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Past 15-Year Trends in Adolescent Marijuana Use: Differences by Race/Ethnicity and Sex

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Abstract

Background—The potential for increases in adolescent marijuana use is an important concern given recent changes in marijuana policy. The purpose of this study was to estimate trends in marijuana use from 1999-2013 among a national sample of US high school students. We examine changes over time by race/ethnicity and sex.

Methods—Data are from the National Youth Risk Behavior Survey (YRBS), which involves biennial, school-based surveys that generate nationally-representative data about 9th-12th grade students in the United States. Students self-reported sex, race/ethnicity, and marijuana use (i.e., lifetime use, current use, any use before age 13). We generated national estimates of the prevalence of marijuana use for the time period, and also tested for linear and quadratic trends (n=115,379).

Results—The prevalence of lifetime marijuana use decreased modestly from 1999 to 2009 (44% to 37%), and has increased slightly since 2009 (41%). Other marijuana use variables (e.g., past 30-day use) followed a similar pattern over time. The prevalence of past 30-day use from 1999-2013 for all groups and both sexes was 22.5%, and it was lowest among Asians and highest among American Indian/Alaska Natives. Although boys have historically had a higher prevalence of marijuana use, results indicate that male-female differences in marijuana use decreased over time.

Conclusion—Despite considerable changes in state marijuana policies over the past 15 years, marijuana use among high school students has largely declined. Continued surveillance is needed to assess the impact of policy changes on adolescent marijuana use.

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Conflict of Interest
None

Keywords

Marijuana/cannabis; Adolescent; Race/ethnicity; Sex differences

INTRODUCTION

After alcohol and tobacco, marijuana has been consistently the most commonly used drug of abuse in the US. In 2012, 42.6% of Americans aged 12 and older reported lifetime marijuana use, whereas 61.9% reported lifetime cigarette use and 82.3% reported lifetime alcohol use (SAMHSA, 2014). Adolescence is the developmental period during which most people first use marijuana (Schulden et al., 2009). National data show that 23.4% of high school students report past 30-day marijuana use and that 40.1% report lifetime marijuana use in 2013 (Kann et al., 2014).

The US has undergone significant social change regarding marijuana policy in the past 15 years. Since 1996, 34 states have passed legislation removing criminal sanctions for medical use of marijuana. Twenty states have passed legislation to “decriminalize” marijuana use and possession, nine in the late 1970s and the remainder since 2001. Additionally, since 2012, statutes that effectively end sanctions for recreational marijuana use by adults (≥21 years) have been passed in four states (National Conference on State Legislatures [NCSL], 2015). There is increasingly widespread public support for loosening laws prohibiting marijuana, particularly among those younger than 30 (Palamar, 2014; The Pew Research Center, 2013; Swift, 2013).

Given the current political climate, it is important to examine patterns of adolescent marijuana use and consider how they may change if marijuana were to become legally available for recreational use. Some have argued that it will result in an increase in use among youth, because: (1) the price would likely fall dramatically – making it more affordable to young people, (2) it would be more widely available to youth (i.e., diversion from legal outlets to adolescents is likely), and (3) use will be normalized (Anderson and Rees, 2014; Friese and Grube, 2013; Pacula et al., 2014; Palamar et al., 2014). Additionally, in the absence of strong public health regulations, adolescent use could increase in response to targeted advertising and promotion efforts by corporations (D'Amico et al., 2015 and Pacula et al., 2014).

Conversely, others suggest that adolescent use will remain stable or increase only marginally. A primary reason for this assertion is that existing and proposed statutes prohibit selling to minors, and selling a product illegally to minors is a risk for businesses (Anderson et al., 2014; Anderson and Rees, 2014; Pacula et al., 2014). Secondarily, the scientific evidence on changes in adolescent marijuana use following medical marijuana legislation does not suggest an increase, although additional studies with longer follow-up periods are needed to draw more definitive conclusions (Choo et al., 2014; Hasin et al., 2015). A third reason that adolescent marijuana use may increase only marginally, if at all, relates to the fact that adolescents already report that they have easy access to marijuana. National data from 2013 show that 70% of 10th graders and 81% of 12th graders say that it would be fairly

easy or very easy to obtain marijuana (Johnston et al., 2014). Thus, a large portion of youth abstainers are likely doing so by choice, rather than because they lack access.

There is uncertainty about how adolescent marijuana use will change in response to policy changes, underscoring the importance of closely monitoring patterns of use. The best information about the prevalence of adolescent marijuana use comes from large, nationally-representative surveillance systems. The three most widely-used such datasets are the NSDUH (SAMHSA, 2014), Monitoring the Future (MTF; Johnston et al., 2014), and the National Youth Risk Behavior Survey (YRBS; Kann et al., 2014). Although direct comparisons are difficult to make given differences in the methodology of the three systems, taken together the data demonstrate that adolescent marijuana use was highest in the 1970s, declined throughout the 1980s and was lowest in 1992, and has remained somewhat stable over the past 20 years (Johnston et al., 2014; Kann et al., 2014; Lanza et al., 2015; Schulden et al., 2009; SAMHSA, 2014). MTF data show that 51% of twelfth graders reported past 12-month use of marijuana use in 1979, compared to 22% in 1992 (Johnston et al., 2014). Although adolescent marijuana use has increased since the early 1990s, the prevalence of use has not reached the peak levels seen in the 1970s (Johnston et al., 2014; Kann et al., 2014; Lanza et al., 2015; Schulden et al., 2009).

The goal of this article is to investigate trends in adolescent marijuana use since 1999. Data are from the national YRBS; which is a biennial, school-based survey that generates nationally-representative estimates about health and risk behaviors, including substance use, among high school students (Kann et al., 2014). First, we examine the prevalence and trends in adolescent marijuana use for the past 15 years overall, and by race/ethnicity and sex. We examine lifetime use, past 30-day use, early use (i.e., any use before age 13), and frequent use (i.e., three or more instances of use over the past 30 days). Second, we examined the lifetime prevalence of seven additional substances (i.e., alcohol, tobacco, cocaine, ecstasy, methamphetamine, heroin, and hallucinogens) to evaluate how observed trends in adolescent marijuana use compare to those for other drugs of abuse. Third, we examine whether there were sex differences in past 30-day marijuana use within each race/ethnicity group.

We selected to use data from the National YRBS rather than from other, nationally-representative and methodologically-rigorous datasets for two reasons. First, because it is administered in schools (vs. in the home), youth are less likely to underreport marijuana use (Kann et al., 2002; SAMHSA, 2012). Second, because 9^{th}-12^{th} graders are surveyed, grade-pooled estimates represent students in US high school students as a whole, versus just specific grades. Thus, the results we present can be used to summarize the prevalence of marijuana use in US high schools.

2. METHODS

2.1. National Youth Risk Behavior Survey (YRBS)

The YRBS was initiated by the Centers for Disease Control and Prevention [CDC] in 1990 to monitor the incidence and prevalence of priority health risk behaviors among adolescents in the US (Kann et al., 2014). The CDC uses a three-stage, cluster random sampling design to obtain the YRBS samples. All 50 US states and the District of Columbia are invited to

participate. The primary sampling unit [PSU] consists of counties or analogous geographic units, and the secondary sampling unit [SSU] consists of schools. Both PSUs and SSUs have a probability of selection that is proportional to their population size. The third sampling unit consists of classrooms (1-2 for each grade level), and all students within selected classrooms are invited to participate. Additional selection strategies are used to oversample Black and Hispanic students (Brener et al., 2013; Kann et al., 2014). Participants complete self-administered, machine-readable questionnaires during a regular class period. Participation is confidential, voluntary, and approved by parents. Overall response rates from 1999-2013 ranged from 63-71% (Brener et al., 2013).

2.2. Measures

Students are asked about sex (male, female) and race/ethnicity (Hispanic, any race; non-Hispanic American Indian/Alaska Native; non-Hispanic Asian; non-Hispanic Black; non-Hispanic Native Hawaiian or other Pacific Islander; non-Hispanic White; and non-Hispanic Multi-Racial).

The YRBS inquires about any lifetime cigarette use, as well as about the frequency of lifetime use of: marijuana, alcohol, cocaine (any form), heroin, hallucinogens, ecstasy, and methamphetamine. (Hallucinogens were described to respondents as including LSD, “acid”, PCP, “angel dust”, mescaline, and mushrooms.) The items are worded as follows: “During your life, how many times have you used marijuana?”; and there are seven response options (i.e., never, 1-2 times, 3-9 times, 10-19 times, 20-39 times, 40-99 times, and 100 times or greater). For all eight substances, those who responded affirmatively to any use were classified as reporting lifetime use. We created an additional lifetime use variable for marijuana, which we termed “repeated lifetime use.” This variable was derived from the lifetime use variable, and represented those who reported having used marijuana at least 3-9 times throughout their lifetimes.

The YRBS item on past 30-day marijuana use is phrased as follows: “During the past 30 days, how many times did you use marijuana?”; and there are 6 response options (i.e., never, 1-2 times, 3-9 times, 10-19 times, 20-39 times, and 40 times or greater). We used data from this question to develop three additional variables representing: (1) *current use* (i.e., any past 30-day use); (2) *repeated past 30-day use* (i.e., reported use at least 3-9 times in the past 30 days); and (3) *frequent use* (i.e., reported use at least 20-39 times in the past 30 days).

Finally, there is one YRBS item on age at first marijuana use (i.e., “How old were you when you tried marijuana for the first time?”), with the following response options: Never used, ≤8 years old, 9-10 years old, 11-12 years old, 13-14 years old, 15-16 years old, or aged 17 years or older. We created a binary variable reflecting *early use*, i.e., whether marijuana had been used for the first time before age 13 (i.e., reported age of first use at ≤8 years, 9-10 year or 11-12 years).

2.3. Analyses

We used YRBS data for the years 1999-2013, for the US and the District of Columbia. There were 117,540 respondents in the full YRBS sample. We excluded 2,161 respondents

due to missing data on sex, race/ethnicity, or substance use, resulting in a final analytic sample of 115,379. The sample was evenly split by sex, and 42% were White, 22% were Black, 27% were Hispanic, 3% each were Asian and Multi-Racial, and 1% each were Native Hawaiian/Pacific Islander and American Indian/Alaska Native. We obtained the YRBS data from a public use dataset, and received an exemption from review by the Boston University School of Public Health IRB.

We conducted three series of analyses to generate national estimates of the prevalence of substance use and 95% confidence intervals (CIs). Estimates were calculated for the entire time period (i.e., from 1999-2013 combined) and for each year of data independently. Additionally, estimates were calculated for the full sample and for girls and boys separately. In sex-stratified analyses, we used Chi-square tests to assess whether sex differences were statistically significant. In instances in which the 95% confidence intervals overlapped, but the *p* value was less than 0.05, we report the finding as statistically significant (Mulla and Cole, 2004). In the three series of analyses we calculated prevalence estimates and confidence intervals for:

(1) marijuana use variables (i.e., lifetime use, repeated lifetime use, current use, repeated past 30-day use, frequent use, and early use);

(2) lifetime use of additional substances (i.e., alcohol, cigarettes, hallucinogens, ecstasy, methamphetamine, cocaine, and heroin); and

(3) current marijuana use for each race/ethnicity group.

For all of the analyses described above, we used logistic regression models to test the statistical significance of linear and quadratic trends. The purpose of these analyses was to characterize changes in substance use over time. A statistically significant linear trend suggests that there is a consistent increase or decrease over the time period. A statistically significant quadratic trend suggests that there was a change in direction over time, i.e., that there was an increase followed by a decrease or vice versa (CDC, 2014). For the linear trend analysis, we estimated the log odds of each substance use behavior as a function of time, with time treated as a continuous covariate (i.e., 1999 was recoded as 1, 2001 was recoded as 3, and so on). For the quadratic trends analysis, we squared the value representing time and added it to the regression model.

As prescribed by the CDC, we used sampling weights to account for nonresponse and differences in sampling probabilities (Brener et al., 2013). The weights were scaled so that the weighted count of students was equal to the total sample size, and so that the weighted proportions of students in each grade matched national population proportions. All analyses were performed using the complex survey procedures in SUDAAN software package, version 10.0.1.

3. RESULTS

3.1. Trends in Marijuana Use Among US High School Students, 1999-2013

Table 1 presents national estimates of the percentage of 9^{th}-12^{th} graders who report marijuana use, and the first column shows the prevalence of lifetime use. Over the 15-year

time period, 40.5% reported lifetime marijuana use. The annual prevalence of lifetime use decreased over time (test for linear trend: β=−0.10, $p<0.001$). It was 47.2% in 1999, hit its lowest level for the time period in 2009 (36.8%), and then increased to 40.7% by 2013. The increase from 2009-2013 is not statistically significant. Although modest in magnitude, tests to assess for a quadratic trend were statistically significant, suggesting that there was a decline followed by an increase in prevalence over time (β<0.01, $p<0.001$).

Fig. 1 shows national estimates of the prevalence of lifetime marijuana use, stratified by sex. There was a statistically significant downward linear trend in prevalence from 1999-2013 for both boys (β=−0.10, $p<0.001$) and girls (β=−0.09, $p<0.001$). The annual prevalence of use was higher for boys than girls for all years, although the gap between the sexes decreased over time. This resulted from boys having a steeper decline in use than girls over the time period. In 1999, 51.0% of boys and 43.4% of girls reported lifetime marijuana use, and by 2013 42.1% of boys and 39.2% of girls reported lifetime use. The male-female difference in 2013 was just 2.9 percentage points, the lowest throughout the time period.

As shown in the second column of Table 1, the shape of the trend for repeated lifetime use (i.e., having used ≥3 times) is similar to the shape for lifetime use. The 2009-2013 prevalence of repeated lifetime use (31.8%) suggests that the high prevalence of lifetime use (40.5%) is not due to a large proportion of youth being “experimental” users (i.e., having used just 1-2 times over their lifetime). In fact, more than three-quarters of the lifetime users were repeated lifetime users.

The final four columns in Table 1 include estimates of the percentage of youth reporting current use (i.e., any past 30-day use), repeated past 30-day use (i.e., used ≥3 times in the past 30 days), frequent use (i.e., used ≥20 times in the past 30 days), and early use (i.e., any use before age 13). From 1999-2013, 22.5% reported current use, 15% reported repeated past 30-day use, 6.7% reported frequent use, and 9.1% reported early use. As with repeated lifetime use, the shape of the trend for these four variables was similar to the shape of the trend for lifetime use. Specifically, there was a statistically significant downward linear trend for all four; βs ranged from −0.08 through −0.11. Additionally, all had modest but statistically significant quadratic trends (i.e., the β coefficients were ≤0.01).

3.2. Comparison with Trends in Lifetime Use of Other Drugs

The trend in annual prevalence for lifetime marijuana use was consistent with a general decline in lifetime use of other drugs over the time period (Table 2). Statistically significant linear decreases from 1999 to 2013 were observed for cigarettes (70.4%-41.1%), hallucinogens (13.3%-7.1%), ecstasy (11.1%-7.9%), methamphetamine (9.1%-6.0%), and cocaine (9.5%-5.5%). Although the lifetime prevalence of alcohol and heroin use also decreased over the time period (81%-66.2% for alcohol, 2.4%-2.2% for heroin), the decreases were not statistically significant. As was the observed trend for marijuana use variables, the results to test for a quadratic trend were statistically significant for hallucinogens, ecstasy, and cocaine (all β coefficients were ≤0.02), representing a small increase in use since 2007 for hallucinogens and ecstasy, and since 2009 for cocaine.

3.3. Trends in Marijuana Use by Race/Ethnicity

National estimates of the prevalence of current marijuana use from 1999-2013 combined, by race and sex, are presented in Table 3. The highest prevalence of use was among American Indian/Alaska Natives (34.6%), and the lowest was among Asians (10.8%). The prevalence of current use for the additional race/ethnic groups ranged from 22% to 26.4%. Within all race/ethnicity groups except Asian and Native Hawaiian, boys had a significantly higher prevalence of current marijuana use than girls. Male-female differences were largest among American Indian/Alaska Natives (41.0% vs. 26.9%, $p<0.001$) and Blacks (27.8% vs. 19.9%, $p<0.001$).

National estimates of current marijuana use by race/ethnicity, sex, and year are shown graphically in Fig. 2 and accompanying data are also available (see supplemental table[1]). (Due to sparse data, Fig. 2 does not include trends for the following groups: American Indian/ Alaska Native, Multi-Racial, and Native Hawaiian/Pacific Islander.) As with the population overall, most race/ethnicity groups had a statistically significant downward linear trend in the prevalence of current marijuana use from 1999 to 2013. The exceptions were American Indians and Native Hawaiians, and the lack of statistical significance for those groups was likely due to limited power. In 1999, the prevalence of current marijuana use for six of the seven racial/ethnic groups exceeded 25% (Asians were the exception). By 2013, four of the seven racial/ethnic groups had a prevalence of current marijuana that exceeded 25%: Blacks (29%), Hispanics (28%), American Indians (36%) and Multi-Racial youth (29%). Although the test to assess a quadratic trend was statistically significant for all groups except American Indians and Native Hawaiians, the β coefficients were modest (0.01-0.02), suggesting that any increase in current use is small.

The magnitude of the sex differences in current marijuana use have decreased over the time period for each race/ethnicity group. As an example, the male-female difference in current marijuana use among Hispanics was 13.1 percentage points in 1999, and had decreased to 0.2 percentage points by 2013. In 2013, Whites were the only race/ethnic group in which boys had a significant higher prevalence of current marijuana use than girls.

4. DISCUSSION

The purpose of this study was to examine past 15-year trends in adolescent marijuana use among US high school students. We examined the prevalence of lifetime and past 30-day marijuana use from 1999-2013, overall and by sex, race/ethnicity, and year. Our rationale was that describing patterns of adolescent marijuana use will contribute to our understanding of how changes in marijuana legislation may impact future use. This is particularly important given how quickly state marijuana policies are changing.

4.1. Summary of Findings

4.1.1. Prevalence of Substance Use—Over the time period, 40.5% of US high school students reported lifetime marijuana use, and the majority reported having used marijuana

[1]Supplementary material can be found by accessing the online version of this paper at http://dx.doi.org and by entering doi:...

three or more times. The prevalence of lifetime use decreased significantly over time, from 47.2% in 1999 to 40.7% in 2013. This finding is consistent with existing literature, as rates of lifetime marijuana use among adolescents have been declining since the mid-1990s (CDC, 2011; Johnston et al., 2014; Lanza et al., 2015). Notably, the observed decline was not entirely steady, as the prevalence of lifetime use was lowest in 2009 (36.8%). Because the increase since then is not statistically significant, it is unclear whether observed increases in annual lifetime marijuana use since 2009 are atypical observations, or early indicators that the decline in use has reversed course. Continued research to monitor the trends in marijuana use is warranted, and information should be used to inform decisions about marijuana policy.

From 1999-2013, 22.5% of US high school students reported past 30-day use, 6.7% reported having used ≥20 times in the past 30 days, and 9.1% reported any use before age 13. The shape of the trend for these three marijuana use variables was similar to the observed trend for lifetime marijuana use. Specifically, all had statistically significant declines over the time period, and the lowest observed prevalence estimates were in 2009. We also found a similarly-shaped trend for lifetime use of hallucinogens, ecstasy, and cocaine. Therefore, these results may reflect a recent increase in adolescent use of illicit drugs overall, rather than an increase unique to marijuana that could be attributable to loosening of restrictions.

There are two caveats to this conclusion drawn above. First, we did not examine trends in use of commonly misused substances, such as inhalants, prescription drugs, or over-the-counter drugs, which may be comparable to marijuana use patterns. Such a comparison should be conducted in the future. Second, the prevalence of marijuana as compared to alcohol and cigarette use from 2009-2013 suggests that distinct patterns of use may be emerging. From 2009-2013, cigarette smoking decreased from 46.3%-41.1% and alcohol use decreased from 72.5%-66.2%. By contrast, marijuana use increased from 36.8%-40.7%. Thus, we may be observing a trend toward decreased use of alcohol and tobacco by adolescents coupled with an increase in marijuana use. A similar pattern was noted by Lanza et al. (2015) in their analysis of substance use among high school seniors from 1976-2013. They note that sustained decreases in cigarette and alcohol use are likely attributable to targeted public health interventions aimed at reducing use of these substances (e.g., enforcement of underage drinking laws, tax increases, prevention programs). Given the current trend toward loosening restrictions on marijuana, it may be important to comprehensively modify public health strategies for adolescent marijuana use prevention. Novel marijuana use prevention programs may include: teaching youth to resist or think critically about advertisements for marijuana, as well as clarifying misperceptions about medical benefits and harms (D'Amico et al., 2015).

4.1.2. Sex Differences in Marijuana Use—Although historically boys have had a higher prevalence of lifetime and past 30-day marijuana use, we observed that sex differences have substantially decreased over time. The gender gap in marijuana use is quickly becoming nonexistent. These results are consistent with national studies (Johnston et al., 2014; Palmer et al., 2009; SAMHSA, 2014). Notably, Johnston et al. (2014) observed that male-female differences in use of marijuana and other drugs narrow during periods of

decline, and increase during periods with higher levels of substance use. Thus, the small gender differences we observed may be a reflection of low levels of marijuana use.

An alternative explanation for decreasing sex differences in marijuana use is that boys are more likely than girls to have an offer or opportunity to use marijuana, and an opportunity to use is a critical step in initiating drug use. Research suggests that girls are just as likely as boys to use marijuana in response to an offer to use (Van Etten and Anthony, 1999; Van Etten et al., 1999). Given that girls and boys are more likely to be in friendship groups that include both sexes than in the past, the increase in girls' use may be due to an increase in offers to use from male friends (Goncy and Mrug, 2013).

The narrowing of the gender gap in marijuana use has implications for the prevalence of cannabis use disorder [CUD] and treatment services. Approximately 9% of those who use marijuana will develop a CUD, and the likelihood increases for those who start in adolescence (Haberstick et al., 2014; Hall and Degenhardt, 2009). A cross-sectional study about marijuana use among high school students in Connecticut showed that girls experience a quicker transition than boys from initiation to regular use, which may increase their risk for a CUD (Schepis et al., 2011). In future years, demands for substance abuse treatment programs for girls and women may increase, and so efforts to modify services to make them more responsive to the complex psychosocial needs of women are warranted (Greenfield et al., 2007).

4.1.3. Race/Ethnicity Differences in Marijuana Use—In 2013, the prevalence of current marijuana use among Black, Hispanic, American Indian/Alaska Native, and Multi-Racial youth exceeded 25%, whereas the prevalence of use was lower among Whites (22%) and Asians (11%). These findings are worth reviewing with a historical lens. From the late 1970s through the early 1990s, White high school students had higher levels of marijuana use than Blacks (Johnston et al., 2014). The Black-White gap in marijuana use narrowed substantially during an increase in marijuana use during the late 1990s and early 2000s. Some have attributed to the increased popularity of marijuana use among Blacks in that time period to "blunt" use, i.e., rolling marijuana within a cigar shell and smoking it (Golub et al., 2006). The year 2013 marks the first time that the prevalence of current marijuana use for Blacks is significantly higher than that of Whites (29% vs. 20%). High levels of marijuana use among Blacks, Hispanics, and American Indians deserve public health attention because these groups are more likely than Whites to experience negative consequences of marijuana use, including CUDs and arrests (ACLU, 2013; Compton et al., 2004; Stinson et al., 2006). Therefore, there is concern that adolescent marijuana use could exacerbate racial disparities in health.

4.2. Limitations

Results should be viewed within the context of important limitations. First, YRBS data are self-reported and respondents may misreport their marijuana use. Importantly, CDC and YRBS administrators have undertaken several strategies to reduce reporting bias, including having instructions that emphasize the confidential nature of answers (Brener et al., 2013).

The lack of parental proximity during school-based survey administration likely promotes more accurate reporting of illegal drug use by youth (Kann et al., 2002; SAMHSA, 2012).

Additional limitations relate to representativeness and generalizability. Response rates for the YRBS are in the acceptable range (63-71%) and can be considered to be nationally representative. However, the YRBS is completed by youth who currently attend school, and is therefore not representative of those who have stopped going. Relevantly, 95% of 16-17 year olds attend school (Chapman et al., 2011), so the group that is not represented is small. However, because youth who leave school permanently or skip school on the day of the survey are more likely to engage in substance use, additional analysis from non-school-based samples are needed to supplement these results (Bray et al., 2000; CDC, 1994; Roebuck et al., 2004). Although levels of marijuana use were high among American Indian/Alaska Natives and Native Hawaiian/Pacific Islanders, there were too few cases of current use to produce reliable estimates by year and sex. Oversampling of these groups may be warranted, as it would enable researchers to more fully understand patterns of marijuana use in these groups.

Finally, the trend analyses were not adjusted for potential confounders that may relate to changing demographics and socioeconomic compositions, policy enactment and implementation at the state level, and other factors that may have led to changes in marijuana use during the study period. Nevertheless, the observed trends provide an empirical basis to explore the temporal association between adolescent marijuana use and these potential sociocontextual determinants.

4.3. Conclusions

In this article, we have described trends in adolescent marijuana use since 1999, a time of significant policy change regarding marijuana. Not surprisingly, we found that use is common. From 1999-2013, more than one-fifth of high school students reported past 30-day use, and 41% reported lifetime use. Although there have been statistically significant declines in use since 1999, more recent data indicate that use may be on the rise. Continued monitoring is needed to assess whether the recent increase in the prevalence of use reflects a trend toward increasing use or random fluctuation. Additionally, carefully-designed research to examine how changes in state-level policies impact youth in that state are also warranted.

Although data for this study come from the US, it is worth noting similarities and differences in marijuana policy in other countries. Compared to the US, other countries have focused less on making marijuana available for medical purposes and more on decriminalization. The Netherlands has had a long history of marijuana decriminalization and de-facto legalization of sales within Dutch coffee shops since the late 1970s; although use, cultivation, and sales of marijuana are not technically legal (Korf, 2002; MacCoun and Reuter, 1997). Italy, Spain, and Portugal likewise decriminalized marijuana, but use remains an arrestable offense (albeit resulting in sanctions or treatment), while sales and production have been kept illegal (Reuter, 2010). Drawing conclusions about the impact of decriminalization on marijuana use in these countries has been elusive due to a lack of data from rigorous, peer-reviewed studies, although some have argued there was a reduction in use following policy changes in of Portugal (Greenwald, 2009). Uruguay is the only other

nation to legalize marijuana. However, production and sales of marijuana must go through the government with the exception of limited personal cultivation, and implementation of the policy has had challenges (Bernas and Lavoix, 2015). Therefore, for the time being, the US may remain the crucible for studying the impacts of changing marijuana policy on trends in consumption.

Despite 15 years of rapid changes of marijuana policy, we did not find a statistically significant increase in adolescent marijuana use from 1999-2013. However, there was a modest, but not statistically significant increase in the prevalence of use from 2009-2013. So, although our results do not suggest that the rapid pace of change to state-level marijuana policies has resulted in immediate and drastic increases in adolescent use, continued monitoring is necessary to observe how trends change over a longer period of time. As our nation continues to enact new marijuana policies, it will be important to track patterns of use and to identify innovative strategies to prevent adolescent marijuana use and related harms. It is particularly important to focus on vulnerable populations, including girls, Blacks, Hispanics, and American Indians. What is learned can be used to inform policy and program development in the US and beyond.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Male-female differences in adolescent marijuana use have decreased since 1999
- Despite considerable changes to the legal status of marijuana in the US over the past 15 years, marijuana use among high school students has largely declined.
- The prevalence of marijuana use among Black adolescents has been historically lower than for Whites. In 2013, the pattern reversed.

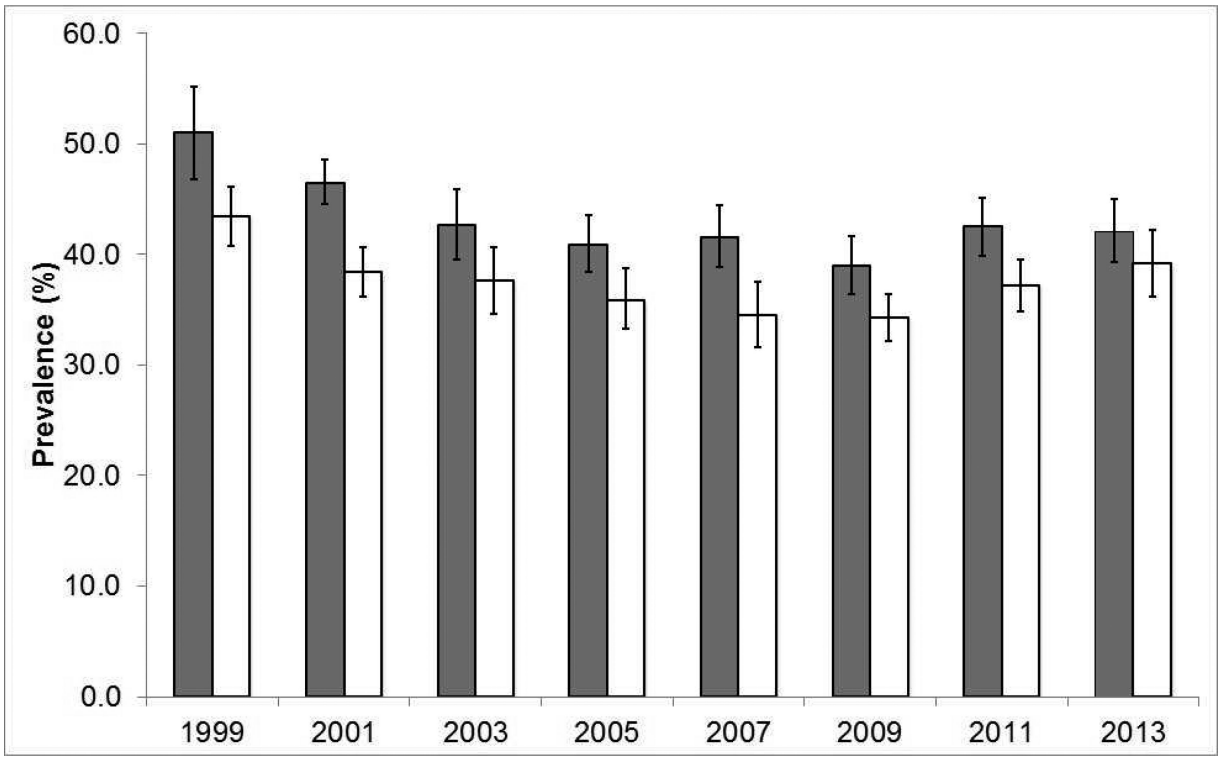
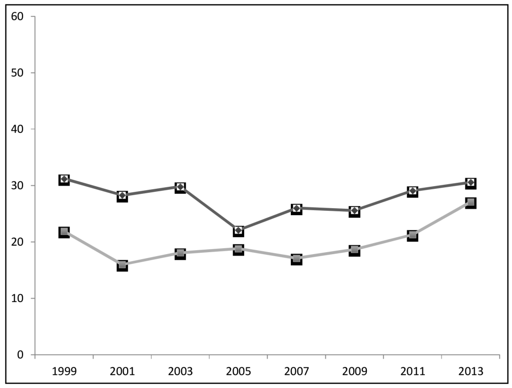
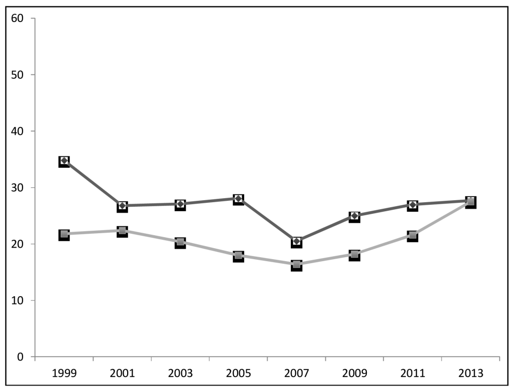
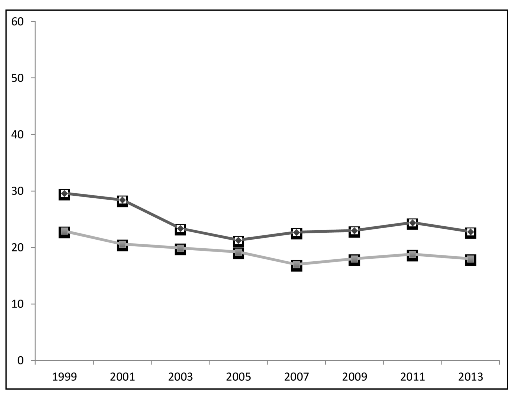


Fig. 1.

National estimate of the percentage (and 95% confidence interval) of lifetime marijuana use among high school students, by year – National Youth Risk Behavior Surveillance Survey, 1999-2013, United States







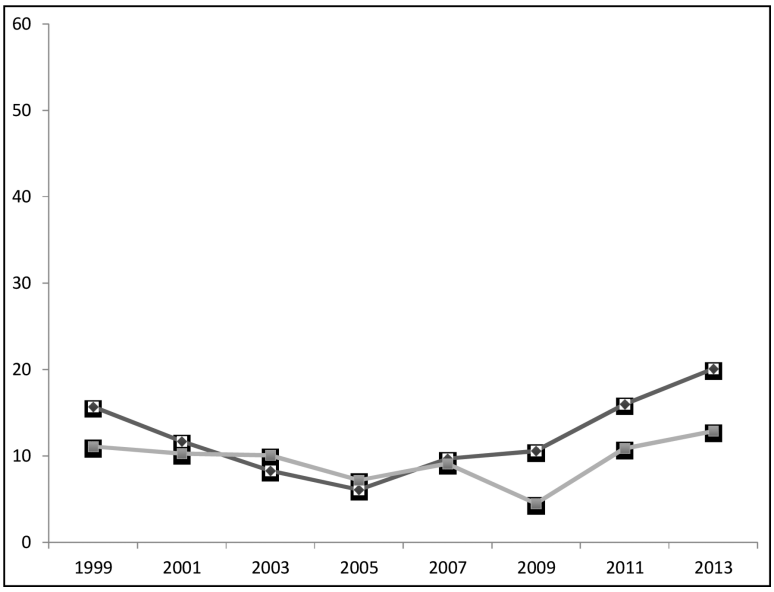


Fig. 2.

National estimate of the percentage of high school students reported current marijuana use, by race, sex, and year – National Youth Risk Behavior Surveillance Survey, 1999-2013, United States

Table 1

National estimate of the percentage (and 95% confidence interval) of marijuana use among high school students, by year – National Youth Risk Behavior Survey, United States, 1999-2013

	Any Lifetime Use	Repeated Lifetime Use	Current Use	Repeated Past 30-Day Use	Frequent Use	Early Use
1999	47.2 (44.4, 50.1)	37.7 (35.0, 40.4)	26.7 (24.2, 29.3)	17.7 (16.0, 19.6)	7.9 (6.7, 9.2)	11.3 (9.6, 13.2)
2001	42.4 (40.5, 44.3)	33.7 (31.9, 35.7)	23.9 (22.4, 25.5)	16.2 (14.7, 17.8)	7.4 (6.3, 8.6)	10.2 (9.1, 11.5)
2003	40.2 (37.4, 43.2)	31.5 (29.1, 34.1)	22.4 (20.2, 24.7)	15.1 (13.3, 17.1)	6.9 (5.9, 8.0)	9.9 (8.7, 11.3)
2005	38.5 (36.1, 40.9)	29.8 (27.6, 32.2)	20.2 (18.6, 22.0)	13.1 (11.8, 14.4)	5.9 (5.2, 6.7)	8.7 (7.8, 9.6)
2007	38.1 (35.5, 40.8)	28.8 (26.4, 31.3)	19.7 (17.9, 21.7)	12.4 (11.0, 14.0)	5.4 (4.6, 6.3)	8.3 (7.0, 9.7)
2009	36.8 (34.8, 38.8)	28.5 (26.8, 30.3)	20.8 (19.5, 22.3)	13.6 (12.5, 14.7)	5.7 (5.2, 6.4)	7.5 (6.7, 8.4)
2011	39.9 (37.9, 42.0)	32.2 (30.5, 33.9)	23.1 (21.6, 24.6)	15.7 (14.6, 16.9)	7.2 (6.5, 8.0)	8.1 (7.3, 9.0)
2013	40.7 (37.9, 43.4)	32.0 (29.6, 34.6)	23.4 (21.4, 25.6)	16.3 (14.5, 18.2)	7.4 (6.6, 8.3)	8.6 (7.5, 10.0)
All Years	40.5 (39.5, 41.4)	31.8 (31.0, 32.6)	22.5 (21.8, 23.3)	15.0 (14.5, 15.6)	6.7 (6.4, 7.1)	9.1 (8.6, 9.5)
Trend						
Linear	β=−0.10, p<0.001	β=−0.10, p<0.001	β=−0.10, p<0.001	β=−0.11, p<0.001	β=−0.10, p<0.001	β=−0.08, p=0.002
Quadratic	β<0.01, p<0.001	β=0.00, p<0.001	β=0.01, p<0.001	β=0.01, p<0.001	β=0.01, p<0.001	β=0.00, p=0.039

Note. Repeated Lifetime Use = Used ≥3 times during lifetime; Current Use = Any past 30-day use; Repeated Past 30-Day Use = Used ≥3 times in the past 30 days; Frequent Use = Used ≥20 times in the past 30 days; Early use = Any use before age 13.

Table 2

National estimate of the percentage (and 95% confidence interval) of high school students reporting lifetime use of selected substances, by year – National Youth Risk Behavior Survey, United States, 1999-2013

	Alcohol	Cigarettes	Hallucinogens	Ecstasy	Metham-phetamine	Cocaine	Heroin
1999	81.0 (79.1,82.8)	70.4 (67.3,73.3)	N/A	N/A	9.1 (7.7,10.8)	9.5 (8.2,11.1)	2.4 (1.9,3.1)
2001	78.2 (76.5,79.8)	63.9 (61.7,66.0)	13.3 (11.7,15.1)	11.1 (9.9,12.5)	9.8 (8.3,11.5)	9.4 (8.3,10.7)	3.1 (2.7,3.6)
2003	74.9 (72.2,77.6)	58.4 (55.3,61.4)	10.6 (8.8,12.7)	11.1 (8.1,15.1)	7.6 (6.7,8.7)	4.1 (3.4,5.1)	3.3 (2.7,4.0)
2005	74.3 (71.2,77.2)	54.3 (51.3,57.3)	8.5 (7.5,9.7)	6.3 (5.4,7.3)	6.2 (5.3,7.2)	3.4 (2.8,4.1)	2.4 (2.0,2.8)
2007	75.0 (72.5,77.3)	50.3 (46.8,53.9)	7.8 (6.7,9.0)	5.8 (5.1,6.6)	4.4 (3.6,5.3)	3.3 (2.8,3.8)	2.3 (1.8,2.8)
2009	72.5 (70.5,74.4)	46.3 (43.5,49.1)	8.0 (7.1,9.0)	6.7 (5.8,7.6)	4.1 (3.6,4.6)	2.8 (2.4,3.2)	2.5 (2.2,2.9)
2011	66.7 (65.0,68.5)	44.7 (42.0,47.5)	8.7 (7.8,9.5)	8.2 (7.3,9.3)	3.8 (3.4,4.3)	6.8 (6.2,7.6)	2.9 (2.5,3.4)
2013	66.2 (63.6,68.6)	41.1 (38.2,44.1)	7.1 (6.0,8.5)	6.6 (5.6,7.7)	3.2 (2.6,4.0)	5.5 (4.6,6.7)	2.2 (1.7,2.8)
Total	73.5 (72.5,74.4)	53.8 (52.4,55.1)	9.1 (8.6,9.6)	7.9 (7.3,8.6)	6.0 (5.7,6.4)	5.6 (5.3,6.0)	2.6 (2.5,2.8)
Linear	β=−0.04 (p=0.065)	β =−0.14 (p<0.001)	β =−0.17 (p<0.001)	β =−0.24 (p<0.001)	β =−0.08 (p=0.007)	β =−0.33 (p<0.001)	β<0.01 (p=0.953)
Quadratic	β<0.01 (p=0.513)	β<0.01 (p=0.011)	β=0.01 (p=0.001)	β=0.01 (p<0.001)	β<0.01 (p=0.634)	β=0.02 (p<0.001)	β<0.01 (p=0.501)

Note. Data not available for hallucinogens and ecstasy for 1999.

Table 3

National estimate of the percentage (and 95% confidence interval) of current marijuana use among high school students, by sex and race/ethnicity – National Youth Risk Behavior Survey, United States, 1999-2013

	Total	Male	Female	Male-Female Difference	Chi-Square (*p* value)
Black	23.8 (22.4, 25.2)	27.8 (26.0, 29.7)	19.9 (18.5, 21.4)	7.9	71.0 ($p<0.001$)
White	22.0 (21.2, 22.9)	24.5 (23.5, 25.6)	19.4 (18.4, 20.3)	5.2	78.7 ($p<0.001$)
Hispanic	23.8 (22.8, 24.9)	26.8 (25.5, 28.1)	20.9 (19.7, 22.1)	5.9	51.9 ($p<0.001$)
Asian	10.8 (9.2, 12.7)	12.0 (9.7, 14.8)	9.4 (7.6, 11.5)	2.7	3.3 ($p=0.069$)
American Indian/Alaska Native	34.6 (30.2, 39.2)	41.0 (35.0, 47.3)	26.9 (22.1, 32.3)	14.1	12.4 ($p<0.001$)
Multi-Racial	26.4 (23.7, 29.3)	29.5 (25.3, 34.1)	23.8 (20.6, 27.3)	5.7	4.2 ($p=0.042$)
Native Hawaiian/Pacific Islander	25.5 (21.4, 30.0)	28.6 (23.1, 34.8)	22.2 (16.7, 28.7)	6.5	2.3 ($p=0.127$)