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ORIGINAL ARTICLE

Assessing the risk of marijuana use disorder among adolescents and adults who use marijuana

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ABSTRACT

Background: The changing political and social climate surrounding marijuana use, coupled with the fact that available estimates of marijuana use disorder prevalence are outdated and do not adequately represent adolescents, underscore the need for up-to-date and comprehensive prevalence estimates of marijuana use disorder. *Objectives*: To provide recent national estimates of marijuana use disorder as a function of usage patterns, age, and other sociodemographic, substance use, and mental health variables. *Methods*: Analyses of data from the 2014 National Survey on Drug Use and Health examined the prevalence of marijuana use disorder among respondents (N = 55,271) with various sociodemographic, substance use, and mental health characteristics. Logistic and multinomial regression analyses examined the correlates of marijuana use disorder as a function of these variables, with a special focus on age. *Results*: In 2014, 3.49% of lifetime, 11.62% of past-year, and 15.32% of past-30-day marijuana users met DSM-IV criteria for a marijuana use disorder; rates among youth generally were at least double those of adults across reported time frame and intensity of use. Regression analyses indicated that young age, black race/ethnicity, greater intensity of use, current tobacco/nicotine use, and alcohol and other drug use disorders were associated with increased odds of a marijuana use disorder. *Conclusions*: A significant proportion of marijuana users, especially youth, are at risk for having a marijuana use disorder, even at relatively low levels of use.

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Introduction

A recent estimate of the prevalence of marijuana use disorder (MUD) among adults in the United States demonstrates a significant increase over the past decade, corresponding to an increase in reported rates of past-year marijuana use (1). However, published studies that have examined the prevalence and correlates of MUD over the years have used different time frames of use (e.g., lifetime and past year), different age ranges, and different diagnostic criteria (e.g., abuse and/or dependence and only dependence). Few have explored variations in MUD prevalence as a function of gradations in use or other known risk factors and most have analyzed data from surveys of adults only, excluding adolescents, despite the fact that adolescents are more susceptible to the adverse effects of marijuana and to developing addiction (2–12).

The most commonly cited estimate of the proportion of marijuana users who develop a MUD is 9.1% (13). This derives from a study that operationalized the disorder as dependence only, based it on the diagnostic criteria of the DSM-III-R (14), and utilized national data collected approximately 25 years ago. Although this study did include older adolescents, it grouped them with young adults (ages 15–24) in its analysis (13).

Another commonly cited study used national data collected in 2001–2002 and estimated the rate of MUD in the total population to be 1.5% and the rate among past-year marijuana users to be 35.6% (15). This analysis operationalized MUD as meeting DSM-IV criteria (16) for abuse or dependence, and derived its estimates from a sample of adults, aged 18 and older. A similar analysis of national data from 2004 to 2005, which operationalized MUD as meeting DSM-IV dependence criteria only, estimated that 8.9% of adults, aged 18 and older, who use marijuana will develop dependence in their lifetime (17). The most recent available national estimate of MUD (operationalized as meeting DSM-IV criteria for abuse or dependence) was 2.9% among adults in the total population and 30.6% among adults reporting past-year use (1).

Against a backdrop of an increase in the potency of marijuana (18), use and acceptance of the drug, low

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perceptions of its harm (19–21), trends toward state-based legalization (22–24), and calls for national legalization, it is important to provide ongoing and up-to-date assessments of MUD prevalence among the people who use the drug. This is especially critical given recent significant shifts in marijuana policy in the United States. Each of the prevalence estimates cited were based on data collected well before states began to legalize marijuana for recreational (and, in most cases, medical) purposes and most were based only on adult samples. The inclusion of adolescents in assessing rates of and risks for MUD is important. National data show that adolescents admitted to publicly funded addiction treatment are diagnosed with a primary MUD at a higher rate than any other substance use disorder; 39% of admissions for a primary MUD are among individuals under age 20, and 56% of all those admitted for a primary MUD reported first using marijuana by age 14 (25).

Most studies examining MUD prevalence estimates also do not present rates as a function of the time frame or intensity of marijuana use, age of initiation, sociodemographic factors associated with risk, or other correlates of MUD, such as other substance use and mental health problems (1,17,26–31). Further, most studies that have examined correlates and risk factors for MUD have used dependence to characterize the disorder, yet notable differences have been found in the few studies that have examined abuse and dependence separately (15,26–29).

The aim of the present study was to address these limitations by providing recent, comprehensive estimates of MUD and the factors associated with MUD risk in the general US population and among specific subgroups, using a large, nationally representative sample.

Method

This study presents secondary analysis of data from the 2014 National Survey on Drug Use and Health (NSDUH), an annual, nationally representative survey of the US noninstitutionalized population (32).

Participants

The 2014 NSDUH public use data file consisted of 55,271 records of individuals aged 12 and older (36,825 for individuals aged 21 and older). The weighted interview response rate was 71.0%, with a final weighted sample size of 265,122,864 (227,139,585 for those aged 21 and older). To ensure an adequate sample size of young respondents, youth were oversampled with a resulting unweighted sample size of 18,446 respondents aged 12–20 (weighted N = 37,983,280). The NSDUH implemented changes to their sampling design in 2014. For a full explanation of these changes, why they were implemented, and their potential implications, see: *National Survey on Drug Use and Health: 2014 and 2015 Redesign Changes* (33). Additional detail regarding the NSDUH's sampling design, approach to missing data (34), and other survey design and processing details can be found at http://www.samhsa.gov. This analysis did not require review by an Institutional Review Board.

Measures

Estimated rates of MUD were examined in relation to the time frame of reported marijuana use (i.e., lifetime, past-year, and past-30-day) in the total sample, and in relation to the reported intensity of marijuana use (i.e., light, moderate, and heavy) among past-30-day users only. The associations between MUD, these usage variables and select sociodemographic, substance use, and mental health variables also were examined.

Sociodemographic variables

Analyses were conducted by respondents' self-reported age, sex, and race/ethnicity (white, black, Hispanic, Native American/Alaskan Native, other).

Age-related analyses divided the sample between adults (aged 21 and older) and youth who may be considered underage (aged 12–20) for the use of legal substances, as well as by more detailed age categories. For the logistic and multinomial regression analyses, age categories included: adolescents (aged 14–17), late adolescents (aged 18–20), young adults (aged 21–25), and adults (aged 26–44). Respondents aged 12–13 and 45 and older were excluded from these latter analyses due to very low rates of reported marijuana use and MUD.

Mental health variables

Reported anxiety and depression were examined as potential correlates of MUD. Respondents were asked to indicate whether a medical professional told them in the past year that they had anxiety and/or depression.

Time frame of marijuana use

Respondents who reported having used marijuana at least once in their lifetime were considered lifetime users (weighted n = 114,857,219), those who reported use at least once in the past 12 months were considered past-year users (weighted n = 34,529,168), and those who reported use at least once in the past 30 days were

considered current users (weighted n = 21,916,925). These categories were not mutually exclusive.

Intensity of marijuana use

Respondents who reported current use indicated the number of days they used marijuana during the past 30 days: light (1–10 days), moderate (11–20 days), and heavy (21–30 days) use (35,36).

Marijuana use disorder

Past-year MUD (abuse and/or dependence) was assessed via responses to items in the NSDUH that corresponded to the symptoms for cannabis use disorders outlined in the DSM-IV. The DSM-IV criteria for substance use disorders include measures assessing abuse (meeting at least four criteria, but not criteria for dependence, in the past 12 months) and dependence (meeting three or more of seven criteria in the past 12 months). The abuse criteria include recurrent use, resulting in failure to fulfill major role obligations or in legal problems, use in physically hazardous situations, and continued use despite persistent social or interpersonal problems. Dependence criteria include: tolerance; withdrawal; taking increasing amounts or using the substance over a longer period than intended; unsuccessful efforts to control use; spending a significant amount of time to obtain, use, or recover from substance use; neglecting important activities because of use; and continuing to use despite physical or psychological problems.

Substance use variables

Reported age of initiation of marijuana use and current use of and addiction to tobacco/nicotine, alcohol, and other drugs were examined as potential correlates of MUD. Current use of tobacco/nicotine products included cigarettes, cigars, snuff, chewing tobacco, pipes, and smokeless tobacco; tobacco/nicotine use disorder was assessed in a past-month time frame only among those who reported current cigarette use, in accordance with the Nicotine Dependence Syndrome Scale (NDSS) criteria (37). Alcohol and other drug use disorders were assessed in accordance with DSM-IV criteria (see criteria summary listed earlier under marijuana use disorder) using a past-year time frame.

Statistical analysis

Bivariate analyses of estimated rates of MUD, overall and by time frame of marijuana use, are presented by the sociodemographic, substance use, and mental health variables. Bivariate analyses of estimated rates of MUD, by marijuana use intensity among current users, are presented by the sociodemographic, substance use, and mental health variables. Cross-tabulations and proportion estimates were computed based on the weighted 2014 NSDUH data set using Stata 11 software. Standard errors were calculated via Taylor series linearization and Stata survey commands were used to denote the weight applied to the dataset prior to analyses. Significance tests were performed using Wald tests, which account for complex survey design (38).

Logistic regression analysis was conducted to discern which factors were associated with increased odds of meeting criteria for MUD. A multinomial logistic regression analysis was performed to estimate the odds of meeting criteria for marijuana abuse or dependence versus no disorder. Age-specific logistic regression analyses assessed which variables were associated with increased odds of MUD in adolescents, young adults, and adults. For all multivariate regression analyses, no multicollinearity issues were detected among the independent variables. To reduce the chance of spurious results, Bonferroni corrections for each logistic regression analysis were utilized. The alpha level of 0.05 was divided by the total number of possible comparisons for multivariate analyses performed within each model.

Results

Marijuana use disorder by time frame of use

Table 1 presents the prevalence of MUD among respondents in the total US population, aged 12 and older, who reported lifetime, past-year, or current marijuana use, overall and by sociodemographic, substance use, and mental health variables. Estimated rates of MUD were 3.49% for lifetime users, 11.62% for past-year users, and 15.32% for current users. Adolescents and young adults, aged 12–20, had significantly higher rates of MUD than adults aged 21 and older. Rates of disorder were lower among females than males and higher among black and Hispanic respondents relative to those who were white or American Indian/Alaskan Native. Respondents who reported first using marijuana at age 14 or younger had a significantly higher rate of MUD relative to those who reported initiating use at age 15 or older.

Rates of MUD were significantly higher among those who reported anxiety or depression. Rates of MUD among lifetime and past-year marijuana users were significantly higher among respondents reporting current tobacco/nicotine and other drug use and among those with tobacco/nicotine, alcohol, or other drug use disorders. Among respondents reporting current

Table 1. Past-year marijuana use disorder (DSM-IV[a]) among lifetime, past-year, and past-30-day marijuana users in the total population, aged 12 and older, by sociodemographic, substance use, and mental health variables, 2014 (weighted percent, *p*-value).

	Lifetime use			Past-year use			Past-30-day use		
	Marijuana abuse	Marijuana dependence	Marijuana use disorder	Marijuana abuse	Marijuana dependence	Marijuana use disorder	Marijuana abuse	Marijuana dependence	Marijuana use disorder
Total	1.31	2.18	3.49	4.36	7.26	11.62	5.64	9.68	15.32
Youth vs. Adult	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*
12–20	6.47	6.95	13.42	8.47	9.10	17.57	10.78	12.65	23.43
21+	0.82	1.73	2.56	3.20	6.75	9.95	4.32	8.92	13.24
Age categories	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*
12–17	8.82	7.69	16.51	10.94	9.54	20.48	13.81	12.41	26.22
18–20	4.93	6.46	11.40	6.70	8.78	15.48	8.81	12.80	21.61
21–25	2.33	5.78	8.12	4.34	10.76	15.10	5.97	14.61	20.58
26–34	1.04	2.84	3.88	2.87	7.83	10.69	3.46	11.15	14.61
35–49	0.61	1.35	1.95	2.79	6.19	8.98	3.73	7.37	11.10
50+	0.43	0.28	0.71	2.82	1.86	4.68	4.30	2.48	6.78
Sex	*.001*	*.001*	*.001*	*.01*	*ns*	*.01*	*.05*	*ns*	*ns*
Female	0.87	1.76	2.62	3.29	6.66	9.94	4.42	9.47	13.90
Male	1.69	2.55	4.23	5.08	7.67	12.74	6.37	9.80	16.17
Race/Ethnicity	*.01*	*.001*	*.001*	*.05*	*.001*	*.001*	*.001*	*.05*	*.001*
White	1.07	1.70	2.77	3.83	6.05	9.88	5.00	8.17	13.17
Black	1.93	4.01	5.94	5.04	10.49	15.54	6.42	13.72	20.14
Hispanic	1.97	3.19	5.16	5.86	9.48	15.34	7.47	12.15	19.62
AI/AN[b]	0.77	2.59	3.36	2.32	7.83	10.15	1.16	10.00	11.16
Other	1.85	2.59	4.44	5.88	8.23	14.12	8.44	12.07	20.51
Marijuana initiation	*.001*	*.001*	*.001*	*.01*	*.001*	*.001*	*ns*	*.001*	*.001*
Age 14 or Younger	2.84	4.99	7.83	5.91	10.38	16.29	6.86	12.49	19.34
Age 15 or older	0.95	1.53	2.48	3.68	5.92	9.60	5.02	8.26	13.28
Past-year anxiety	*.05*	*.01*	*.001*	*ns*	*.05*	*.01*	*ns*	*.05*	*.01*
Yes	2.03	3.41	5.44	5.80	9.74	15.53	7.54	13.19	20.73
No	1.23	2.05	3.28	4.16	6.93	11.10	5.38	9.21	14.59
Past-year depression	*ns*	*.001*	*.01*	*ns*	*.05*	*.01*	*ns*	*.01*	*.05*
Yes	1.31	3.49	4.80	4.15	11.09	15.25	5.19	14.50	19.69
No	1.31	2.02	3.33	4.38	6.76	11.15	5.70	9.03	14.74

Past-30-day Substance use									
Tobacco/Nicotine[c]	*.001*	*.001*	*.001*	*.05*	*.001*	*.001*	*ns*	*.001*	*.001*
Yes	2.00	3.96	5.96	4.83	9.57	14.40	5.81	11.58	17.40
No	0.84	0.97	1.80	3.75	4.33	8.08	5.35	6.45	11.80
Alcohol	*ns*	*.01*	*.05*	*.05*	*ns*	*.01*	*ns*	*ns*	*ns*
Yes	1.29	2.35	3.64	3.91	7.09	11.00	5.28	9.63	14.91
No	1.35	1.78	3.12	5.98	7.88	13.86	7.12	9.89	17.01
Other drug[d]	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*
Yes	5.71	9.18	14.89	8.10	13.02	21.12	9.63	15.41	25.03
No	1.03	1.74	2.76	3.74	6.32	10.06	4.80	8.47	13.27
Other substance use disorders									
Tobacco/Nicotine[e]	*ns*	*.001*	*.001*	*ns*	*.001*	*.01*	*ns*	*.01*	*ns*
Yes	1.61	4.01	5.62	4.07	10.17	14.24	4.98	12.16	17.14
No	1.26	1.89	3.15	4.42	6.61	11.03	5.83	8.98	14.81
Alcohol	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*
Yes	4.13	7.08	11.21	7.93	13.61	21.55	9.94	16.60	26.54
No	0.94	1.53	2.47	3.44	5.64	9.09	4.48	7.81	12.28
Other drug	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*	*.001*
Yes	7.82	12.05	19.87	11.91	18.34	30.26	14.60	20.41	35.00
No	1.13	1.92	3.05	3.89	6.58	10.48	5.03	8.95	13.98

[a]Met DSM-IV criteria for marijuana abuse or dependence.
[b]AI = American Indian; AN = Alaskan Native.
[c]Tobacco/nicotine products include cigarettes, cigars, snuff, chewing tobacco, pipes, and smokeless tobacco.
[d]Illicit drug use and/or misuse of controlled prescription drugs.
[e]Met criteria for a tobacco/nicotine use disorder in the past month, based on responses to the Nicotine Dependence Syndrome Scale. Only those who reported current cigarette use were asked to respond to the NDSS.

marijuana use, MUD rates were significantly higher among those who reported current tobacco/nicotine and other drug use and among those with alcohol and other drug use disorders. Across analyses, rates of marijuana dependence were consistently higher than rates of marijuana abuse.

Marijuana use disorder by intensity of use

Table 2 presents MUD prevalence among respondents, aged 12 and older, who reported light, moderate, or heavy past-30-day marijuana use, overall and by sociodemographic, substance use, and mental health variables. Of respondents who reported current use, 48.17% reported light use (1–10 days), 16.60% reported moderate use (11–20 days), and 35.23% reported heavy use (21–30 days). The prevalence of MUD was consistently higher among heavy (22.35%) or moderate (15.54%) versus light (10.10%) users, and about twice as high among youth versus adults, across categories of marijuana use intensity. Notably, the proportion of young respondents reporting light marijuana use who met criteria for an MUD was very similar to the proportion of adult respondents reporting heavy use who met criteria for an MUD. The highest rate of MUD was found among youth aged 12–17, with 20.02% of those who reported light marijuana use and more than a third (38.60%) of those who reported moderate or heavy marijuana use meeting MUD criteria. When examining MUD rates by intensity of use, there were no significant sex differences. Significant racial/ethnic differences in MUD emerged only among heavy users, and significant differences by age of initiation emerged only among light users.

Anxiety was associated with a higher prevalence of MUD among heavy marijuana users only; depression was not significantly associated with MUD as a function of intensity of use.

Among light and heavy marijuana users, respondents reporting current use of tobacco/nicotine products or other drugs (but not alcohol) had significantly higher rates than nonusers of MUD. Respondents reporting symptoms consistent with an alcohol or other drug use disorder generally had higher rates of MUD across levels of intensity of marijuana use.

Correlates of marijuana use disorder

Table 3 presents logistic and multinomial regression analyses of the odds of having an MUD in the total population, aged 14–44, by sociodemographic, substance use, and mental health variables. In all multivariate analyses, individuals aged 12–13 and 45 and older were excluded due to low rates of reported marijuana use and MUD.

Net of all other variables, compared to adolescents aged 14–17, respondents in every other age category had significantly lower odds of having an MUD. Sex differences were not found, but relative to white respondents, black respondents had significantly higher odds of meeting criteria for an MUD (OR = 1.88, CI = 1.42, 2.15, $p < 0.002$). Of respondents who reported current marijuana use, any level of use relative to no current use was associated with increased odds of MUD, but the odds increased with intensity of use (OR = 8.20 for light, OR = 13.61 for moderate, and OR = 23.59 for heavy users, all $p < 0.002$). Age of initiation was not significantly associated with MUD in the multivariate model, nor was anxiety or depression. Current tobacco/nicotine use (relative to nonuse) was the only substance use variable that was significantly associated with increased odds of MUD (OR = 1.49, CI=1.20, 1.84, $p < 0.002$); current alcohol use was significantly associated with decreased odds of MUD. With regard to measures of substance use disorders, alcohol use disorder (OR = 3.03, CI = 2.41, 3.82, $p < 0.001$), and other drug use disorder (OR = 2.35, CI = 1.51, 3.67, $p < 0.002$), but not tobacco/nicotine use disorder, were significantly associated with increased odds of MUD.

The association of the study variables with the odds of meeting criteria for marijuana abuse versus dependence differed by certain sociodemographic variables. Specifically, females were significantly less likely than males to meet criteria for abuse but not dependence and black and Hispanic respondents were significantly more likely than white respondents to meet criteria for dependence, but not abuse.

Correlates of marijuana use disorder by age

Table 4 presents individual multivariate logistic regression analyses of the correlates of MUDs among adolescents (aged 14–17), young adults (aged 18–20), and adults (aged 21–44). The correlates of MUD differed by age group such that black respondents had significantly increased odds of MUD only among respondents aged 18–44. Although the odds of MUD generally increased with intensity of marijuana use across age groups, the odds were higher and the differences by intensity of use were more striking among adults than youth. Current tobacco/nicotine use was associated with significantly increased odds of MUD and alcohol use was associated with significantly decreased odds of MUD only among adults aged 21–44. Having an

Table 2. Past-year marijuana use disorder (DSM-IV[a]) among light, moderate, and heavy past-30-day marijuana users, aged 12 and older, by sociodemographic, substance use, and mental health variables, 2014 (weighted percent, *p*-value).

	Light use (1–10 days)				Moderate use (11–20 days)				Heavy use (21–30 days)			
	% of current users	Marijuana abuse	Marijuana dependence	Marijuana use disorder	% of current users	Marijuana abuse	Marijuana dependence	Marijuana use disorder	% of current users	Marijuana abuse	Marijuana dependence	Marijuana use disorder
Total	48.17	5.10	5.00	10.10	16.60	5.06	10.48	15.54	35.23	6.65	15.70	22.35
Youth vs. Adult		*.001*	*ns*	*.001*		*.001*	*.05*	*.001*		*.01*	*.001*	*.001*
12–20	57.13	10.81	6.26	17.06	16.07	11.75	14.69	26.44	26.80	10.15	25.05	35.20
21+	45.87	3.27	4.60	7.87	16.74	3.42	9.45	12.86	37.39	6.01	13.98	19.99
Age categories		*.001*	*.001*	*.001*		*.001*	*.001*	*.001*		*.01*	*.001*	*.001*
12–17	66.57	12.80	7.22	20.02	17.20	15.18	23.37	38.56	16.23	16.52	22.08	38.60
18–20	50.99	9.11	5.44	14.55	15.34	9.24	8.35	17.59	33.67	8.16	25.98	34.14
21–25	44.16	5.46	8.67	14.14	16.02	4.10	15.55	19.65	39.82	7.27	20.82	28.09
26–34	41.91	1.47	5.22	6.69	16.20	2.40	9.54	11.94	41.89	5.86	17.71	23.57
35–49	49.48	2.29	3.95	6.25	16.83	7.20	12.59	19.80	33.68	4.11	9.78	13.89
50+	48.07	4.14	1.03	5.17	17.95	—*	0.81	0.81	33.97	6.79	5.43	12.22
Sex		*ns*	*ns*	*ns*		*ns*	*ns*	*ns*		*ns*	*ns*	*ns*
Female	55.24	4.27	4.73	9.00	17.05	3.71	10.98	14.69	27.70	5.17	18.02	23.19
Male	43.95	5.72	5.20	10.92	16.34	5.91	10.17	16.08	39.71	7.27	14.73	22.01
Race/Ethnicity		*ns*	*ns*	*ns*		*.01*	*ns*	*ns*		*ns*	*.01*	*.01*
White	48.68	4.56	4.35	8.90	15.82	3.47	9.56	13.03	35.50	6.28	12.79	19.07
Black	44.51	6.56	5.71	12.27	19.24	8.73	11.48	20.21	36.25	5.03	24.75	29.78
Hispanic	51.30	5.88	6.94	12.82	16.71	8.54	12.08	20.62	32.00	9.46	20.53	29.99
AI/AN[b]	42.44	1.64	7.44	9.09	25.11	—*	17.28	17.28	32.45	1.43	7.71	9.14
Other	44.97	7.13	6.92	14.05	18.01	5.25	13.63	18.87	37.01	11.58	17.58	29.16
Marijuana initiation		*ns*	*.01*	*.001*		*ns*	*ns*	*ns*		*ns*	*ns*	*ns*
Age 14 or younger	40.03	7.00	7.94	14.94	17.18	6.41	10.42	17.00	42.78	6.48	14.46	20.94
Age 15 or older	52.29	4.36	3.86	8.22	16.31	4.34	10.59	14.77	31.40	6.90	17.50	24.40

(*Continued*)

Table 2. (Continued).

	Light use (1–10 days)				Moderate use (11–20 days)				Heavy use (21–30 days)			
	% of current users	Marijuana abuse	Marijuana dependence	Marijuana use disorder	% of current users	Marijuana abuse	Marijuana dependence	Marijuana use disorder	% of current users	Marijuana abuse	Marijuana dependence	Marijuana use disorder
Past-year mental illness												
Anxiety		*ns*	*ns*	*ns*		*ns*	*ns*	*ns*		*ns*	*ns*	*.05*
Yes	43.61	6.68	5.44	12.12	22.77	6.44	12.88	19.32	33.62	9.41	23.44	32.85
No	48.78	4.91	4.95	9.85	15.77	4.79	10.01	14.81	35.44	6.30	14.71	21.01
Depression		*ns*	*.05*	*ns*		*ns*	*ns*	*ns*		*ns*	*ns*	*ns*
Yes	47.24	4.97	8.70	13.67	16.64	7.27	16.48	23.75	36.12	4.52	21.17	25.69
No	48.29	5.11	4.52	9.63	16.60	4.77	9.68	14.45	35.11	6.95	14.95	21.89
Past-30-day Substance use												
Tobacco/ Nicotine[c]		*ns*	*.01*	*.05*		*ns*	*ns*	*ns*		*ns*	*.01*	*.05*
Yes	42.99	5.28	5.99	11.27	17.49	4.98	11.91	16.89	39.52	6.76	17.52	24.29
No	56.94	4.86	3.74	8.60	15.11	5.24	7.67	12.91	27.95	6.39	11.33	17.72
Alcohol		*ns*	*ns*	*ns*		*ns*	*ns*	*ns*		*ns*	*ns*	*ns*
Yes	49.30	4.92	4.66	9.58	16.25	4.66	10.27	14.93	34.45	6.09	16.43	22.52
No	43.35	5.90	6.58	12.49	18.05	6.57	11.27	17.84	38.43	8.75	13.00	21.75
Other drug[d]		*.05*	*ns*	*.001*		*ns*	*ns*	*ns*		*.01*	*.01*	*.001*
Yes	40.74	8.94	8.06	17.01	17.66	6.69	12.94	19.63	41.60	11.54	23.65	35.19
No	49.73	4.43	4.47	8.91	16.38	4.69	9.92	14.62	33.89	5.39	13.64	19.03
Other substance Use disorders												
Tobacco/ Nicotine[e]		*ns*	*ns*	*ns*		*.01*	*.01*	*ns*		*ns*	*ns*	*ns*
Yes	37.40	3.62	4.70	8.32	19.18	2.37	17.18	19.55	43.42	7.30	16.36	23.66
No	51.20	5.40	5.06	10.46	15.88	5.98	8.20	14.18	32.92	6.41	15.45	21.86
Alcohol		*.001*	*.01*	*.001*		*ns*	*.01*	*.01*		*ns*	*.001*	*.001*
Yes	49.91	10.72	8.62	19.33	16.57	8.56	21.26	29.82	33.52	9.47	26.17	35.64
No	47.70	3.51	3.97	7.48	16.61	4.12	7.57	11.69	35.69	5.94	13.04	18.97
Other drug		*.05*	*.05*	*.01*		*ns*	*ns*	*ns*		*.01*	*.01*	*.001*
Yes	40.84	12.75	11.49	24.24	17.39	6.31	18.69	25.00	41.77	19.85	29.84	49.69
No	48.67	4.66	4.63	9.29	16.55	4.97	9.89	14.87	34.78	5.57	14.54	20.12

*No observations.
[a]Met DSM-IV criteria for marijuana abuse or dependence.
[b]AI = American Indian; AN = Alaskan Native
[c]Tobacco/nicotine products include cigarettes, cigars, snuff, chewing tobacco, pipes, and smokeless tobacco.
[d]Illicit drug use and/or misuse of controlled prescription drugs.
[e]Met criteria for a tobacco/nicotine use disorder in the past month, based on responses to the Nicotine Dependence Syndrome Scale. Only those who reported current cigarette use were asked to respond to the NDSS.

Table 3. Multivariate logistic and multinomial logistic regression analysis[a] of past-year marijuana use disorder (DSM-IV[b]) in the total population, aged 14–44, by sociodemographic, substance use, and mental health variables, 2014 (OR for multivariate logistic regression/RRR for multinomial logistic regression, confidence interval).

	Marijuana abuse (RRR, 95% CI)	Marijuana dependence (RRR, 95% CI)	Marijuana use disorder (OR, 95% CI)
Age categories[c] 14–17 (Ref)			
18–20	0.45 (0.32, 0.63)*	0.58 (0.40, 0.85)	0.51 (0.38, 0.68)*
21–25	0.24 (0.17, 0.34)*	0.58 (0.40, 0.83)	0.40 (0.30, 0.54)*
26–44	0.12 (0.08, 0.17)*	0.24 (0.17, 0.34)*	0.17 (0.13, 0.23)*
Sex Male (Ref)			
Female	0.58 (0.41, 0.82)*	0.88 (0.69, 1.12)	0.75 (0.61, 0.93)
Race/Ethnicity White (Ref)			
Black	1.60 (1.06, 2.40)	2.04 (1.47, 2.82)*	1.88 (1.43, 2.48)*
Hispanic	1.40 (0.83, 2.36)	1.68 (1.23, 2.29)*	1.57 (1.15, 2.15)
AI/AN[d]	0.58 (0.25, 1.33)	0.81 (0.39, 1.71)	0.74 (0.39, 1.38)
Other	1.60 (0.89, 2.90)	1.43 (0.93, 2.19)	1.51 (1.13, 2.00)
Intensity of Past-30-day marijuana use			
No current use of marijuana (Ref)			
Light (1–10 days)	9.72 (6.76, 13.98)*	7.10 (5.00, 10.10)*	8.20 (6.27, 10.72)*
Moderate (11–20 days)	10.72 (7.19, 16.00)*	15.52 (10.05, 23.96)*	13.61 (9.94, 18.63)*
Heavy (21–30 days)	17.11 (10.48, 27.96)*	27.65 (19.43, 39.33)*	23.59 (17.48, 31.84)*
Marijuana use initiation			
Age 14 or younger (Ref)			
Age 15 or Older	0.97 (0.67, 1.42)	0.82 (0.61, 1.10)	0.87 (0.67, 1.14)
Past-year mental illness			
No mental illness (Ref)[e]			
Anxiety	1.95 (1.10, 3.45)	1.17 (0.78, 1.75)	1.40 (0.98, 2.01)
Depression	0.67 (0.38,1.18)	1.57 (1.05, 2.34)	1.19 (0.83, 1.71)
Past-30-day substance use			
No past-30 day use (Ref)[f]			
Tobacco/Nicotine[g]	1.27 (0.92, 1.76)	1.65 (1.30, 2.11)*	1.49 (1.20, 1.84)*
Alcohol	0.57 (0.39, 0.83)	0.66 (0.52, 0.84)*	0.62 (0.50, 0.77)*
Other drug[h]	1.40 (0.98, 2.01)	1.19 (0.81, 1.75)	1.26 (0.94, 1.67)
Substance use disorders			
No substance use disorder (Ref)[i]			
Tobacco/Nicotine[j]	0.84 (0.56, 1.26)	1.01 (0.76, 1.34)	0.96 (0.75, 1.22)
Alcohol	3.05 (2.06, 4.52)*	3.04 (2.37, 3.89)*	3.03 (2.41, 3.82)*
Other drug	2.74 (1.74, 4.30)*	2.17 (1.24, 3.80)	2.35 (1.51, 3.67)*

[a]No multicollinearity issues were detected among the independent variables.
[b]Met DSM-IV criteria for marijuana abuse or dependence.
[c]Age categories were condensed to compare odds of marijuana use disorder among adolescents, young adults, and adults. The age variable excludes individuals aged 12–13 and 45 and older due to low rates of marijuana use and marijuana use disorder in these age groups.
[d]AI = American Indian; AN = Alaskan Native
[e]No report of past-year anxiety, depression.
[f]No report of past-30 day use of the specific substance (tobacco/nicotine, alcohol, other drugs).
[g]Tobacco/nicotine products include cigarettes, cigars, snuff, chewing tobacco, pipes, and smokeless tobacco.
[h]Illicit drug use and/or misuse of controlled prescription drugs.
[i]No report of a substance use disorder related to the specific substance (tobacco/nicotine, alcohol, other drug).
[j]Met criteria for a tobacco/nicotine use disorder in the past month, based on responses to the Nicotine Dependence Syndrome Scale. Only those who reported current cigarette use were asked to respond to the NDSS.
Utilizing Bonferroni correction for logistic regression model: *$p < 0.002$; for multinomial logistic regression model: *$p < 0.001$.

alcohol use disorder was associated with a two- to three-fold increase in the odds of MUD across age groups, whereas the odds of MUD among those with other drug use disorders were significantly higher only among adults aged 21–44.

Discussion

The present analyses provide recent prevalence estimates of MUD as a function of the time frame and intensity of marijuana use, age of initiation, and specific sociodemographic, substance use, and mental health characteristics. Unlike most other studies of this nature, we utilized a recent nationally representative sample that included adolescents.

Our findings indicate that, in 2014, 3.49% of lifetime, 11.62% of past-year, and 15.32% of current marijuana users, aged 12 and older, met diagnostic criteria for an MUD.

Across the analyses, we found that the odds of having an MUD were significantly and substantially greater among younger than older respondents who reported marijuana use, regardless of the time frame or intensity of use. This finding is consistent with other research (31, 40–41), as is the more nuanced finding that earlier age of initiation of marijuana use is associated with higher rates of MUD (25,31,39–51). The relationship between age of initiation and MUD was not statistically significant in the multivariate analyses, probably due to the inclusion of the intensity of use variable in the

Table 4. Age-specific multivariate logistic regression analysis[a] of past-year marijuana use disorder (DSM-IV[b]), in the total population, aged 14–44, by sociodemographic, substance use, and mental health variables among adolescents, young adults, and adults, 2014 (OR, confidence interval).

	Marijuana use disorder Age 14–17	Marijuana use disorder Age 18–20	Marijuana use disorder Age 21–44
Sex Male (Ref)			
Female	0.81 (0.59, 1.12)	0.63 (0.42, 0.95)	0.84 (0.62, 1.13)
Race/Ethnicity White (Ref)			
Black	1.02 (0.67, 1.54)	2.42 (1.59, 3.70)*	1.96 (1.37, 2.81)*
Hispanic	1.22 (0.77, 1.92)	1.66 (0.99, 2.79)	1.79 (1.16, 2.76)
AI/AN[c]	0.45 (0.15, 1.33)	0.80 (0.20, 3.21)	0.73 (0.32, 1.67)
Other	1.13 (0.71, 1.81)	1.99 (1.22, 3.26)	1.54 (0.99, 2.39)
Intensity of past-30-day marijuana use			
No current use of marijuana (Ref)			
Light (1–10 days)	2.35 (1.62, 3.42)*	4.98 (2.76, 8.97)*	13.57 (9.26, 19.88)*
Moderate (11–20 days)	4.66 (2.92, 7.44)*	5.90 (2.96, 11.79)*	21.97 (15.15, 31.86)*
Heavy (21–30 days)	3.81 (2.08, 6.98)*	14.29 (7.82, 26.13)*	38.27 (26.11, 56.10)*
Marijuana use initiation			
Age 14 or younger (Ref)			
Age 15 or older	0.57 (0.41, 0.79)*	0.94 (0.62, 1.43)	0.94 (0.67, 1.31)
Past-year mental illness			
No mental illness (Ref)[d]			
Anxiety	1.42 (0.71, 2.85)	1.20 (0.71, 2.03)	1.50 (1.01, 2.25)
Depression	1.11 (0.61, 2.00)	2.23 (1.27, 3.89)	0.99 (0.61, 1.63)
Past-30-day substance use			
No past-30-day use (Ref)[e]			
Tobacco/Nicotine[f]	1.36 (0.99, 1.88)	1.35 (0.91, 1.99)	1.71 (1.28, 2.29)*
Alcohol	0.93 (0.68, 1.28)	0.93 (0.59, 1.46)	0.58 (0.43, 0.78)*
Other drug[g]	1.25 (0.74, 2.13)	1.12 (0.64, 1.96)	1.32 (0.94, 1.84)
Substance use disorder			
No substance use disorder (Ref)[h]			
Tobacco/Nicotine[i]	0.96 (0.51, 1.80)	1.14 (0.64, 2.03)	0.84 (0.63, 1.11)
Alcohol	2.19 (1.37, 3.51)*	2.34 (1.61, 3.41)*	3.37 (2.51, 4.52)*
Other drug	1.92 (0.99, 3.74)	2.08 (1.01, 4.26)	2.45 (1.50, 3.98)*

[a]No multicollinearity issues were detected among the independent variables.
[b]Met DSM-IV criteria for marijuana abuse or dependence.
[c]AI = American Indian; AN = Alaskan Native
[d]No report of past-year anxiety, depression.
[e]No report of past-30-day use of the specific substance (tobacco/nicotine, alcohol, other drugs).
[f]Tobacco/nicotine products include cigarettes, cigars, snuff, chewing tobacco, pipes, and smokeless tobacco.
[g]Illicit drug use and/or misuse of controlled prescription drugs.
[h]No report of a substance use disorder related to the specific substance (nicotine, alcohol, other drug).
[i]Met criteria for a tobacco/nicotine use disorder in the past month, based on responses to the Nicotine Dependence Syndrome Scale. Only those who reported current cigarette use were asked to respond to the NDSS.
Utilizing Bonferroni correction for each logistic regression model: *p <0.003.

model, which accounts for much of the variance in MUD (26–28). In fact, post-hoc analyses, in which we removed the intensity of use variable from the model, resulted in a significant association between early age of initiation and increased odds of MUD.

The age-related findings contribute to the expanding literature documenting the increased risk associated with substance use among young people relative to adults and highlight the need to enhance prevention and early intervention efforts targeted to the adolescent population. This need is especially acute now that more states are legalizing marijuana for medical and recreational purposes, and as young people's perceptions of harm or risk related to marijuana is declining (43–45).

Consistent with prior research (17,40), our findings also indicated that females who reported using marijuana were less likely than their male counterparts to have an MUD across measures of time frame of use. However, when examining sex differences based on intensity of use, we found that although females were more likely than males to report lighter use of marijuana, there were no statistically significant sex differences in the prevalence of MUD by intensity of use. This is consistent with research finding a general heightened susceptibility among females relative to males to addiction, even at lower levels of substance use (46).

With regard to racial/ethnic differences, black respondents were more likely to meet criteria for an MUD relative to white respondents. Some researchers have speculated that the relatively higher rate of MUD among black relative to white marijuana users may be attributable to acculturative stress and racial discrimination (17,47–49), which may affect neurochemical vulnerability to addiction (50), or to genetic factors that predispose black people to an increased risk of addiction (51).

Overall, these findings are consistent with a growing body of literature demonstrating the greater

vulnerability of youth (2–12), women (46), and racial/ethnic minorities (17) to the adverse and addicting effects of addictive substances.

The findings also suggest that a significant proportion of individuals who report marijuana use are at risk not only for MUD (especially younger users), but also for tobacco/nicotine use and meeting criteria for alcohol and other drug use disorders. The lower odds of MUD found among alcohol users is consistent with other research showing relatively low co-occurrence of marijuana and alcohol use (52). However, having an alcohol or other drug use disorder was associated with an increased risk of MUD.

The present findings regarding the prevalence of MUD differ somewhat from those found in prior studies (1,13,15), which may be attributable to methodological inconsistencies. Anthony and colleagues (13) analyzed data from 1990 to 1992 using the National Comorbidity Survey as opposed to our use of data from the 2014 NSDUH. That survey only included respondents aged 15–54 in the 48 coterminous United States and yielded DSM-III-R cannabis dependence rates of 9.1% among lifetime users. This was in comparison to our finding of a DSM-IV 2014 NSDUH rate of dependence of 2.18% among lifetime users aged 12 and older in all 50 states. Compton and colleagues (15), who analyzed data from 2001 to 2002 using the National Epidemiologic Survey on Alcohol and Related Conditions, found that 35.6% of past-year marijuana users, aged 18 and older, met DSM-IV criteria for MUD (abuse and/or dependence). This was in comparison to our finding from the 2014 NSDUH of an MUD rate of 11.62% among past-year users. Restricting our analysis to past-year users aged 18 and older, we found the rate to be only 7.16%.

The differences in rates of MUD found in the present analyses relative to these earlier studies may be due to many factors. While it is possible that the differences reflect actual changes or declines in rates of MUD, it is not possible to draw this conclusion since the analyses were based on different data sets, different sampling frames, and different methods of collecting diagnostic data. The exact means by which diagnostic criteria are determined in the particular datasets employed in a given study can strongly influence the findings regarding prevalence estimates (53).

Limitations

The NSDUH, a reliable and widely used source of national substance use data, relies on self-reports and is conducted in person in the respondents' residences. Given that the survey is conducted face to face and in the home where a parent or guardian may be present, the NSDUH, relative to other national surveys of substance use that are conducted in schools or online, is believed to yield conservative or lower prevalence estimates of substance use among youth (54). The NSDUH estimates also are considered conservative because the survey excludes institutionalized populations, many of which have relatively higher rates of substance use and addiction than the general population.

The NSDUH is a cross-sectional survey; therefore, temporal associations among the variables cannot be inferred. Finally, estimates of MUD in the present analyses were based on data from survey items corresponding to the DSM-IV rather than the newer DSM-5 diagnostic criteria, which eliminate the abuse/dependence distinction and instead include determinations of disorder severity on the basis of the number of criteria met by the individual (55). However, given the considerable evidence that the overall prevalence of substance use disorder diagnoses are not expected to differ substantially as a result of changes in the DSM-5 relative to the DSM-IV criteria (56,57), we believe that the estimates presented here will be applicable to future estimates that utilize measures consistent with DMS-5 criteria.

Conclusions

Using the NSDUH to derive estimates of MUD prevalence in the context of major changes in marijuana-related policies and regulations and for purposes of follow-up over the years may be advisable, given its inclusion of youth in the sample and its administration on an annual basis. Still, future iterations of the survey should be supplemented with more detailed measures of frequency, intensity, duration, dose, form, and potency of marijuana use. As marijuana's legal status expands, as well as the possible modes of delivering the substance (traditional, medical, edible, vaporized), the assessment of its use should expand and become as detailed as possible to allow for the most reliable and valid monitoring of changes in prevalence, trends, and risk for addiction. It also is important to monitor the degree to which people report using marijuana for medical reasons, the types of conditions for which it is reportedly used, and the perceived benefits. Data should be collected in a way that will allow for comparative analysis of marijuana use and the risk of disorder between states as a function of the type of legalization and regulatory procedures each state adopts.

The trend toward marijuana legalization in the United States requires research-based strategies to

ensure that it is not accompanied by increases in marijuana and other substance use disorders, which constitute one of this country's largest preventable health problems. Although the direction of the relationship between the study variables and the risk of MUD cannot be inferred from this study, the findings do suggest that the presence of marijuana use can serve as an indicator or marker of risk for other substance use and substance use disorders. This is especially important for parents, educators, and health professionals to consider as they screen and identify youth for specific substance use risk. Understanding which subgroups (e.g., youth, racial/ethnic minorities, and those who use other addictive substances) are most at risk for MUD allows health professionals and policy makers to better target prevention and intervention strategies to those groups in hopes of preventing or delaying the initiation of use and reducing the likelihood that use will progress to addiction.

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