences in social characteristics across marijuana trajectory groups. Non-users were less likely than users to be a member or pledge of a sorority or fraternity (23% vs. 29%–34%, $p < 0.001$) and more likely to participate regularly in religious activities (33% vs. 5%–11%, $p < 0.001$), live on campus (30% vs. 8%–16%, $p < 0.001$), and be in a committed relationship (49% vs. 34%–42%, $p = 0.020$).

Non-users were also far less likely to use cigarettes (6% vs. 21%–58%, $p < 0.001$), partake in heavy episodic drinking (54% vs. 86%–94%, $p < 0.001$), use hookah tobacco (6% vs. 11%–21%, $p < 0.001$), or use other illicit drugs (1% vs. 7%–44%, $p < 0.001$) than members of the four marijuana user groups. Mean age of initiation was higher for infrequent (17.4) and increasing users (17.0) than for decreasing (16.2) and frequent (15.7) users ($p < 0.001$). Trajectory groups also differed by mean sensation seeking score, with non-users having the lowest average (2.9), and frequent users having the highest average (3.7, $p < 0.001$).

3.4 Regression modeling

3.4.1 Current enrollment in college—In a bivariate model, both decreasing marijuana users (OR=0.4; CI: 0.2, 0.6) and frequent users (OR=0.4; CI: 0.2, 0.97) were less likely than non-users to be still enrolled or have graduated from college (Table 4). After adjusting for covariates, decreasing marijuana users (AOR=0.3; CI: 0.2, 0.7) and frequent users (AOR=0.4; CI: 0.2, 0.97) were still less likely than non-users to be still enrolled in college or to have graduated. In these adjusted models, students who attended religious services often, students who were not in a committed relationship, heavy episodic drinkers, and hookah users were more likely to be still enrolled in college or to have graduated.

3.4.2 Plans to graduate from college on time—In an unadjusted model, infrequent marijuana users (OR=0.7; CI: 0.6, 0.96), decreasing users (OR=0.5; CI: 0.3, 0.9), increasing users (OR=0.6; CI: 0.4, 0.9), and frequent users (OR=0.4; CI: 0.3, 0.8) were all less likely to plan to graduate from college on time than non-users. After adjusting for covariates, only decreasing users (AOR=0.6; CI: 0.4, 0.99) and frequent users (AOR=0.5; CI: 0.3, 0.97) were still less likely than non-users to plan to graduate from college on time. In these adjusted models, white students and students who lived on campus were more likely to plan to graduate on time.

3.4.3 Grade point average—In the unadjusted linear regression model, infrequent marijuana users ($\beta=-0.10$, SE=0.04, $p=0.009$), decreasing users ($\beta=-0.20$, SE=0.06, $p=0.001$), increasing users ($\beta=-0.34$, SE=0.04, $p<0.001$), and frequent users ($\beta=-0.29$, SE=0.05, $p<0.001$) all had lower GPAs, on average, than non-users. In an adjusted linear regression model, infrequent users ($\beta=-0.08$, SE=0.04, $p=0.030$), decreasing users ($\beta=-0.14$, SE=0.06, $p=0.015$), increasing users ($\beta=-0.25$, SE=0.04, $p<0.001$), and frequent users ($\beta=-0.18$, SE=0.05, $p=0.001$) all had lower GPAs, on average, than non-users. When allowing for multiple comparisons in the multivariable model, increasing users were found to have lower GPAs, on average, than infrequent users ($\beta=-0.17$, SE=0.06, $p=0.003$). In the adjusted models, females, white students, and students whose mothers possessed at least a four year college degree had higher GPAs, on average. There was a negative association between GPA and both cigarette use and stress.

4. DISCUSSION

We identified five marijuana trajectory groups that were similar to those found in prior research on college students, though we observed fewer students in each user group and more students in the non-user group [69.0% in our study vs. 60.2% “minimal users” reported by Arria et al. (2013b)]. This difference may be due to the fact that the prior study only included students from one college that is not representative of our sample.

All four marijuana use groups reported significantly lower GPAs, on average, than non-users. Even students who used marijuana infrequently exhibited lower academic performance. Students who increased marijuana use had the lowest adjusted average GPA, at 0.25 points lower than non-users. These findings are consistent with prior studies that have established a link between marijuana use and lower GPAs among college students (Arria et al., 2013a, 2015; Bell et al., 1997), even among infrequent users (Buckner et al., 2010). This association may be explained by the fact that marijuana users tend to skip more classes and in turn, earn lower GPAs (Arria et al., 2013a, 2015). The relationship between marijuana use and impaired mental functioning (Caldeira et al., 2008; Churchwell et al., 2010; Hermann et al., 2007; McHale et al., 2008; Ramaekers et al., 2006; Shillington and Clapp, 2001; Vadhan et al., 2007; Wadsworth et al., 2006) could also explain poorer performance among marijuana users.

Decreasing and frequent marijuana users were both less likely to be currently enrolled in college as of senior year and were less likely to plan to graduate on time. These findings suggest that students who frequently use marijuana early in their college career are most at

risk of not completing college and delaying graduation. These results are consistent with Arria et al.'s finding that frequent marijuana use during the freshman year of college is associated with delayed graduation from college (2015). Campus prevention efforts should focus on early intervention in order to increase retention.

Males, whites, Hispanics, students whose mothers do not possess a four year degree, and students who report having at least \$100 per month in spending money are more likely to be a member of at least one of these two most at-risk marijuana trajectory groups, compared to non-users. Students who participate in a fraternity or sorority, have low religious participation, live off campus, are not in a committed relationship, and use other substances are also more likely to be classified as a decreasing or frequent marijuana user instead of a non-user. Frequent and decreasing users also initiate marijuana at an earlier age than infrequent and increasing users, further underscoring the need for early intervention. In an earlier study of this sample, we found that students who have more spending money, attend church rarely or never, and use other substances are more likely to have initiated marijuana before attending college (Suerken et al., 2014). These students might have started to use regularly prior to college entry and might especially benefit from screening and early intervention. Our previous research also showed that Hispanic students were more likely to initiate marijuana during the first year of college (Suerken et al, 2014). In the current study, Hispanic students were more likely to be frequent marijuana users during college, further illustrating the need for more research into the association between ethnicity and marijuana use.

We acknowledge several limitations to this study. Our study included students from 11 four-year colleges in 2 states and may not be generalizable to college students in other areas of the country or to small private schools, given that most of the colleges that participated in our study were public institutions. Future research should consider the school environment, given that some types of institutions may monitor student performance more carefully. Graduation date was self-reported and based on future plans that may not come to fruition. Some students may take longer to graduate than expected, and some students who plan to delay graduation may eventually drop out of college. GPA was also self-reported and may have been rounded or remembered incorrectly. Self-reported college GPAs are commonly inflated, especially among students with lower grades (Kuncel et al., 1995). Findings on graduation time and GPA may be conservative because they are restricted to the subset of students who were enrolled or had graduated. Marijuana use may have been underreported (Akinci et al., 2001; Delaney-Black et al., 2010; Gruenwald and Johnson, 2006; Wagenaar et al., 1993), although measuring drug use in a school or research setting is more likely to produce honest responses (Kandel et al., 2006). The sample may also be subject to selection bias, given that substance users may have been less likely to continue participation in the study (McCoy et al., 2008).

Although all marijuana user groups exhibited lower academic performance, students who use marijuana frequently at the beginning of the college career are at the highest risk for dropping out or delaying graduation. Campus prevention efforts should focus on early intervention and target demographic and social groups who are most at risk for early frequent use. Academic assistance centers should screen students for frequent marijuana use

during the first semester of college in order to identify students who may be struggling academically. Future research should investigate the association between marijuana trajectories and post-college outcomes.

Acknowledgments

Role of Funding Source

This research was supported by Award Number R01CA141643 from the National Cancer Institute. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Cancer Institute or the National Institutes of Health.

References

- Akinci IH, Tarter RE, Kirisci L. Concordance between verbal report and urine screen of recent marijuana use in adolescents. *Addict Behav.* 2001; 26:613–619. [PubMed: 11456081]
- Arria AM, Wilcox HC, Caldeira KM, Vincent KB, Garnier-Dykstra LM, O’Grady KE. Dispelling the myth of “smart drugs”: Cannabis and alcohol use problems predict nonmedical use of prescription stimulants for studying. *Addict Behav.* 2013a; 38:1643–1650. [PubMed: 23254212]
- Arria AM, Garnier-Dykstra LM, Caldeira KM, Vincent KB, Winick ER, O’Grady KE. Drug use patterns and continuous enrollment in college: results from a longitudinal study. *J Stud Alcohol Drugs.* 2013b; 74:71–83. [PubMed: 23200152]
- Arria AM, Caldeira KM, Bugbee BA, Vincent KB, O’Grady KE. The academic consequences of marijuana use during college. *Psychol Addict Behav.* 2015; 29:564–575. [PubMed: 26237288]
- Battistella G, Fornari E, Annoni JM, Chtioui H, Dao K, Fabritius M, Favrat B, Mall JF, Maeder P, Giroud C. Long-term effects of cannabis on brain structure. *Neuropsychopharmacology.* 2014; 39:2041–2048. [PubMed: 24633558]
- Bell R, Wechsler H, Johnston LD. Correlates of college student marijuana use: results of a US national survey. *Addiction.* 1997; 92:571–581. [PubMed: 9219379]
- Block RI, O’Leary DS, Hichwa RD, Augustinack JC, Boles Ponto LL, Ghoneim MM, Arndt S, Hurtig RR, Watkins GL, Hall JA, Nathan PE, Andreasen NC. Effects of frequent marijuana use on memory-related regional cerebral blood flow. *Pharmacol Biochem Behav.* 2002; 72:237–250. [PubMed: 11900794]
- Bolla KI, Brown K, Eldreth D, Tate K, Cadet JL. Dose-related neurocognitive effects of marijuana use. *Neurology.* 2002; 59:1337–1343. [PubMed: 12427880]
- Braun BL, Hannan P, Wolfson M, Jones-Webb R, Sidney S. Occupational attainment, smoking, alcohol intake, and marijuana use: ethnic-gender differences in the CARDIA study. *Addict Behav.* 2000; 25:399–414. [PubMed: 10890293]
- Brook JS, Zhang C, Brook DW. Developmental trajectories of marijuana use from adolescence to adulthood: personal predictors. *Arch Pediatr Adolesc Med.* 2011; 165:55–60. [PubMed: 21199981]
- Buckman JF, Yusko DA, Farris SG, White HR, Pandina RJ. Risk of marijuana use in male and female college student athletes and nonathletes. *J Stud Alcohol Drugs.* 2011; 72:586–591. [PubMed: 21683040]
- Buckner JD, Ecker AH, Cohen AS. Mental health problems and interest in marijuana treatment among marijuana-using college students. *Addict Behav.* 2010; 35:826–833. [PubMed: 20483200]
- Caldeira KM, Arria AM, O’Grady KE, Vincent KB, Wish ED. The occurrence of cannabis use disorders and other cannabis-related problems among first-year college students. *Addict Behav.* 2008; 33:397–411. [PubMed: 18031940]
- Chen CY, Storr CL, Anthony JC. Early-onset drug use and risk for drug dependence problems. *Addict Behav.* 2009; 34:319–322. [PubMed: 19022584]
- Churchwell JC, Lopez-Larson M, Yurgelun-Todd DA. Altered frontal cortical volume and decision making in adolescent cannabis users. *Front Psychol.* 2010; 1:225. [PubMed: 21833280]

- Cohen, S.; Williamson, G. Perceived stress in a probability sample of the United States. In: Spacapan, S.; Oskamp, S., editors. *The Social Psychology Of Health: Claremont Symposium On Applied Social Psychology*. Sage; Newbury Park, CA: 1988. p. 31-67.
- Degenhardt L, Coffey C, Carlin JB, Swift W, Moore E, Patton GC. Outcomes of occasional cannabis use in adolescence: 10-year follow-up study in Victoria, Australia. *Br J Psychiatry*. 2010; 196:290–295. [PubMed: 20357305]
- Delaney-Black V, Chiodo LM, Hannigan JH, Greenwald MK, Janisse J, Patterson G, Huestis MA, Ager J, Sokol RJ. Just say “I don’t”: lack of concordance between teen report and biological measures of drug use. *Pediatrics*. 2010; 5:887–893. [PubMed: 20974792]
- Donner A, Birkett N, Buck C. Randomization by cluster sample size requirements and analysis. *Am J Epidemiol*. 1981; 114:906–914. [PubMed: 7315838]
- Ellickson PL, D’Amico EJ, Collins RL, Klein DJ. Marijuana use and later problems: when frequency of recent use explains age of initiation effects (and when it does not). *Subst Use Misuse*. 2005; 40:343–359. [PubMed: 15776981]
- Fergusson DM, Horwood LJ, Beautrais AL. Cannabis and educational achievement. *Addiction*. 2003; 98:1681–1692. [PubMed: 14651500]
- Fergusson DM, Boden JM. Cannabis use and later life outcomes. *Addiction*. 2008; 103:969–976. [PubMed: 18482420]
- Fleming CB, White HR, Haggerty KP, Abbott RD, Catalano RF. Educational paths and substance use from adolescence into early adulthood. *J Drug Issues*. 2012; 42:104–126.
- Flory K, Lynam D, Milich R, Leukefeld C, Clyaton R. Early adolescent through young adult alcohol and marijuana use trajectories: early predictors, young adult outcomes, and predictive utility. *Dev Psychopathol*. 2004; 16:193–213. [PubMed: 15115071]
- Green BE, Ritter C. Marijuana use and depression. *J Health Soc Behav*. 2000; 41:40–49. [PubMed: 10750321]
- Gruenewald PJ, Johnson FW. The stability and reliability of self-reported drinking measures. *J Stud Alcohol Drugs*. 2006; 65:738–45.
- Hammersley R, Leon V. Patterns of cannabis use and positive and negative experiences of use amongst university students. *Addict Res Theory*. 2006; 14:189–205.
- Hermann D, Sartorius A, Welzel H, Walter S, Skopp G, Ende G, Mann K. Dorsolateral prefrontal cortex N-acetylaspartate/total creatine (NAA/tCr) loss in male recreational cannabis users. *Biol Psychiatry*. 2007; 61:1281–1289. [PubMed: 17239356]
- Hoyle RH, Stephenson MT, Palmgreen P, Lorch EP, Donohew RL. Reliability and validity of a brief measure of sensation seeking. *Pers Individ Dif*. 2002; 32:401–414.
- Horwood LJ, Fergusson DM, Hayatbakhsh MR, Najman JM, Coffey C, Patton GC, Silins E, Hutchinson DM. Cannabis use and educational achievement: findings from three Australasian cohort studies. *Drug Alcohol Depend*. 2010; 110:247–253. [PubMed: 20456872]
- Hunt J, Eisenberg D, Kilbourne AM. Consequences of receipt of a psychiatric diagnosis for completion of college. *Psychol Serv*. 2010; 61:399–404.
- Johnston, LD.; O’Malley, PM.; Bachman, JG.; Schulenberg, JE.; Miech, RA. *Monitoring The Future National Survey Results On Drug Use, 1975–2014: Volume 2, College Students And Adults Ages*. Institute for Social Research, The University of Michigan; Ann Arbor: 2015. p. 19-55.
- Kandel DB, Schaffran C, Griesler PC, Hu MC, Davies M, Benowitz N. Salivary cotinine concentration versus self-reported cigarette smoking: three patterns of inconsistency in adolescence. *Nicotine Tob Res*. 2006; 8:525–537. [PubMed: 16920650]
- Kena, G.; Aud, S.; Johnson, F.; Wang, X.; Zhang, J.; Rathbun, A.; Wilkinson-Flicker, S.; Kristapovich, P. *The Condition of Education 2014 (NCES 2014–083)*. U.S. Department of Education, National Center for Education Statistics; Washington, DC: 2014.
- Kouri E, Pope HG, Yurgelun-Todd D, Gruber S. Attributes of heavy vs. occasional marijuana smokers in a college population. *Biol Psychiatry*. 1995; 38:475–481. [PubMed: 8672609]
- Kuncel NR, Crede M, Thomas L. The validity of self-reported grade point averages, class ranks, and test scores: a meta-analysis and review of the literature. *Rev Educ Res*. 2005; 75:63–82.
- Martinez JA, Roth MG, Johnson DN, Jones JA. How robustly does cannabis use associate to college grades? Findings from two cohorts. *J Drug Educ*. 2015; 45:56–67. [PubMed: 26224748]

- McCabe SE, Schulenberg JE, Johnston LD, O'Malley PM, Bachman JG, Kloska DD. Selection and socialization effects of fraternities and sororities on US college student substance use: a multi-cohort national longitudinal study. *Addiction*. 2005; 100:512–524. [PubMed: 15784066]
- McCoy TP, Ip EH, Blocker JN, Champion H, Rhodes SD, Wagoner KG, Mitra A, Wolfson M. Attrition bias in a U.S. internet survey of alcohol use among college freshmen. *J Stud Alcohol Drugs*. 2008; 70:606–614. [PubMed: 19515302]
- McHale S, Hunt N. Executive function deficits in short-term abstinent cannabis users. *Hum Psychopharmacol*. 2008; 23:409–415. [PubMed: 18421794]
- Mohler-Kuo M, Lee JE, Wechsler H. Trends in marijuana and other illicit drug use among college students: results from 4 Harvard School of Public Health college alcohol study surveys: 1993–2001. *J Am Coll Health*. 2003; 52:17–24. [PubMed: 14717576]
- Murray DM, Short B. Intraclass correlation among measures related to alcohol use by young adults: estimates, correlates and applications in intervention studies. *J Stud Alcohol Drugs*. 1995; 56:681–694.
- Murray DM, Short B. Intraclass correlation among measures related to alcohol use by school aged adolescents: estimates, correlates and applications in intervention studies. *J Drug Educ*. 1996; 26:207–230. [PubMed: 8952207]
- Nagin DS. Analyzing developmental trajectories: a semiparametric, group-based approach. *Psychol Methods*. 1999; 4:139–157.
- Nagin, DS. *Group-Based Modeling Of Development*. Cambridge, MA: Harvard University Press; 2005.
- Nagin DS, Tremblay RE. Analyzing developmental trajectories of distinct but related behaviors: a group-based method. *Psychol Methods*. 2001; 6:18–34. [PubMed: 11285809]
- National Institute of Alcohol Abuse and Alcoholism. NIAAA council approves definition of binge drinking. *NIAAA Newsletter*. 2004:3.
- Pfefferman D, Skinner CJ, Holmes DJ, Goldstein H, Rasbash J. Weighting for unequal selection probabilities in multilevel models. *J R Stat Soc Series B*. 1998; 60:23–40.
- Phillips KT, Phillips MM, Lalonde TL, Tormohlen KN. Marijuana use, craving, and academic motivation and performance among college students: an in-the-moment study. *Addict Behav*. 2015; 47:42–47. [PubMed: 25864134]
- Pope HG, Yurgelun-Todd D. The residual cognitive effects of heavy marijuana use in college students. *JAMA*. 1996; 275:521–527. [PubMed: 8606472]
- Ramaekers JG, Kauert G, van Ruitenbeek P, Theunissen EL, Schneider E, Moeller MR. High-potency marijuana impairs executive function and inhibitory motor control. *Neuropsychopharmacology*. 2006; 31:2296–2303. [PubMed: 16572123]
- Royston P. Multiple imputation of missing values: further update of ice, with an emphasis on categorical variables. *Stata J*. 2009; 9:466–477.
- Schulenberg JE, Merline AC, Johnston LD, O'Malley PM, Bachman JG, Laetz VB. Trajectories of marijuana use during the transition to adulthood: the big picture based on national panel data. *J Drug Issues*. 2005; 35:255–280. [PubMed: 16534532]
- Shillington AM, Clapp JD. Substance use problems reported by college students: combined marijuana and alcohol use versus alcohol-only use. *Subst Use Misuse*. 2001; 36:663–672. [PubMed: 11419493]
- Solowij N, Michie PT, Fox AM. Differential impairments of selective attention due to frequency and duration of cannabis use. *Biol Psychiatry*. 1995; 37:731–739. [PubMed: 7640328]
- Solowij N, Stephens RS, Roffman RA, Babor T, Kadden R, Miller M, Christiansen K, McRee B, Vendetti J. Cognitive functioning of long-term heavy cannabis users seeking treatment. *JAMA*. 2002; 287:1123–31. [PubMed: 11879109]
- Solowij N, Jones KA, Rozman ME, Davis SM, Ciarrochi J, Heaven PC, Lubman DI, Yücel M. Verbal learning and memory in adolescent cannabis users, alcohol users and non-users. *Psychopharmacology*. 2011; 216:131–144. [PubMed: 21328041]
- Spangler J, Song E, Pockey J, Sutfin EL, Reboussin BA, Wagoner K, Wolfson M. Correlates of smokeless tobacco use among first year college students. *Health Educ J*. 2014; 73:693–701. [PubMed: 25484378]

- Suerken CK, Reboussin BA, Sutfin EL, Wagoner KG, Spangler J, Wolfson M. Prevalence of marijuana use at college entry and risk factors for initiation during freshman year. *Addict Behav.* 2014; 39:302–307. [PubMed: 24455784]
- Tucker JS, Ellickson PL, Orlando M, Martino SC, Klein DJ. Substance use trajectories from early adolescence to emerging adulthood: a comparison of smoking, binge drinking, and marijuana use. *J Drug Issues.* 2005; 35:307–332.
- Tucker JS, Ellickson PL, Collins RL, Klein DJ. Are drug experimenters better adjusted than abstainers and users? A longitudinal study of adolescent marijuana use. *J Adolesc Health.* 2006; 39:488–494. [PubMed: 16982382]
- Vadhan NP, Hart CL, van Gorp WG, Gunderson EW, Haney M, Foltin RW. Acute effects of smoked marijuana on decision making, as assessed by a modified gambling task, in experienced marijuana users. *J Clin Exp Neuropsychol.* 2007; 29:357–364. [PubMed: 17497559]
- Verdejo-García A, Rivas-Pérez C, López-Torrecillas F, Pérez-García M. Differential impact of severity of drug use on frontal behavioral symptoms. *Addict Behav.* 2006; 31:1373–1382. [PubMed: 16326022]
- Wadsworth EJ, Moss SC, Simpson SA, Smith AP. Cannabis use, cognitive performance and mood in a sample of workers. *J Psychopharmacol.* 2006; 20:14–23. [PubMed: 16204329]
- Wagenaar AC, Komro KA, McGovern P, Williams CL, Perry CL. Effects of a saliva test pipeline procedure on adolescent self-report alcohol use. *Addiction.* 1993; 88:199–208. [PubMed: 8220058]
- Wechsler H, Davenport AE, Dowdall GW, Grossman SJ, Zanakos SI. Binge drinking, tobacco, and illicit drug use and involvement in college athletics. A survey of students at 140 American colleges. *J Am Coll Health.* 1997; 45:195–200. [PubMed: 9069676]
- Whitehill JM, Rivara FP, Moreno MA. Marijuana-using drivers, alcohol-using drivers, and their passengers: prevalence and risk factors among underage college students. *JAMA Pediatr.* 2014; 168:618–624. [PubMed: 24820649]
- Whitlow CT, Liguori A, Livengood LB, Hart SL, Mussat-Whitlow BJ, Lamborn CM, Laurienti PJ, Porrino LJ. Long-term heavy marijuana users make costly decisions on a gambling task. *Drug Alcohol Depend.* 2004; 76:107–111. [PubMed: 15380295]
- Windle M, Wiesner M. Trajectories of marijuana use from adolescence to young adulthood: predictors and outcomes. *Dev Psychopathol.* 2004; 16:1007–1027. [PubMed: 15704825]
- Wolfson M, Pockey JR, Reboussin BA, Sutfin EL, Egan KL, Wagoner KG, Spangler J. First-year college students' interest in trying dissolvable tobacco products. *Drug Alcohol Depend.* 2014; 134:309–313. [PubMed: 24309296]
- Yücel M, Solowij N, Respondek C, Whittle S, Fornito A, Pantelis C, Lubman DI. Regional brain abnormalities associated with long-term heavy cannabis use. *Arch Gen Psychiatry.* 2008; 65:694–701. [PubMed: 18519827]
- Yusko DA, Buckman JF, White HR, Pandina RJ. Alcohol, tobacco, illicit drugs, and performance enhancers: a comparison of use by college student athletes and nonathletes. *J Am Coll Health.* 2008; 57:281–290. [PubMed: 18980883]

Highlights

- Students from 11 colleges in NC and VA were surveyed at 6 time points.
- Five marijuana trajectory groups were identified.
- Decreasing and frequent users were more likely to drop out or delay graduation.
- All marijuana user groups reported lower GPAs, on average, than non-users.
- Early intervention may identify students at risk for struggling academically.

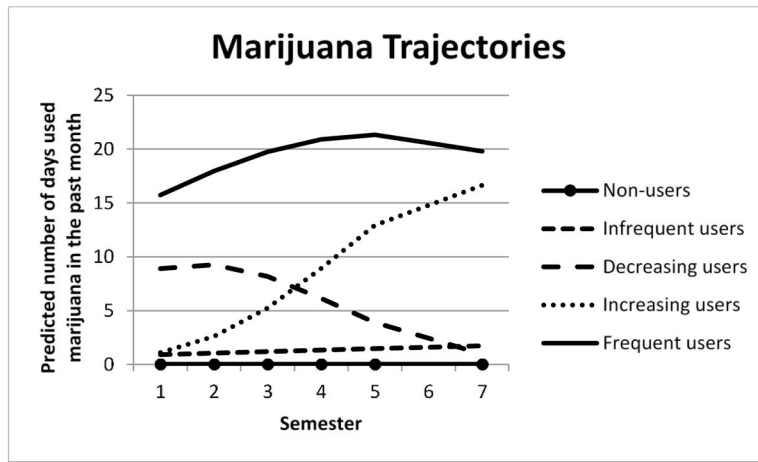


Figure 1.

Table 1

Sample Characteristics and Substance Use Estimates among All Wave 6 Participants (N= 2500)

Characteristics		N (%) / Mean (SD)
Demographics ¹	Female	1216 (48.6)
	Nonwhite	398 (16.1)
	Hispanic	173 (7.0)
	Mother four year college degree	1527 (62.7)
	Spending money >= \$100 per month	2046 (82.6)
Social Characteristics ¹	Athlete	845 (34.6)
	Member or pledge of a sorority or fraternity	627 (26.0)
	Attends religious services at least twice per month	532 (21.8)
	Lives on campus	532 (24.5)
	In a committed relationship	1120 (45.3)
Other Substance Use ²	Past month cigarette use	571 (14.6)
	Past month binge drinking	1688 (64.2)
	Past month hookah tobacco use	253 (8.8)
	Past 6 month marijuana use	883 (29.8)
	Past 6 month other illicit drug use	247 (6.6)
Mental Health and Psychological Factors ²	Sensation seeking	3.0 (0.8)
	Stress	15.9 (6.9)

¹Unweighted estimates²Weighted estimates

Table 2

Bayesian Information Criteria for trajectory group solutions

Number of Trajectory Groups	BIC
1	-80,929.3
2	-37,506.0
3	-31,589.4
4	-28,997.8
5	-27,219.2
6	-26,385.1
7	-25,663.6
8	-25,242.0

Smaller negative numbers indicate better fit.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 3 Sample Characteristics, Substance Use, and Age of Marijuana Initiation by Marijuana Trajectory Group.

Characteristics	N (%) / Mean (SD)					P-value
	Non-users N = 1495	Infrequent Users N = 460	Decreasing Users N = 178	Increasing Users N = 196	Frequent Users N = 171	
Demographics						
Female	778 (68.1)	254 (67.6)	77 (55.7)	61 (43.5)	46 (28.6)	< 0.001
Nonwhite	274 (18.4)	54 (12.1)	25 (12.1)	30 (17.4)	15 (11.4)	0.002
Hispanic	100 (6.5)	31 (6.1)	8 (4.4)	15 (8.4)	19 (16.0)	0.006
Mother four year college degree	911 (61.9)	278 (64.2)	117 (66.4)	120 (62.3)	101 (53.8)	0.485
Spending money >= \$100 per month	1170 (78.3)	401 (85.8)	156 (88.6)	169 (87.2)	150 (85.4)	< 0.001
Athlete	514 (32.6)	166 (36.1)	57 (31.7)	57 (24.7)	51 (30.1)	0.254
Member or pledge of a sorority or fraternity	332 (22.9)	150 (32.9)	52 (34.3)	49 (29.0)	44 (31.7)	< 0.001
Attends religious services at least twice per month	456 (32.9)	41 (11.3)	15 (9.2)	12 (6.9)	8 (5.3)	< 0.001
Lives on campus	426 (30.0)	66 (15.9)	14 (10.0)	14 (7.8)	12 (10.2)	< 0.001
In a committed relationship	720 (48.7)	194 (40.5)	72 (41.6)	66 (34.1)	68 (39.1)	0.020
Past month cigarette use	144 (6.0)	142 (21.2)	78 (39.7)	103 (47.7)	104 (58.0)	< 0.001
Past month heavy episodic drinking	806 (53.5)	399 (86.7)	149 (86.1)	175 (90.4)	159 (93.8)	< 0.001
Past month hookah tobacco use	93 (6.3)	57 (11.0)	30 (16.8)	40 (20.8)	33 (17.8)	< 0.001
Past 6 month other illicit drug use	22 (1.1)	45 (7.1)	38 (22.9)	63 (30.2)	79 (43.5)	< 0.001
Mental Health and Psychological Factors						
Sensation seeking	2.9 (0.8)	3.2 (0.7)	3.4 (0.6)	3.6 (0.7)	3.7 (0.5)	< 0.001
Stress	15.9 (7.4)	15.7 (6.6)	17.2 (5.4)	16.4 (6.5)	16.2 (5.1)	0.059
Age of Marijuana Initiation		17.4 (1.7)	16.2 (1.3)	17.0 (1.4)	15.7 (1.3)	< 0.001

Table 4

Odds ratios and adjusted odds ratios for predictors of college outcomes

Predictor	Currently Enrolled in College ¹		Plan to Graduate on Time ²		GPA ³			
	Odds Ratio	Adjusted Odds Ratio	Odds Ratio	Adjusted Odds Ratio	Unadjusted β (SE)	Unadjusted p-value	Adjusted β (SE)	Adjusted p-value
Marijuana Trajectory (Reference = Non-users)	0.9 (0.4, 1.8)	0.7 (0.3, 1.5)	0.7 (0.6, 0.96)	0.8 (0.6, 1.1)	-0.10 (0.04)	0.009	-0.08 (0.04)	0.030
	0.4 (0.2, 0.6)	0.3 (0.2, 0.7)	0.5 (0.3, 0.9)	0.6 (0.4, 0.99)	-0.20 (0.06)	0.001	-0.14 (0.06)	0.015
	0.4 (0.1, 1.1)	0.3 (0.1, 0.8)	0.6 (0.4, 0.9)	0.7 (0.4, 1.1)	-0.34 (0.04)	< 0.001	-0.25 (0.04)	< 0.001
	0.4 (0.2, 0.97)	0.4 (0.2, 0.97)	0.4 (0.3, 0.8)	0.5 (0.3, 0.97)	-0.29 (0.05)	< 0.001	-0.18 (0.05)	0.001
Demographics	1.4 (0.8, 2.4)		1.3 (1.1, 1.6)	1.2 (0.97, 1.5)	0.12 (0.02)	< 0.001	0.09 (0.02)	< 0.001
	0.7 (0.4, 1.3)		0.6 (0.4, 1.02)	0.5 (0.3, 0.9)	-0.28 (0.03)	< 0.001	-0.28 (0.02)	< 0.001
	0.5 (0.2, 1.4)		0.8 (0.5, 1.3)		-0.16 (0.06)	0.012	-0.09 (0.06)	0.174
	0.9 (0.6, 1.2)		1.3 (0.9, 1.9)		0.12 (0.03)	< 0.001	0.09 (0.03)	0.001
	1.4 (0.6, 3.3)		0.7 (0.5, 1.1)	0.8 (0.5, 1.3)	-0.01 (0.02)	0.683		
Social Characteristics	---	---	1.1 (0.9, 1.4)		-0.003 (0.03)	0.916		
	---	---	0.9 (0.6, 1.4)		-0.04 (0.02)	0.062	-0.03 (0.02)	0.182
	2.4 (1.2, 4.7)	2.7 (1.5, 4.8)	1.2 (0.8, 1.8)		0.11 (0.03)	< 0.001	0.04 (0.02)	0.069
	---	---	2.1 (1.4, 3.1)	1.9 (1.2, 3.0)	0.05 (0.02)	0.028	0.04 (0.02)	0.062
	0.5 (0.3, 0.9)	0.5 (0.2, 0.9)	1.1 (0.9, 1.4)		0.05 (0.03)	0.055	0.02 (0.02)	0.391
Other Substance Use	0.4 (0.2, 0.99)	0.4 (0.1, 1.004)	0.7 (0.5, 0.9)	1.0 (0.7, 1.4)	-0.20 (0.04)	< 0.001	-0.09 (0.04)	0.027
	2.5 (0.997, 6.4)	5.6 (2.7, 11.6)	0.8 (0.6, 1.1)	1.0 (0.7, 1.4)	-0.09 (0.03)	< 0.001	-0.04 (0.02)	0.136
	1.9 (1.01, 3.6)	2.5 (1.4, 4.5)	0.9 (0.6, 1.4)		-0.16 (0.05)	0.001	-0.04 (0.06)	0.420
	0.4 (0.2, 0.8)	0.6 (0.2, 1.5)	0.7 (0.4, 1.1)	1.1 (0.7, 1.8)	-0.17 (0.03)	< 0.001	0.008 (0.03)	0.785
Mental Health and Psychological Factors	0.9 (0.7, 1.3)		0.8 (0.7, 0.97)	0.9 (0.7, 1.2)	-0.05 (0.01)	< 0.001	0.02 (0.01)	0.291
	1.0 (0.97, 1.04)		1.0 (0.97, 1.02)		-0.005 (0.002)	0.006	-0.005 (0.002)	0.001

Bolded confidence intervals indicate that the odds ratio is significant at the 5% level.

¹Odds ratio greater than 1 means that covariate is associated with increased odds of being currently enrolled in college or having graduated.

²Odds ratio greater than 1 means that covariate is associated with increased odds of planning to graduate on time.

³Positive beta associated with higher average GPA; negative beta associated with lower average GPA.