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Predicting Young Adult Degree Attainment by Late Adolescent Marijuana Use

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Abstract

Purpose—Assess whether infrequent and frequent marijuana use at age 19/20 predicts receipt of educational degrees by the mid 20s, independent of confounding age 18 adolescent risk factors.

Methods—Data were from the Monitoring the Future study, an annual nationally-representative survey of high school seniors followed into adulthood. Thirteen cohorts (1990 to 2002) of high school seniors were followed longitudinally to their mid 20s (*n*=4,925; 54% female). We used logistic regression and propensity score matching with successive inclusion of age 18 risk factors and substance use to compare age 19/20 frequent marijuana users (6+ occasions in past 30 days) to non-users, frequent users to infrequent users (1 to 6 occasions), and infrequent users to non-users on their likelihood of degree attainment by the mid 20s.

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Results—Frequent marijuana users were less likely than infrequent users and non-users to earn Bachelor's degrees, even after controlling for a host of age 18 risk factors (e.g., family socioeconomic background, academic performance, educational expectations, truancy). However, these differences were reduced in magnitude to statistical non-significance when we controlled for age 18 substance use. Across analyses, the proportion reaching this educational milestone did not differ significantly between infrequent users and non-users.

Conclusions—Results support a growing body of work suggesting that frequent marijuana use predicts a lower likelihood of post-secondary educational attainment, and this difference may originate during secondary school.

Keywords

Marijuana use; marijuana use consequences; drug use consequences; educational attainment; degree attainment; propensity score methods; adolescents; young adults

Marijuana is the most widely used illegal drug among adolescents [1]. Marijuana use during adolescence is clearly associated with many deleterious social and psychological correlates, with evidence of a link to lower educational attainment, especially among early and frequent users [2, 3, 4, 5, 6]. However, significant methodological challenges have led some scholars to question the evidence for marijuana's detrimental causal impact [4, 7, 8]. Notably, ethical and legal constraints against randomized trials make it difficult to rule out reverse causality (low achievement leading to substance use) or third variable influences (confounders underlying substance use and educational attainment). Using nationally representative longitudinal data from 13 cohorts of US high school seniors, we use regression and propensity score methods to examine whether the frequency of late adolescent marijuana use (age 19/20) predicts lower likelihood of degree attainment by the mid 20s. By successive consideration of risk factors assessed in high school (including age 18 substance use), we test the robustness of observed differences in the face of potential selection effects.

Past Research: Empirical Work and Methodological Challenges

The majority of longitudinal epidemiological research on consequences of marijuana use has focused on use by adolescents in secondary school [4]. Early onset during middle and high school are associated with lower school commitment, grades, and high school graduation [6, 9, 10, 12, 15]. Recent longitudinal studies also show persistent predictive power of adolescent marijuana use on enrollment in and completion of post-secondary education [9, 12, 16].

We add to a growing literature evaluating longer-term detrimental impacts of marijuana use on post-secondary credentials in three ways. First, much extant research has not accounted for prior selection effects that may underlie observed associations [5] [8]. We use logistic regression with and without controls for prior risk factors and substance use as well as propensity score methods matching individuals with similar risk (or propensity) for marijuana use to further reduce confounding; these alternative approaches have benefits and limitations. Second, many samples have been small or contained insufficient numbers of drug users for optimal statistical power [12, 15]. The national US Monitoring the Future

study over-samples drug users for longitudinal follow-up, providing increased power to distinguish non-users from infrequent and frequent marijuana users. Finally, the majority of research has focused on early onset or use of marijuana during secondary school [16, 17]. However, the normative lifetime peak of marijuana use occurs later [18, 19]. We focus on marijuana use during the years immediately following high school, a pivotal period for career planning and educational enrollment. Any factors reducing successful transitions to new accomplishments may have long-term detrimental effects on qualifications and occupational attainment [13, 18, 20].

Alternative Process Models

We examine two hypotheses to explain links between marijuana use and lower educational attainment. The causal hypothesis proposes a detrimental effect on attainment [9] through multiple intervening processes [6, 7, 21]. Marijuana users, especially frequent users, may be more likely to adopt a delinquent, illegal lifestyle [3, 6] or make earlier transitions to work, partnering, and parenting [23]. Alternatively, marijuana use may increase risk for accident and injuries [24] or harm cognitive neuropsychological performance, neural connectivity, and brain development [19, 25]. Finally, marijuana users are more likely to use other substances with their own harmful effects [6]. In summary, the causal hypothesis views early, frequent, or heavy marijuana use as the underlying direct or indirect cause of reduced educational attainment.

Alternatively, the common cause hypothesis, posits that apparent harmful impacts of marijuana use may be spurious, that is, due primarily to shared underlying risk factors for both marijuana use and low achievement [7]. In support of this view, apparent effects of heavy marijuana use on educational attainment tend to be attenuated (though not eliminated) in longitudinal studies that statistically controlled for likely confounders including family background and functioning, parent substance use, child cognitive ability and adjustment, and early educational performance [e.g., 10, 11]. Effects of infrequent use appear more sensitive to adjustment for confounding than effects of frequent use [26]. In addition to a broad range of demographic, attitudinal, academic, and behavioral risk factors at age 18, we assess whether age 18 substance use attenuates any observed effects of post-high school marijuana use.

Aims of Paper

Objectives were to: (a) test whether infrequent and frequent marijuana use during the transition to adulthood predict a lower likelihood of Bachelor's (4-year) degree attainment by the mid 20s; and (b) examine the generality of results by extending follow-up through age 25/26, focusing only on those who initiated higher education, and predicting 2-year degree attainment. We hypothesized that frequent marijuana use relative to non-use and infrequent use would reduce the likelihood of obtaining a degree by the mid 20s. Post-secondary enrollees are the most likely to graduate but are also are vulnerable to dropping out. Logistic regression models predicting degree attainment are presented, followed by propensity score methods, which first match participants who had similar *propensities* for

marijuana use but differed in their *actual* use frequency. Using both approaches, we present results accounting for age 18 risk factors, and then for age 18 risk factors and substance use.

Methods

Participants

Data come from the Monitoring the Future study, an ongoing series of annual surveys of nationally-representative samples of high school seniors in the 48 contiguous United States. Random subsamples of respondents participate in biennial follow-up surveys beginning 1 or 2 years after high school, with a random half assigned to each. Drug users are over-sampled for follow-up, making these surveys ideal for examining effects of frequency of marijuana use on Bachelor's degree completion. The project is overseen and approved by the University of Michigan's institutional review board. The survey design and methods are described in detail elsewhere [18, 27].

We used longitudinal data collected among high school seniors from 1990 to 2002 (modal age 18; background risk variables), 1–2 years later (modal age 19/20; frequency of marijuana use) and 5–6 years later (modal age 23/24; degree completion). The analytic sample included 4,925 cases (54% female) that provided complete data. Previous attrition analyses found that retained cases were more likely to be female, have higher parent education, and have lower high school drug use [28]. Attrition weights were used only in logistic regressions; the propensity models' focus on creating matched samples for comparison, rather than obtaining population estimates of prevalence.

Measures

Age 18 Risk Factors—Guided by past research [29, 30], a wide range of risk factors assessed by self-report in the last year of high school (age 18) for subsequent marijuana use and educational attainment were identified. All descriptive statistics reported here are weighted for over-sampling of drug users and attrition through age 23/24. Demographic variables were gender; race/ethnicity (White [75% of respondents] versus each of American Indian/Native American [1%], Asian American [3%], African American [9%], Hispanic [8%], and Other [4%]); parent education (neither parent completing high school [7%] versus at least one parent completing high school only [23%] and at least one parent obtaining some college education [70%]); family structure (contrasting 2-parent [70%] versus not); and region of country (Northeast [19%] versus South [34%], Midwest [28%], and West [19%]).

Educational predictor variables were attendance at public high school (89%; versus private school); enrollment in a high school college preparatory program (60%, versus general, vocational/technical, or other program); high school grade-point average (GPA) from 1='D' to 9='A' (M=6.4; SD=1.9, indicating a 'B' average); academic ability, the mean of perceived school ability and intelligence from 1='far below average' to 7='far above average' (α=.84; M=5.03; SD=1.06); likelihood of graduating from a 4-year college program or higher rated as 'definitely will' [58%] versus 'probably will', 'probably won't', or 'definitely won't'; likelihood of other training (graduating from technical/vocational school

or 2-year college, serving in armed forces) rated as ‘definitely will’ [23%] versus other responses; and hours working for pay per week during the school year, from 1=‘none’ to 8=‘30 or more hours’ (*M*=3.96; *SD*=2.27; 11–15 hours per week).

Social predictor variables were number of evenings per week going out for fun and recreation, from 1=‘less than 1’ to 6=‘6 or 7’ (*M*=3.47; *SD*=1.33; about two evenings per week), and truancy (i.e., days of school skipped or ‘cut’), ranging from 1=‘none’ to 5=‘four or more days’ (*M*=1.57; *SD*=1.08; less than once per week).

Final models also controlled for age 18 substance use. 30-day tobacco use was defined as the number of cigarettes smoked per day from 1=‘No cigarette use’ to 5=‘One or more packs/day’ (*M*=1.63; *SD*=1.13). 30-day alcohol use was measured as number of occasions from 1=‘No occasions’ to 6=‘20+ occasions’ (*M*=2.07; *SD*=1.38, indicating 1–2 occasions on average). 30-day marijuana use was measured as number of occasions from 1=‘No occasions’ to 7=‘40+ occasions’ (*M*=1.40; *SD*=1.16; indicating little use).

Age 19/20 Marijuana Use—Marijuana use at age 19/20 was measured as the number of occasions participants reported using marijuana during the last 30 days with response categories as at age 18. A Mantel-Haenszel test showed a non-significant linear association between marijuana use and 4-year degree attainment. We classified all participants into one of three groups for all contrasts based on prior research and the available data: Non-users (0 occasions [84% of respondents]); Infrequent users (1–5 occasions [9%]); and Frequent users (6 or more occasions [7%]). Preliminary analyses showed that associations varied little with different cutoffs.

Bachelor’s Degree Attainment—Post-secondary degree attainment was assessed at age 23/24 to allow time for degree completion within a normative timetable, allowing for part-time or interrupted enrollment. Participants were asked, ‘What is the highest degree you have earned?’ with responses indicating ‘Less than a high school diploma’ to ‘Doctoral degree or equivalent’ coded as 1=Bachelor’s degree or higher; 0=Associate’s degree or less. By age 23/24, 38% of the sample had attained a 4-year degree or higher.

Plan of Analysis

In all analyses, the outcome was degree attainment and non-users versus infrequent users, non-users versus frequent users, and infrequent users versus frequent users were contrasted. First, a series of logistic regressions, weighted for oversampling of drug users and attrition, were estimated contrasting using Stata [31], with and without controls for age 18 risk factors and substance use. Second, we used propensity score matching [32, 33] to address selection by matching ‘treated’ (e.g., frequent marijuana users) and ‘untreated’ (e.g., non-users) individuals on age 18 risk factors. More specifically, we used logit regression models to estimate the conditional probability of age 19/20 frequent marijuana users compared to infrequent users and non-users and infrequent marijuana users compared to non-users based on age 18 risk factors. The predicted probabilities ranged from .122 to .986 (*M*=.870, *SD*=.138) for non-use compared to infrequent use, .004 to .974 (*M*= .110, *SD*=.212) for non-use compared to frequent use, and .070 to .950 (*M* =.318; *SD* =.174) for infrequent use compared to frequent use. These propensity scores were also generated with age 18 risk

factors *and* substance use included in the models. Next, using each individual's generated propensity score, a matching algorithm ('teffects psmatch' in Stata) [34, 35] performed a nearest neighbor matching (minimum match of one-to-one) of respondents in the 'treated' group with 'untreated' respondents who had similar propensities to use marijuana. By comparing non-, infrequent, and frequent users who are similar on a range of risk factors through propensity score methods, we aim to produce less biased estimates of the marijuana-education relationship.

Results

Matching: Preliminary Analyses

For the propensity score models, the age 18 risk factors for marijuana use were used to create matched samples that did not differ significantly in their estimated propensity for marijuana use level at age 19/20. Prior to matching, across 21 risk factors, 3 contrasts (non-use vs. infrequent use; infrequent use vs. frequent use; non-use vs. frequent use), and 2 samples (full sample; those who ever initiated higher education), the 126 ($21 \times 3 \times 2$) contrasts showed statistically significant (i.e., $p < .05$) differences. For example, frequent users were more likely to be male, white, from non-two-parent families, and to have lower grades and educational aspirations. After matching, *none* of the 126 contrasts was significant, indicating the matching models succeeded in creating matched groups with respect to this set of observed risk factors (analyses available upon request).

Estimated Links of Marijuana Use with Bachelor's Degree Attainment: Full Sample

Table 1 presents results of the three contrasts between marijuana use groups tested with the five alternative analyses for the full sample predicting 4-year degree attainment by age 23/24. To ease interpretation we show the estimated proportion of people who earned a degree based on the three logistic and two propensity models. No differences in degree attainment were observed between non-users and infrequent users of marijuana, regardless of the analysis or controls. Logistic regressions and propensity models including age 18 risk factors showed that frequent users were less likely than both non-users and infrequent users to attain Bachelor's degrees. When age 18 substance use was included, however, no differences were observed.

The same analyses predicting degree attainment at age 25/26 yielded almost identical results (not shown). Non-users' and infrequent users' degree attainment did not differ significantly. Frequent users had lower degree attainment than non-users and infrequent users in logistic regressions and propensity models including models with age 18 risk factors. When age 18 substance use was included, differences were reduced to non-significance.

Estimated Links of Marijuana Use with Bachelor's Degree Attainment: College Sub-sample

Next, we considered whether these differences were maintained if we focused only on the 78% of participants who reported that they had initiated any post-secondary education by the age 19/20 surveys (see Table 2). No analysis found differences between non-users and infrequent users. Logistic models with and without risk factors controlled showed lower degree attainment among frequent age 19/20 marijuana users than among infrequent or non-

users. The propensity matched models, however, did not find significant differences between frequent users and the other groups, and no analysis showed differences after accounting for age 18 substance use.

Estimated Links of Marijuana Use with Associate's Degree Attainment

Finally, although our primary focus was on Bachelor's degree receipt due to its importance for occupational attainment, Table 3 shows differences in the proportion of respondents who had attained a 2-year degree or higher by age 23/24 as a function of marijuana use in late adolescence. Results were similar to those in Tables 1 and 2. In comparisons of non-users with infrequent users, there was one exception to the prior consistent finding of no differences: In propensity models matching for age 18 risk factors only, infrequent users were less likely to obtain 2-year degrees. Comparisons of frequent users with infrequent and non-users were also primarily similar. That is, logistic regressions with and without controls showed frequent users to have lower degree attainment; parallel propensity models contrasting frequent with non-users reached the same conclusion and in all models where age 18 substance use was included, no differences were observed. The only exception to the prior pattern was the contrast of frequent with infrequent users in propensity models with age 18 risk factors only, where no difference was observed.

Discussion

Controversy continues about whether marijuana use reduces educational attainment, with some researchers, commentators, and reviewers asserting that epidemiological evidence is strongly suggestive of adverse effects [2, 3, 5, 12] and others questioning the empirical basis for this conclusion [4, 7, 8, 36]. This debate is of major public health importance due to the high prevalence of late adolescent marijuana use; the pivotal career, income and health boosts of educational credentials; and changing drug policies [6]. Despite disagreement, prominent scientists have concluded that stronger evidence is needed to address this issue [4, 6, 37].

We built on strengths of past work by addressing weaknesses noted by critics of the causal hypothesis [4, 8, 15]. Specifically, we used multiple analytic approaches including regression and propensity matching to address myriad selection effects, examined associations in a national longitudinal sample that oversampled drug users, and targeted the lifetime period of greatest marijuana use. Following recent recommendations [8, 15], we focused on variations in frequency of use, reported effect sizes, and predicted college degree attainment.

Across methods and in varied follow-up periods, samples, and levels of degree attainment, results showed no differences between non-users and infrequent users. In contrast, almost all tests showed that frequent marijuana users were less likely to obtain degrees by their mid-20s than non-users. Results comparing infrequent and frequent users depended on analytic method: Logistic regressions suggested that frequent users were less likely to obtain degrees than infrequent users, but propensity models contrasting individuals with equal propensities for use based on a wide range of age 18 risk factors yielded mixed findings.

Once age 18 substance use was controlled, no comparison defined by age 19/20 marijuana use showed significant differences in degree attainment.

Selection Effects

A notable strength is the comparison of matched samples of non-, infrequent, and frequent marijuana users who, after balancing, were similar in their estimated propensities for use in terms of age 18 socio-demographic, educational/academic, and social risk factors. Results are consistent with Fergusson and Boden's [2] analyses of a New Zealand birth cohort study that documented adverse links of increasing cannabis use across adolescence (age 14–21) with degree attainment, income, unemployment, and welfare dependence (age 25), even after adjustment for confounding child and adolescent variables, as well as subsequent analyses with additional samples [12]. In the present case, however, accounting for prior substance use reduced differences in degree attainment to non-significance, suggesting that these differences originate by the last year of high school, prior to the post-secondary period. In all nonexperimental designs it remains possible that drug use groups differ by prior and subsequent non-assessed variables including poverty, arrest, and mental health. Future research should replicate these findings, balance for a wider range of risk factors assessed earlier in life [7], and test for mediators and moderators of any drug use consequences.

Notably, we found little evidence of adverse effects of infrequent use on degree attainment, similar to Fergusson and Boden [2] who observed a wide range of achievementrelated deleterious sequelae of escalating and heavy cannabis use but not among those who used it 'sparingly' (i.e., <100 times between ages 14 and 21). Examination of the proportions completing degrees, as well as the relatively large sample with greater power due to oversampling of drug users, suggest that insufficient power is not an explanation for this null finding. Why would frequent but not infrequent use impact college attainment? Although not addressed here, frequent marijuana use may increase the likelihood of an official sanction (from criminal justice or educational institutions), facilitate precocious transitions to adult roles, increase risks for injury, or have detrimental neuropsychological effects [4, 19, 23, 20, 37], each of which could negatively impact educational attainment. These arguments notwithstanding, the present analyses based on frequency of use in the non-clinical range were not consistent with a dose-response relationship because infrequent users did not differ significantly from non-users.

Strengths and Limitations

Monitoring the Future provides major strengths, including nationally representative data on secondary students followed into adulthood with over-sampling of drug users, providing sufficient frequent users for analysis [15] and time for normative attainment of post-secondary credentials. Advantages of longitudinal designs include specification of temporal precedence of potential causal factors, avoidance of recall bias introduced by long-term retrospective recall, and statistical control of confounding factors. Future research should replicate results in other large-scale longitudinal studies or harmonized datasets [e.g., 37], examine a broader range of achievement, relational, and health outcomes [e.g. 12], and use propensity or other quasi-experimental analytic methods to control for residual confounding including childhood risk factors [32, 33]. Results should be considered in light of several

limitations. First, generalizability is limited by the non-inclusion of high school drop outs in the sample. Second, uncontrolled selection influences, such as early life factors, mental illness, personality, or criminality may explain associations [4, 36]. Third, the operationalization of marijuana use as past 30-day frequency likely underestimates association strength. Fourth, most 'frequent' users were not chronic (e.g., daily or near daily) users; adverse effects for chronic use were not evaluated but likely to be greater [7, 20, 38, 39].

Timing and Extent of Marijuana Use

Late adolescent marijuana use was targeted to test hypotheses about whether use during the period of life when it is most statistically normative might be detrimental. Although correlational data cannot demonstrate causal effects, results are consistent with detrimental effects of frequent use, though not independently from late high school use, suggesting detrimental effects may begin earlier or be explained by earlier use. Whereas a larger body of research has demonstrated deleterious correlates of early onset and early-to-middle adolescent marijuana use [3, 10], effects on educational attainment might operate differently later. *Early* onset of substance use may impede the development of healthy coping and social skills and lead to detrimental segregation into deviant peer groups and precocious adult roles [5, 21]. In *late* adolescence, relatively lighter use may be less harmful than earlier or heavier use. Prevention and intervention programs as well as public health and drugs policies should target those at most risk [8]; age, maturity, and stage of life should be considered.

Implications and Contributions Statement

In a national sample, late adolescent frequent marijuana users were less likely to attain Bachelor's degrees by their mid 20s compared to infrequent and non-users, independent of adolescent risk factors but not of adolescent substance use. Infrequent users and non-users did not differ in degree attainment.

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Table 1

Estimated Effect of Age 19/20 Frequency of Marijuana Use on Bachelor's Degree Attainment by Age 23/24 (Full Longitudinal Sample): Logistic Regression and Propensity Score Analyses

	Estimated Proportion with Bachelor's degree or higher			
	No/Less Use	**More Use**	**z**	**p**
Non-Users vs Infrequent Users (n=4,466)				
Logistic regressions				
No Controls	0.386	0.421	−1.38	0.168
With age 18 risk factor controls[a]	0.308	0.332	−0.75	0.456
With age 18 risk factor + SU[b] controls	0.303	0.337	−1.01	0.312
Propensity models				
Matched on age 18 risk factors	0.493	0.450	−1.37	0.170
Matched on age 18 risk factors + SU	0.425	0.450	0.87	0.386
Non-Users vs Frequent Users (n=4,452)				
Logistic regressions				
No Controls	0.386	0.295	3.36	0.001
With age 18 risk factor controls	0.300	0.218	2.76	0.006
With age 18 risk factor + SU[a] controls	0.293	0.242	1.24	0.214
Propensity models				
Matched on age 18 risk factors	0.386	0.312	−2.45	0.014
Matched on age 18 risk factors + SU	0.349	0.312	−0.92	0.357
Infrequent Users vs Frequent Users (n=932)				
Logistic regressions				
No Controls	0.421	0.295	3.58	0.000
With age 18 risk factor controls	0.323	0.235	2.28	0.023
With age 18 risk factor + SU[a] controls	0.292	0.232	1.44	0.150
Propensity models				
Matched on age 18 risk factors	0.375	0.312	−0.064	0.057
Matched on age 18 risk factors + SU	0.303	0.312	0.009	0.820

[a] Age 18 risk factor controls: gender, race/ethnicity, parent education, family structure, region of country, public high school, college prep curriculum, grade point average, academic ability, 4-yr college plans, other post-high-school training plans, hours worked for pay, evenings out, and truancy.

[b] SU=Substance use: Age 18 30-day tobacco use, alcohol use and marijuana use.

Table 2

Estimated Effect of Age 19/20 Frequency of Marijuana Use on Bachelor's Degree Attainment by Age 23/24 years (College Sub-Sample): Logistic Regression and Propensity Score Analyses

	Estimated Proportion with Bachelor's degree or higher			
	No/Less Use	**More Use**	**z**	**p**
Non-Users vs Infrequent Users (n=3592)				
Logistic regressions				
No Controls	0.476	0.511	−1.20	0.229
With age 18 risk factor controls	0.447	0.473	−0.68	0.495
With age 18risk factor + SU[a] controls	0.444	0.483	−0.96	0.336
Propensity models				
Matched on age 18 risk factors	0.514	0.532	0.62	0.538
Matched on age 18 risk factors + SU	0.543	0.532	−0.31	0.755
Non-Users vs Frequent Users (n=3545)				
Logistic regressions				
No Controls	0.476	0.378	3.02	0.003
With age 18 risk factor controls	0.441	0.337	2.66	0.008
With age 18 risk factor + SU[a] controls	0.437	0.360	1.48	0.138
Propensity models				
Matched on age 18 risk factors	0.462	0.406	−1.52	0.128
Matched on age 18 risk factors + SU	0.432	0.406	−0.44	0.662
Infrequent Users vs Frequent Users (n=727)				
Logistic regressions				
No Controls	0.511	0.378	3.19	0.001
With age 18 risk factor controls	0.472	0.364	2.18	0.030
With age 18 risk factor + SU[a] controls	0.447	0.369	1.41	0.158
Propensity models				
Matched on age 18 risk factors	0.429	0.406	−0.49	0.624
Matched on age 18 risk factors + SU	0.447	0.406	−0.63	0.530

[a] Age 18 risk factor controls: gender, race/ethnicity, parent education, family structure, region of country, public high school, college prep curriculum, grade point average, academic ability, 4-yr college plans, other post-high-school training plans, hours worked for pay, evenings out, and truancy.

[b] SU=Substance use: Age 18 30-day tobacco use, alcohol use and marijuana use.

Table 3

Estimated Effect of Age 19/20 Frequency of Marijuana Use on Two-Year Degree Attainment by Age 23/24 years (Full Longitudinal Sample): Logistic Regression and Propensity Score Analyses

	Estimated Proportion with Bachelor's degree or higher			
	No/Less Use	**More Use**	**z**	**p**
Non-Users vs Infrequent Users (n=4,466)				
Logistic regressions				
No Controls	0.529	0.533	−0.17	0.868
With age 18 risk factor controls	0.533	0.522	0.33	0.742
With age 18 risk factor + SU[a] controls	0.531	0.532	−0.04	0.967
Propensity models				
Matched on age 18 risk factors	0.649	0.552	−3.17	0.002
Matched on age 18 risk factors + SU	0.571	0.552	−0.54	0.586
Non-Users vs Frequent Users (n=4,452)				
Logistic regressions				
No Controls	0.529	0.426	3.63	0.000
With age 18 risk factor controls	0.529	0.437	2.70	0.007
With age 18 risk factor + SU[a] controls	0.526	0.461	1.50	0.135
Propensity models				
Matched on age 18 risk factors	0.514	0.447	−2.01	0.045
Matched on age 18 risk factors + SU	0.486	0.447	−0.92	0.358
Infrequent Users vs Frequent Users (n=932)				
Logistic regressions				
No Controls	0.533	0.426	2.87	0.004
With age 18 risk factor controls	0.516	0.443	1.72	0.085
With age 18 risk factor + SU[a] controls	0.496	0.440	1.18	0.237
Propensity models				
Matched on age 18 risk factors	0.466	0.447	−0.50	0.620
Matched on age 18 risk factors + SU	0.399	0.447	0.84	0.401

[a] Age 18 risk factor controls: gender, race/ethnicity, parent education, family structure, region of country, public high school, college prep curriculum, grade point average, academic ability, 4-yr college plans, other post-high-school training plans, hours worked for pay, evenings out, and truancy.

[b] SU=Substance use: Age 18 30-day tobacco use, alcohol use and marijuana use.