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Article

Recreational marijuana legalization and college student use: Early evidence☆

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ABSTRACT

We analyze marijuana use by college undergraduates before and after legalization of recreational marijuana. Using survey data from the National College Health Assessment, we show that students at Washington State University experienced a significant increase in marijuana use after legalization. This increase is larger than would be predicted by national trends. The change is strongest among females, Black students, and Hispanic students. The increase for underage students is as much as for legal-age students. We find no corresponding changes in the consumption of tobacco, alcohol, or other drugs.

1. Introduction

Recreational marijuana has been legalized for adults 21 years of age or older in several states beginning with Colorado and Washington in 2012. In 2014, Alaska, Oregon, and the District of Columbia voted to legalize recreational marijuana, followed by California, Massachusetts, Nevada, and Maine in 2016. We use data for students at Washington State University (WSU) to explore the role legalization plays in marijuana use among college students, a population generally thought to be predisposed towards risky behavior, including marijuana use. Our main hypothesis is that legalization of recreational marijuana induces more students to use marijuana by lowering one or more of the costs of using it. These costs may include the threat of punishment, the price and/or availability of marijuana, a lack of social acceptability, and an inherent desire to be law-abiding.

Throughout the U.S., marijuana access has been relaxed in three general ways: decriminalization, medical marijuana legalization (MML), and recreational marijuana legalization (RML). In the early 1970s, eleven states officially decriminalized the possession of small amounts of marijuana.[1] Though there is some evidence that use may increase with decriminalization (e.g., Damrongplasit et al., 2010), most research finds no evidence for such an increase (Thies and Register, 1993; Reinarman et al., 2004).

Since 1996, 28 states have legalized medical marijuana, which still prohibits recreational use. Most evidence shows that MML has not increased marijuana use among people younger than 21 (Khatapoush & Hallfors, 2004; Lynne-Landsman et al., 2013; Choo, Benz, Zaller, Warren, Rising & McConnell, 2014; Anderson, Hansen, & Rees, 2015), although Pacula, Powell, Heaton, and Sevigny (2015) find that MML increased use and abuse by those under and over the age of 21. Other studies find MML is associated with more non-medical use and abuse (Wen et al., 2014), more marijuana-related arrests and marijuana rehabilitation treatments (Chu, 2014), and a decrease in the price of illegal marijuana (Malivert & Hall, 2013).

There have been no direct assessments of the impact of RML on marijuana use of college students, though Cerdá et al. (2017) find some evidence that RML is associated with lower perceived risk and higher use for youth. Pacula (2010) predicts that use will increase. Hall and Lynskey (2016) predict that the price of marijuana will drop and heavy use will increase. Anderson, Hansen and Rees (2013) find evidence that RML has decreased the price of marijuana.

Our population of interest in this paper is students at WSU in Pullman, Washington. Many changes with respect to marijuana law and availability have occurred in Washington in the past two decades. In 1998, Washington decriminalized marijuana for adult medical use, with

Abbreviations: GPA, Grade point average; MML, Medical marijuana legalization; NCHA, National College Health Assessment; NSDUH, National Survey on Drug Use and Health; RML, Recreational marijuana legalization; WSU, Washington State University

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[1] Decriminalization is the elimination of criminal punishments such as arrests and jail time associated with the possession of small amounts of marijuana, presumably intended for personal use rather than for sale or distribution. States differ with respect to how it is implemented (Pacula et al., 2003).

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qualifying conditions expanding in 2007, 2010, and 2011. In November 2012, Washington passed Initiative 502, which legalized the possession of marijuana for personal recreational use by people aged 21 and older and established a structure for licensing and taxing the production and distribution of recreational marijuana. Legal possession and use of marijuana took effect in December 2012. The first licensed retail stores opened in July 2014. In this paper, we investigate whether the 2012 legalization of recreational marijuana is associated with an increase in use above the long-term trend toward more use in Washington.

We hypothesize that marijuana use at WSU increased after RML because both the direct and social costs of using went down. RML increases the availability of marijuana for those 21 and older, and likely for those under 21 as well. It is expected that RML lowers the price of marijuana (e.g., Anderson et al., 2013), increasing demand. Legalization eliminates the threat of punishment to legal-age users, and sends a strong message about changing norms, lowering the social costs of marijuana use. Also, Moreno, Whitehill, Quach, Midamba, and Manskopf (2016) find that legalization may have caused some Washington college students to perceive marijuana as safer.

The first indication that marijuana use may have changed in Washington after Initiative 502 is observed in the trend of reported marijuana use. Fig. 1 shows the proportion of students who reported using marijuana in the past 30 days across years. For comparison, we also include the proportions over time of students who reported using tobacco, alcohol, or illegal drugs other than marijuana. To facilitate comparisons, proportions for use of each substance are presented as deviations from the 2012-use levels. We observe a substantial increase over a general upward trend in marijuana users after 2012. Use of the other substances does not show a similar increase.

More rigorously, we test for changes against a linear trend in the reported use of marijuana at WSU after RML at the end of 2012 and after legal sales began in Pullman in October 2014. We find that the probability of having used marijuana in the past 30 days increased after RML and remained high though did not increase significantly again after the first marijuana stores opened.

We also test for these same changes within specific subgroups of the population. First, we compare the change in use for legal-age students to those under 21, who are not directly affected by RML. We find that for those under 21, the probability of using marijuana increased both after RML and after legal sales began. For students age 21 and over we find no increase at either juncture that is statistically significant at conventional levels. Among other subgroups, we find consistent evidence of an especially large increase in the probability of use for females and for Black and Hispanic students (pooling both genders).

RML may also affect the use of tobacco, alcohol, or other drugs, either as a substitute or complement. Moreover, factors other than RML that affect marijuana use (e.g., changes in incomes or attitudes toward risk) likely also change the use of other substances. We find no evidence for any systematic changes in the use of other substances that correspond directly with the changes in marijuana use after RML.

We are also interested in the intensity of marijuana use, so we test whether the average frequency of marijuana use increased after RML or legal sales. These results show the intensity of marijuana increased after RML, but decreased again after legal sales commenced.

Data limitations prevent us from including a reliable control group in the regressions.[2] Thus, the estimated effect of RML from the above tests represents the actual treatment effect of RML only to the extent that the linear trend is a good proxy for what marijuana use would have been like without RML. We provide an alternative evaluation by comparing marijuana use at WSU to two national datasets. Although we are unable to include any covariate controls in the national data after 2011, we calculate simple difference-in-differences estimations of the impact of RML at WSU using two national samples as counterfactuals.

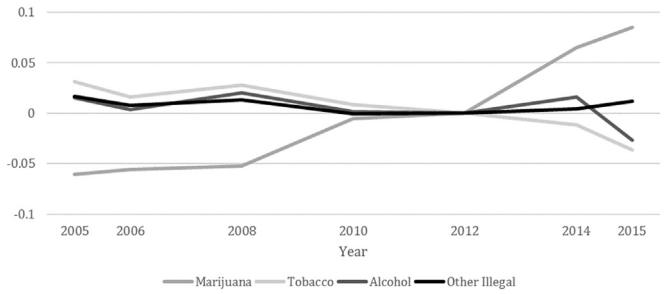

Fig. 1. Marijuana and other substance use trends: Probability of having used in the past 30 days (deviations from year 2012).

2. Data

We use repeated cross-sectional data of undergraduate students at Washington State University (WSU), collected for the National College Health Assessment (NCHA), a comprehensive health survey collected and made available by the American College Health Association.[3] WSU has participated in the NCHA in seven different survey years: 2005, 2006, 2008, 2010, 2012, 2014, and 2015. The total number of survey responses available is 14,485, with a mean of 2,069 students surveyed each year. Participants were randomly selected from the student population for all survey years except for 2012 and 2014; in those years, invitations were distributed to the entire student population. After eliminating observations for missing values, our sample contains 13,335 observations. The first column of Table 1 shows the number of students in each year of the WSU sample. The distribution of surveys across years for the excluded observations is nearly identical to the distribution for the whole sample.

The NCHA surveys contain questions about students' use of marijuana, tobacco, alcohol, and other drugs. Our main variable of interest is a count of how many times a student used marijuana in the past 30 days. For tests 1 and 2, this variable is modified into a binary indicator of whether a student used marijuana at all in the past 30 days. Variables included as controls in our regressions include age, sex, race, and year in school. In other specifications, we also include respondents' grade point average (GPA), type of residence, membership in a fraternity or sorority, and whether a student is international or if they have used tobacco, alcohol, or illegal drugs other than marijuana in the past 30 days. Table 2 provides summary statistics for these variables.[4] Also included in this table are mean values for all variables both before and after the passage of Initiative 502, and summary statistics for the same variables in the national sample of NCHA data and in the NSDUH sample as available.

The student population at WSU is about 53-percent male, 68-percent white, 3-percent Black, 5-percent Asian, 10-percent Hispanic, and 5-percent international. The distribution across years for undergraduates is about 23-percent first-year, 23-percent second-year, 24-percent third-year, and 31-percent fourth-year or more (Office of Institutional Research, 2017a). The average GPA for students is about 3.08 (Office of Institutional Research, 2017b). In 2014, the average age

[2] Although the NCHA has been administered to students at colleges and universities across the nation since 2000, we were unable to obtain data from any other university and the national sample does not contain school or state identifiers nor does it include enough observations post-RML to match the timing of the WSU data.

[3] The NCHA was also administered to graduate students, but we focus our analysis on undergraduate students.

[4] Apart from tobacco use, no significant difference for these variables was found between observations included in and excluded from analysis. For tobacco use, the excluded observations had a mean of 0.27 and standard deviation of 0.44 compared to included observations that have a mean of 0.19 and standard deviation of 0.39. We have no reason to believe that the estimates of our main results should be affected by this difference. We also observed no significant difference between the changes in marijuana use over time for included and excluded observations.

Table 1
Distribution of students and schools across years for WSU and national samples.

Year	WSU NCHA Students	National NCHA							NSDUH Students
		Students			Schools[a]			Mean Students/School	
		Spring	Fall	Year	Spring	Fall	Year		
2005	905	38,902	12,196	51,098	71	29	100	511	6,841
2006	1,190	65,799	17,864	83,663	112	34	146	573	6,669
2007		57,325	14,847	72,172	108	38	146	494	6,819
2008	1,606	60,478	18,796	79,274	101	35	136	583	7,091
2009		61,625	21,840	83,465	112	55	167	500	7,350
2010	1,313	73,000	22,046	95,046	136	38	174	546	7,834
2011		78,422	21,411	99,833	129	44	173	577	7,764
2012	2,951		21,679	21,679		51	51	425	7,279
2013			23,327	23,327		57	57	409	7,081
2014	3,297								5,037
2015	2,073								5,336
Totals	13,335	435,551	174,006	609,557	769	386	1,155	513[b]	75,101

[a] An unknown number of schools are sampled multiple times in the national NCHA data. Thus, the total number of schools does not represent the number of distinct schools in this sample.
[b] Total of students per school is mean across all years with non-zero values.

across all six campuses was 23 for undergraduate students (Washington State University, 2015).[5] Between 2013 and 2015, 21- to 24-percent of undergraduate students were in fraternities or sororities (WSU Center for Fraternity and Sorority Life, 2015).

Because the cited WSU population statistics are measured after 2012, we compare the NCHA sample statistics to the WSU population for observations after 2012. It appears that the NCHA sample is representative of the WSU population, except for an oversampling of white and Asian students and an undersampling of male and older students. In the NCHA surveys, students are encouraged to select all races that apply to them, which may explain the oversampling of white and Asian students.[6] WSU population data for race is available from 2009 and the NCHA sample closely matches with respect to trends in race composition over time. Specifically, the proportion of white students decreases, Black and Hispanic students increase, and Asian students remain constant since 2009. The average age of students in the NCHA sample is lower in part because it only includes students from the Pullman campus, which is WSU's main undergraduate campus. Finally, there is a small difference in the proportion of male-to-female students in the sample, though this proportion is consistent before and after RML.

For difference-in-differences calculations, we use two national-level data sources on marijuana use. First, we use a national sample from the NCHA survey beginning in 2005 that contains surveys from the spring and fall of each year until 2011 and from only fall in 2012 and 2013. Only schools that survey a random sample of students are included in the national dataset. According to the ACHA, the NCHA's national data is reliable, valid, and suitable for use as a national reference group (American College Health Association, 2014). We also use data from the National Survey on Drug Use and Health (NSDUH) for 18–25-year-old college students from 2005 to 2015. Both national samples contain the same measures as the WSU sample for whether and how many times a respondent had used marijuana in the past 30 days. To more closely match the WSU sample, observations are excluded from the national samples that have missing values for any variables matching those included in the regressions. Table 1 displays the number of students, the number of schools, and the average number of students per school in each year of the national NCHA sample and the number of students in each year of the NSDUH sample.

The difference-in-differences calculations are only a valid estimate of the effect of RML to the extent that the national data is a sufficient counterfactual to what we would see at WSU in the absence of RML. We evaluate the extent to which the WSU sample matches the national samples in the pre-RML period by first comparing the means in Table 2. Compared to the national data, the WSU sample pre-RML appears to be more white, more likely to be in a fraternity or sorority, more likely to live off campus or in a fraternity/sorority house, and less likely to live with parents. We will see based on the regressions (and the results in Tables 3 and 4) that although these variables are associated with higher likelihood of marijuana use, they are also associated with a lower likelihood of increasing use after RML. To the extent that differences in composition between the WSU and national samples affect differences in the trend of marijuana use, we expect that such differences are likely to bias against an observed relative increase in use at WSU.

We also compare pre-RML marijuana use between the WSU sample and the two national samples. Fig. 2 shows the percentage of respondents each year who have used marijuana in the past 30 days for all three samples. The NCHA national data is only through 2011.[7] For the national NCHA data after 2011 and for the WSU data after 2012, we forecast each series based on the data through 2012. Forecasts are generated using best-fit double exponential smoothing to account both for levels and for changing trends.[8] Both the national NCHA and NSDUH data show an increase over the period before 2012 and are consistently within 1 and 4 percentage points of each other. The WSU series starts out slightly lower than both national series but with a nearly parallel trend and remains in the range of both national series through 2012. Readers will note the relatively large increase in the WSU series between 2008 and 2010, which corresponds to changes in Washington's MML laws. Though the magnitude is smaller, we observe an increase at this same time in both the national samples. It may be the

[5] WSU has campuses in Pullman, Spokane, Tri-Cities, Vancouver, and Everett, WA, and an online campus.
[6] White and Asian are the most highly correlated race groups in the sample and it is likely that the observed proportions of these race groups reflect a high proportion of students that identify as both Asian and white and are thus double counted.
[7] National NCHA data is available through 2013, but only for fall samples. We chose to present the national averages that contain data from both spring and fall surveys. The fall samples tend to be lower than spring samples with respect to marijuana use and thus the average drops significantly after 2011 due to the absence of any spring samples. This drop introduces additional external error to the exponential smoothing function. For robustness, we also calculated forecasts separately for spring- and fall-only samples, which enabled use of 2012 and 2013 data, and though the level is slightly higher for the spring forecasts and slightly lower for the fall, the slopes of both forecasts are the same as the slope of the average forecast included in Figure 2 and in the difference-in-differences calculation.
[8] Double exponential smoothing functions were generated separately for each series, with parameters chosen to minimize mean square error between forecasted values and actual values. Forecasts were then generated through 2015 based on these best-fit models.

Table 2
Summary statistics for variables used in regressions, with national samples for comparison.

Variables	WSU NCHA			National NCHA Sample Mean	NSDUH Sample Mean
	Sample Mean	Pre-RML Mean	2014–2015 Mean		
Used Marijuana Past 30 Days	0.20 (0.40)	0.16 (0.37)	0.26 (0.44)	0.16 (0.37)	0.18 (0.38)
Number of Days Used Marijuana Past 30 Days	1.71 (5.50)	1.25 (4.63)	2.39 (6.53)	1.34 (4.91)	2.22 (6.67)
Age in Years	20.49 (2.94)	20.59 (2.95)	20.36 (2.92)	21.09 (4.63)	20.84 (0.38)
Legal Age (21 and older)	0.39 (0.49)	0.41 (0.49)	0.36 (0.48)	0.41 (0.49)	0.50 (0.50)
Male	0.42 (0.49)	0.43 (0.49)	0.40 (0.49)	0.35 (0.48)	0.45 (0.50)
Race[a]: White	0.80 (0.40)	0.82 (0.38)	0.78 (0.41)	0.77 (0.42)	0.61 (0.49)
Race[a]: Black	0.03 (0.18)	0.03 (0.16)	0.05 (0.21)	0.06 (0.23)	0.13 (0.34)
Race[a]: Asian	0.12 (0.33)	0.11 (0.32)	0.14 (0.34)	0.10 (0.30)	0.14 (0.35)
Race[a]: Hispanic	0.08 (0.27)	0.06 (0.23)	0.11 (0.31)	0.08 (0.27)	0.06 (0.24)
1st-year Undergraduate	0.31 (0.46)	0.29 (0.45)	0.34 (0.34)	0.28 (0.45)	0.30 (0.47)
2nd-year Undergraduate	0.22 (0.41)	0.22 (0.41)	0.22 (0.41)	0.24 (0.43)	0.44 (0.50)
3rd-year Undergraduate	0.24 (0.43)	0.25 (0.43)	0.24 (0.42)	0.23 (0.42)	
4th-year Undergraduate	0.18 (0.38)	0.19 (0.39)	0.16 (0.37)	0.19 (0.39)	0.26 (0.44)
5th-year Undergraduate or More	0.05 (0.22)	0.06 (0.23)	0.05 (0.21)	0.06 (0.24)	
International Student	0.06 (0.23)	0.06 (0.23)	0.06 (0.23)	0.05 (0.22)	
GPA	3.07 (0.71)	3.10 (0.69)	3.04 (0.72)	3.22 (0.68)	
Member of Fraternity/ Sorority	0.17 (0.38)	0.15 (0.36)	0.21 (0.41)	0.10 (0.30)	
Residence: Campus Residence Hall	0.40 (0.49)	0.39 (0.49)	0.42 (0.49)	0.44 (0.50)	
Residence: Fraternity/ Sorority House	0.07 (0.26)	0.08 (0.27)	0.06 (0.25)	0.02 (0.13)	
Residence: Other University Housing[b]	0.07 (0.26)	0.07 (0.25)	0.07 (0.26)	0.05 (0.23)	
Residence: With Parents	0.01 (0.10)	0.01 (0.10)	0.01 (0.09)	0.13 (0.33)	
Residence: Other Off-campus Housing	0.44 (0.50)	0.45 (0.50)	0.43 (0.50)	0.32 (0.47)	
Used Tobacco Past 30 Days	0.19 (0.39)	0.20 (0.40)	0.17 (0.37)	0.22 (0.41)	
Used Alcohol Past 30 Days	0.68 (0.47)	0.68 (0.46)	0.68 (0.47)	0.65 (0.48)	
Used Other Illegal Drugs Past 30 Days	0.04 (0.21)	0.04 (0.20)	0.05 (0.21)	0.03 (0.18)	
Number of Observations =	13,335	7,965	5,370	609,557	75,101

Standard deviations included in parentheses.
Only observations with non-missing values for all relevant variables are included.
[a] Many students reported multiple races and are thus included in multiple race groups. Other races not reported include American Indian, Hawaiian/Alaskan Native, and all other races, and constitute about 5 percent of each sample.
[b] Other university housing includes graduate-student and family housing.

Table 3
Probability of having used marijuana in the past 30 days.

Variables	(1) logit I	(2) logit II	(3) logit III	(4) logit IV
Year 2014 (After RML)	0.0345*** (0.0124)	0.0293** (0.0122)	0.0241** (0.0118)	0.0197** (0.00949)
Year 2015 (After Legal Sales)	0.0430*** (0.0154)	0.0418*** (0.0152)	0.0334** (0.0147)	0.0334*** (0.0124)
Year Trend	0.0118*** (0.00189)	0.0123*** (0.00186)	0.0115*** (0.00182)	0.0117*** (0.00145)
Male		0.0651*** (0.00724)	0.0600*** (0.00706)	0.0179*** (0.00581)
Race: White		0.0471*** (0.0114)	0.0408*** (0.0114)	0.000752 (0.00997)
Race: Black		0.0759*** (0.0235)	0.0622*** (0.0228)	0.0651*** (0.0205)
Race: Asian		-0.0446*** (0.0124)	-0.0298** (0.0126)	-0.0183* (0.0100)
Race: Hispanic		0.0279* (0.0159)	0.00920 (0.0151)	0.00925 (0.0120)
2nd-year Undergraduate		-0.000526 (0.0117)	-0.0523*** (0.0112)	-0.0299*** (0.00947)
3rd-year Undergraduate		-0.00392 (0.0143)	-0.0517*** (0.0138)	-0.0304*** (0.0117)
4th-year Undergraduate		0.0194 (0.0179)	-0.0363** (0.0163)	-0.0292** (0.0130)
5th-year Undergraduate or More		0.0118 (0.0243)	-0.0496*** (0.0187)	-0.0388*** (0.0140)
International Student			-0.0717*** (0.0130)	-0.0362*** (0.0108)
GPA: 2.0			0.0115 (0.0257)	0.0123 (0.0217)
GPA: 3.0			-0.0181 (0.0244)	0.0123 (0.0199)
GPA: 4.0			-0.0993*** (0.0200)	-0.0319* (0.0184)
Member of Fraternity/Sorority			0.122*** (0.0117)	0.0395*** (0.00853)
Residence: Fraternity/Sorority House			0.121*** (0.0200)	0.0413*** (0.0144)
Residence: Other University Housing			0.0877*** (0.0204)	0.0438*** (0.0161)
Residence: With Parents			0.0333 (0.0463)	0.0231 (0.0381)
Residence: Other Off-campus Housing			0.126*** (0.0115)	0.0571*** (0.00942)
Used Tobacco Past 30 Days				0.165*** (0.0107)
Used Alcohol Past 30 Days				0.210*** (0.00573)
Used Other Illegal Drugs Past 30 Days				0.432*** (0.0288)

(continued on next page)

Table 3 *(continued)*

Variables	(1) logit I	(2) logit II	(3) logit III	(4) logit IV
Age Dummies	NO	YES	YES	YES
Pre-2014 Probability of Marijuana Use = 0.16				
Observations = 13,335				

Logit results reported as marginal effects.
Standard errors in parentheses.
Omitted sex is female.
Omitted race is other races: including American Indian, Hawaiian/Alaskan Native, and all other races.
Omitted year in school is 1st-year undergraduate.
Omitted GPA is 1.0.
Omitted residence is university residence hall.
*** p < 0.01.
** p < 0.05.
* p < 0.1.

case that national changes (MML in more states and the U.S. Department of Justice announcing in 2009 that it will no longer prioritize the prosecution of medical marijuana patients) affected students both in and out of Washington. Any long-term effects of such national changes are reflected in the NSDUH data. The forecasts for both the WSU and the national NCHA samples are almost parallel to the actual trend in the NSDUH and the 95-percent confidence interval for each forecast contains the other forecast as well as the NSDUH actual values. It appears that the increase in marijuana use at WSU after 2008 may have been a one-time jump, a proposition more fully examined in the conclusion of the paper.

It is also relevant to note that both national samples are "contaminated" with observations from WSU and from others in Washington and Colorado.[9] If RML increases marijuana use for college students, as we expect, then including Washington and Colorado students in the national samples biases against finding an effect in the difference-in-differences analysis.

3. Estimation methodology

We use a logit regression to estimate the probability of a student choosing to engage in use of a substance (whether use of marijuana or another substance). When testing the intensity of marijuana use, we employ an ordinary least squares (OLS) regression to estimate the number of days that a student uses marijuana. Specifically, we estimate the following equation using a logit regression[10]:

$$m_i = \begin{cases} 1 & if\ \mathbf{X}_i\mathbf{B} + \gamma_1 Year_i + \gamma_2 RML_i + \gamma_3 Sales_i + \varepsilon_i > 0 \\ 0 & otherwise \end{cases}, \quad (1)$$

where m_i is an indicator of whether individual i has used marijuana and ε_i~logistic(0, 1). Intensity of use is estimated with OLS regression:

$$Number\ of\ Days_i = \mathbf{X}_i\mathbf{\Gamma} + \delta_1 Year_i + \delta_2 RML_i + \delta_3 Sales_i + \eta_i, \quad (2)$$

where the left-hand side is the number of days that individual i uses marijuana. On the right-hand side of both equations, $\mathbf{X}_i$ is a vector of individual-level characteristics, $Year_i$ refers to the year that individual i completed the survey (this estimates a linear trend in the dependent variable over time), RML_i is an indicator of whether the student was surveyed in 2014 (the first survey that occurs after RML), and $Sales_i$ is an indicator of whether the student was surveyed in 2015 (after legal sales began).[11] The timing variables in this estimation model (including $Year_i$, RML_i, and $Sales_i$) are variables that control for changes in marijuana use that occur between survey periods. This means that changes over time in price, punishment, social norms, etc. are all captured by these variables.

When exploring the probability of marijuana use, we run each

Table 4
Probability of having used marijuana in the past 30 days- by subgroup.

(I)	Variables	(1) Under 21	(2) 21 and over	(3) Male	(4) Female
	Year 2014 (After RML)	0.0435***	0.00827	0.0134	0.0399**
		(0.0165)	(0.0175)	(0.0190)	(0.0160)
	Year 2015 (After Legal Sales)	0.0467**	0.0382	0.0280	0.0492**
		(0.0200)	(0.0234)	(0.0241)	(0.0197)
	Year Trend	0.0108***	0.0146***	0.0140***	0.0116***
		(0.00249)	(0.00275)	(0.00289)	(0.00247)
	Pre−2014 Probability of Marijuana Use	0.18	0.15	0.20	0.14
	Observations	8152	5183	5552	7783
(II)	Variables	(5) Race: White	(6) Race: Black	(7) Race: Asian	(8) Race: Hispanic
	Year 2014 (After RML)	0.0186	0.158*	0.0178	0.140***
		(0.0136)	(0.0851)	(0.0297)	(0.0541)
	Year 2015 (After Legal Sales)	0.0287*	0.156	0.0279	0.156**
		(0.0168)	(0.104)	(0.0365)	(0.0706)
	Year Trend	0.0144***	−0.00176	0.00810*	−0.00158
		(0.00209)	(0.0133)	(0.00489)	(0.00887)
	Pre−2014 Probability of Marijuana Use	0.17	0.18	0.11	0.15
	Observations	10,718	460	1637	1016
(III)	Variables	(9) International	(10) Domestic	(11) Greek	(12) Non-Greek
	Year 2014 (After RML)	0.0155	0.0267**	0.0490	0.0214*
		(0.0282)	(0.0128)	(0.0353)	(0.0125)
	Year 2015 (After Legal Sales)	0.0578	0.0359**	0.0548	0.0267*
		(0.0524)	(0.0157)	(0.0414)	(0.0156)
	Year Trend	0.00703	0.0132***	0.0201***	0.00958***
		(0.00554)	(0.00195)	(0.00588)	(0.00187)
	Pre−2014 Probability of Marijuana Use	0.08	0.17	0.27	0.15
	Observations	700	12,567	2329	11,006

Logit results reported as marginal effects.
Standard errors in parentheses.
All regressions include indicators for age, sex, race, and year-in-school where appropriate.
*** p < 0.01
** p < 0.05
* p < 0.1

[9] WSU responses represent less than 2 percent of the national NCHA data in any year and only 0.8 percent of all the observations in the national data, but we cannot account for other Washington or Colorado students in either survey.

[10] The results of this regression are robust to estimation with probit or OLS regression as well.

[11] All 2012 surveys were administered in the spring, before legalization, and all 2014 and 2015 surveys occurred after possession was legal. Likewise, legal sale of marijuana began in Washington in July 2014 and in Pullman (where WSU is located) in October 2014. The 2014 surveys were administered in the spring, before legal sales began, and all 2015 surveys were completed after legal sales began.

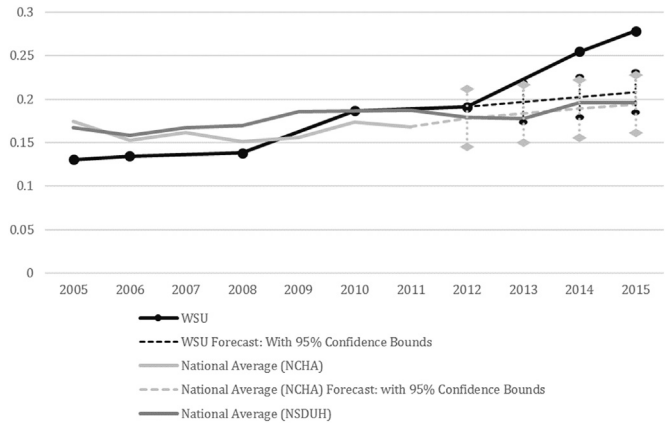

Fig. 2. Probability of having used marijuana in the past 30 days: WSU actual vs. WSU and national forecasts- NCHA and NSDUH national average.

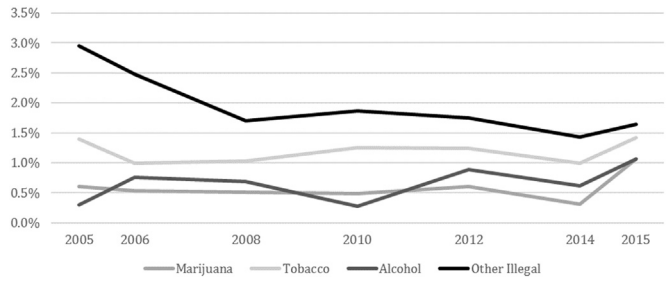

Fig. 3. Percent of responses with missing values for substance use, by year.

regression four times, each time including more variables in $\mathbf{X}_i$, starting with the least likely to be endogenous to legalization. The first regression contains no variables in $\mathbf{X}_i$; the second regression adds an indicator variable for each year of age between 19 and 24 and for any age over 24, and indicators for sex, race, and year in school; the third regression adds indicators for GPA, whether a student is international, whether a student is in a fraternity or sorority, and the student's type of residence; the fourth regression adds separate indicators for whether a student has used in the past 30 days tobacco, alcohol, or illegal drugs other than marijuana.

The parameters of interest are γ_2, γ_3, and $\gamma_3 - \gamma_2$. Coefficient γ_2 represents the deviation from a linear trend in the likelihood of having used marijuana in 2014 (the first survey year after legalization). The coefficient γ_3 is the same deviation associated with a student who was surveyed in 2015. Every student surveyed in 2015 was subject to both RML and legal sales. For these students, the estimate of the legal sales effect is the difference $\gamma_3 - \gamma_2$. Analogously, when testing if the rate of use has increased with Eq. (2), we use standard t-tests to determine whether δ_2, δ_3, and $\delta_3 - \delta_2$ are statistically different from zero. Like the results of the logit regressions, δ_2 represents the deviation from a linear trend for students surveyed after RML. Coefficient δ_3 is the same deviation associated with a student who was surveyed after legal sales, and $\delta_3 - \delta_2$ is the estimate of the isolated legal sales effect.

The difference-in-differences estimations are calculated by

$$Treatment\,Effect = (WSU_{after} - WSU_{before}) - (National_{after} - National_{before}),$$

where X_{after} is the average likelihood of marijuana use after 2012 in sample X, and X_{before} is the average likelihood of marijuana use across all observations through 2012 for sample X. These calculations are repeated for the number of times respondents used marijuana in the past 30 days; these results are displayed in the Appendix.

4. Results and discussion

4.1. Full-sample likelihood of marijuana use

Estimates for the logit regressions on the probability of having used marijuana in the past 30 days are reported in Table 3. The far-left column shows the basic regression, controlling only for a linear trend. Column 2 shows the results of the regression with demographic controls (age, sex, race, and year in school) added. Columns 3 and 4 show the results with more covariates added, some potentially endogenous.

Controlling for a predicted increase of about 1.2 percentage points each year, we find that marijuana use among WSU students increased between 2.0 and 3.5 percentage points (or 12–22 percent[12]) after RML and remained higher through 2015. Each estimate across specifications is statistically different from zero with at least 95-percent confidence. We find no evidence that legal sales had an additional impact on the proportion of marijuana users. The additional change after legal sales is consistently positive but not statistically different from zero at conventional levels; t-scores for these differences range from 0.43 ($p = 0.67$) to 0.88 ($p = 0.38$).

This regression model also provides estimates of relative marijuana use among WSU students. Male students are between 2 and 7 percentage points more likely to have used marijuana than females. Black and white students are the most likely to use marijuana compared to other races with Asian students being the least likely. In results not shown (available upon request), we also see a decreasing likelihood of marijuana use with age of about 3 percentage points per year after age 20. After controlling for GPA, Greek membership, residence, and international status, 1st-year undergraduates are the most likely to use marijuana by between 3 and 5 percentage points over students of other years. International students are between 4 and 7 percentage points less likely to use marijuana than domestic students. Students with a 4.0 GPA are between 3 and 10 percentage points less likely to use than other students. Students in fraternities or sororities are between 4 and 12 percentage points more likely than other students. Living in the university dormitories or living with parents is strongly negatively correlated with marijuana use. Finally, the likelihood of marijuana use is positively correlated with the use of tobacco, alcohol, and illegal drugs.

4.2. Likelihood of marijuana use by subgroup

To better understand the impact of RML, we repeat the analysis for different subgroups and present the results in Table 4. Results of these regressions are generally consistent across all four specifications for each group. For brevity, we report only the results that include controls for age, sex, race, and year in school (equivalent to column 2 in Table 3). The proportion of each group that reported having used marijuana before 2014 is included at the bottom of each column. Though the estimates differ greatly in magnitude, and only a few of the estimates are statistically significant at conventional levels, all groups are associated with a positive increase above the trend in marijuana use after RML.

The results suggest marijuana use by underage students increased at least as much as that by legal-age students after RML. The estimates for the increase in underage students' likelihood of using marijuana are large and statistically significant with a p-value < .01, while the estimates for legal-age students are smaller and not statistically different from zero. Using a chi-squared test after estimation, the differences between the two groups' estimates for 2014 and 2015 have p-values of 0.206 and 0.955, respectively. We also note that the difference between the estimates for 2015 and 2014 for legal-age students is marginally

[12] Percent changes are calculated using the predicted increase in percentage divided by the percentage of students before 2014 who reported having used marijuana; e.g., 0.02 / 0.16 = 0.125 or 12.5 percent.

statistically significant with a p-value = 0.081, indicating that legal-age students waited to use marijuana until after they could obtain it from authorized distributors.

The subgroup analysis provides insight into which groups are driving the changes overall. There is a relatively large increase in likelihood of marijuana use for Black and Hispanic Students, although only Hispanic students showed changes that are statistically significant with a p-value < 0.05. The likelihood of marijuana use among Black and Hispanic students increased in 2014 by 15.8 and 14 percentage points, respectively. This change represents an 88-percent increase in recent users for Black students and a 93-percent increase for Hispanic students. This is 8–9 times the estimated effect for Asian and white students. This relatively large increase is made more significant by the fact that it occurs over a previously non-increasing trend for both groups. In fact, though not statistically different from zero, Black and Hispanic students are the only groups with estimated negative trends over this time. In other words, both groups started out with a proportion of marijuana users that remained essentially constant since 2005 until RML, after which Black and Hispanic students were among the most likely students to have used marijuana. Females are the group with the next highest increase after RML that is statistically significant with a p-value < 0.05.

Table 5
Probability of having used other substances in the past 30 days.

Variables	(1) Marijuana	(2) Tobacco	(3) Alcohol	(4) Other Illegal
Year 2014 (After RML)	0.0293**	-0.00893	0.0159	0.00817
	(0.0122)	(0.0108)	(0.0136)	(0.00648)
Year 2015 (After Legal Sales)	0.0418***	-0.0243*	-0.00821	0.0216**
	(0.0152)	(0.0125)	(0.0166)	(0.00922)
Year Trend	0.0123***	-0.00201	0.000426	-0.00183**
	(0.00186)	(0.00157)	(0.00204)	(0.000831)
Male	0.0651***	0.167***	-0.00812	0.0196***
	(0.00724)	(0.00722)	(0.00843)	(0.00367)
Race: White	0.0471***	0.0394***	0.155***	0.0133***
	(0.0114)	(0.0113)	(0.0156)	(0.00512)
Race: Black	0.0759***	-0.0107	0.00232	0.00940
	(0.0235)	(0.0207)	(0.0231)	(0.0118)
Race: Asian	-0.0446***	-0.0132	-0.0722***	0.000285
	(0.0124)	(0.0131)	(0.0162)	(0.00684)
Race: Hispanic	0.0279*	-0.0162	0.0430***	0.00560
	(0.0159)	(0.0144)	(0.0164)	(0.00802)
2nd-year Undergraduate	-0.000526	-0.00608	0.0299**	-0.00710
	(0.0117)	(0.0113)	(0.0132)	(0.00529)
3rd-year Undergraduate	-0.00392	-0.0139	0.0328*	-0.00532
	(0.0143)	(0.0138)	(0.0171)	(0.00685)
4th-year Undergraduate	0.0194	0.0132	0.0821***	0.00839
	(0.0179)	(0.0170)	(0.0197)	(0.00927)
5th-year Undergraduate or More	0.0118	-0.0400**	0.104***	0.0239
	(0.0243)	(0.0178)	(0.0228)	(0.0163)
Pre-2014 Probability of Use	0.17	0.20	0.68	0.04
Observations = 13,335				

Logit results reported as marginal effects.
Standard errors in parentheses.
All regressions contain indicators for age.
Omitted race is other races: including American Indian, Hawaiian/Alaskan Native, and all other races.
Omitted year in school is 1st-year undergraduate.
*** p < 0.01.
** p < 0.05.
* p < 0.1.

4.3. Likelihood of use of other substances

Results from the logit regressions on the likelihood of using tobacco, alcohol, or illegal drugs are reported in Table 5. Again for brevity, we report only the results for the regressions that include controls only for age, sex, race, and year in school. For convenience, we report again the estimates for marijuana use from column 2 of Table 3. On average, the yearly trends in the likelihood of use for tobacco, alcohol, and illegal drugs are in the opposite direction and significantly smaller in magnitude than the yearly increase of 1.2 percentage points in marijuana use. No significant changes occur in 2014. In 2015, the only significant changes include a 2.4-percentage-point (12 percent) decrease in the likelihood of using tobacco and a 2.2-percentage-point (55 percent) increase in the likelihood of using other illegal drugs. These results imply a possible substitute/complement effect or a spillover effect on norms against other illegal drugs, though the changes did not occur until a full year after the major changes in marijuana use. Additionally, relative to the changes for marijuana, the changes for tobacco and illegal drugs are not as robust to alternative specifications and estimation methods (results available upon request). We see no evidence that RML or legal sales affected the use of alcohol. Overall, our results do not support any systematic changes in other substances that occur parallel with changes in marijuana use. This supports a conjecture that RML was the cause of the changes we find for marijuana.

4.4. Marijuana use intensity

Results of the OLS regressions with respect to regularity of marijuana use are presented in Table 6. In 2014, we find an increase of about 0.5 days in the past 30 days (40 percent over the pre-2014 average) above a linear trend of between 0.13 and 0.16 days per year.

Table 6
Frequency of marijuana use in past 30 days.

Variables	(1) OLS I	(2) OLS II	(3) OLS III	(4) OLS IV
Year 2014 (After RML)	0.545***	0.467***	0.415**	0.397***
	(0.169)	(0.167)	(0.166)	(0.153)
Year 2015 (After Legal Sales)	0.303	0.315	0.265	0.239
	(0.198)	(0.197)	(0.197)	(0.181)
Year Trend	0.132***	0.145***	0.133***	0.157***
	(0.0198)	(0.0198)	(0.0197)	(0.0185)
Male		1.207***	1.168***	0.636***
		(0.105)	(0.103)	(0.0963)
Race: White		0.612***	0.632***	0.275
		(0.181)	(0.183)	(0.175)
Race: Black		1.337***	1.176***	1.233***
		(0.362)	(0.364)	(0.333)
Race: Asian		-0.373**	-0.291	-0.237
		(0.185)	(0.186)	(0.177)
Race: Hispanic		0.452*	0.265	0.314
		(0.236)	(0.236)	(0.222)
2nd-year Undergraduate		0.159	-0.354**	-0.107
		(0.163)	(0.166)	(0.152)
3rd-year Undergraduate		0.393*	-0.108	0.111
		(0.210)	(0.210)	(0.195)
4th-year Undergraduate		0.764***	0.215	0.240
		(0.244)	(0.246)	(0.227)
5th-year Undergraduate or More		0.830**	0.146	0.274
		(0.328)	(0.330)	(0.300)
International Student			-0.189	0.0271
			(0.202)	(0.182)
GPA: 2.0			0.380	0.486
			(0.409)	(0.382)

(continued on next page)

Table 6 *(continued)*

Variables	(1) OLS I	(2) OLS II	(3) OLS III	(4) OLS IV
GPA: 3.0			-0.300	0.191
			(0.389)	(0.365)
GPA: 4.0			-1.173***	-0.270
			(0.389)	(0.364)
Member of Fraternity/Sorority			1.080***	0.378**
			(0.182)	(0.168)
Residence: Fraternity/Sorority House			0.668***	0.0296
			(0.257)	(0.236)
Residence: Other University Housing			0.771***	0.464***
			(0.189)	(0.170)
Residence: With Parents			0.786*	0.541
			(0.475)	(0.430)
Residence: Other Off-campus Housing			1.317***	0.771***
			(0.125)	(0.116)
Used Tobacco Past 30 Days				2.558***
				(0.173)
Used Alcohol Past 30 Days				1.212***
				(0.0754)
Used Other Illegal Drugs Past 30 Days				6.895***
				(0.450)
Age Dummies	NO	YES	YES	YES
Pre-2014 Average Days of Marijuana Use = 1.26				
Observations = 13,335				

Robust standard errors in parentheses.
Omitted sex is female.
Omitted race is other races: including American Indian, Hawaiian/Alaskan Native, and all other races.
Omitted year in school is 1st-year undergraduate.
Omitted GPA is 1.0.
Omitted residence is university residence hall.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

This increase is statistically significant across specifications with at least 95-percent confidence. The estimates for after legal sales are smaller than for after RML and are not statistically significant at conventional levels. Though the magnitude of the estimates in 2015 are not significantly lower than in 2014, the lack of a significant increase in 2015 could indicate that the effect of RML on frequency is short-lived and the equilibrium trends in frequency are unaffected by legalization. Alternatively, this may indicate that a proportion of students who began using before legal sales of marijuana are more likely to use it more frequently than those who waited.

Table 7
Effect of RML on likelihood of marijuana use: difference-in-differences.

	Pre-RML	Post-RML	Difference	Difference-in-differences
WSU (Treated)	0.156	0.267	0.11 (0.007)	
	(0.37)	(0.44)		
National NCHA Forecast (Control)	0.164	0.189	0.024 (0.006)	0.086
	(0.37)	(0.017)[a]		(0.010)
NSDUH (Control)	0.175	0.190	0.015 (0.003)	0.096
	(0.38)	(0.39)		(0.008)

Standard deviations or standard errors in parentheses.
[a] Standard error from smoothing forecast.

4.5. Comparisons to national data

The calculation of the difference-in-differences estimations are reported in Table 7. Using the national NCHA forecast as a counterfactual, the estimated effect of RML is an increase of 8.6 percentage points. Using the NSDUH, the estimated effect is 9.6 percentage points. These estimates are both statistically significant with over 99-percent confidence and are 3–5 times larger than the estimated increase over a linear trend in the regressions. Although limited by not accounting for covariate changes over time, the difference-in-differences estimations suggest that the increase over a linear trend in the regressions may be a conservative estimate of the effect of RML on the likelihood of using marijuana.

5. Conclusions

We provide evidence of the short-term effect that RML may have on college students' use of marijuana. At Washington State University, RML was associated with a significant increase both in the proportion of undergraduate students who reported having recently used marijuana and in the average frequency of use. This increase is robust to multiple specifications and statistical models and varies across subgroups. We find that underage students, females, Black students, and Hispanic students experienced the most significant changes in marijuana use after RML. The increase in marijuana use at WSU is both above a linear trend and above the reported use of marijuana in two national samples.

It is likely that RML affects factors other than legality, which drive the increase in use. We find evidence that some students may have waited to use until they could legally obtain marijuana from authorized distributors, but the most significant increase in use occurred after RML and before marijuana was available in a legal market. We also find that underage students (for whom marijuana use continues to remain illegal) had as big of a response as legal-age students. Changes in price, availability, social acceptability, and perhaps reduced law enforcement are likely to affect students of all ages whereas only legal-age students experience a direct change in the law. Finally, we find evidence that students did not significantly change their use of tobacco, alcohol, or illegal drugs simultaneously with changes in marijuana.

It is possible that the observed increase in marijuana use at WSU is driven not by RML but by some other underlying changes. Changes in the underlying WSU population are controlled for in the regressions, but marijuana use may have increased at WSU even without RML, as suggested by the jump in use in 2010. To verify that our results are particular to changes that occur after 2012, we run our analyses as if RML occurred in each other year. In each such regression, the pseudo-treatment is not associated with a significant increase in marijuana use. Additionally, a positive jump between 2008 and 2010 is observed in both national samples and the best-fit forecast using the WSU data shows a trend similar to national trends even after the 2010 increase in use.

An important limitation in our analysis is the lack of ideal counterfactual for WSU use in the absence of RML. Particularly, the missing years of WSU survey data limit the estimation of the linear trend. Nevertheless, we show that the increase in marijuana use after RML is significantly larger than what would have been predicted with data through 2012, and the increase at WSU exceeds that predicted and observed for national data.

It is also possible that students are more willing to report marijuana use after RML. We use the likelihood that a responder skips a question as a proxy for willingness to report. Fig. 3 shows the percent of responses each year that had missing values for recent use of each substance. A decrease in the percentage of missing responses with respect to marijuana use after RML would be consistent with an increase in willingness to report. Though we do observe such a decrease in 2014, the decrease is observed for all substances and the percentage increases again for all substances in 2015. It is possible that willingness to report plays a role in the increase in reported use, but it does not appear to be the main driver of the results.

RML is still new and college students are an important group of potentially at-risk young adults. To the extent that WSU is like other universities, we provide some idea of the early impact of RML on college students. Future studies will benefit from more post-RML observations to determine whether the change in marijuana use after RML fades or grows over time. Our analysis is limited by having observations from only one university. Future studies may benefit from the inclusion of data from more universities in more states that have and have not legalized marijuana.

Ethical statement

This research did not receive any specific grant funding from agencies in the public, commercial, or not-for-profit sectors.

All authors declare that there are no conflicts of interest with respect to this work.

Appendix

Table A.1 displays the results of the difference-in-differences calculations for the trends in the frequency of marijuana use. Using the national NCHA forecast as a control group, the estimated treatment effect is an increase of 0.8 days out of 30. Using the NSDUH, the estimated effect is 1 day. These estimates are both statistically significant with over 99-percent confidence.

Table A.1
Effect of RML on frequency of marijuana use in past 30 days: difference-in-differences.

	Pre-RML	Post-RML	Difference	Difference-in-differences
WSU (Treated)	1.13	2.38	1.24	
	(4.63)	(6.53)	(0.10)	
National NCHA Forecast	1.37	1.81	0.44	0.80
(Control)	(4.91)	(0.28)[a]	(0.11)	(0.15)
NSDUH (Control)	2.16	2.40	0.24	1.00
	(6.57)	(6.93)	(0.06)	(0.12)

Standard deviations or standard errors in parentheses.

[a] Standard error from smoothing forecast.

References

American College Health Association (2014). *About ACHA-NCHA*. ⟨http://www.acha-ncha.org/grvanalysis.html⟩ Accessed 19 June 2017.

Anderson, D. M., Hansen, & Rees, D. I. (2013). Medical marijuana laws, traffic fatalities, and alcohol consumption. *Journal of Law and Economics*, *56*(2), 333–369. http://dx.doi.org/10.1086/668812.

Anderson, D. M., Hansen, B., & Rees, D. I. (2015). Medical marijuana laws and teen marijuana use. *American Law and Economics Review*. http://dx.doi.org/10.1093/aler/ahv002.

Cerdá, M., Wall, M., Feng, T., Keyes, K. M., Sarvet, A., Schulenberg, J., O'Malley, P. M., Pacula, R. L., Galea, S., & Hasin, D. S. (2017). Association of state recreational marijuana laws with adolescent marijuana use. *JAMA Pediatrics*, *171*(2), 142–149. http://dx.doi.org/10.1001/jamapediatrics.2016.3624.

Choo, E. K., Benz, M., Zaller, N., Warren, O., Rising, K. L., & McConnell, K. J. (2014). The impact of state medical marijuana legislation on adolescent marijuana use. *Journal of Adolescent Health*, *55*(2), 160–166. http://dx.doi.org/10.1016/j.jadohealth.2014.02.018.

Chu, Y.-W. L. (2014). The effects of medical marijuana laws on illegal marijuana use. *Journal of Health Economics*, *38*, 43–61. http://dx.doi.org/10.1016/j.jhealeco.2014.07.003.

Damrongplasit, K., Hsiao, C., & Zhao, X. (2010). Decriminalization and marijuana smoking prevalence: Evidence from Australia. *Journal of Business Economic Statistics*, *28*(3), 344–356. http://dx.doi.org/10.1198/jbes.2009.06129.

Hall, W., & Lynskey, M. (2016). Evaluating the public health impacts of legalizing recreational cannabis use in the United States. *Addiction*, *111*(10), 1764–1773. http://dx.doi.org/10.1111/add.13428.

Khatapoush, S., & Hallfors, D. (2004). Sending the wrong message: Did medical marijuana legalization in California change attitudes about and use of marijuana? *Journal of Drug Issues*, *34*(4), 751–770. http://dx.doi.org/10.1177/002204260403400402.

Lynne-Landsman, S. D., Livingston, M. D., & Wagenaar, A. C. (2013). Effects of state medical marijuana laws on adolescent marijuana use. *American Journal of Public Health*, *103*(8), 1500–1506. http://dx.doi.org/10.2105/AJPH.2012.301117.

Malivert, R., & Hall, J. C. (2013). The effect of medical marijuana laws on extralegal marijuana prices. *Atlantic Economic Journal*, *41*(4), 455–456. http://dx.doi.org/10.1007/s11293-013-9384-0.

Moreno, M. A., Whitehill, J. M., Quach, V., Midamba, N., & Manskopf, I. (2016). Marijuana experiences, voting behaviors, and early perspectives regarding marijuana legalization among college students from 2 states. *Journal of American College Health*, *64*(1), 9–18. http://dx.doi.org/10.1080/07448481.2015.1062769.

Office of Institutional Research (2017a). *Overall Enrollment*. ⟨https://ir.wsu.edu/enrollment/⟩ Accessed 19 June 2017.

Office of Institutional Research (2017b). *Retention, Graduation, and GPA*. ⟨https://ir.wsu.edu/retention-graduation-and-gpa/⟩ Accessed 19 June 2017.

Pacula, R. L., Chriqui, J. F., & King, J. (2003). *Marijuana decriminalization: What does it mean in the United States?* (Working Paper No. 9690)National Bureau of Economic Researchhttp://dx.doi.org/10.3386/w9690.

Pacula, R.L. (2010). *Examining the impact of marijuana legalization on marijuana consumption: Insights from the economics literature*. ⟨http://www.rand.org/pubs/working_papers/WR770.html⟩ Accessed 04 May 2016.

Pacula, R. L., Powell, D., Heaton, P., & Sevigny, E. L. (2015). Assessing the effects of medical marijuana laws on marijuana and alcohol use: The devil is in the details. *Journal of Policy Analysis and Management*, *34*(1), 7–31. http://dx.doi.org/10.1002/pam.21804.

Reinarman, C., Cohen, P. D. A., & Kaal, H. L. (2004). The limited relevance of drug policy: Cannabis in Amsterdam and in San Francisco. *American Journal of Public Health*, *94*(5), 836–842. http://dx.doi.org/10.2105/AJPH.94.5.836.

Thies, C. F., & Register, C. A. (1993). Decriminalization of marijuana and the demand for alcohol, marijuana and cocaine. *The Social Science Journal*, *30*(4), 385–399. http://dx.doi.org/10.1016/0362-3319(93)90016-O.

Washington State University (2015). *Facts and Figures 2014-15*. ⟨https://wsu.edu/wp-content/uploads/sites/625/2015/06/147617-B-Facts-Figures-8-5x11.pdf⟩ Accessed 20 May 2016.

Wen, H., Hockenberry, J., & Cummings, J.R. (2014). The effect of medical marijuana laws on marijuana, alcohol, and hard drug use (Working Paper No. 20085). *National Bureau of Economic Research*. ⟨http://www.nber.org/papers/w20085⟩ Accessed 09 November 2015.

WSU Center for Fraternity and Sorority Life (2015). *Facts & Figures*. ⟨http://gogreek.wsu.edu/our-community/facts-and-figures/⟩ Accessed 26.10.17.