Washington State Institute for Public Policy

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November 2013

Legalization of Recreational Marijuana in Washington: *Monitoring Trends in Use Prior to the Implementation of I-502*

In November 2012, the citizens of the state of Washington passed Initiative 502 (I-502) which authorized the state Liquor Control Board to regulate and tax recreational marijuana for persons 21 years of age and older.[1]

The law directs the Washington State Institute for Public Policy (WSIPP) to conduct benefit-cost evaluations of the implementation of I-502 by examining outcomes related to:

- public health
- public safety
- criminal justice
- economic impacts
- agencies' administrative costs and revenues.

WSIPP is required to produce reports for the legislature in 2015, 2017, 2022, and 2032. The purpose of this initial report is to provide estimates of marijuana use among youth and adults prior to the implementation of I-502.

Estimates from the period prior to implementation provide baseline data to compare future estimates against. If we observe that trends in marijuana use in Washington are consistently different compared to trends in other states, we may be able attribute the difference, in part, to the new law.

Monitoring trends in the prevalence of marijuana use is only one part of WSIPP's larger assignment. I-502 directs us to conduct in-depth benefit-cost analyses taking into account outcomes in the key areas identified above. The purpose of this report is to provide initial trends for a few key public health indicators prior to implementation, which we will continue to monitor throughout our evaluation.

[1] Initiative Measure No. 502; Full text available at http://apps.leg.wa.gov/documents/billdocs/2011-12/Pdf/Initiatives/Initiatives/INITIATIVE%20502.pdf

Summary

The Washington State Institute for Public Policy is directed to conduct a benefit-cost analysis of the implementation of I-502, which legalizes recreational marijuana use for adults within the state. As a preliminary step, we analyzed population-level data to begin monitoring four key indicators of marijuana use prior to implementation.

We used data from the 2002 to 2011 administrations of the National Survey on Drug Use and Health to examine trends in the prevalence of current marijuana use, lifetime marijuana use, age of initiation, and marijuana abuse or dependency. We examined these trends separately for youth and adults in Washington, and also provide estimates for Colorado (the other state that has legalized recreational marijuana use) and the rest of the United States (US).

Examining trends in this manner will allow us to monitor whether the implementation of I-502 appears to affect these key indicators of marijuana use over time. Although more sophisticated analyses will be required for us to evaluate the policy, these initial trends provide a baseline to compare future data against.

Findings. The prevalence of marijuana use in the past 30 days—a key indicator of the proportion of people who are current marijuana users—appears to be on the rise in recent years among both youth and adults in Washington, Colorado, and the US. The other indicators of use appear to be relatively stable or increasing slightly over time. In general, the estimates from Washington are slightly higher than the US and slightly lower than Colorado.

Next steps. We will continue to monitor these trends over time within the context of our larger benefit-cost analysis to examine whether the new policy appears to affect marijuana use rates within the state.

Suggested citation: Hanley, S. (2013). *Legalization of recreational marijuana in Washington: Monitoring trends in use prior to the implementation of I-502.* (Document No. 13-11-1401). Olympia: Washington State Institute for Public Policy.

I. Trends in Marijuana Use over Time

We derived our estimates of marijuana use from the National Survey on Drug Use and Health (NSDUH), which is a national household survey conducted annually by the Substance Abuse and Mental Health Administration in the US Department of Health and Human Services.[2]

For this report, we focus on four indicators of marijuana use:

A. Current use
B. Lifetime use
C. Age of initiation
D. Abuse and dependency

We present the biennial trends for 2002-2003 through 2010-2011 in Exhibits 1 through 4 below.[3] The 2012-2013 data from NSDUH will not be available until fall 2014.

Although NSDUH is conducted annually, each data point in the exhibits represents the average of two years. NSDUH combines survey data in this manner so that the sample size is sufficiently large. Larger sample sizes result in estimates that are more precise (i.e., contain less error).

We provide estimates for Colorado and the US to serve as comparison data for Washington. We also break out the data by age group (i.e., those ages 12 to 20 and those 21 and older) to get a preliminary sense of how legalization of recreational marijuana may affect youth and adults differentially. This is of particular importance in light of the US Department of Justice's August 2013 statement on legalization in Washington and Colorado that indicates the federal government's particular interest in preventing the diversion of marijuana to minors.[4]

As we proceed with our evaluation, we caution that it may take time for meaningful changes in marijuana use to appear in trend data. As can be seen in the following exhibits, natural fluctuations occur from year to year. Looking only at a limited number of years, therefore, can provide an incomplete picture. This point will be particularly important with regard to I-502, as detectable changes in marijuana use may not manifest until well after implementation of the new law. Fortunately, we will be able to monitor these changes over a long period of time in the reports we will provide to the legislature in 2015, 2017, 2022, and 2032.

We also recognize that any changes in trends over time could be due to other factors besides the introduction of the new law. In future analyses, we will attempt to isolate the effect of the law from other factors by using sophisticated techniques such as time series analyses that formally assess changes in trends over time.

The results for the four NSDUH indicators follow. We scaled each graph in the exhibits to best accommodate the given data. As a result, the vertical axis is not the same in each graph.

A. Current use

This indicator is measured by asking survey respondents whether they have used marijuana in the past 30 days. It is used to estimate how many people can be characterized as current users of marijuana. The figures in Exhibit 1, therefore, represent the percent of individuals who report any marijuana use in the past 30 days.

The results in Exhibit 1 indicate that current marijuana use among Washington youth and adults was 16.6% and 9.1%, respectively, in 2010-2011.[5] The prevalence has been rising for both age groups in recent years, from a low of 10.2% in 2004-2005 for youth, and a low of 5.3% in 2002-2003 for adults. For both age groups, the prevalence has typically been slightly higher in Washington compared to the US but slightly lower compared to Colorado.

[2] Future reports will utilize data from additional surveys such as the Washington Healthy Youth Survey, the Behavioral Risk Factor Surveillance System, and Monitoring the Future.
[3] Age of initiation was not measured until the 2004 administration of the survey.
[4] http://www.justice.gov/iso/opa/resources/305201382913275685747.pdf
[5] Specific figures for the graphs can be found in the appendix.

B. Lifetime use

Lifetime marijuana use is measured by asking respondents whether they have used marijuana at least once in their lifetime. The proportion of Washington youth who reported doing so was 31.4% in 2010-2011, while the figure for adults was 54.6%. Trends among Washington youth have been relatively stable while those among adults have been rising (Exhibit 2). As with current use, estimates of lifetime use for Washington have typically been between those for Colorado and the US.

C. Age of initiation

Age of initiation is typically measured by asking respondents the age at which they first used marijuana. Previous research has shown that those who initiate marijuana use at younger ages are more likely to use more heavily as adults and have poorer educational outcomes compared to those who initiate use later.[6]

The NSDUH data set does not give us the ability to report the average age of initiation directly. Instead, we are only able to provide the percent of respondents who report using before age 21. The proportion of Washington youth in 2010-2011 who initiated marijuana use before age 21 was 31.4%, while the figure for adults was 43.1% (Exhibit 3). For both age groups, the trends have remained relatively stable over time and have typically been between those for Colorado and the US.

D. Abuse or dependency

The last indicator, marijuana abuse and dependency, is of particular interest because I-502 directs WSIPP to consider "diagnosis of marijuana-related substance use disorder, substance abuse, or substance dependence" in its evaluation.

SAMHSA calculates the measure of abuse or dependency from four items on the NSDUH survey that assess problems in the respondent's personal life in the past year caused by marijuana use (e.g., problems with family, trouble with the law). These items are considered collectively, and SAMHSA makes a determination according to criteria specified in the Diagnostic and Statistical Manual of Mental Disorders. The estimates we provide represent the proportion of respondents who met the criteria for abuse or dependency in the past year.

The proportion of Washington youth exhibiting marijuana abuse or dependency in the past year was 5.9% in 2010-2011 (Exhibit 4). Estimates appear to have risen in recent years, with those for Washington similar to those of the nation and slightly lower than those from Colorado.

Abuse or dependency among adults was 1.7% in 2010-2011 (Exhibit 4). Because of relatively small sample sizes, estimates from both Washington and Colorado have fluctuated while national estimates have remained stable.

II. Next Steps

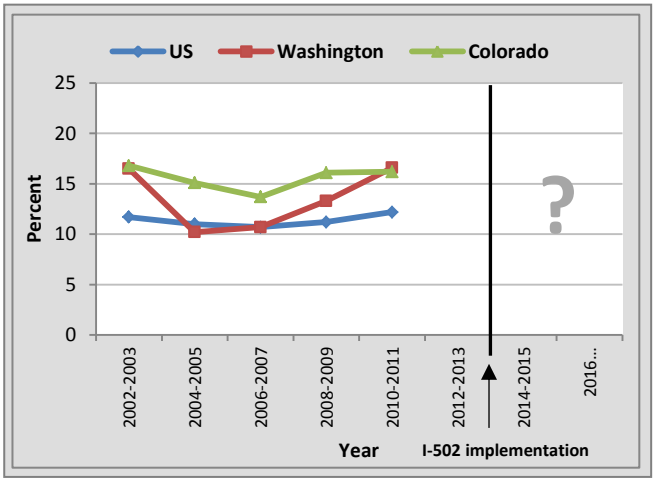
We will continue to monitor trends in marijuana use as part of our larger assignment within the initiative. Future reports will examine additional public health outcomes, as well as those related to public safety, criminal justice, and economic impacts, all within the context of a benefit-cost analysis. The purpose of the current report is to offer a baseline snapshot of marijuana use within our state prior to implementation of I-502.

[6] For example, see Lynskey, M.T., Heath, A.C., Bucholz, K.K., et al. (2003). Escalation of drug use in early-onset cannabis users vs. co-twin controls. *Journal of the American Medical Association, 289*(4), 427-433; Townsend, L., Flisher, A.J., & King, G. (2007). A systematic review of the relationship between high school dropout and substance use. *Clinical Child and Family Psychology, 10*(4), 295-317.

Exhibit 1

Current Marijuana Use in the United States, Washington, and Colorado 2002-2011

Ages 12–20



Ages 21 and older

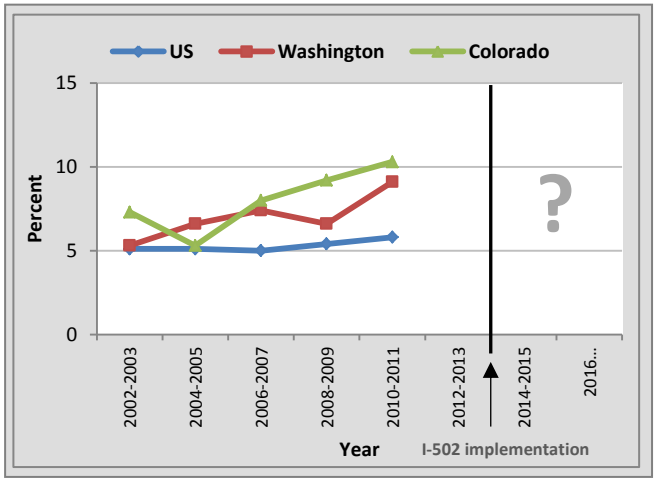
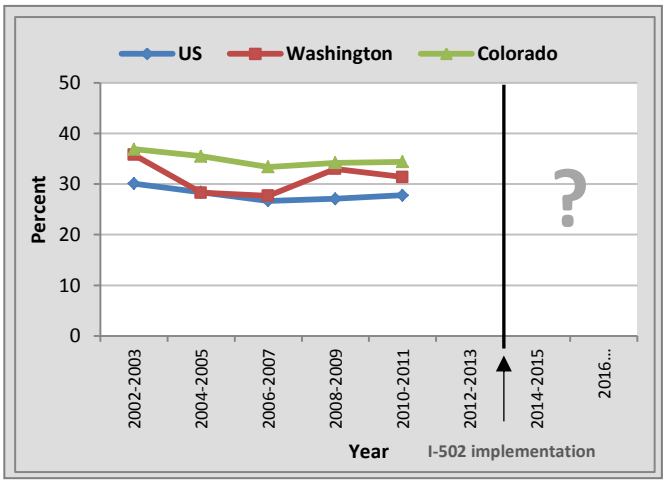


Exhibit 2

Lifetime Marijuana Use in the United States, Washington, and Colorado 2002-2011

Ages 12–20



Ages 21 and older

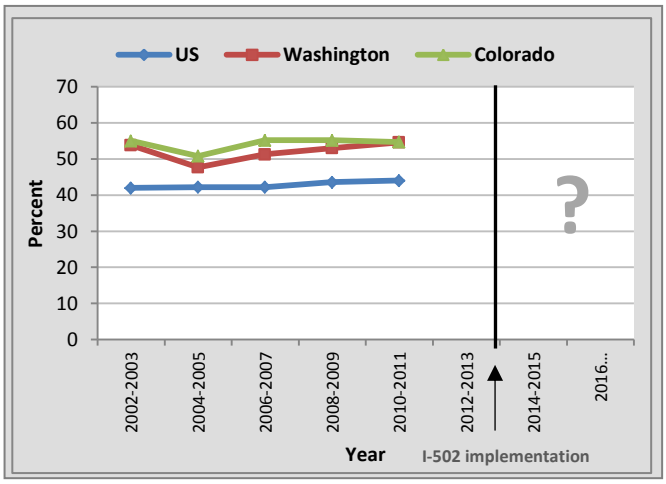
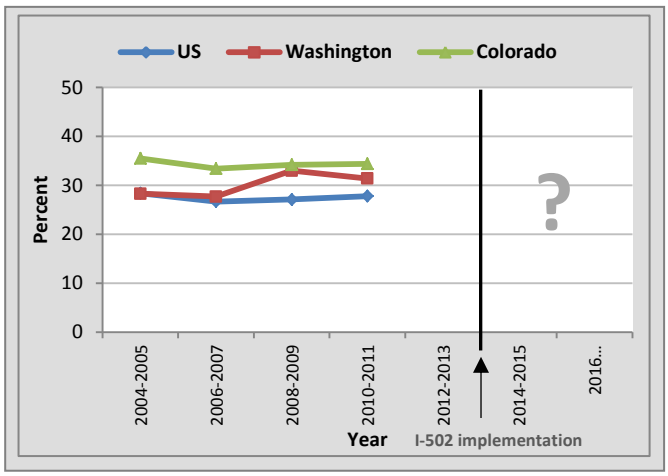


Exhibit 3

Marijuana Use before Age 21 in the United States, Washington, and Colorado 2004-2011

Ages 12–20



Ages 21 and older

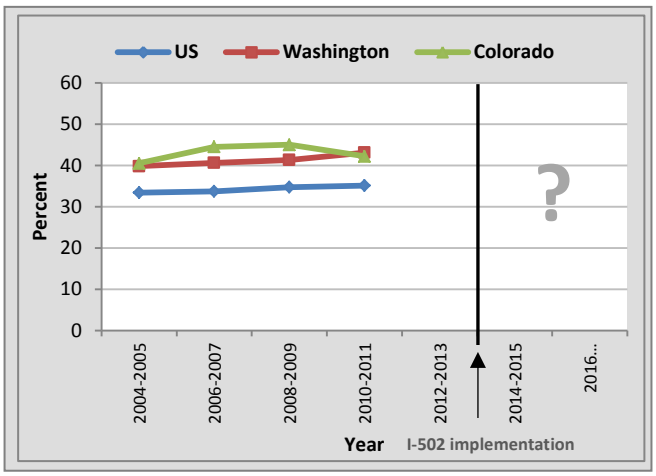
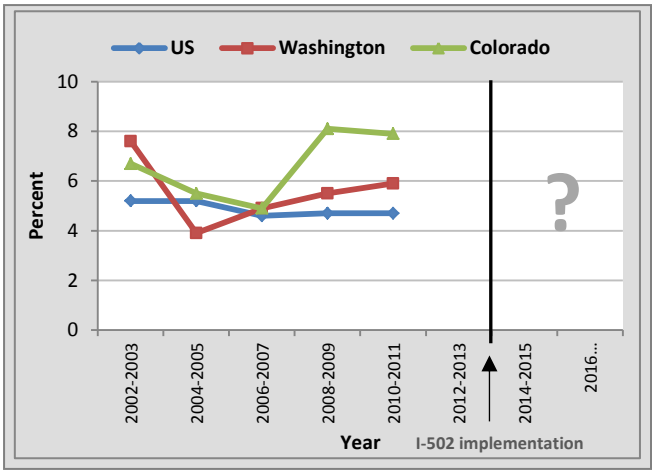


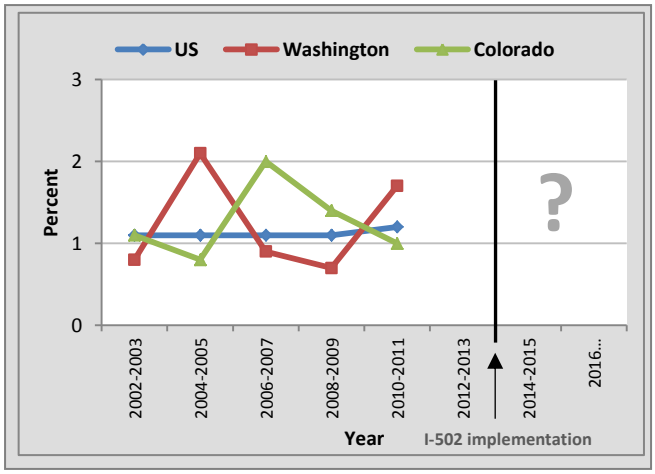
Exhibit 4

Marijuana Abuse or Dependency in the United States, Washington, and Colorado 2002-2011

Ages 12–20



Ages 21 and older



Additional information about the National Survey on Drug Use and Health

The National Survey on Drug Use and Health (NSDUH) is an annual survey conducted with a random sample of over 70,000 residents age 12 and older throughout the United States. The survey is used to provide yearly estimates of a variety of health behaviors including alcohol, tobacco, and other drug use including marijuana. Results are used by a variety of national- and state-level stakeholders to monitor drug use and to direct prevention and treatment efforts. More information about the survey can be found at http://nsduhweb.rti.org.

We conducted our analyses using the NSDUH Restricted Use Data Analysis System (R-DAS) online analysis tool.[7] This tool allows the user to produce frequencies, cross-tabulations, and other descriptive statistics for each item available on the survey.

We used the following variables in the R-DAS dataset to generate the estimates for four outcomes:

- Current use: IRMJRC
- Lifetime use: MJEVER
- Age of initiation: FUMJ21
- Abuse and dependency: ABODMRJ

Unlike other publically-available NSDUH data sets, R-DAS has the advantage of allowing the user to generate state-specific estimates. This feature allows us to provide separate estimates for Washington, Colorado, and the US in this report.

A note about confidence intervals

The tradeoff for using R-DAS to provide state-specific estimates is that the dataset combines two years of NSDUH data to produce biennial estimates. We therefore cannot provide separate estimates for each year. The R-DAS combines data in this manner because the sample sizes for a particular state in any given year are often too small to provide reliable estimates. Combining data from two years results in larger sample sizes which, in turn, produce estimates with greater precision. We have more confidence therefore that the estimates from our sample are an accurate reflection of the true number within the population.

We quantify this confidence by constructing 95% confidence intervals (CIs) around each estimate. Because the data come from a sample of respondents and not the entire population, the estimates contain some amount of error. We accommodate this error by creating CIs, which can be interpreted as the range of values in which the true value is likely to fall. That is, we can say that we are 95% confident that the interval bound by the error bands contains the true population value. We provide the estimates and their associated CIs in Tables 1 through 4. The estimates are the same as those presented in Exhibits 1 through 4.

[7] United States Department of Health and Human Services. Substance Abuse and Mental Health Services Administration. Center for Behavioral Health Statistics and Quality. National Survey on Drug Use and Health: 2-Year R-DAS (2002 to 2003, 2004 to 2005, 2006 to 2007, 2008 to 2009, and 2010 to 2011). ICPSR34482-v1. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2012-12-07. doi:10.3886/ICPSR34482.v1; online analysis tool available at www.icpsr.umich.edu/icpsrweb/content/SAMHDA/rdas.html

CIs provide measures of precision for a particular estimate and also offer an indication of whether two estimates may be statistically different from one another. For example, if the CIs for two estimates overlap, we can say that the difference between the estimates is not statistically significant. This is the case for many of the estimates in Tables 1 through 4. One example is Table 1, where we see that the CIs associated with the 2010-2011 estimates for those ages 21 and older in Washington and Colorado overlap. Although it may appear that Colorado's estimate (10.3%) is slightly higher than Washington's (9.1%), the overlapping CIs (8.4% to 12.6% and 6.8% to12.0%, respectively) indicate that this difference is not statistically significant. Alternatively, we see that neither the CI for Washington nor that for Colorado overlaps with the CI for the US (5.6% to 6.1%). This indicates that both states' estimates are significantly different from the estimate for the US. There are limits to interpreting CIs in this manner—in rare cases, slightly overlapping CIs may still be statistically significant, for example—but it provides a good rule of thumb when interpreting results.

Table 1

Trends in current marijuana use by age category
Washington, Colorado, and US

	WA		CO		US	
	%	CI	%	CI	%	CI
1	2	3	4	5	6	7
Ages 12-20						
2002-2003	16.5	13.2-20.3	16.8	13.6-20.6	11.7	11.3-12.1
2004-2005	10.2	8.0-12.9	15.1	12.0-18.8	11.0	10.6-11.4
2006-2007	10.7	8.1-13.9	13.7	10.8-17.3	10.7	10.3-11.1
2008-2009	13.3	10.7-16.5	16.1	13.3-19.3	11.2	10.8-11.6
2010-2011	16.6	13.0-21.0	16.2	13.0-19.9	12.2	11.8-12.7
Ages 21 or older						
2002-2003	5.3	3.7-7.6	7.3	5.8-9.2	5.1	4.8-5.3
2004-2005	6.6	4.9-8.9	5.3	4.1-6.9	5.1	4.8-5.3
2006-2007	7.4	5.2-10.5	8.0	6.1-10.5	5.0	4.7-5.2
2008-2009	6.6	4.6-9.2	9.2	7.0-12.0	5.4	5.2-5.7
2010-2011	9.1	6.8-12.0	10.3	8.4-12.6	5.8	5.6-6.1

Table 2

Trends in lifetime marijuana use by age category
Washington, Colorado, and US

	WA		CO		US	
	%	CI	%	CI	%	CI
1	2	3	4	5	6	7
Ages 12-20						
2002-2003	35.8	31.1-40.7	36.9	32.5-41.5	30.1	29.5-30.7
2004-2005	28.3	24.1-32.9	35.5	30.8-40.5	28.4	27.8-28.9
2006-2007	27.7	22.7-33.3	33.4	29.4-37.7	26.7	26.2-27.3
2008-2009	33.0	28.9-37.5	34.2	29.2-39.6	27.1	26.5-27.7
2010-2011	31.4	27.1-36.2	34.4	30.1-38.9	27.8	27.1-28.4
Ages 21 or older						
2002-2003	53.8	48.2-59.3	55.0	49.6-60.3	42.0	41.3-42.6
2004-2005	47.7	43.0-52.5	50.8	46.3-55.2	42.2	41.5-42.8
2006-2007	51.3	46.6-56.0	55.2	50.3-60.0	42.2	41.6-42.9
2008-2009	53.0	48.1-57.9	55.2	50.4-59.9	43.6	42.9-44.2
2010-2011	54.6	49.4-59.6	54.7	49.5-59.9	44.0	43.4-44.7

Table 3

Trends in age of marijuana initiation by age category
Washington, Colorado, and US

	WA		CO		US	
	%	CI	%	CI	%	CI
1	2	3	4	5	6	7
Ages 12-20						
2004-2005	28.3	24.1-32.9	35.5	30.8-40.5	28.4	27.8-28.9
2006-2007	27.7	22.7-33.3	33.4	29.4-37.7	26.7	26.2-27.3
2008-2009	33.0	28.9-37.5	34.2	29.2-39.6	27.1	26.5-27.7
2010-2011	31.4	27.1-36.2	34.4	30.1-38.9	27.8	27.2-28.4
Ages 21 or older						
2004-2005	39.8	35.3-44.5	40.5	36.5-44.7	33.4	32.8-34.0
2006-2007	40.6	36.0-45.5	44.5	39.5-49.5	33.7	33.1-34.3
2008-2009	41.3	36.9-45.8	45.0	40.3-49.9	34.7	34.1-35.3
2010-2011	43.1	37.8-48.6	42.2	38.0-46.5	35.1	34.5-35.7

Note: Age of initiation was not measured in the NSDUH survey prior to 2004.
Figures represent percentage of respondents indicating marijuana use before age 21.

Table 4

Trends in marijuana abuse or dependency by age category
Washington, Colorado, and US

	WA		CO		US	
	%	CI	%	CI	%	CI
1	2	3	4	5	6	7
Ages 12-20						
2002-2003	7.6	5.2-10.9	6.7	5.0-9.1	5.2	5.0-5.5
2004-2005	3.9	2.6-5.7	5.5	4.0-7.6	5.2	4.9-5.4
2006-2007	4.9	3.5-6.6	4.9	3.3-7.1	4.6	4.4-4.8
2008-2009	5.5	4.1-7.4	8.1	6.2-10.7	4.7	4.5-5.0
2010-2011	5.9	4.2-8.3	7.9	5.6-11.1	4.7	4.5-4.9
Ages 21 or older						
2002-2003	0.8	0.5-1.5	1.1	0.6-2.1	1.1	1.1-1.2
2004-2005	2.1	1.3-3.5	0.8	0.5-1.4	1.1	1.0-1.2
2006-2007	0.9	0.6-1.5	2.0	0.9-4.5	1.1	1.0-1.2
2008-2009	0.7	0.4-1.2	1.4	0.8-2.6	1.1	1.1-1.2
2010-2011	1.7	1.0-2.8	1.0	0.6-1.6	1.2	1.1-1.3

Differences in trends over time

The estimates and associated confidence intervals in Tables 1-4 indicate whether Washington, Colorado, and the US statistically differ on a given outcome in a given year. They also indicate whether the estimates within a state statistically differ in one year compared to another. However, one may be interested to know whether the *trends* over time differ between the states. For example, is marijuana use growing more rapidly in Washington compared to Colorado and the US?

Methodology. To answer this question, we conducted a series of regression analyses that tested whether the trajectory in the outcome was different for Washington compared to Colorado and the US. More specifically, we regressed each outcome on main effects for time and state as well as a time-by-state interaction term. Time was entered into the model as a linear term while state was entered with dummy variables for Colorado and the US such that Washington served as the referent.

The outcome variables were represented in the models as the proportions presented in Tables 1-4. We transformed the values by taking the natural log of the proportions. In doing so, the parameter estimates obtained from the models can be interpreted as the percentage change in the outcome for every unit increase in the predictor. The general model we fit is presented below.

$$\ln(Y) = \beta_0 + \beta_1 X_{time} + \beta_2 X_{CO} + \beta_3 X_{US} + \beta_4 (X_{time} * X_{CO}) + \beta_5 (X_{time} * X_{US}) + e$$

Where,
$\ln(Y)$ = natural log of the outcome
X_{time} = linear term for year (1 = 2002-2003; 5 = 2010-2011)
X_{CO} = dummy variable for Colorado
X_{US} = dummy variable for US
$X_{time} * X_{CO}$ = interaction between time and Colorado dummy
$X_{time} * X_{US}$ = interaction between time and US dummy
e = error term

Because the results presented in Tables 1-4 indicate that trends may vary by age, we stratified our analyses by age category: for each outcome, we ran separate models for those 12 to 20 and those 21 or older.

We focus on the interaction terms in each model to draw conclusions about whether the percentage change in outcome differs by state. The parameter estimate associated with the time-by-Colorado term (β_4) quantifies the degree to which the percent change in the outcome over time differs for Colorado versus Washington. Likewise, β_5 quantifies the degree to which the percent change in the outcome over time differs for the US versus Washington.

Results. Table 5 presents the results of our regression models. We have not provided parameter estimates or p-values for the time and state main effects because the interaction terms are the parameters of interest. The regression coefficients in the table approximately represent the difference in average percentage change in the outcome between Washington and Colorado and the US, respectively. A more precise estimate is obtained, however, by exponentiating the coefficient and subtracting 1 from the result, or $(e^{\beta} - 1)*100$.[8]

The figures of interest in Table 5, therefore, are those in columns 5 and 9 (difference in % change). A positive figure indicates that the trend over time for the focal state (i.e., CO or US) is greater than the trend over time for Washington, while a negative beta indicates the opposite. For example, for current marijuana use among those age 12 to 20 in Colorado vs. Washington, the difference in % change value is -2.82. This means that the relative percent change in the proportion reporting current marijuana use was 2.82% *less* in Colorado than in Washington. Conversely, among those ages 21 or older, we see the difference in percent change was 1.60%. This means that the relative percent change in the proportion reporting current marijuana use was 1.60% *greater* in Colorado than in Washington.

[8] For more information, see http://www.kenbenoit.net/courses/ME104/logmodels2.pdf

Table 5

Differences in use trajectories between Washington, Colorado, and US (n=15)[1]

	WA vs. CO				WA vs. US			
	β	p	e^{β}	Diff in % change[2]	β	p	e^{β}	Diff in % change[2]
1	2	3	4	5	6	7	8	9
CURRENT USE								
Ages 12-20	-0.029	0.705	0.972	-2.820	-0.018	0.816	0.983	-1.742
Ages 21 or older	0.016	0.788	1.016	1.602	-0.077	0.214	0.926	-7.380
LIFETIME USE								
Ages 12-20	-0.007	0.844	0.993	-0.688	-0.010	0.781	0.990	-0.967
Ages 21 or older	-0.006	0.736	0.994	-0.626	-0.001	0.960	0.999	-0.092
AGE OF INITIATION[3]								
Ages 12-20	-0.056	0.105	0.946	-5.424	-0.054	0.117	0.948	-5.220
Ages 21 or older	-0.012	0.581	0.988	-1.208	-0.008	0.722	0.992	-0.776
ABUSE OR DEPENDENCY								
Ages 12-20	0.088	0.368	1.092	9.190	-0.014	0.883	0.986	-1.397
Ages 21 or older	-0.004	0.983	0.996	-0.398	-0.024	0.898	0.977	-2.322

Note: Figures in table correspond to model's time-by-state interaction term.

[1] The age of initiation question was not included in the 2002-2003 surveys. As such the sample size for analyses involving that outcome is 12 rather than 15.

[2] Calculated as $(e^{\beta} - 1)*100$

[3] Figures represent percent of respondents indicating marijuana use before age 21.

A negative value in column 5 or 9 does not necessarily indicate that use decreased over time, nor does a positive value necessarily indicate that use increased over time. A negative value simply indicates that there was more use in Washington over time compared to Colorado or the US, while a positive value indicates the opposite. For example, a negative value may indicate that use in both Washington and Colorado rose, but that the rise in Washington was greater than that in Colorado. Alternatively, it could mean that use in both states decreased but that the decrease in Washington was less than that in Colorado. It could also mean that use rose in Washington but declined in Colorado. Consulting the graphs in Exhibits 1-4 will help interpret the nature of the figures in Table 5 more fully.

Conclusion. The figures in column 5 indicate that there was more use in Washington compared to Colorado in six of the eight outcomes we examined. The two exceptions are current use among those ages 21 or older and abuse or dependency among those ages 12 to 20. The figures in column 9 indicate that for all eight outcomes, there was more use in Washington over time compared to the US.

Two important points should be kept in mind when interpreting these results. The magnitude of the difference in relative percent change is small in most cases, with 12 of the 16 scores having absolute values less than 3% and all 16 being less than 10%. This suggests that although there was often more use in Washington over time compared to Colorado and the US, the difference is not great. A second point to consider is that none of the differences are statistically significant ($p<0.05$) as indicated in columns 3 and 7. However, this is likely due to a lack of statistical power given the small sample size (n=15). Had we been able to analyze the respondent-level data rather than simply the yearly prevalence estimates, some of the differences in change percentages may have emerged as statistically significant.

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Document No. 13-11-1401