HHS Public Access

Author manuscript

Am J Drug Alcohol Abuse. Author manuscript; available in PMC 2020 March 14.

Published in final edited form as:

Am J Drug Alcohol Abuse. 2019 ; 45(6): 623–643. doi:10.1080/00952990.2019.1569668.

Time trends in U.S. cannabis use and cannabis use disorders overall and by sociodemographic subgroups: a narrative review and new findings

Deborah S. Hasin[1,2,3], **Dvora Shmulewitz**[1,2], **Aaron L. Sarvet**[2,4]

[1]Department of Psychiatry, Columbia University Medical Center, Columbia University, New York, NY, USA

[2]New York State Psychiatric Institute, New York, NY, USA

[3]Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY, USA

[4]Department of Epidemiology, T. H. Chan Harvard School of Public Health, Harvard University, Boston, MA, USA

Abstract

Background.—Due to significant comorbidity and impairment associated with cannabis use and cannabis use disorder, understanding time trends in cannabis use and cannabis use disorder is an important public health priority.

Objectives.—To identify trends in cannabis use and cannabis use disorder overall, and by sociodemographic subgroup.

Methods.—Narrative review of published findings on trends in cannabis use and cannabis use disorders in data from repeated cross-sectional US general population surveys. In addition, in National Epidemiologic Survey on Alcohol and Related Conditions (NESARC; 2002–2002) and NESARC-III (2012–2013) data, logistic regression was used to examine whether trends differed between subgroups of adults.

Results.—The review showed that in adults, cannabis use increased over the past decade overall and within sociodemographic subgroups (gender, age, race/ethnicity, income, education, marital status, urbanicity, region, pregnancy status, disability status), with greater increases in men and disabled adults. Most sources also indicated significant increases in cannabis use disorders. New analysis showed significantly greater increases in adult cannabis use and cannabis use disorder in men ($p \leq .0001$); young adults ($p < .05$); Blacks (vs. Whites, $p < .01$); low income groups ($p < .001$); never-married $p \leq .0001$), and urban residents ($p < .05$). In adolescents, cannabis use generally decreased, although recent increases were observed in older and non-White adolescents.

Conclusion.—Cannabis use and cannabis use disorder are increasing in adults, with specific sociodemographic groups at higher risk, and may be increasing in some adolescent subgroups.

Correspondence: Deborah Hasin, Ph.D. Columbia University/New York State Psychiatric Institute, 1051 Riverside Drive, Box 123, New York, NY 10032, Phone: 646-774-7909, Fax: 212-543-5913, dsh2@cumc.columbia.edu, deborah.hasin@gmail.com.

Studies should determine mechanisms for differential trends to provide information to policy makers and enable informed decisions on cannabis legalization and service planning.

Keywords

cannabis use; cannabis use disorder; general population; trends; sociodemographic groups

Introduction

Cannabis is one of the substances most widely used non-medically in the United States (1–6). While some individuals can use cannabis without harm, others experience acute cognitive/motor impairments (7, 8), a withdrawal syndrome (9), respiratory symptoms (10), vehicle crashes (11–19), other acute symptoms requiring emergency room visits (20–22) and cannabis use disorder (23, 24). Cannabis use disorder is also associated with significant comorbidity and impairments (24). Therefore, understanding time trends in cannabis use and cannabis use disorder is an important public health priority. Cross-sectional studies show that sociodemographic subgroups such as men, younger adults, and those with lower education or income have a higher prevalence of cannabis use and cannabis use disorder (2, 4, 6, 25) than other groups. However, such studies do not provide information on whether time trends in cannabis use and cannabis use disorder are similar or different across these demographic subgroups. Such information is needed to determine if particular groups are becoming more vulnerable over time. Other reviews on the epidemiology of cannabis use and associated problems have been published recently (26, 27). However, none focused specifically on cannabis use and cannabis use disorder, and on U.S. time trends by demographic subgroups. We therefore conducted a comprehensive review of time trends in cannabis use and cannabis use disorder, overall and by demographic subgroups, utilizing studies using nationally representative United States (US) general population survey data. We had two goals for this review.

Our first goal was to provide a narrative review summarizing national time trends in US non-medical cannabis use and cannabis use disorder since the 1990s, overall and by sociodemographic groups: age, gender, race/ethnicity, education, marital status, income, urbanicity, and region. The review thus focuses on published data from series of nationally representative US surveys. Specifically, we sought to determine if non-medical cannabis use and cannabis use disorder had increased overall and within demographic subgroups in the last two decades. Adults and adolescents are considered separately because their overall patterns differ (26–28). For cannabis use disorder, time trends from other sources of national information, e.g., US inpatient databases, are also considered, due to some inconsistencies in nationally representative surveys.

Additionally, trends in special sub-populations with specific vulnerabilities (pregnant women, older individuals, and disabled adults) are also summarized. Understanding trends in cannabis use among pregnant women is important because although prenatal cannabis exposure may harm the fetus (26, 29), commentaries and news stories suggest that women increasingly consider cannabis safe to use during pregnancy (29, 30). Older adults are more vulnerable than others to chronic conditions/diseases and impaired cognitive and physical

functioning, and thus may face increased risks from cannabis use. Similarly, people with disabilities already have impaired functionality, which may be further affected by cannabis use, or may be using cannabis to treat conditions associated with their disability.

Many of the papers on trends from nationally representative surveys that included information on demographic subgroups evaluated change over time within subgroups, but did not test for differences in these trends between the subgroups. Our second goal was therefore to provide new information on whether changes in the prevalence of adult non-medical cannabis use and cannabis use disorder between 2001–2002 and 2012–2013 differed significantly by demographic subgroup (e.g., men vs. women; low vs. high income) by testing whether the changes differed significantly between the groups.

Methods

To accomplish the two goals of this review, we used nationally representative survey data on adults and adolescents. For the first goal, the narrative review portion of this paper covered published or publicly available national findings on adults and adolescents. Data were available from five series of nationally representative surveys, described below. For the second goal, we conducted new analyses of data from one of the adult sets of surveys, specifically testing whether changes in the prevalence of cannabis use and cannabis use disorder within demographic subgroups differed over time.

Peer-reviewed and other publicly available findings

To accomplish the first goal, we included peer-reviewed papers published since 2000 that reported on sets of nationally representative cross-sectional general population surveys conducted repeatedly across years. These are large studies with consistent sample designs and measures across years, providing data that could be concatenated to evaluate time trends. We also included information from online reports from these surveys when they included information not otherwise available. Table 1 shows the five survey series that were included. These are widely known in the substance abuse epidemiology area, as indicated by their inclusion in previous reviews of cannabis in the US (26, 27). To identify papers from those surveys, we examined the references cited in the previous reviews, checked Scopus for each relevant paper to see if any newer papers on US demographic trends in cannabis had been published, and searched PubMed for additional papers using the keywords, “trends” *and* “marijuana” *or* “cannabis” and each of the five surveys included in Table 1. In addition, to ensure that we did not overlook other sources of information, we searched PubMed for additional studies, and the first 100 citations that came up in Google Scholar. In these searches, we used the following sets of keywords: (marijuana *or* cannabis) *and* “time trends” *and* (NHANES *or* “National Health and Nutrition Examination Survey” *or* NHIS *or* “National Health Interview Survey” *or* BRFSS or “Behavioral Risk Factor Surveillance System”). Those surveys are widely-known, widely-analyzed, high-quality US national health surveys.

Adult surveys.—The three main sources of adult data (Table 1) included the National Survey on Drug Use and Health (NSDUH) surveys (31), the set of national surveys conducted by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) (32–35)

and the National Alcohol Surveys (NAS) (36). Household residents comprise the target population of all of these surveys. The NSDUH has used consistent methods and measures since 2002, so yearly data from then can be combined to examine recent time trends. Approximately 70,000 participants are included in each yearly NSDUH survey; of these, approximately 47,000 are adults age 18 and older. Participants are interviewed in their homes, using a combination of self-administered and interviewer-administered modalities of data collection. Another key source of adult data (age 18 and older) is the set of three NIAAA surveys conducted since 1991: (1) the National Longitudinal Alcohol Epidemiologic Survey (NLAES; N=42,862), conducted in 1991–1992 (32, 33); (2) the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC; N=43,093), conducted in 2001–2002 (34); and (3) the NESARC-III, consisting of a new sample (independent of the NESARC sample), conducted in 2012–2013 (N=36,309) (35). In the NIAAA surveys, participants are interviewed in their homes using interviewer-administered measures. Both the NSDUH and NIAAA surveys included measures of cannabis use and DSM-IV cannabis use disorder. The National Alcohol Surveys (NAS) are conducted every 4–6 years. These surveys have included questions on cannabis use since 1979. NAS sample sizes analyzed in reports on cannabis ranged from 5,221 (1984) to 7,071 (2014–2015). Participants were interviewed in person in their homes up to 1995, and by telephone since 2000 (36). NAS provides information on adult cannabis use but not cannabis use disorder (5, 36).

Adolescent surveys.—The three main sources of yearly, nationally representative data on adolescents are the NSDUH, the Monitoring the Future (MTF) study (37), and the Youth Risk Behavior Surveillance (YRBS) System (38). The NSDUH includes approximately 23,000 youth aged 12–17 each year. Monitoring the Future includes 8^{th}, 10^{th} and 12^{th} graders who participate in anonymous (8^{th} and 10^{th} grade) or confidential (12^{th} grade) self-administered surveys in their schools. The MTF study samples schools within states and regions, and then classes of students within schools, permitting national estimates to be made. MTF has been collecting data on cannabis use in 12^{th} graders since 1976, and in 8^{th} and 10^{th} graders since 1991. Approximately 50,000 students are included each year. YRBS surveys are conducted biennially, also in schools. YRBS includes 9^{th} through 12^{th} graders, assessing cannabis use in approximately 15,000 students in each survey.

New analysis of trends by sociodemographic characteristics

We conducted new analyses using data from two NIAAA surveys, the NESARC and NESARC-III, to test whether adult sociodemographic groups showed statistically different trends in cannabis use and cannabis use disorder from 2001–2002 to 2012–2013.

NESARC-III and NESARC design.—Both surveys were nationally representative face-to-face interview surveys of civilian adults 18 years and older, with similar field procedures, described in detail elsewhere (34, 35, 39–41). Respondents were selected through multistage probability sampling and data were adjusted for nonresponse and weighted to represent the U.S. civilian population, based on the 2012 American Community Survey for NESARC-III (35) and the 2000 Census for NESARC (34). All respondents gave informed consent. Institutional Review Boards from NIAAA (both surveys) and Westat (NESARC-III)

approved the protocol and consent procedures. Interviewer quality assurance methods involved initial structured home study and in-class training. During data collection, interviewers received regular ongoing supervision by trained supervisors. In addition, random respondent callbacks were conducted to verify interview data. For NESARC-III, interviews were conducted 2012–2013, with an overall response rate of 60.1%, comparable to other contemporaneous U.S. national surveys (42, 43), and a final N of 36,309. For NESARC, interviews were conducted 2001–2002, with an overall response rate of 81.2%, and a final N of 43,093.

NESARC-III and NESARC measures.—In the NESARC-III, past-year DSM-IV cannabis use and cannabis use disorder were assessed using the NIAAA Alcohol Use Disorder and Associated Disabilities Interview Schedule-5 (AUDADIS-5) (44). The AUDADIS-5 is a structured interview designed for experienced survey interviewers. Past-year DSM-IV cannabis use disorder diagnoses were defined as positive if respondents met criteria for cannabis dependence or abuse in the past year. Dependence required three or more of the six DSM-IV dependence criteria (DSM-IV did not include marijuana withdrawal). DSM-IV cannabis abuse required one or more of the four DSM-IV abuse criteria. Abuse and dependence were combined into a single variable because extensive evidence indicates that their criteria reflect a single disorder rather than two different conditions (23). Similarly, in the NESARC, the AUDADIS-IV was used to measure cannabis use and cannabis use disorders (45). The symptom items that assessed DSM-IV marijuana use disorders in the NESARC and NESARC-III were virtually identical, and analyses suggested that the trivial differences in operationalization could not account for the more substantial differences in prevalence between the surveys (46). Reliability and validity of AUDADIS DSM-IV substance disorder diagnoses are documented in clinical and general population national and international studies (47–58). Test-retest reliability of 12-month AUDADIS-IV cannabis use disorder diagnoses and symptom scales, and validity of diagnoses are fair to excellent in the general population (47–52, 56–59). Studies also show that reliability and validity of cannabis use and AUDADIS-5 cannabis use disorder diagnoses and criteria is also in the fair to excellent range (52, 60, 61). As in previous reports (2, 46), participants missing information on the cannabis variables (368 in NESARC, 66 in NESARC-III) were coded as “no.”

Additional variables obtained from the AUDADIS-5 and AUDADIS-IV included the sociodemographic characteristics of interest, measured identically in NESARC and NESARC-III: gender; age; race/ethnicity; education; marital status; family income; urbanicity; and region. These were defined using Census definitions.

Statistical analysis of subgroup differences in trends

The two datasets were concatenated and a variable representing the survey was added, following previous studies that examined substance-related trends in those datasets (2, 62–64). For each outcome (cannabis use, cannabis use disorder) and each sociodemographic variable, logistic regression determined trends over time (change between surveys) for each subgroup, and whether trends differed between subgroups. Regression models included main effects of the sociodemographic variable and survey, and sociodemographic-survey

interaction. SUDAAN 11.0.1 (65) was used to adjust for complex sampling and survey weights. Weighted model-predicted marginal prevalence estimates (back transformed from log odds) and standard errors were generated in each survey for each sociodemographic subgroup. Prevalence differences between NESARC-III and NESARC within each subgroup indicated the time trends. Contrasts for subgroup prevalence differences compared to the reference subgroup prevalence difference tested whether the trends differed significantly between sociodemographic subgroups. In all tests, significance was set at $p<0.05$.

Results

Prior to the PubMed and Google Scholar searches for articles, 12 citations on adults and 7 citations on adolescents were known to the authors. None of the searches using the keywords marijuana *or* cannabis *and* time trends *and* NHANES, NHIS, *or* BRFSS recovered any relevant publications in PubMed or Google Scholar. The PubMed search for keywords: "time trends" *and "*marijuana" *or* "cannabis" produced 28 citations, of which 24 were published since 2000. Twenty studies were excluded because they reported only non-US data (n=10), lacked time trend information (n=1), or focused mainly on other outcomes, e.g., cigarettes, suicide, schizophrenia (n=9). This left 4 articles, 3 of which were already known (4, 27, 66) and one article that was included (67).

Adults

Overall trends

Cannabis use (Table 2A).: In NSDUH surveys from 2002 to 2014 (1, 4, 6), overall past-year use increased significantly, from 10.4% to 13.3%, as did several other indicators of use: past-year daily/near daily use; mean number of days used; and past-month use and daily/near daily use. Several reports showed that these increases began in 2007 (1, 4). In NIAAA surveys, between 1991–1992 (NLAES) and 2001–2002 (NESARC), the prevalence of past-year use did not change significantly, remaining at ~4% (25). However, between 2001–2002 and 2012–2013 (NESARC-III), the prevalence of cannabis use more than doubled, to 9.5%, a significant increase (2). The NAS surveys showed that past-year use decreased significantly from 1984–2000 (68), and then nearly doubled, from 6.7% (2004–2005) to 12.9% (2014–2015) (5).

Cannabis Use Disorder (Table 2A).: In NSDUH surveys, the prevalence of cannabis use disorder did not change significantly, remaining approximately 1.5% across all years (1, 3). In contrast, in NIAAA surveys, the prevalence of past-year cannabis use disorder increased significantly from 1991–1992 to 2001–2002 (from 1.2% to 1.5%) (25), and then further increased to 2.9% by 2012–2013 (2).

Given these inconsistent results in the major US adult national surveys, additional information on national trends in cannabis use disorder was compiled from various patient sources of large-scale electronic medical record data. In these datasets, cannabis use disorder was defined using the International Classification of Diseases, Ninth Revision, Clinical Modification (69). These studies indicated that the prevalence of cannabis use disorders increased over time, including between 2002 and 2009 in Veterans Health Administration

patients (70); in gastroenterology patients from 1986 to 2013 (71); in national hospital inpatients from 2002 to 2011 (72); and in inpatients from individual states between 1997 and 2014 (73). Additionally, cannabis or its metabolites increased in drivers in fatal accidents (1999 to 2010) (11) and in pilots in fatal crashes (since 2000) (74). Taken together, these studies suggest that cannabis use disorder and other serious consequences of use are increasing nationally, consistent with the results from the NIAAA surveys showing increases in cannabis use disorder prevalence between 2001–2002 and 2012–2013 (26, 27, 75).

By sociodemographic group

Cannabis use (Table 2B).: Data from the 1991–1992 and 2001–2002 NIAAA surveys showed scattered increases in past-year prevalence of cannabis use in a few subgroups (i.e., those aged 18–29 and 45–64), but little evidence of change in other sociodemographic subgroups (25). In contrast, the more recent data from the 2001–2002 and 2012–2013 NIAAA surveys, the NSDUH surveys, and in NAS surveys all showed significant increases in cannabis use across sociodemographic subgroups.

Gender.: The prevalence of use increased in men and in women (2, 4, 5) (significantly for both genders in NIAAA and NSDUH surveys (2, 4), and significantly in women and descriptively in men in NAS data (5)). The single study that tested if rates of change differed by gender used NSDUH data (4). In this study, men had a significantly greater rate of change, a difference that began in 2007 (4).

Age.: The prevalence of use increased significantly in all age groups (2, 6, 76), including young adults (defined as age 18–29 (2) or 18–25 (6, 76)), those of middle age (defined variously); and older adults (age ≥65) (2, 6, 76). In the only study testing if rates of change differed by age, those aged 18–25, 26–34, 35–49, and 50–64 years did not differ, while the rate of change was significantly lower in those aged ≥65 (76).

Race/ethnicity.: Cannabis use increased significantly in all race/ethnicity groups (2) but these groups were not tested to determine if their rates of change differed.

Socioeconomic status.: The prevalence of use increased significantly in all income groups (2, 4) and all education groups (2, 6).

Marital status.: The prevalence of use increased significantly across groups defined by marital status, including those who were married, never married, or previously married (2).

Location.: The prevalence of use increased in all US geographic regions (2), and in urban and rural areas (2).

Cannabis Use Disorder (Table 2B).

Gender.: In the NIAAA surveys, the prevalence of cannabis use disorder increased significantly in women from 1991–1992 to 2001–2002 (25), and in men and women from 2001–2002 to 2012–2013 (2).

Age.: In the NIAAA surveys, the prevalence of cannabis use disorder increased significantly in ages 18–29, 30–44, 45–64, and ≥65 from 2001–2002 to 2012–2013 (2). In NSDUH surveys from 2002–2014, cannabis use disorder prevalence decreased in those age 18–25, with no change in those ≥26 (6).

Race/ethnicity.: In the NIAAA surveys, the prevalence of cannabis use disorder increased significantly in Blacks and Hispanics from 1991–1992 to 2001–2002 (25), and in Whites, Blacks, Hispanics, and Asians from 2001–2002 to 2012–2013 (2), while in the NSDUH surveys, cannabis use disorder prevalence did not change significantly in any race/ethnicity group (77).

Socioeconomic status.: In the 2001–2002 and 2012–2013 NIAAA surveys, the prevalence of cannabis use disorder increased significantly in all income groups ($0-$19,999; $20,000-$34,999; $35,000-$69,999; ≥$70,000) and in those with less than high school; high school; and some college or more (2).

Marital status.: In the 2001–2002 and 2012–2013 NIAAA surveys, the prevalence of cannabis use disorder increased significantly in those who were married, never married, or previously married (2).

Location.: In the 2001–2002 and 2012–2013 NIAAA surveys, the prevalence of cannabis use disorder increased in all geographic areas and in urban and rural regions (2).

Trends in cannabis use in specific populations using NSDUH data

Pregnant women.: Data from 2002 to 2014 indicated that while the overall prevalence of past-month cannabis use was lower in pregnant than non-pregnant women aged 18–44, pregnant and non-pregnant women had similar rates of increase (78). Of note, use was consistently higher across the years among pregnant women aged 18–25 than in other pregnant women (78). These findings are consistent with national data on hospitalized pregnant women aged 15–44 from 1993 to 2014 showing that during these years, the prevalence of ICD-9-CM cannabis use disorder increased significantly, overall and within all age and race/ethnicity subgroups (66).

Older individuals.: From 2002 to 2014, significant increases in cannabis use occurred among older adults (age ≥50), including among men and women, in those age 50–64 and ≥65, in Whites, lower income groups, all education groups, and in those who are currently married and divorced/separated. However, no significant changes occurred in older Blacks, Hispanics, higher income groups, and widowed or never married participants (79, 80).

Disabled individuals.: In data from 2002 to 2010, participants of working age (age 18–64) who reported work disabilities or being Medicare-eligible (indicating disability) were compared to other participants on their prevalence of past-month cannabis use (67). In 2002, the rate of past-month cannabis use in these two groups was nearly identical. However, by 2010, the two groups had diverged significantly, with only a slight, non-significant increase in the non-disabled group, in contrast to significant increases in those who were disabled.

New results testing differences between adult subgroups: the 2001–2002 and 2012–2013 NIAAA surveys—Table 3 shows the results of tests of differences in change in prevalence of cannabis use and cannabis use disorder by sociodemographic subgroups. Differences in trends between groups are noted below if tests were significant ($p<0.05$).

Cannabis use.

Gender.: The prevalence of use increased significantly more in men than in women.

Age.: The prevalence of use increased more in young adults age 18–29 than in all older age groups (age 30–34, 35–44, and ≥45).

Race/ethnicity.: Compared to whites, the prevalence of use increased more in blacks, but not in Hispanics.

Socioeconomic status.: The prevalence of use increased more in participants at the lowest income level ($0-$19,999), compared to those at all higher incomes ($20,000-$34,999, $35,000-$69,999, and ≥$70,000). The prevalence of use increased significantly more in adults with only high school education than in those who had at least some college education.

Marital status.: Compared to those who were currently married, the prevalence of use increased significantly more in those who were never or previously married.

Location.: With those in the Northeast as the reference group, the prevalence of cannabis use was significantly less among those living in the South. The prevalence of use increased significantly more among those in urban areas than those in rural areas.

Cannabis use disorder.

Gender.: Men had significantly greater increases in the prevalence of cannabis use disorder than women.

Age.: Significantly greater increases in the prevalence of cannabis use disorder were found in adults age 18–29 than in those age 35–44 and ≥45.

Race/ethnicity.: Blacks had significantly greater increases in the prevalence of cannabis use disorder than Whites.

Socioeconomic status.: The prevalence of cannabis use disorder increased significantly more in participants at the lowest income at the lowest income level ($0-$19,999), than in those at higher income levels ($20,000-$34,999, $35,000-$69,999, and ≥$70,000).

Marital status.: Significantly greater increases in prevalence of cannabis use disorder were found among those who were never married compared to those who were currently married.

Location.: Significantly greater increases in the prevalence of cannabis use disorder were found among those in urban areas than in rural areas.

Adolescents

Overall trends

Cannabis use (Table 4).: Overall, adolescent time-trend data since 2002 showed either no change or decreases in the prevalence of adolescent cannabis use. In NSDUH data from 2002 to 2014, past-year use decreased significantly overall between 2002 to 2014 (81, 82), e.g., from 15.8% to 13.1% (82). Within this overall trend, decreases were significant between 2002 and 2007 (76, 82). Descriptively, data from the MTF surveys show little change between 2005 and 2016 in the prevalence of past-year cannabis use among 8th, 10th and 12th graders (83). YRBS surveys indicated a significant overall decrease in youth prevalence of current (past 30 days) cannabis use, repeated use and frequent use between 1999 and 2013, with prevalence lowest in 2007 (consistent with NSDUH finding) and descriptively, slight subsequent increases (84).

Cannabis use disorder (Table 4).: Only NSDUH surveys assessed cannabis use disorder in adolescents. From 2002 to 2014, the prevalence of cannabis use disorder in NSDUH participants age 12–17 decreased significantly (81, 82), from 4.3% in 2002 to 2.3% in 2014. The years in which significant decreases occurred were 2002–2007 and 2010–2014 (82).

By sociodemographic groups—To put time trends in cannabis use in historical perspective, we note that greater prevalence of cannabis use and cannabis use disorder is generally found in older adolescents (81, 85, 86), boys (81, 84, 87–89), and in Hispanic and White adolescents (87, 88, 90).

Cannabis use.

Age or grade.: In NSDUH surveys, when adolescents age 12–14 and 15–17 were examined separately, past-year use decreased significantly from 2002 to 2013 in both age groups (81, 85), with most of the decrease occurring between 2002–2007, and stabilization or fluctuation subsequently. In the one study that tested for differential trends by age, no significant differences occurred (81). In the MTF surveys, decreases occurred in 8th, 10th and 12th graders until 2007–2008. After this, descriptively, use stabilized in 8th graders, fluctuated in 10th graders, and increased in 12th graders (86).

Gender.: YRBS surveys showed significant overall decreases from 1999 to 2013 in both boys and girls, but a significant change in trend direction occurred in both groups (84). Although differential rates of change were not tested by gender, descriptively, boys were noted as decreasing more than girls, resulting in near-convergence in gender rates of prevalence of use by 2013.

Race/ethnicity.: Overall decreases from 1999 to 2013 were found in YRBS data within the subgroups of white, black, and Hispanic teens (84). Descriptively, all three groups decreased until the mid-2000s and White teens changed little subsequently. However, a significant change in trend direction emerged after the mid-2000s in black and Hispanic teens, who began to increase after that point (84). In the MTF surveys, descriptively, prevalence of cannabis use among white 12th-graders changed little between 2000 and 2010, but increased among black 12th graders (89). Examining the later years (2006 to 2015) of MTF data more

closely, significantly different race/ethnicity trends arose by grade (91). In 8th graders, past-month cannabis use did not change significantly in any racial/ethnic group. In 10th graders, a significant increase occurred in blacks in a trend that differed significantly from whites. In 12th graders, significant increases were observed for blacks and Hispanics, which differed significantly from whites, who changed little over these years (91). These results are consistent with YRBS data (84) in showing increases in non-White adolescents from the mid-2000s.

Cannabis use disorder.: In NSDUH data from 2002 to 2013, cannabis use disorder decreased significantly in those age 12–14 and 15–17; in boys and girls; and in white teens. In the one study that tested for differential trends between demographic groups, changes in rates did not differ significantly by age, gender, or race/ethnicity (81).

Discussion

Overall, the prevalence of adult cannabis use increased in recent years across all US national studies, particularly since 2007. Increases were observed among all sociodemographic subgroups (men, women, all ages, Whites, Blacks, Hispanics, all incomes, all education levels, married, unmarried, those in urban and rural areas, all regions) and in special populations (pregnant women, older individuals, those with disabilities). The consistency of the findings on adult increases suggests that the observed trends were quite robust, despite the many methodological differences between surveys and the exact time periods covered by each. While many people can use cannabis use without harm, cannabis use places individuals at risk for various adverse health consequences (e.g., vehicle crashes due to intoxicated driving, cannabis withdrawal, and cannabis use disorder). Thus, cannabis use is a health behavior that is important to study, just as alcohol consumption is a widely-studied health behavior even though not all persons who drink alcohol have drinking problems. Less national data are available on overall time trends in adult prevalence of cannabis use disorder. The NIAAA surveys showed significant increases in the prevalence of adult cannabis use disorder between 2001–2002 and 2012–2013, but the NSDUH surveys did not show such an increase during these years. Additional large-scale national data sources based on the electronic medical records of patient populations consistently showed increases in the prevalence of cannabis use disorder since the early 2000s, (e.g., in Veterans Administration patients and using discharge diagnoses of hospitalized inpatients). The consistency of these sources of information with the increases found in the NIAAA surveys. suggested that the findings on increases in the prevalence of adult were real, and should be considered in addressing their possible policy and clinical implications.

The increases in adult prevalence of cannabis use and cannabis use disorder have numerous possible explanations. Since the early 2000s, Americans have become increasingly likely to see cannabis use as harmless (1, 6, 92), and perceptions of low harm have long been accompanied by greater rates of use (93). Thus, changing perceptions of cannabis are likely to have led to higher rates of use, putting more users at risk for cannabis-related problems, including cannabis use disorder. Another possible explanation is the changing legal landscape around cannabis use. In 1996, California was the first state to legalize cannabis use for medical purposes (medical marijuana laws, or MML); as of this writing, 33 states

have passed MML. In 2012, Colorado and Washington State were the first states to legalize cannabis use for recreational purposes (recreational marijuana laws, or RML); as of this writing, 10 states have passed RML. By making cannabis more available and seem more acceptable, these laws may also have encouraged greater use, leading to greater consequences (such as cannabis use disorder). A cross-sectional study (94) of the NESARC showed that rates of adult cannabis use and cannabis use disorder were higher in MML states, and three multi-level modeling studies of MML effects on adults using NSDUH and NIAAA survey data indicated that MML lead to greater rates of adult cannabis use (46, 95, 96), while the two of these that also examined cannabis use disorder showed that MML also led to higher rates of cannabis use disorder (46, 96). While RML are likely to have stronger effects than MML due to commercialization, further increasing in availability, and direct efforts to improve acceptability and desirability through advertising and other forms of marketing, data are not yet available to analyze the effects of RML. Additional studies of the effects of MML and RML are needed, including studies of whether the effects of these laws differ between population subgroups (e.g., by gender or race/ethnicity) or in populations whose characteristics (e.g., a high prevalence of pain or psychiatric disorders) place them at greater risk for cannabis use and adverse health consequences. At the same time, increases in adult use should not be viewed in isolation from trends in rates of other substance use. The increases in adult cannabis use reviewed above are consistent with increases in adult use of other substances, including binge drinking (63), cocaine (97), non-medical use of opioids (98), and heroin (62). Consistent trends across these substances suggest that larger social forces are operating, which should be identified to facilitate effective prevention and intervention efforts.

Age differences in trends were marked when adolescents were compared to adults. In contrast to the findings on adults, the overall prevalence of adolescent cannabis use tended to decrease, although results were less consistent than those for adults, with periods of stability or fluctuation occurring as well. Less information was available on cannabis use disorder, but the decreases in adolescent cannabis use disorder seen in NSDUH data were consistent with the decreases in rates of cannabis use. Unlike the findings for adults, an extensive body of research shows that MML are unrelated to increases in adolescent cannabis use (28). Tests or descriptive results on age group differences in trends within adults or adolescents did not prove strong or consistent, indicating that the major difference in trends by age was between teens and adults. The evidence on overall declines in the prevalence of adolescent use is consistent with declines for other substances, including alcohol (99), cocaine, amphetamines, tranquillizers (100), heroin (101), non-medical use of prescription opioids (102), and in conduct problems (103). However, these changes have been accompanied by increases in adolescent mental health problems, including suicidal ideation (104) and suicide (105). Explaining such findings and the disjuncture between adolescent substance and mental health problems has become a priority in adolescent health research and an important direction for future studies.

Time trends differed by gender, with different patterns in adults and adolescents. In adults, published tests and our new analyses showed that men had greater increases in cannabis use and cannabis use disorders than women. The reasons for the greater increases in men are not known, although a conjoint examination of income and gender found that gender differences

were significantly sharper in participants of low income (4). Because these differences appeared to coincide with the financial recession of 2007, economic forces may have had a stronger impact on men, who are traditionally greater users of substances than women. In contrast, descriptive results for adolescents suggested greater decreases in boys than in girls, resulting in near-convergence of rates of cannabis use. The reasons for these changes by gender in teens is not known. One possible factor is increased time spent using social media or games on electronic devices such as cellphones (106). If adolescents, especially adolescent boys, are spending more time at home on activities involving electronic devices, then they are less likely to be spending face-to-face time with peers in situations where substances such as cannabis are available and typically used as part of group activities. This is one possible direction for future research investigation.

Race/ethnic group analyses, when done, suggest that both adult and adolescent blacks are increasing their use of cannabis use, and that this is changing the historical pattern of greater rates of use in whites than in blacks. Our new analyses also show a similar significantly greater rate of increase in cannabis use disorder among blacks compared to whites, consistent with the patterns in cannabis use. The reasons for the increases in blacks are currently unclear. Explanations offered include the increasing popularity of blunts (rolling marijuana within a cigar shell and smoking it) among adolescents (84). Broader socioecological explanations encompass social change linked to race in the U.S. coupled with a widespread recession that was worse economically for blacks than for whites, and political unrest due to high-profile aggressive policing tactics (91). All of these factors could differentially increase perceived stress, discrimination, and other vulnerabilities to substance use among black adolescents and adults compared to others (91). This is also an important topic for future research studies, especially given potential exacerbation in these stressors in the last few years.

Study limitations are noted. The three sets of adult surveys used questions about cannabis use that differed slightly. NSDUH asked about any marijuana use without specifying non-medical use, only adding an additional question about medical use in 2013. The NAS surveys had similar questions, adding an additional question on non-medical use only in 2015. In contrast, the NIAAA surveys asked about illicit marijuana use within a module on illicit drugs, all of which were defined to participants as use without a prescription or other than prescribed, e.g., to get high (44, 45). The NIAAA surveys added a question on medical marijuana use in the 2012–2013 NESARC-III. Thus, the intent of the NIAAA survey questions on cannabis use as non-medical would have been clear to participants even after legalization for medical use in an increasing number of states. While this could potentially overestimate recreational cannabis use in more recent NSDUH and NAS surveys, studies show that a very small proportion of users used cannabis exclusively for medical purposes (96, 107, 108), so estimates are unlikely to be inaccurate. However, future surveys should carefully define medical and non-medical use to participants when the intent is to determine cannabis use for non-medical purposes. In addition, study modalities and locations of data collection varied. In adolescents, the MTF and YRBS surveys were conducted in schools, while NSDUH was conducted in homes. In adults, the NIAAA surveys were interviewer-administered, while the NSDUH surveys were self-administered on a computer in homes, and the NAS surveys shifted from home to telephone administration in 2000. The impact of

these differences between surveys on their results is difficult to quantify. Further, many studies either described but did not test subgroup differences in rates of change of cannabis use or cannabis use disorder, or described subgroup by subgroup differences (e.g., race by gender) without testing overall differences between the main subgroups. Especially for continued research on trends by gender and race, tests of differences between the main subgroups are important for a clear understanding of the overall trends and how they differ by important characteristics. Further, no studies (aside from our new analyses) formally tested whether trends differed by income, education, region, or urbanicity. Replications of these differences are warranted.

Conclusion

Cannabis use and cannabis use disorders have recently increased in adults across all sociodemographic groups. While stable rates or decreases were seen in adolescents, evidence suggests recent increases in specific groups (e.g., non-Whites) which demand attention. As marketing increases after passage of recreational marijuana laws and as attitudes towards cannabis continue to become more positive, further increases in use may be seen in adults and in minority youth. Policy makers will need to address the need for prevention in passing legislation, and in increasing treatment services to meet an increasing need. Some public education may prove useful as well. Such educational efforts should avoid the exaggerated scare tactics such as those of the mid-20th century, but instead provide a balanced picture that informs the public about potential pros and cons of cannabis use.

Financial Disclosures:

Deborah S. Hasin reports contract support from Campbell Alliance. Dvora Shmulewitz and Aaron L. Sarvet report no conflicts of interest.

Funding: This work was supported by the National Institute on Drug Abuse under Grants R01DA034244 and R01DA018652, and by the New York State Psychiatric Institute.

References

1. Compton WM, Han B, Jones CM, Blanco C, Hughes A. Marijuana use and use disorders in adults in the USA, 2002–14: Analysis of annual cross-sectional surveys. Lancet Psychiatry. 2016; 3(10):954–64. [PubMed: 27592339]
2. Hasin DS, Saha TD, Kerridge BT, Goldstein RB, Chou SP, Zhang H, et al. Prevalence of marijuana use disorders in the United States between 2001–2002 and 2012–2013. JAMA Psychiatry. 2015; 72(12):1235–42. [PubMed: 26502112]
3. Grucza RA, Agrawal A, Krauss MJ, Cavazos-Rehg PA, Bierut LJ. Recent trends in the prevalence of marijuana use and associated disorders in the United States. JAMA Psychiatry. 2016; 73(3):300–1. [PubMed: 26864618]
4. Carliner H, Mauro PM, Brown QL, Shmulewitz D, Rahim-Juwel R, Sarvet AL, et al. The widening gender gap in marijuana use prevalence in the U.S. during a period of economic change, 2002–2014. Drug Alcohol Depend. 2017; 170:51–8. [PubMed: 27875801]
5. Kerr WC, Lui C, Ye Y. Trends and age, period and cohort effects for marijuana use prevalence in the 1984–2015 US National Alcohol Surveys. Addiction. 2018; 113(3):473–81. [PubMed: 28895239]
6. Azofeifa A, Mattson ME, Schauer G, McAfee T, Grant A, Lyerla R. National estimates of marijuana use and related indicators: National Survey on Drug Use and Health, United States, 2002–2014. MMWR Surveill Summ. 2016; 65(11):1–28.

7. Sofuoglu M, Sugarman DE, Carroll KM. Cognitive function as an emerging treatment target for marijuana addiction. Exp Clin Psychopharmacol. 2010; 18(2):109–19. [PubMed: 20384422]
8. Volkow ND, Swanson JM, Evins AE, DeLisi LE, Meier MH, Gonzalez R, et al. Effects of cannabis use on human behavior, including cognition, motivation, and psychosis: A review. JAMA Psychiatry. 2016; 73(3):292–7. [PubMed: 26842658]
9. Livne O, Shmulewitz D, Lev-Ran S, Hasin DS. DSM-5 cannabis withdrawal syndrome: Demographic and clinical correlates in U.S. adults. Drug Alcohol Depend. 2018.
10. Ghasemiesfe M, Ravi D, Vali M, Korenstein D, Arjomandi M, Frank J, et al. Marijuana use, respiratory symptoms, and pulmonary function: A systematic review and meta-analysis. Ann Intern Med. 2018; 169(2):106–15. [PubMed: 29971337]
11. Brady JE, Li G. Trends in alcohol and other drugs detected in fatally injured drivers in the United States, 1999–2010. Am J Epidemiol. 2014; 179(6):692–9. [PubMed: 24477748]
12. Rogeberg O, Elvik R. The effects of cannabis intoxication on motor vehicle collision revisited and revised. Addiction. 2016; 111(8):1348–59. [PubMed: 26878835]
13. Asbridge M, Hayden JA, Cartwright JL. Acute cannabis consumption and motor vehicle collision risk: Systematic review of observational studies and meta-analysis. BMJ. 2012; 344:e536. [PubMed: 22323502]
14. Li MC, Brady JE, DiMaggio CJ, Lusardi AR, Tzong KY, Li G. Marijuana use and motor vehicle crashes. Epidemiol Rev. 2012; 34:65–72. [PubMed: 21976636]
15. Watson TM, Mann RE. International approaches to driving under the influence of cannabis: A review of evidence on impact. Drug Alcohol Depend. 2016; 169:148–55. [PubMed: 27810658]
16. Strand MC, Gjerde H, Morland J. Driving under the influence of non-alcohol drugs: An update. Part II: Experimental studies. Forensic Sci Rev. 2016; 28(2):79–101. [PubMed: 27257716]
17. Hartman RL, Huestis MA. Cannabis effects on driving skills. Clin Chem. 2013; 59(3):478–92. [PubMed: 23220273]
18. Hartman RL, Brown TL, Milavetz G, Spurgin A, Pierce RS, Gorelick DA, et al. Cannabis effects on driving lateral control with and without alcohol. Drug Alcohol Depend. 2015; 154:25–37. [PubMed: 26144593]
19. Lenne MG, Dietze PM, Triggs TJ, Walmsley S, Murphy B, Redman JR. The effects of cannabis and alcohol on simulated arterial driving: Influences of driving experience and task demand. Accid Anal Prev. 2010; 42(3):859–66. [PubMed: 20380913]
20. Zhu H, Wu LT. Trends and correlates of cannabis-involved emergency department visits: 2004 to 2011. J Addict Med. 2016; 10(6):429–36. [PubMed: 27574753]
21. Bollom A, Austrie J, Hirsch W, Nee J, Friedlander D, Iturrino J, et al. Emergency department burden of nausea and vomiting associated with cannabis use disorder: US trends from 2006 to 2013. J Clin Gastroenterol. 2017.
22. Richards JR. Cannabinoid hyperemesis syndrome: Pathophysiology and treatment in the emergency department. J Emerg Med. 2018.
23. Hasin DS, O'Brien CP, Auriacombe M, Borges G, Bucholz K, Budney A, et al. DSM-5 criteria for substance use disorders: Recommendations and rationale. Am J Psychiatry. 2013; 170(8):834–51. [PubMed: 23903334]
24. Hasin DS, Kerridge BT, Saha TD, Huang B, Pickering R, Smith SM, et al. Prevalence and correlates of DSM-5 cannabis use disorder, 2012–2013: Findings from the National Epidemiologic Survey on Alcohol and Related Conditions-III. Am J Psychiatry. 2016; 173(6):588–99. [PubMed: 26940807]
25. Compton WM, Grant BF, Colliver JD, Glantz MD, Stinson FS. Prevalence of marijuana use disorders in the United States: 1991–1992 and 2001–2002. JAMA. 2004; 291(17):2114–21. [PubMed: 15126440]
26. Hasin DS. US epidemiology of cannabis use and associated problems. Neuropsychopharmacology. 2018; 43(1):195–212. [PubMed: 28853439]
27. Carliner H, Brown QL, Sarvet AL, Hasin DS. Cannabis use, attitudes, and legal status in the U.S.: A review. Prev Med. 2017; 104:13–23. [PubMed: 28705601]

28. Sarvet AL, Wall MM, Fink DS, Greene E, Le A, Boustead AE, et al. Medical marijuana laws and adolescent marijuana use in the United States: A systematic review and meta-analysis. Addiction. 2018; 113(6):1003–16. [PubMed: 29468763]
29. Volkow ND, Compton WM, Wargo EM. The risks of marijuana use during pregnancy. JAMA. 2017; 317(2):129–30. [PubMed: 27992628]
30. Saint Louis C A balm when you're expecting: Sometimes pot does the trick [Internet]. The New York Times; 2017 2 20 Available from: https://www.nytimes.com/2017/02/20/health/marijuana-pregnancy-mothers.html.
31. National Survey on Drug Use and Health. NSDUH [Internet]. Substance Abuse and Mental Health Services Administration; RTI International. Available from: https://nsduhweb.rti.org/respweb/homepage.cfm.
32. Grant BF. Prevalence and correlates of alcohol use and DSM-IV alcohol dependence in the United States: Results of the National Longitudinal Alcohol Epidemiologic Survey. J Stud Alcohol. 1997; 58(5):464–73. [PubMed: 9273910]
33. Grant BF. Prevalence and correlates of drug use and DSM-IV drug dependence in the United States: Results of the National Longitudinal Alcohol Epidemiologic Survey. J Subst Abuse. 1996; 8(2):195–210. [PubMed: 8880660]
34. Grant BF, Moore TC, Shepard J, Kaplan K. Source and accuracy statement: Wave 1 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). Bethesda (MD): National Institute on Alcohol Abuse and Alcoholism; 2003 Available from:
35. Grant BF, Chu A, Sigman R, Amsbary M, Kali J, Sugawara Y, et al. Source and accuracy statement: National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III). Rockville (MD): National Institute on Alcohol Abuse and Alcoholism; 2014 Available from: https://www.niaaa.nih.gov/sites/default/files/NESARC_Final_Report_FINAL_1_8_15.pdf.
36. Alcohol Research Group. National alcohol surveys [Internet]. Emeryville (CA): Public Health Institute; 2018 Available from: http://arg.org/center/national-alcohol-surveys/.
37. Johnston LD, O'Malley PM, Miech RA, Bachman JG, Schulenberg JE. Monitoring the future: National survey results on drug use, 1975–2016. Overview: Key findings on adolescent drug use [Internet]. Ann Arbor (MI): Institute for Social Research, University of Michigan; 2017 Available from: http://www.monitoringthefuture.org/pubs/monographs/mtf-overview2016.pdf.
38. Centers for Disease Control and Prevention. Adolescent and school health: Youth risk behavior surveillance system (YRBSS) [Internet]. Atlanta (GA): U.S. Department of Health & Human Services; 2018 Available from: https://www.cdc.gov/healthyyouth/data/yrbs/index.htm.
39. Grant BF, Stinson FS, Dawson DA, Chou SP, Dufour MC, Compton W, et al. Prevalence and co-occurrence of substance use disorders and independent mood and anxiety disorders: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. Arch Gen Psychiatry. 2004; 61(8):807–16. [PubMed: 15289279]
40. Grant BF, Stinson FS, Dawson DA, Chou SP, Ruan WJ, Pickering RP. Co-occurrence of 12-month alcohol and drug use disorders and personality disorders in the United States: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. Arch Gen Psychiatry. 2004; 61(4):361–8. [PubMed: 15066894]
41. Grant BF, Goldstein RB, Saha TD, Chou SP, Jung J, Zhang H, et al. Epidemiology of DSM-5 alcohol use disorder: Results from the National Epidemiologic Survey on Alcohol and Related Conditions III. JAMA Psychiatry. 2015; 72(8):757–66. [PubMed: 26039070]
42. Substance Abuse and Mental Health Services Administration. Results from the 2012 National Survey on Drug Use and Health: Summary of national findings. Appendix B: Statistical methods and measurement. Rockville (MD): U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality; 2013 NSDUH Series H-46, HHS Publication No. (SMA) 13–4795. Available from: https://www.samhsa.gov/data/sites/default/files/NSDUHresults2012/NSDUHresults2012.pdf.
43. Adams PF, Kirzinger WK, Martinez M. Summary health statistics for the U.S. population: National Health Interview Survey, 2012. Vital Health Stat 10 2013; (259):1–95.
44. Grant BF, Goldstein RB, Chou SP, Saha TD, Ruan WJ, Huang B, et al. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-Diagnostic and Statistical Manual of Mental

Disorders, fifth edition version (AUDADIS-5). Rockville (MD): National Institute on Alcohol Abuse and Alcoholism; 2011.

45. Grant BF, Dawson DA, Hasin DS. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-DSM-IV version. Bethesda (MD): National Institute on Alcohol Abuse and Alcoholism; 2001.
46. Hasin DS, Sarvet AL, Cerda M, Keyes KM, Stohl M, Galea S, et al. US adult illicit cannabis use, cannabis use disorder, and medical marijuana laws: 1991–1992 to 2012–2013. JAMA Psychiatry. 2017; 74(6):579–88. [PubMed: 28445557]
47. Canino G, Bravo M, Ramirez R, Febo VE, Rubio-Stipec M, Fernandez RL, et al. The Spanish Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS): Reliability and concordance with clinical diagnoses in a Hispanic population. J Stud Alcohol. 1999; 60(6):790–9. [PubMed: 10606491]
48. Chatterji S, Saunders JB, Vrasti R, Grant BF, Hasin D, Mager D. Reliability of the alcohol and drug modules of the Alcohol Use Disorder and Associated Disabilities Interview Schedule-Alcohol/Drug-Revised (AUDADIS-ADR): An international comparison. Drug Alcohol Depend. 1997; 47(3):171–85. [PubMed: 9306043]
49. Cottler LB, Grant BF, Blaine J, Mavreas V, Pull C, Hasin D, et al. Concordance of DSM-IV alcohol and drug use disorder criteria and diagnoses as measured by AUDADIS-ADR, CIDI and SCAN. Drug Alcohol Depend. 1997; 47(3):195–205. [PubMed: 9306045]
50. Grant BF. DSM-IV, DSM-III-R, and ICD-10 alcohol and drug abuse/harmful use and dependence, United States, 1992: A nosological comparison. Alcohol Clin Exp Res. 1996; 20(8):1481–8. [PubMed: 8947328]
51. Grant BF, Dawson DA, Stinson FS, Chou PS, Kay W, Pickering R. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV): Reliability of alcohol consumption, tobacco use, family history of depression and psychiatric diagnostic modules in a general population sample. Drug Alcohol Depend. 2003; 71(1):7–16. [PubMed: 12821201]
52. Grant BF, Harford TC, Dawson DA, Chou PS, Pickering RP. The Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS): Reliability of alcohol and drug modules in a general population sample. Drug Alcohol Depend. 1995; 39(1):37–44. [PubMed: 7587973]
53. Hasin D, Carpenter KM, McCloud S, Smith M, Grant BF. The Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS): Reliability of alcohol and drug modules in a clinical sample. Drug Alcohol Depend. 1997; 44(2–3):133–41. [PubMed: 9088785]
54. Hasin D, Grant BF, Cottler L, Blaine J, Towle L, Ustun B, et al. Nosological comparisons of alcohol and drug diagnoses: A multisite, multi-instrument international study. Drug Alcohol Depend. 1997; 47(3):217–26. [PubMed: 9306047]
55. Nelson CB, Rehm J, Ustun TB, Grant B, Chatterji S. Factor structures for DSM-IV substance disorder criteria endorsed by alcohol, cannabis, cocaine and opiate users: Results from the WHO reliability and validity study. Addiction. 1999; 94(6):843–55. [PubMed: 10665074]
56. Pull CB, Saunders JB, Mavreas V, Cottler LB, Grant BF, Hasin DS, et al. Concordance between ICD-10 alcohol and drug use disorder criteria and diagnoses as measured by the AUDADIS-ADR, CIDI and SCAN: Results of a cross-national study. Drug Alcohol Depend. 1997; 47(3):207–16. [PubMed: 9306046]
57. Ustun B, Compton W, Mager D, Babor T, Baiyewu O, Chatterji S, et al. WHO study on the reliability and validity of the alcohol and drug use disorder instruments: Overview of methods and results. Drug Alcohol Depend. 1997; 47(3):161–9. [PubMed: 9306042]
58. Vrasti R, Grant BF, Chatterji S, Ustun BT, Mager D, Olteanu I, et al. Reliability of the Romanian version of the alcohol module of the WHO Alcohol Use Disorder and Associated Disabilities Interview Schedule-Alcohol/Drug-Revised. Eur Addict Res. 1998; 4(4):144–9. [PubMed: 9852366]
59. Grant BF, Harford TC, Dawson DA, Dufour M, Pickering R, Chou P. Prevalence of DSM-IV alcohol abuse and dependence: United States, 1992. Alcohol Health Res World. 1994; 18(3):243–8.
60. Grant BF, Goldstein RB, Smith SM, Jung J, Zhang H, Chou SP, et al. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-5 (AUDADIS-5): Reliability of substance use and

psychiatric disorder modules in a general population sample. Drug Alcohol Depend. 2015; 148:27–33. [PubMed: 25595052]

61. Hasin DS, Greenstein E, Aivadyan C, Stohl M, Aharonovich E, Saha T, et al. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-5 (AUDADIS-5): Procedural validity of substance use disorders modules through clinical re-appraisal in a general population sample. Drug Alcohol Depend. 2015; 148:40–6. [PubMed: 25604321]
62. Martins SS, Sarvet A, Santaella-Tenorio J, Saha T, Grant BF, Hasin DS. Changes in US lifetime heroin use and heroin use disorder: Prevalence from the 2001–2002 to 2012–2013 National Epidemiologic Survey on Alcohol and Related Conditions. JAMA Psychiatry. 2017; 74(5):445–55. [PubMed: 28355458]
63. Grant BF, Chou SP, Saha TD, Pickering RP, Kerridge BT, Ruan WJ, et al. Prevalence of 12-month alcohol use, high-risk drinking, and DSM-IV alcohol use disorder in the United States, 2001–2002 to 2012–2013: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. JAMA Psychiatry. 2017; 74(9):911–23. [PubMed: 28793133]
64. Saha TD, Kerridge BT, Goldstein RB, Chou SP, Zhang H, Jung J, et al. Nonmedical prescription opioid use and DSM-5 nonmedical prescription opioid use disorder in the United States. J Clin Psychiatry. 2016; 77(6):772–80. [PubMed: 27337416]
65. Research Triangle Institute. SUDAAN, release 11.0.1 [software]. Research Triangle Park (NC): RTI International.
66. Shi Y, Zhong S. Trends in cannabis use disorder among pregnant women in the U.S., 1993–2014. J Gen Intern Med. 2018; 33(3):245–6. [PubMed: 29030807]
67. Glazier RE, Kling RN. Recent trends in substance abuse among persons with disabilities compared to that of persons without disabilities. Disabil Health J. 2013; 6(2):107–15. [PubMed: 23507161]
68. Kerr WC, Greenfield TK, Bond J, Ye Y, Rehm J. Age-period-cohort influences on trends in past year marijuana use in the US from the 1984, 1990, 1995 and 2000 National Alcohol Surveys. Drug Alcohol Depend. 2007; 86(2–3):132–8. [PubMed: 16806739]
69. Centers for Disease Control and Prevention. International Classification of Diseases, ninth revision, clinical modification (ICD-9-CM) [Internet]. 2013 6 18 Available from: https://www.cdc.gov/nchs/icd/icd9cm.htm.
70. Bonn-Miller MO, Harris AH, Trafton JA. Prevalence of cannabis use disorder diagnoses among veterans in 2002, 2008, and 2009. Psychol Serv. 2012; 9(4):404–16. [PubMed: 22564034]
71. Gubatan J, Staller K, Barshop K, Kuo B. Cannabis abuse Is increasing and associated with increased emergency department utilization in gastroenterology patients. Dig Dis Sci. 2016; 61(7): 1844–52. [PubMed: 26935430]
72. Charilaou P, Agnihotri K, Garcia P, Badheka A, Frenia D, Yegneswaran B. Trends of cannabis use disorder in the inpatient: 2002 to 2011. Am J Med. 2017; 130(6):678–87 e7. [PubMed: 28161344]
73. Shi Y Medical marijuana policies and hospitalizations related to marijuana and opioid pain reliever. Drug Alcohol Depend. 2017; 173:144–50. [PubMed: 28259087]
74. McKay MP, Groff L. 23 years of toxicology testing fatally injured pilots: Implications for aviation and other modes of transportation. Accid Anal Prev. 2016; 90:108–17. [PubMed: 26928292]
75. Hasin DS, Grant B. NESARC findings on increased prevalence of marijuana use disorders: Consistent with other sources of information. JAMA Psychiatry. 2016; 73(5):532.
76. Mauro PM, Carliner H, Brown QL, Hasin DS, Shmulewitz D, Rahim R, et al. Age differences in daily and nondaily cannabis use in the United States, 2002–2014. J Stud Alcohol Drugs. 2018; 79(3):423–31. [PubMed: 29885150]
77. Wu LT, Zhu H, Swartz MS. Trends in cannabis use disorders among racial/ethnic population groups in the United States. Drug Alcohol Depend. 2016; 165:181–90. [PubMed: 27317045]
78. Brown QL, Sarvet AL, Shmulewitz D, Martins SS, Wall MM, Hasin DS. Trends in marijuana use among pregnant and nonpregnant reproductive-aged women, 2002–2014. JAMA. 2017; 317(2): 207–9. [PubMed: 27992619]
79. Han BH, Sherman S, Mauro PM, Martins SS, Rotenberg J, Palamar JJ. Demographic trends among older cannabis users in the United States, 2006–13. Addiction. 2017; 112(3):516–25. [PubMed: 27767235]

80. Salas-Wright CP, Vaughn MG, Cummings-Vaughn LA, Holzer KJ, Nelson EJ, AbiNader M, et al. Trends and correlates of marijuana use among late middle-aged and older adults in the United States, 2002–2014. Drug Alcohol Depend. 2017; 171:97–106. [PubMed: 28063338]
81. Grucza RA, Agrawal A, Krauss MJ, Bongu J, Plunk AD, Cavazos-Rehg PA, et al. Declining prevalence of marijuana use disorders among adolescents in the United States, 2002 to 2013. J Am Acad Child Adolesc Psychiatry. 2016; 55(6):487–94 e6. [PubMed: 27238067]
82. Han B, Compton WM, Jones CM, Blanco C. Cannabis use and cannabis use disorders among youth in the United States, 2002–2014. J Clin Psychiatry. 2017; 78(9):1404–13. [PubMed: 28686820]
83. Miech R, Johnston L, O'Malley PM. Prevalence and attitudes regarding marijuana use among adolescents over the past decade. Pediatrics. 2017; 140(6).
84. Johnson RM, Fairman B, Gilreath T, Xuan Z, Rothman EF, Parnham T, et al. Past 15-year trends in adolescent marijuana use: Differences by race/ethnicity and sex. Drug Alcohol Depend. 2015; 155:8–15. [PubMed: 26361714]
85. Salas-Wright CP, Vaughn MG, Todic J, Cordova D, Perron BE. Trends in the disapproval and use of marijuana among adolescents and young adults in the United States: 2002–2013. Am J Drug Alcohol Abuse. 2015; 41(5):392–404. [PubMed: 26156683]
86. Monitoring the Future. Table 2: Trends in annual prevalence of use of various drugs in grades 8, 10, and 12 [Internet]. Ann Arbor (MI): University of Michigan Available from: http://www.monitoringthefuture.org/data/17data/17drtbl2.pdf.
87. Pacek LR, Mauro PM, Martins SS. Perceived risk of regular cannabis use in the United States from 2002 to 2012: Differences by sex, age, and race/ethnicity. Drug Alcohol Depend. 2015; 149:232–44. [PubMed: 25735467]
88. Johnston LD, O'Malley PM, Miech RA, Bachman JG, Schulenberg JE. Demographic subgroup trends among adolescents in the use of various licit and illicit drugs, 1975–2016 [Internet]. Ann Arbor (MI): Institute for Social Research, University of Michigan; 2017 Available from: http://www.monitoringthefuture.org/pubs/occpapers/mtf-occ88.pdf.
89. Lanza ST, Vasilenko SA, Dziak JJ, Butera NM. Trends among U.S. high school seniors in recent marijuana use and associations with other substances: 1976–2013. J Adolesc Health. 2015; 57(2): 198–204. [PubMed: 26206440]
90. Miech RA, Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE, Patrick ME. Monitoring the Future national survey results on drug use, 1975–2017: Volume I, secondary school students. Ann Arbor (MI): Institute for Social Research, University of Michigan; 2018 Available from: http://monitoringthefuture.org/pubs/monographs/mtf-vol1_2017.pdf.
91. Keyes KM, Wall M, Feng T, Cerda M, Hasin DS. Race/ethnicity and marijuana use in the United States: Diminishing differences in the prevalence of use, 2006–2015. Drug Alcohol Depend. 2017; 179:379–86. [PubMed: 28846954]
92. Wilkinson ST, van Schalkwyk GI, Davidson L, D'Souza DC. The formation of marijuana risk perception in a population of substance abusing patients. Psychiatr Q. 2016; 87(1):177–87. [PubMed: 25982082]
93. Sarvet AL, Wall MM, Keyes KM, Cerda M, Schulenberg JE, O'Malley PM, et al. Recent rapid decrease in adolescents' perception that marijuana is harmful, but no concurrent increase in use. Drug Alcohol Depend. 2018; 186:68–74. [PubMed: 29550624]
94. Cerda M, Wall M, Keyes KM, Galea S, Hasin D. Medical marijuana laws in 50 states: Investigating the relationship between state legalization of medical marijuana and marijuana use, abuse and dependence. Drug Alcohol Depend. 2012; 120(1–3):22–7. [PubMed: 22099393]
95. Martins SS, Mauro CM, Santaella-Tenorio J, Kim JH, Cerda M, Keyes KM, et al. State-level medical marijuana laws, marijuana use and perceived availability of marijuana among the general U.S. population. Drug Alcohol Depend. 2016; 169:26–32. [PubMed: 27755989]
96. Wen H, Hockenberry JM, Cummings JR. The effect of medical marijuana laws on adolescent and adult use of marijuana, alcohol, and other substances. J Health Econ. 2015; 42:64–80. [PubMed: 25863001]

97. Kerridge BT, Chou SP, Pickering RP, Ruan WJ, Huang B, Jung J, et al. Changes in the prevalence and correlates of cocaine use and cocaine use disorder in the United States, 2001–2002 and 2012–2013. Addict Behav. 2018; 90:250–7. [PubMed: 30471553]

98. Mital S, Windle M, Cooper HLF, Crawford ND. Trends in non-medical prescription opioids and heroin co-use among adults, 2003–2014. Addict Behav. 2018; 86:17–23. [PubMed: 29778489]

99. Cheng HG, Anthony JC. A new era for drinking? Epidemiological evidence on adolescent male-female differences in drinking incidence in the United States and Europe. Soc Psychiatry Psychiatr Epidemiol. 2017; 52(1):117–26. [PubMed: 27915406]

100. Miech RA, Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE, Patrick ME. Monitoring the Future national survey results on drug use, 1975–2016: Volume I, secondary school students. Ann Arbor (MI): Institute for Social Research, University of Michigan; 2017 Available from: http://www.monitoringthefuture.org/pubs/monographs/mtf-vol1_2016.pdf.

101. Martins SS, Segura LE, Santaella-Tenorio J, Perlmutter A, Fenton MC, Cerda M, et al. Prescription opioid use disorder and heroin use among 12–34 year-olds in the United States from 2002 to 2014. Addict Behav. 2017; 65:236–41. [PubMed: 27614657]

102. National Center for HIV/AIDS VH, STD, and TB Prevention. Trends in the prevalence of marijuana, cocaine, and other illegal drug use, national YRBS: 1991–2015 [Internet]. Centers for Disease Control and Prevention. Available from: https://www.cdc.gov/healthyyouth/data/yrbs/pdf/trends/2015_us_drug_trend_yrbs.pdf.

103. Keyes KM, Gary DS, Beardslee J, Prins SJ, O'Malley PM, Rutherford C, et al. Joint effects of age, period, and cohort on conduct problems among American adolescents from 1991 through 2015. Am J Epidemiol. 2018; 187(3):548–57. [PubMed: 28679165]

104. Centers for Disease Control and Prevention. Trends in the prevalence of suicide-related behavior, national YRBS: 1991–2015 [Internet]. Division of Adolescent and School Health, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention. Available from: https://www.cdc.gov/healthyyouth/data/yrbs/pdf/trends/2015_us_suicide_trend_yrbs.pdf.

105. Curtin SC, Warner M, Hedegaard H. Increase in suicide in the United States, 1999–2014. NCHS Data Brief. 2016; (241):1–8.

106. Twenge JM, Campbell WK. Associations between screen time and lower psychological well-being among children and adolescents: Evidence from a population-based study. Prev Med Rep. 2018; 12:271–83. [PubMed: 30406005]

107. Han B, Compton WM, Blanco C, Jones CM. Trends in and correlates of medical marijuana use among adults in the United States. Drug Alcohol Depend. 2018; 186:120–9. [PubMed: 29567626]

108. Wall MM, Olfson M, Hasin D, Liu J, Blanco C. Use of marijuana exclusively for medical purposes. Drug Alcohol Depend. (in press).

Table 1.

Surveys with national data on time trends in cannabis use and cannabis use disorder

Survey	Representation	Years of consistent data collection	Ages	Sample size	Population	Survey methodology[a]	Funder	Cannabis outcomes of interest
Adults								
National Survey on Drug Use and Health (NSDUH)	National; state-level	2002-present (annual)	≥18	~47,000/ year	Non-institutionalized individuals in households and some group quarters	Interviewer- and self-administered computer-assisted assessments	SAMHSA	Cannabis use and frequency; DSM-IV cannabis use disorder
National Institute on Alcohol Abuse and Alcoholism (NIAAA) Surveys	National	1991–1992 (NLAES) 2001–2002 (NESARC) 2012–2013 (NESARC-III)	≥18	42,862 43,093 36,309	Non-institutionalized individuals and some group quarters	Similar interviewer-administered assessment methods	NIAAA, NIDA	Cannabis use and frequency; DSM-IV cannabis use disorder
National Alcohol Survey (NAS)	National	1979–2015 (every 4–6 years)	≥18	37,357	Adult household	Interviewer-administered assessments	ARG	Cannabis use
Adolescents								
National Survey on Drug Use and Health (NSDUH)	National; state-level	2002-present (annual)	12–17	~23,000/ year	Non-institutionalized individuals in households	Interviewer- and self-administered computer-assisted assessments	SAMHSA	Cannabis use and frequency; cannabis use disorder
Monitoring the Future (MTF)	National	1991-present (annual, 8th and 10th grades); 1976-present (annual, 12th grade)	8th, 10th, and 12th grades	~50,000/ year	Students	Self- administered questionnaires	NIDA	Cannabis use and frequency
Youth Risk Behavior Surveillance (YRBS) System	National; state-level (not all states included)	1991-present (biennial)	9th-12th grades	~15,000/ year	Students	Self- administered questionnaires	CDC	Cannabis use and frequency

NIDA = National Institute on Drug Abuse, National Institutes of Health; NLAES = National Longitudinal Alcohol Epidemiologic Survey; NESARC = National Epidemiologic Survey on Alcohol and Related Conditions; SAMHSA = Substance Abuse and Mental Health Services Administration; ARG = Alcohol Research Group, Public Health Institute, Emeryville, CA, USA; CDC = Centers for Disease Control and Prevention, US Department of Health and Human Services; DSM-IV = Diagnostic & Statistical Manual, American Psychiatric Association, 4th edition (1994); CUD = Cannabis use disorder

[a]All modes maintained strict confidentiality; specifically, for students, parents and school staff cannot access responses

Table 2A.

Adult studies with statistical tests of trends in cannabis use and cannabis use disorder (CUD), overall.

Reference	Data source	Ages	Years	Change over time
Compton 2004 (25)	NIAAA surveys	≥18	1991–1992 (NLAES) 2001–2002 (NESARC)	*Past year use:* no significant change *Past year CUD:* significant increase
Hasin 2015 (2)	NIAAA surveys	≥18	2001–2002 (NESARC) 2012–2013 (NESARC-III)	*Past year use:* significant increase *Past year CUD:* significant increase
Azofeifa 2016 (6)	NSDUH	≥18	2002–2014	*Past month use:* significant increase; descriptively, increased after 2007 *Past month daily/near daily use*: significant increase; descriptively, increased after 2007 *Past year use:* significant increase; descriptively, increased after 2007 *Past year daily/near daily use:* significant increase; descriptively, increased after 2007
Compton 2016 (1)	NSDUH	≥18	2002–2014	*Past year use:* significant increase 2002 to 2014; no significant change 2002 to 2007; significant increase 2007 to 2014 *Past year daily/near daily use:* significant increase 2002 to 2014; no significant change 2002 to 2007; significant increase 2007 to 2014 *Past year mean number of days used:* significant increase 2002 to 2014; no significant change 2002 to 2007; significant increase 2007 to 2014 *Past year CUD:* no significant change
Grucza 2016 (3)	NSDUH	≥18	2002–2013	*Past year use:* significant increase *Past year CUD:* no significant change
Carliner 2017 (4)	NSDUH	≥18	2002–2014	*Past year use:* significant increase 2002 to 2014; no significant change 2002 to 2007; significant increase 2007 to 2014
Kerr 2007 (68)	NAS	≥18	1984–2000	*Past year use:* significant decrease
Kerr 2018 (5)	NAS	≥18	1984–2015	*Past year use:* significant increase; descriptively, increased after 2004–2005

Table 2B.

Adult studies with statistical tests of trends in cannabis use and cannabis use disorder (CUD) by demographic groups

Characteristic	Data source	Ages	Years	Trends over time within subgroups	Tests of whether time trends differed between demographic subgroups
Gender					
Compton 2004 (25)	NIAAA surveys	≥18	1991–1992 (NLAES) 2001–2002 (NESARC)	**Men.** *Past year use*: no significant change *Past-year CUD*: no significant change **Women.** *Past year use*: no significant change *Past-year CUD*: significant increase	Not tested
Hasin 2015 (2)	NIAAA surveys	≥18	2001–2002 (NESARC) 2012–2013 (NESARC-III)	**Men.** *Past year use*: significant increase *Past-year CUD*: significant increase **Women.** *Past year use*: significant increase *Past-year CUD*: significant increase	Not tested
Carliner 2017 (4)	NSDUH	≥18	2002–2014	**Men.** *Past year use:* significant increase overall 2002 to 2014; no significant change 2002 to 2007; significant increase 2007 to 2014 **Women.** *Past year use:* significant increase overall 2002 to 2014; significant decrease 2002 to 2007; significant increase 2007 to 2014	Significantly greater increase in **men** than in **women** from 2002 to 2014 and 2007 to 2014. From 2007 to 2014, the greater increases in men as compared to women were observed in income levels **0-$19,999** and **$20,000-$49,999**.
Kerr 2007 (68)	NAS	≥18	1984–2000	**Men.** *Past year use:* significant decrease **Women.** *Past year use:* no significant change	Not tested
Kerr 2018 (5)	NAS	≥18	1984–2015	**Men.** *Past year use*: no significant change **Women.** *Past year use:* significant increase (descriptively, increased after 2004–2005)	Not tested
Age					
Compton 2004 (25)	NIAAA surveys	≥18	1991–1992 (NLAES) 2001–2002 (NESARC)	**18–29.** *Past year use*: significant increase *Past year CUD*: significant increase **30–44.** *Past year use*: no significant change *Past year CUD*: no significant change **45–64.** *Past year use*: significant increase *Past year CUD*: significant increase **≥65.** *Past year use*: no significant change *Past year CUD*: no significant change	Not tested
Hasin 2015 (2)	NIAAA surveys	≥18	2001–2002 (NESARC) 2012–2013 (NESARC-III)	**18–29.** *Past year use*: significant increase *Past-year CUD*: significant increase **30–44.** *Past year use*: significant increase *Past-year CUD*: significant increase **45–64**. *Past year use*: significant increase *Past year CUD*: significant increase **≥65.** *Past year use*: significant increase *Past year CUD*: no significant change	Not tested
Azofeifa 2016 (6)	NSDUH	≥18	2002–2014	**18–25.** *Past month use:* significant increase *Past month daily/near daily use:* significant increase *Past year use:* significant increase *Past year daily/near daily use:* significant increase *Past year CUD:* significant decrease **≥26** *Past month use:* significant increase *Past month daily/near daily use:* significant increase *Past year use:* significant increase *Past year daily/near daily use:* significant increase *Past year CUD:* no significant change	Not tested

Characteristic	Data source	Ages	Years	Trends over time within subgroups	Tests of whether time trends differed between demographic subgroups
				26–34. *Past month use:* significant increase **35–44.** *Past month use:* significant increase **45–54.** *Past month use:* significant increase **55–64.** *Past month use:* significant increase **≥65.** *Past month use:* significant increase	
Mauro 2018 (76)	NSDUH	≥18	2002–2014 (examined overall, and by 2002–2007, 2007–2014)	**18–25.** *Past year daily use*: significant increase overall 2002 to 2014; significant increase 2007 to 2014 **26–34.** *Past year daily use*: significant increase overall 2002 to 2014; significant increase 2007 to 2014 **35–49.** *Past year daily use*: significant increase overall 2002 to 2014; significant increase 2007 to 2014 **50–64.** *Past year daily use*: significant increase overall 2002 to 2014; significant increase 2007 to 2014 **≥65.** *Past year daily use*: no significant change overall 2002 to 2014; significant increase 2007 to 2014	No significant differences in the increases from 2007 to 2014 between ages **18–25**, **26–34**, **35–49**, and **50–64** Significantly lower increase from 2007 to 2014 for ages **≥65** as compared to **18–25** and **26–34**
Race/ethnicity					
Compton 2004 (25)	NIAAA surveys	≥18	1991–1992(NLAES) 2001–2002 (NESARC)	**White.** *Past year use*: No significant change *Past year CUD*: No significant change **Black.** *Past year use*: No significant change *Past year CUD:* significant increase **Hispanic.** *Past year use*: No significant change *Past year CUD:* significant increase	Not tested
Hasin 2015 (2)	NIAAA surveys	≥18	2001–2002 (NESARC) 2012–2013 (NESARC-III)	**White.** *Past year use*: significant increase *Past year CUD*: significant increase **Black.** *Past year use*: significant increase *Past year CUD*: significant increase **Hispanic.** *Past year use*: significant increase *Past year CUD*: significant increase **Asian.** *Past year use*: significant increase *Past year CUD*: significant increase **Native American.** *Past year use*: significant increase *Past year CUD*: no significant change	Not tested
Wu 2016 (77)	NSDUH	≥18	2005–2013	**White.** *Past year CUD*: no significant change **Black.** *Past year CUD*: no significant change **Hispanic.** *Past year CUD*: no significant change **Asian.** *Past year CUD*: no significant change **Native American.** *Past year CUD*: no significant change **Native Hawaiian/Pacific Islander.** *Past year CUD*: no significant change **Mixed race.** *Past year CUD*: no significant change	Not tested
Income					
Hasin 2015 (2)	NIAAA surveys	≥18	2001–2002 (NESARC) 2012–2013 (NESARC-III)	**0-$19,999.** *Past year use:* significant increase *Past year CUD:* significant increase **$20,000-$34,999.** *Past year use:* significant increase *Past year CUD:* significant increase **$35,000-$69,999.** *Past year use:* significant increase *Past year CUD:* significant increase **$70,000+.** *Past year use:* significant increase *Past year CUD:* significant increase	Not tested
Carliner 2017 (4)	NSDUH	≥18	2007–2014	**0-$19,999.** *Past year use:* significant increases in men, women *Past year daily use:* significant increases in men, women **$20,000-$49,999.** *Past year use:* significant increases in men, women *Past year daily use:* significant increases in men, women **$50,000-$74,999.** *Past year use:* significant increases in men, women	Not tested

Characteristic	Data source	Ages	Years	Trends over time within subgroups	Tests of whether time trends differed between demographic subgroups
				Past year daily use: significant increases in men, women **$75,000+.** *Past year use:* significant increases in men, women *Past year daily use:* significant increases in men, women	
Education					
Hasin 2015 (2)	NIAAA surveys	≥18	2001–2002 (NESARC) 2012–2013 (NESARC-III)	**Less than high school.** *Past year use:* significant increase *Past year CUD:* significant increase **Completed high school.** *Past year use:* significant increase *Past year CUD:* significant increase **Some college or more.** *Past year use:* significant increase *Past year CUD:* significant increase	Not tested
Azofeifa 2016 (6)	NSDUH	≥18	2002–2014	**Less than high school.** *Past month use:* significant increase **High school graduate.** *Past month use:* significant increase **Some college.** *Past month use:* significant increase **College graduate.** *Past month use:* significant increase	Not tested
Marital status					
Hasin 2015 (2)	NIAAA surveys	≥18	2001–2002 (NESARC) 2012–2013 (NESARC-III)	**Married/cohabiting.** *Past year use:* significant increase *Past year CUD:* significant increase **Previously married (widowed/separated/divorced).** *Past year use:* significant increase *Past year CUD:* significant increase **Never married.** *Past year use:* significant increase *Past year CUD:* significant increase	Not tested
Region					
Hasin 2015 (2)	NIAAA surveys	≥18	2001–2002 (NESARC) 2012–2013 (NESARC-III)	**Northeast.** *Past year use:* significant increase *Past year CUD:* significant increase **South.** *Past year use:* significant increase *Past year CUD:* significant increase **West.** *Past year use:* significant increase *Past year CUD:* significant increase **Midwest.** *Past year use:* significant increase *Past year CUD:* significant increase	Not tested
Urbanicity					
Hasin 2015 (2)	NIAAA surveys	≥18	2001–2002 (NESARC) 2012–2013 (NESARC-III)	**Urban.** *Past year use:* significant increase *Past year CUD:* significant increase **Rural.** *Past year use:* significant increase *Past year CUD:* significant increase	Not tested
Special groups					
Pregnant women					
Brown 2017 (78)	NSDUH	18–44	2002–2014	**Pregnant women.** *Past month use:* significant increase *Past year use:* significant increase **Non-pregnant women.** *Past month use:* significant increase *Past year use:* significant increase	No significant difference in the increases in **pregnant** and **non-pregnant women**
Older individuals					

Characteristic	Data source	Ages	Years	Trends over time within subgroups	Tests of whether time trends differed between demographic subgroups
Han 2017 (79)	NSDUH	≥50	2006–2013	**Overall**. *Past year use*: significant increase By **gender**. *Past year use*: significant increases in men, women By **age.** *Past year use*: significant increases in ages 50–64, ≥65 By **race/ethnicity**. *Past year use*: significant increase in White; no significant change in Black, Hispanic, Other By **income.** *Past year use*: significant increase in $0-$19,999, $20,000-$49,999; no significant change in $50,000-$74,999, $75,000+ By **education.** *Past year use*: significant increase in less than high school, high school, some college, college graduate By **marital status.** *Past year use*: significant increase in married, divorced/separated; no significant change in widowed, never married	Tested for differential trends by **gender** and **age** and found no significant differences
Salas-Wright 2017 (80)	NSDUH	≥50	2002–2014	**Ages 50–64.** *Past year use*: significant increase (descriptively, increase from 2008) **Ages ≥65**. *Past year use*: significant increase (descriptively, increase from 2007)	Not tested
Disabled adults of working age					
Glazier 2013 (67)	NSDUH	18–64	2002–2010	**Disabled adults.** *Past month use:* significant increase **Non-disabled adults.** *Past month use:* significant increase	Significantly greater increase in **disabled adults** than **non-disabled adults**

NSDUH = National Survey on Drug Use and Health; NIAAA = National Institute on Alcohol Abuse and Alcoholism; NLAES= National Longitudinal Alcohol Epidemiologic Survey; NESARC = National Epidemiologic Survey on Alcohol and Related Conditions; NAS = National Alcohol Survey; CUD = DSM-IV Cannabis use disorder (dependence or abuse)

[a]Sample n for 18+ not provided in manuscript

Table 3.

Trends in past year cannabis use and DSM-IV Cannabis Use Disorder between NESARC (2001–2002; N=43,093) and NESARC-III (2012–2013; N=36,309) by sociodemographic subgroups

	Any cannabis use				*DSM-IV Cannabis Use Disorder*			
	Prevalence % (SE)		**Change over time from NESARC to NESARC-III[a] (SE), p-value**	**Difference in change over time between subgroups[b] (SE), p-value**	**Prevalence % (SE)**		**Change over time from NESARC to NESARC-III[a] (SE), p-value**	**Difference in change over time between subgroups[b] (SE), p-value**
	NESARC survey	**NESARC-III survey**			**NESARC survey**	**NESARC-III survey**		
Gender								
Men	5.6 (.24)	12.3 (.40)	6.7 (.47), p≤.0001	2.4 (.52), p≤.0001	2.2 (.14)	4.2 (.21)	2.0 (.25), p≤.0001	1.1 (.27), p≤.0001
Women	2.6 (.14)	6.9 (.29)	4.3 (.32), p≤.0001	Reference	0.8 (.07)	1.7 (.13)	0.9 (.15), p≤.0001	Reference
Age, years								
18–29	10.5 (.47)	21.2 (.67)	10.7 (.82), p≤.0001	Reference	4.4 (.30)	7.5 (.45)	3.1 (.54), p≤.0001	Reference
30–34	5.0 (.47)	13.2 (.69)	8.2 (.83), p≤.0001	−2.5 (1.12), p=.029	1.4 (.23)	4.0 (.49)	2.6 (.54), p≤.0001	−0.5 (.75), p=.52
35–44	3.7 (.27)	8.6 (.50)	4.8 (.57), p≤.0001	−5.8 (.87), p≤.0001	1.1 (.13)	2.4 (.23)	1.4 (.26), p≤.0001	−1.7 (.57), p=003
45+	1.1 (.10)	4.4 (.21)	3.4 (.23), p≤.0001	−7.3 (.83), p≤.0001	0.3 (.05)	1.0 (.10)	0.7 (.11), p≤.0001	−2.4 (.56), p≤.0001
Race/ethnicity								
White	4.1 (.17)	9.4 (.34)	5.3 (.38), p≤.0001	Reference	1.4 (.10)	2.7 (.16)	1.3 (.19), p≤.0001	Reference
Black	4.7 (.35)	12.7 (.64)	8.0 (.73), p≤.0001	2.7 (.80), p=.001	1.8 (.22)	4.5 (.39)	2.7 (.45), p≤.0001	1.4 (.49), p=.004
Other	4.3 (.55)	7.6 (.61)	3.2 (.82), p≤.0001	−2.1 (.90), p=.02	1.8 (.37)	2.2 (.37)	0.4 (.53), p=.41	−0.9 (.56), p=.11
Hispanic	3.3 (.31)	8.4 (.50)	5.1 (.59), p≤.0001	−0.2 (.65), p=.73	1.2 (.17)	2.8 (.22)	1.6 (.28), p≤.0001	0.3 (.31), p=.41
Income								
$0–19,999	6.3 (.34)	15.6 (.61)	9.3 (.70), p≤.0001	Reference	2.3 (.18)	5.4 (.35)	3.1 (.40), p≤.0001	Reference
$20,000–34,999	4.2 (.28)	9.8 (.47)	5.6 (.54), p≤.0001	−3.7 (.79), p≤.0001	1.4 (.16)	2.8 (.26)	1.4 (.30), p≤.0001	−1.7 (.45), p=.0002
$35,000–69,999	3.4 (.23)	8.4 (.33)	5.0 (.40), p≤.0001	−4.4 (.72), p≤.0001	1.3 (.14)	2.5 (.17)	1.2 (.22), p≤.0001	−1.9 (.44), p≤.0001
$70,000+	2.8 (.24)	5.9 (.33)	3.2 (.41), p≤.0001	−6.2 (.77), p≤.0001	0.8 (.11)	1.5 (.15)	0.7 (.19), p=.0003	−2.4 (.44), p≤.0001
Education								
<High School	4.5 (.38)	9.7 (.51)	5.2 (.63), p≤.0001	0.1 (.66), p=.88	1.8 (.23)	3.3 (.34)	1.5 (.42), p=.0002	0.2 (.42), p=.61
High School	4.0 (.26)	10.4 (.43)	6.4 (.50), p≤.0001	1.3 (.56), p=.026	1.7 (.15)	3.6 (.27)	1.9 (.31), p≤.0001	0.6 (.34), p=.076
≥Some College	4.0 (.17)	9.1 (.32)	5.1 (.37), p≤.0001	Reference	1.2 (.09)	2.5 (.15)	1.3 (.17), p≤.0001	Reference

	Any cannabis use				*DSM-IV Cannabis Use Disorder*			
	Prevalence % (SE)		**Change over time from NESARC to NESARC-III[a] (SE), p-value**	**Difference in change over time between subgroups[b] (SE), p-value**	**Prevalence % (SE)**		**Change over time from NESARC to NESARC-III[a] (SE), p-value**	**Difference in change over time between subgroups[b] (SE), p-value**
	NESARC survey	**NESARC-III survey**			**NESARC survey**	**NESARC-III survey**		
Marital Status								
Married/ cohabiting	2.1 (.13)	5.5 (.24)	3.4 (.28), p≤.0001	Reference	0.6 (.07)	1.4 (.12)	0.8 (.14), p≤.0001	Reference
Previously married	3.4 (.30)	8.2 (.40)	4.9 (.50), p≤.0001	1.5 (.55), p=.006	1.0 (.17)	2.3 (.25)	1.2 (.30), p≤.0001	0.5 (.34), p=.19
Never married	10.5 (.41)	21.0 (.64)	10.5 (.76), p≤.0001	7.1 (.77), p≤.0001	4.2 (.27)	7.3 (.38)	3.1 (.47), p≤.0001	2.4 (.49), p≤.0001
Region								
Northeast	4.3 (.30)	10.7 (.52)	6.4 (.61), p≤.0001	Reference	1.6 (.16)	3.1 (.30)	1.5 (.34), p≤.0001	Reference
Midwest	4.1 (.25)	9.0 (.64)	4.9 (.69), p≤.0001	−1.5 (.92), p=.11	1.6 (.15)	2.8 (.28)	1.1 (.32), p=.0004	−0.3 (.46), p=.46
South	2.9 (.19)	7.7 (.43)	4.8 (.47), p≤.0001	−1.6 (.77), p=.04	1.0 (.10)	2.6 (.24)	1.6 (.26), p≤.0001	0.2 (.42), p=.73
West	5.6 (.43	11.9 (.50)	6.3 (.66), p≤.0001	−0.1 (.90), p=.96	1.9 (.25)	3.4 (.22)	1.5 (.33), p≤.0001	0.0 (.47), p=1.0
Urbanicity								
Urban	4.3 (.18)	10.1 (.27)	5.9 (.32), p≤.0001	2.0 (.64), p=.002	1.5 (.09)	3.1 (.13)	1.6 (.16), p≤.0001	0.7 (.34), p=.04
Rural	3.3 (.27)	7.2 (.53)	3.9 (.59), p≤.0001	Reference	1.4 (.18)	2.3 (.26)	0.9 (.31), p=.004	Reference

NESARC = National Epidemiologic Survey on Alcohol and Related Conditions

[a] Change over time is calculated as prevalence in NESARC-III minus prevalence in NESARC; prevalences were back-transformed from predicted marginal log-odds

[b] To determine if rates of change over time differed between sociodemographic subgroups, the change over time (prevalence in NESARC-III minus prevalence in NESARC) in the reference subgroup was subtracted from the change over time in each other subgroup. A positive value indicates a greater change than in the reference, while a negative value indicates a lower change than in the reference.

p-values:

[c] <.05;

[d] <.01;

[e] <.001;

[f] ≤.0001

Table 4A.

Adolescent studies with statistical tests of trends in cannabis use and cannabis use disorder (CUD), overall

Reference	Source	Ages	Years	Change over time
Johnson 2015 (84)	YRBS	9th-12th	1999–2013	*Past month use:* significant decrease overall 1999 to 2013, with a significant change in trend direction; descriptively, decrease 1999 to 2007, followed by an increase *Past month frequent use:* significant decrease overall 1999 to 2013, with a significant change in trend direction; decrease 1999 to 2007 followed by an increase
CDC 2016 (102)	YRBS	9th-12th	1991–2015	*Past month use:* no significant change overall 1991 to 2015; significant increase 1991 to 1995; significant decrease 1995 to 2015
Grucza 2016 (81)	NSDUH	12–17	2002–2013	*Past year use:* significant decrease *Past year CUD:* significant decrease
Han 2017 (82)	NSDUH	12–17	2002–2014	*Past year use:* significant decrease overall 2002 to 2014; significant decrease 2002 to 2007; no significant change 2007 to 2014 *Past year CUD:* significant decrease overall 2002 to 2014; significant decrease 2002 to 2007; significant increase 2007 to 2010; significant decrease 2010 to 2014
Mauro 2018 (76)	NSDUH	12–17	2002–2014	*Past year daily use*: no significant change overall 2002 to 2014; significant decrease 2002 to 2007; no significant change 2007 to 2014

MTF = Monitoring the Future; NSDUH = National Survey on Drug Use and Health; YRBS = Youth Risk Behavior Survey

Table 4B.

Adolescent studies with statistical tests of trends in cannabis use and cannabis use disorder (CUD), by demographic groups

Characteristic	Data source	Ages	Years	Trends over time within subgroups	Tests of whether time trends differed between demographic subgroups
Age					
Salas-Wright 2015 (85)	NSDUH	12–17	2002–2013	**Ages 12–14.** *Past year use:* significant decrease Age 12. *Past year use:* no significant change Age 13. *Past year use:* no significant change Age 14. *Past year use:* significant decrease **Ages 15–17.** *Past year use:* significant decrease Age 15. *Past year use:* significant decrease Age 16. *Past year use:* significant decrease Age 17. *Past year use:* no significant change	Not tested
Grucza 2016 (81)	NSDUH	12–17	2002–2013	**Ages 12–14.** *Past year use:* significant decrease *Past year CUD:* significant decrease **Ages 15–17.** *Past year use:* significant decrease *Past year CUD:* significant decrease	*Past year use:* No significant difference in the decrease in **ages 12–14** and **ages 15–17** *Past year CUD:* No significant difference in the decrease in **ages 12–14** and **ages 15–17**
Gender					
Johnson 2015 (84)	YRBS	9th-12th	1999–2013	**Boys.** *Past month use:* significant decrease overall 1999 to 2013, with a significant change in trend direction; descriptively, decrease until 2007 then increase **Girls.** *Past month use:* significant decrease overall 1999 to 2013, with a significant change in trend direction; descriptively, decrease until 2005 then increase	Did not test if rates of change differed by gender overall, but tested the difference in prevalence between **boys** and **girls** each year, showing convergence (smaller differences) over time.
Grucza 2016 (81)	NSDUH	12–17	2002–2013	**Boys.** *Past year CUD:* significant decrease **Girls.** *Past year CUD:* significant decrease	*Past year CUD:* No significant difference in the decrease in **boys** and **girls**
Race/ethnicity					
Keyes 2017 (91)	MTF	8th, 10th, 12th	2006–2015	**White.** *Past month use:* no significant change in 8th grade, 10th grade, 12th grade **Black.** *Past month use:* no significant change in 8th grade; significant increases 10th grade, 12th grade **Hispanic.** *Past month use:* no significant change in 8th grade, 10th grade; significant increase in 12th grade **Multi-racial.** *Past month use:* no significant change in 8th grade, 10th grade; significant increase in 12th grade **Asian.** *Past month use:* no significant change in 8th grade, 10th grade; significant increase in 12th grade	*Past month use:* Significantly greater increase in the **Black** group than the **White** group in 10th grade Significantly greater increases in the **Black, Hispanic, and Multi-racial** groups than the **White** group in 12th grade
Johnson 2015 (84)	YRBS	9th-12th	1999–2013	**White.** *Past month use:* significant decrease **Black.** *Past month use:* significant decrease overall 1999 to 2013, with a significant change in trend direction; descriptively, decrease until 2005 then increase **Hispanic.** *Past month use:* significant decrease overall 1999 to 2013, with a significant change in trend direction; descriptively, decrease until 2007 then increase **Asians.** *Past month use:* significant decrease overall 1999 to 2013, with a significant change in trend direction; descriptively, decrease until 2009 then increase **Multi-racial.** *Past month use:* significant decrease overall 1999 to 2013, with a significant change in	Did not test if rates of change differed by race/ethnicity, but tested the difference in prevalence between **boys** and **girls** each year in each race/ethnicity group, showing complete convergence (no differences) by 2013 for **Black, Hispanic, Asian, Multi-racial** groups.

Characteristic	Data source	Ages	Years	Trends over time within subgroups	Tests of whether time trends differed between demographic subgroups
				trend direction; descriptively, decrease until 2005 then increase	
Grucza 2016 (81)	NSDUH	12–17	2002–2013	**White.** *Past year CUD:* significant decrease **Black.** *Past year CUD:* no significant change **Hispanic.** *Past year CUD:* no significant change **Other.** *Past year CUD:* significant decrease	*Past year CUD:* No significant differences in the decreases in **White, Black**, **Hispanic, Other**

MTF = Monitoring the Future; NSDUH = National Survey on Drug Use and Health; YRBS = Youth Risk Behavior Survey