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Margaret Horton Date

Cannabis Usage Trends

Among Men who have Sex with Men in the United States,

2014-2018

By

Margaret Horton

Master of Public Health

Epidemiology

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B.A., Tulane University, 2014

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An abstract of

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in partial fulfillment of the requirements for the degree of

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in Epidemiology

2019

Abstract

Cannabis Usage Trends

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By Margaret Horton

Background: The role of cannabis in sexual health behaviors and outcomes among American men who have sex with men (MSM) is poorly understood. As medical and recreational legalization become more common, usage is likely to increase. This study evaluates cannabis usage trends and associations with sexual health behaviors/outcomes using five years of survey data from MSM in the United States.

Methods: The American Men's Internet Survey (AMIS) is a serial, cross-sectional survey of men who have sex with men in the United States. Using five years of data from AMIS (n=37,346), we evaluate cannabis usage patterns using the Cochrane-Armitage test for trend and estimate prevalence ratios of cannabis usage and sexual health behaviors/outcomes through modified Poisson regression with robust variance.

Results: Cannabis usage is increasing among American MSM. High frequency use is also increasing among this population. Usage is associated with more serodiscordant condomless anal intercourse (aPR 1.10, 95% CI: 1.04, 1.16), higher PrEP use (aPR 1.11, 95% CI: 1.01, 1.22), and fewer STI diagnoses (aPR: 0.89, 95% CI: 0.82, 0.96).

Conclusions: Cannabis use is increasing among this population. Cannabis users might engage in riskier sexual behaviors than nonusers; however, they also employ protective health measures at a higher frequency.

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Introduction

Men who have sex with men (MSM) in the United States are disproportionately affected by HIV and sexually transmitted infections (STIs) compared to the non-MSM population, accounting for 67% of all new HIV diagnoses in 2016 and 58% of all new primary and secondary syphilis diagnoses in 2017 (1, 2). Additionally, antimicrobial resistant strains of *Neisseria gonorrhoeae* are more common among MSM than among men who have sex with women only (MSWO), posing a substantial threat to both the MSM and non-MSM population in the United States (2). The disproportionate effects of these outcomes are due in part to interconnected sexual networks, concurrent partnerships, and condomless sex (2).

Substance use has been consistently identified as an important factor associated with sexual risk-taking among MSM (3, 4, 5, 6). Most studies focus on the roles of "club drugs," such as ketamine, MDMA (3,4methyl enedioxy methamphetamine)/ecstasy, GHB (γ-hydroxybutyricacid), cocaine, and methamphetamine. However, the substances that fall under the "club drug" umbrella are subject to interpretation, and often vary by time period and by region (7). Club drug usage, and in particular sexualized drug use ("chemsex"), is associated with condomless anal intercourse (3, 4, 8), sex with HIV-status unknown or serodiscordant partners (8), suboptimal anti-retroviral therapy (ART) and pre-exposure prophylaxis (PrEP) adherence (9, 10), and increased bacterial STI incidence (3, 8). Many of these studies collect data on these behaviors in general but are unable to analyze the effect of substance use at the level of individual sexual events. Brown, et al. examined the role of substance use in partner-level interactions, confirming associations between club drug use during the last sexual encounter, condomless anal intercourse, and serodiscordant condomless anal intercourse (3).

However, the Brown study did not analyze cannabis use. Cannabis is typically excluded from analyses of the effect of substance use on sexual risk behavior. Qualitative studies among both MSM and the broader population indicate that cannabis users perceive cannabis as distinct

from other substances, associating it with relaxation (11). Moreover, there is conflicting evidence about whether cannabis use increases sexual risk behaviors and negative health outcomes. Grov et al. concluded that cannabis use is not associated with missed PrEP doses overall, but there is a potential association with individual missed doses (9). Past-year cannabis use is associated with sex with multiple partners among young MSM age 11-32 years old (12). However, others have found no association between cannabis and ART adherence or viral suppression among people living with HIV (13, 14). The overall risk/benefit of cannabis usage is obscured even further when considering distinct individual motivations for use and diversity in cannabis potency and chemical makeup (15).

The broader public health implications of cannabis are still under investigation. Legalization of both medical and recreational cannabis has spread throughout the country and has gained speed in recent years. There are currently 33 states, plus Washington D.C., that have legalized cannabis use in some form. As a result, usage is expected to increase due to higher accessibility and more permissive attitudes (16). Usage prevalence in the United States doubled from 2002-2003 and 2012-2013 (17). Studies have found that usage is associated with both age and gender: men are more likely to use cannabis than women, and younger people are more likely than older people (18, 19, 20). Moreover, the potency of the drug has dramatically increased in recent years. The average concentration of 9-tetrahydrocannabinol (THC), the primary psychoactive chemical in cannabis, rose from 4% in 1995 to 12% in 2014 (21). The increase in potency could exacerbate detrimental health effects (16, 21, 22). Both individual and population health impacts of cannabis are poorly understood. Much of the existing literature examines the association between cannabis use and injury, respiratory complications, cognitive development, and other mental health effects (16, 17, 20, 22, 23, 24). Further research is needed to evaluate cannabis's role in decision-making, risk assessment, and sexual health.

There is not currently enough information available to understand how cannabis affects the health and wellbeing of the MSM population. As usage and potency increase under the evolving legal structure, it is imperative that we understand how cannabis affects health, especially among populations that are under-represented in cannabis research, such as MSM. To address these deficits, this study assesses cannabis usage trends among MSM in the United States from 2014 to 2018. First, we describe trends in cannabis use among MSM over the study period. Second, we examine associations between cannabis use and the following behaviors and outcomes during the 12 months prior to survey response: condomless anal intercourse, serodiscordant condomless anal intercourse, exchange partners, number of partners, post-exposure prophylaxis (PEP) use, PrEP use, STI diagnosis and testing, HIV testing, and current ART use. To our knowledge, this is the first study to examine cannabis usage trends among the MSM population at a national level.

Methods

Participants

This study utilizes five years of cross-sectional survey data (2014-2018) from the American Men's Internet Survey (AMIS), an online behavioral survey of approximately 10,000 MSM in the United States per year. The survey methods have been previously described in detail (25, 26, 27, 28). To participate in the study, respondents must be 15 years of age or older, reside in the United States, and report ever having sex with a man or identify as gay or bisexual. The analysis population (n=37,346) was further restricted to first-time respondents that reported anal intercourse with a man in the past 12 months, residing in one of the 50 states or Washington, D.C., and identifying as gay, bisexual, or heterosexual (Figure 1.).

Demographics, Sexual Behavior, and Substance Use

Survey questions used in this analysis were similar across all AMIS cycles. Demographic covariates (age, region, rurality, income, HIV status, sexual identity, and race) represent the respondent at the time of the survey. Cannabis use, other illicit substance use, and sexual behaviors and outcomes represent behavior in the 12 months preceding the survey. Concurrent partnerships were only measured among men reporting that their most recent sex partner was a main partner and was defined as reporting an additional sex partner at any time during the main partnership. The legal status of cannabis for each respondent was determined using the respondent's survey year and state of residence (see Appendix for details).

Statistical Analysis

Chi-square tests were used to assess the association between cannabis use and demographic characteristics. Cannabis usage trends across time were assessed using Cochran-Armitage test for trend for use in the past 12 months and use at last sexual encounter (29). Among respondents reporting any cannabis use in the past 12 months, annual trends in frequency of cannabis use and legal status in state of residence was assessed by chi-square test. Modified Poisson regression with robust standard errors was used to estimate crude and adjusted prevalence ratios for cannabis use and demographic and sexual behavior outcomes. (30). All adjusted prevalence ratios controlled for race, education, income, age, other illicit substance use, sexual identity, HIV status, 2013 National Center for Health Statistics (NCHS) rural-urban classification scheme (31), and region. Covariates were identified using a directed acyclic graph (32, 33, 34) (Figure 2.). Associations between cannabis use and sexual health behaviors/outcomes were assessed using separate models, controlling for the covariates previously mentioned. All sexual health behavior/outcome models were evaluated for interaction between cannabis use and use of other illicit substances. All statistical analyses were conducted in SAS 9.4 (SAS Institute Inc., Cary, NC, USA.). A spatial representation of reported cannabis prevalence from the 2018 survey was

generated using R Studio 1.1.463, using dplyr, tidycensus, tigris, tmap, and sf packages and the USA Contiguous Albers Equal Area map projection (Figure 3.).

Results

The study population consisted of 37,346 individual respondents across five annual survey cycles. The study population was predominantly white (71.2%), 40 years of age or older (39.2%), homosexual or gay (81%), HIV negative (71.9%), received a college degree or higher (54.9%), resided in the southern United States (38.7%), resided in large central metropolitan areas (40.9%), and earned more than $75,000 per year (37.6%) (Table 1.). Approximately one third reported using any illicit substances, including cannabis, in the past twelve months (34.1%).

Reported cannabis use in the past 12 months increased each year (Figure 4.). In 2014, 23.6% of respondents reported cannabis use. In 2018, this proportion increased to 33.2% ($p < 0.0001$). A similar trend was observed among those reporting only using cannabis and no other substances (8.4% in 2014, 14.7% in 2018, $p < 0.0001$). Moreover, frequent cannabis usage, defined as once a week or more, increased year to year. Among those reporting cannabis use, 32.6% indicated using cannabis more than once a week in 2014 and 38.7% reported doing so in 2018 ($p <0.0001$).

Cannabis use differed by levels of each demographic characteristic. In adjusted models, cannabis prevalence was most strongly associated with other drug use, age, education, and NCHS urban/rural classification (Table 2.). Cannabis usage was 5.48 (95% CI: 5.25, 5.73) times more likely among those reporting other drug use than among those who did not report other drug use. The prevalence of cannabis usage decreased by age (aPR 15-24 vs. 40 or older: 1.74 (1.64, 1.85), aPR 25-29 vs 40 or older: 1.42 (1.32, 1.51), aPR 30-39 vs 40 or older: 1.31 (1.23, 1.40)). Cannabis use was 18% more common among those with less than a high school diploma than among those with a college degree or higher (95% CI: 1.04, 1.33). Cannabis use was also

associated with increasing levels of urbanicity. Compared to non-core areas, cannabis prevalence was 16% (aPR = 1.16, 95% CI: 1.00, 1.33) higher in large central metro areas. Other demographic covariates, race/ethnicity, sexual identity, HIV status, region, and income did not have strong associations in adjusted models.

The prevalence of sexual health behaviors and outcomes reported ranged from 10-75% of the total study population, suggesting substantial heterogeneity in sexual risk (Table 3.). However, some behaviors were more common: 77.7% of respondents reported condomless anal intercourse in the past 12 months and 71.5% reported two or more partners in the past 12 months. Approximately 30% of each of these groups also reported using cannabis in the past 12 months. Among respondents living with HIV, 80.6% reported currently taking ART. Approximately one fourth of ART users also reported cannabis use. Among HIV-negative respondents, 76.5% reported recent HIV testing in the past year. Approximately 30% of this group also reported cannabis use. A small portion of the study population reported receiving money or drugs in exchange for sex (3.1%), but 55.7% of these respondents also reported using cannabis in the past 12 months. This was the largest overlap of reported cannabis usage and sexual health behaviors.

Adjusted prevalence ratios indicate associations between cannabis use and some sexual health behaviors and outcomes, both harmful and protective (Table 4.). Serodiscordant condomless anal intercourse was 10% more common among those reporting cannabis use than among nonusers (aPR = 1.10, 95% CI: 1.04, 1.16). Statistically significant interaction between cannabis and other drug use was only present in the model assessing cannabis use and receiving drugs or payment for sex. Receiving money or drugs in exchange for sex was more common among cannabis-only users and nonusers (aPR: 1.26, 95% CI: 0.99, 1.61). However, this behavior was less common among cannabis users that also used other drugs compared to nonusers (aPR: 0.82 95% CI: 0.67, 1.00). Giving money or drugs for sex was less common among cannabis users than nonusers (aPR 0.83 95%CI: 0.72, 0.96). PrEP use in the past 12 months was 11% more

common among cannabis users than nonusers (95% CI: 1.01, 1.22), but PEP use was 22% less common (95% CI: 0.65, 0.93). Diagnosis with any STI was less common among cannabis users (aPR: 0.89, 95% CI: 0.82, 0.96).

Discussion

Our results suggest that cannabis use is increasing among MSM in the United States. Furthermore, higher frequency of use is becoming more common among users. Our findings indicate that reported cannabis use is associated with increased serodiscordant condomless anal intercourse and exchange sex, but it is also associated with positive health behaviors and outcomes, namely fewer STI diagnoses and increased PrEP use.

Reported condomless anal intercourse and serodiscordant condomless anal intercourse were more common among those also reporting cannabis use. Among Black MSM in Chicago, cannabis use as a sex drug has been associated with CAI and group sex (35). Skalski *et al.* found no association between cannabis use and sexual risk-taking among heterosexual couples, but there are different dynamics, risks, and motivations in regard to sexual risk-taking among that population (36). Despite linkages between acute cannabis use, decision making, and sexual risk taking, the evidence is inconclusive. Others have argued that prolonged, recurring cannabis use affects cognitive development, especially when initiated at a young age (16). Under this hypothesis, frequent users may evaluate risks differently than nonusers. However, two longitudinal studies have indicated decreased verbal recall while sober or under the influence of cannabis for long-term users, but no difference in overall executive function (37, 38). These studies bolster the argument that cannabis use does not drastically affect processing abilities. Nevertheless, additional high-quality research into the acute and long-term effects of cannabis use on decision-making are needed. Current epidemiologic analysis is limited by its observational nature and is further complicated by the diverse chemical composition and effects of cannabis (15, 39).

Our analyses suggest there is greater reported PrEP use among cannabis users, indicating that this population may be more proactive in seeking preventative health measures that are not required to take place at the time of a sexual encounter. Grov found no association between missed PrEP doses and cannabis use overall but did observe variation at the individual level (9). The individual-level differences in the effect of cannabis on PrEP adherence was determined by the significant variance in the random slope for day-level cannabis use in the researchers' mixed model, suggesting that the effect of cannabis use differs from person to person. This result highlights plausible heterogeneity in cognitive effects, doses, and motivations for use. However, there is also evidence from an Atlanta-based, longitudinal study of HIV negative MSM indicating cannabis users are more likely to discontinue PrEP, which is distinct from missed PrEP doses (40, 41). Further research into the specific relationship between cannabis use, PrEP uptake, adherence, and persistence is needed.

Cannabis users in our study reported a lower prevalence of STI diagnoses in the past year. This finding is consistent with a longitudinal analysis of MSM in the Los Angeles area (42). The authors of that paper point to two potential mechanisms for these findings. First, cannabis use is comparatively less risky in terms of acquisition, utilization, and potential legal consequences than that of other drugs, including lower motivation to seek sexual encounters when using heavily. The second mechanism is biological, whereby cannabis use has been tied to lower levels of inflammation, thereby reducing the risk of STI and HIV acquisition. Our analysis did not show any meaningful difference in STI testing, which adds support to the plausibility of these mechanisms.

This study benefits from the inclusion of five years of data from a large, nationwide survey. However, there are several limitations. Its cross-sectional design prevents temporal sequences of exposures and outcomes, thereby limiting causal inference. Moreover, all data are self-reported and participants were asked to recall exposures and outcomes over a 12 month

period. The variables central to this analysis are subject to substantial misclassification, such as sexual behaviors, HIV/STI testing and diagnoses, and substance use. There is evidence that the validity of self-reported cannabis use varies by race among MSM in Atlanta, GA, possibly due to concerns of discrimination and structural inequities in the American criminal justice system (43). Misclassification of cannabis use by race may explain the nonsignificant relationship between race and reported cannabis use in Table 2. Furthermore, a preliminary bias analysis (44) of cannabis use and condomless anal intercourse indicate the findings may be substantially affected by differential misclassification. Crude analysis of condomless anal intercourse and cannabis use stratified by race (African American, White) indicated condomless anal intercourse was more common among cannabis users of both races (PR = 1.30, 1.16, respectively). Using sensitivities and specificities of self-reported cannabis use identified in the literature (43, 45), sensitivity analyses suggest that condomless anal intercourse is less common among cannabis users of both races (PR = 0.37, 0.43, respectively). Another important limitation of this analysis is the exclusion of homelessness and alcohol use from the sexual behavior models. Data on these covariates were not collected every survey cycle, so they could not be included in the models. Homelessness and alcohol use may confound the relationship between cannabis and sexual health behaviors, but we believe that the other covariates adequately control for these unmeasured confounders by proxy.

Our findings, taken in the context of the current literature, suggest that cannabis-using MSM may be more likely to engage in sexual risk behaviors like serodiscordant condomless anal intercourse, but may also be more likely to take PrEP and have fewer STI diagnoses than nonusers, despite equal levels of reported STI testing. This paper adds to the growing body of literature showing the complex relationship between cannabis and sexual health among MSM. However, there are several future research topics that should be explored in order to establish a causal relationship between cannabis use and sexual health behaviors and outcomes. This

information can then inform interventions and policies aimed at reducing negative health outcomes like HIV and STI transmission among this population. Research topics include evaluating event-level associations between cannabis use and sexual health behaviors and outcomes, identifying potential associations between frequency of use and sexual health behaviors and outcomes , determining the acute effects of cannabis on sexual decision-making among this population, evaluating the relationship between cannabis and PrEP use, and identifying the varying contexts of cannabis use, all of which are critical to better understand cannabis's public health impact. As cannabis use increases in the United States, policymakers and public health practitioners will need this information to create evidenced-based policies, interventions, and laws aimed at improving the health and well-being of MSM in the United States.

Conclusion

Cannabis use and frequency of use is increasing among MSM in the United States. Cannabis users may be more likely to engage in sexual risk behaviors like serodiscordant condomless anal intercourse. However, they may also be more likely to take PrEP and have fewer STI diagnoses than nonusers, despite equal levels of reported STI testing. The association between cannabis use and sexual health merits additional research.

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Tables

Table 1. Demographic characteristics and reported cannabis use in the past 12 months among men who have sex with men (MSM) in the United States, American Men's Internet Survey, 2014-2018 (n = 37,346).

	Total AMIS Participants		**Cannabis Usage Past 12 Months**	
	n	**%**	**n**	**%**
Age Category (n = 37,346)				
15-24	10,746	28.8	3,965	38.6
25-29	5,666	15.2	1,813	17.6
30-39	6,302	16.9	1,827	17.8
40 or older	14,632	39.2	2,677	26.0
				p <.0001[a]
Race/Ethnicity (n = 36,763)				
White	26,188	71.2	7,114	70.3
Hispanic/Latino	5,562	15.1	1,707	16.9
Black or African American	2,359	6.4	555	5.5
Asian, Native Hawaiian or other Pacific Islander	947	2.6	203	2.0
American Indian/Alaska Native	262	0.7	68	0.7
Multiracial/Other	1,445	3.9	478	4.7
				p <.0001[a]
Sexual Identity (n = 37,346)				
Homosexual or Gay	30,237	81	8,412	81.8
Bisexual	6,876	18.4	1,823	17.7
Heterosexual or Straight	233	0.6	47	0.5
				p = 0.004[a]
HIV Status (n = 37,346)				
Positive	3,624	9.7	1,029	10.0
Negative	26,864	71.9	7,361	71.6
Unknown (includes never tested)	6,858	18.4	1,892	18.4
				p = 0.45[a]
Education (n = 33,699)				
Less than high school diploma	896	2.7	294	3.3
High School diploma or equivalent	3,264	9.7	895	10.1
Some college or technical degree	11,040	32.8	3,197	36
College degree or post graduate education	18,499	54.9	4,488	50.6
				p <.0001[a]
Region (n = 37,346)				
Northeast	6,566	17.6	1,928	18.8
Midwest	7,652	20.5	2,068	20.1
South	14,436	38.7	3,652	35.5
West	8,692	23.3	2,634	25.6

				p <.0001[a]
NCHS Urban/Rural Classification, 2013 (n = 37,342)				
Large central metro	15,276	40.9	4,597	44.7
Large fringe metro	7,575	20.3	1,961	19.1
Medium metro	7,724	20.7	2,052	20.0
Small metro	3,352	9	879	8.5
Micropolitan	2,337	6.3	551	5.4
Non-core	1,078	2.9	241	2.3
				p <.0001[a]
Income (n = 32,179)				
$0 - 19,999	4,635	14.4	1,598	17.9
$20,00 - 39,999	6,551	20.4	2,006	22.5
$40,000 - 74,999	8,884	27.6	2,350	26.3
$75,000 or more	12,109	37.6	2,980	33.4
				p <.0001[a]
Other illicit drug use (n = 37,346)	7,923	21.2	6,261	p <.0001[a]

[a] p-value associated with corresponding chi-square test

Table 2. Crude and adjusted prevalence ratios of demographic characteristics and reported cannabis use in the past 12 months among men who have sex with men (MSM) in the United States, American Men's Internet Survey, 2014-2018 (n = 37,346).

	Cannabis usage past 12 months	
	Crude PR (95% CI)	**Adjusted PR (95% CI)[a]**
Age Category (n = 37,346)		
15-24	2.02 (1.92, 2.12)	1.74 (1.64, 1.85)
25-29	1.75 (1.65, 1.86)	1.42 (1.32, 1.51)
30-39	1.58 (1.49, 1.68)	1.31 (1.23, 1.40)
40 or older	1.00	1.00
Race/Ethnicity (n = 36,763)		
White	0.82 (0.75, 0.90)	0.97 (0.88, 1.07)
Hispanic/Latino	0.93 (0.84, 1.03)	0.93 (0.83, 1.03)
Black or African American	0.71 (0.63, 0.80)	0.95 (0.83, 1.08)
Asian, Native Hawaiian or other Pacific Islander	0.65 (0.55, 0.76)	0.77 (0.65, 0.92)
American Indian/Alaska Native	0.78 (0.61, 1.01)	0.96 (0.73, 1.27)
Multiracial/Other	1.00	1.00
Sexual Identity (n = 37,346)		
Homosexual or Gay	1.38 (1.04, 1.84)	1.20 (0.86, 1.67)
Bisexual	1.31 (0.98, 1.76)	1.23 (0.88, 1.72)
Heterosexual or Straight	1.00	1.00
HIV Status (n = 37,346)		
Positive	1.03 (0.95, 1.11)	1.01 (0.92, 1.10)
Negative	0.99 (0.94, 1.04)	1.02 (0.96, 1.09)
Unknown (includes never tested)	1.00	1.00
Education (n = 33,699)		
Less than high school diploma	1.38 (1.26, 1.52)	1.18 (1.05, 1.33)
High School diploma or equivalent	1.24 (1.16, 1.32)	1.08 (1.00, 1.16)
Some college or technical degree	1.22 (1.17, 1.28)	1.08 (1.02, 1.13)
College degree or post graduate education	1.00	1.00
Region (n = 37,346)		
Northeast	0.97 (0.91, 1.03)	1.02 (0.95, 1.08)
Midwest	0.89 (0.84, 0.94)	0.97 (0.91, 1.03)
South	0.83 (0.79, 0.88)	0.92 (0.87, 0.97)
West	1.00	1.00
NCHS Urban/Rural Classification, 2013 (n = 37,342)		

Large central metro	1.35 (1.18, 1.53)	1.16 (1.00, 1.33)
Large fringe metro	1.16 (1.01, 1.32)	1.09 (0.94, 1.27)
Medium metro	1.19 (1.04, 1.36)	1.10 (0.95, 1.27)
Small metro	1.17 (1.02, 1.35)	1.07 (0.91, 1.25)
Micropolitan	1.05 (0.91, 1.23)	1.04 (0.88, 1.23)
Non-core	1.00	1.00
Income (n = 32,179)		
$0 - 19,999	1.40 (1.32, 1.49)	1.04 (0.97, 1.11)
$20,00 - 39,999	1.24 (1.18, 1.32)	1.01 (0.95, 1.07)
$40,000 - 74,999	1.07 (1.02, 1.13)	1.00 (0.95, 1.06)
$75,000 or more	1.00	1.00

[a] Adjusted race/ethnicity, education, income, age, other illicit drug use, HIV status, sexual identity, NCHS rurality classification, and region using modified Poisson regression with robust variance.

Table 3. Prevalence of reported cannabis use and sexual behaviors (within past 12 months unless otherwise noted) among men who have sex with men (MSM) in the United States, American Men's Internet Survey, 2014-2018 (n = 37,346).

	Number reporting behavior	Number and percent also reporting cannabis use	
Behavior	**n**	**n**	**%**
Condomless anal intercourse	29,017	8,489	29.3
Serodiscordant condomless anal intercourse	8,909	3,146	35.3
Any STI diagnosis	4,266	1,549	36.3
Exchange Partner: Gave money or drugs for sex	1,693	482	28.5
Exchange Partner: Received money or drugs for sex	1,169	651	55.7
Used post-exposure prophylaxis (PEP)[a] (n = 24,974)	1,174	352	30.0
Ever concurrency during sexual relationship with main partner (n = 16,417)	8,270	2,374	28.7
Two or more partners	26,700	6,198	29.8
Currently taking antiretroviral therapy (ART)[b] (n = 4,341)	3,499	965	27.6
Used pre-exposure prophylaxis[a] (PrEP) (n = 26,864)	3,192	1,150	36.0
HIV Testing[a] (n = 25,506)	19,518	5,577	28.6
STI Testing	16,963	5,307	31.3

[a]Among HIV negative respondents

[b]Among HIV positive respondents

Table 4. Crude and adjusted prevalence ratios of sexual health behaviors and outcomes within past twelve months between cannabis users and nonusers, estimated with separate modified Poisson regression with robust variance models, among men who have sex with men (MSM) in the United States, American Men's Internet Survey, 2014-2018 (n = 37,346).

Behavior	Crude PR (95% CI)	Adjusted PR[a] (95% CI)
Condomless anal intercourse (n = 31,585)	1.09 (1.08, 1.10)	1.03 (1.01, 1.05)
Serodiscordant condomless anal intercourse (n = 31,585)	1.44 (1.38, 1.49)	1.10 (1.04, 1.16)
Two or more partners (n = 23,262)	1.04 (1.04, 1.05)	1.01 (1.00, 1.01)
Any STI diagnosis (n = 31,585)	1.50 (1.42, 1.59)	0.89 (0.82, 0.96)
Exchange Partner: Gave money or drugs for sex (n = 31,585)	1.05 (0.95, 1.16)	0.83 (0.72, 0.96)
Exchange Partner: Received money or drugs for sex (n = 31,585) [c]		
Cannabis alone	1.77 (1.44, 2.19)	1.26 (0.99, 1.61)
Cannabis and other drugs	1.11 (0.92, 1.33)	0.82 (0.67, 1.00)
Used post-exposure prophylaxis (PEP) (n = 26,615)[d]	1.07 (0.95, 1.21)	0.78 (0.65, 0.93)
Currently taking antiretroviral therapy (ART) (n = 2,849)[e]	0.98 (0.95, 1.00)	1.00 (0.97, 1.03)
Used pre-exposure prophylaxis (PrEP) (n = 28,425)[d]	1.48 (1.38, 1.59)	1.11 (1.01, 1.22)
HIV Testing (n = 29,251)[d]	1.04 (1.03, 1.06)	0.99 (0.97, 1.01)
STI testing (n = 31,585)	1.20 (1.17, 1.23)	1.03 (1.00, 1.06)

[a]Adjusted for race/ethnicity, education, income, age, other illicit drug use, HIV status, sexual identity, NCHS rurality classification, and region.

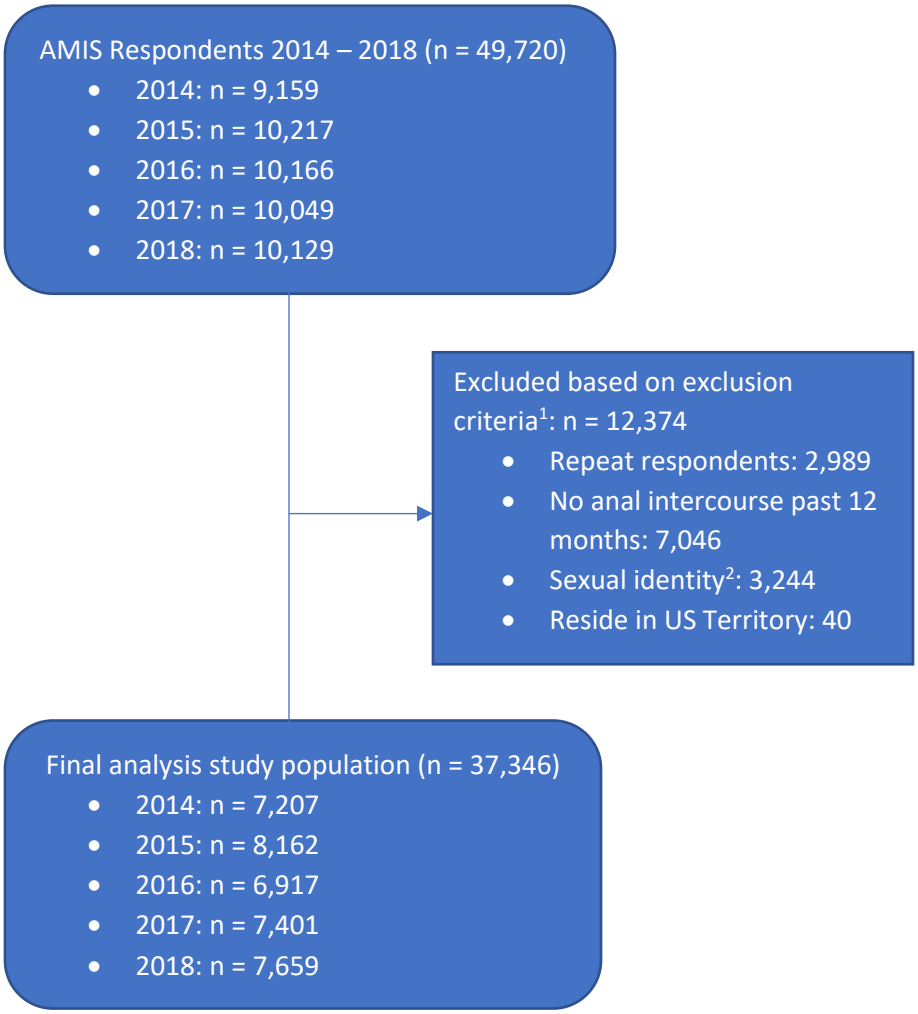
[c] Significant statistical interaction between cannabis and other drug use for this outcome.

[d]Among HIV-negative or HIV status-unknown respondents only.

[e]Among HIV-positive respondents only.

Figures

Figure 1. Participant flow chart.



1. 945 participants were excluded based on multiple criteria.
2. 2,675 respondents did not provide a response. 212 respondents identified as another sexuality, but this response option was not available all years. 135 responded “Prefer not to answer.” 222 responded “Don’t know”.

Figure 2. Directed acyclic graph (DAG) of cannabis use, sexual health behavior, and relevant covariates.

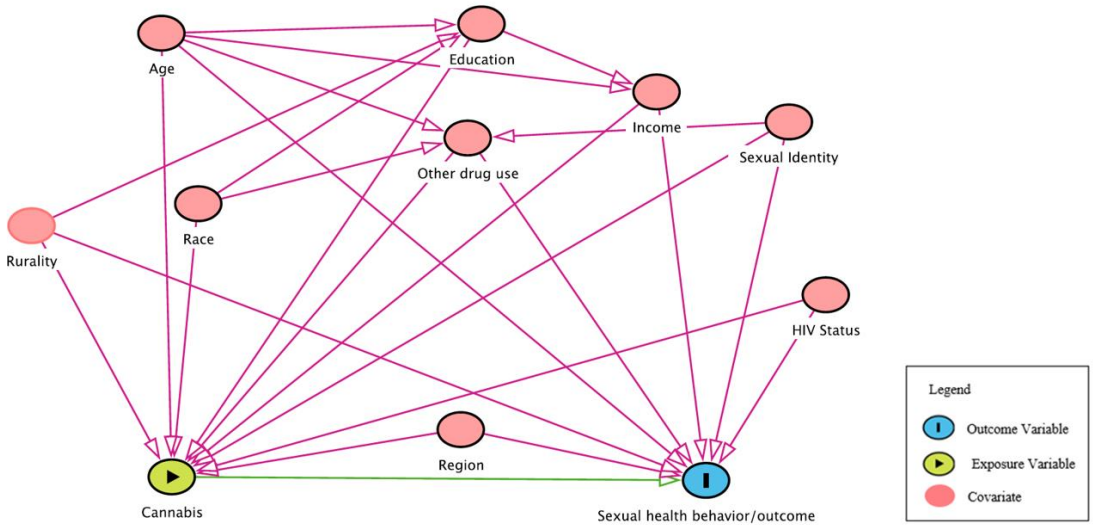


Figure 3. Reported cannabis use in the past 12 months among MSM in the United States, AMIS 2018.

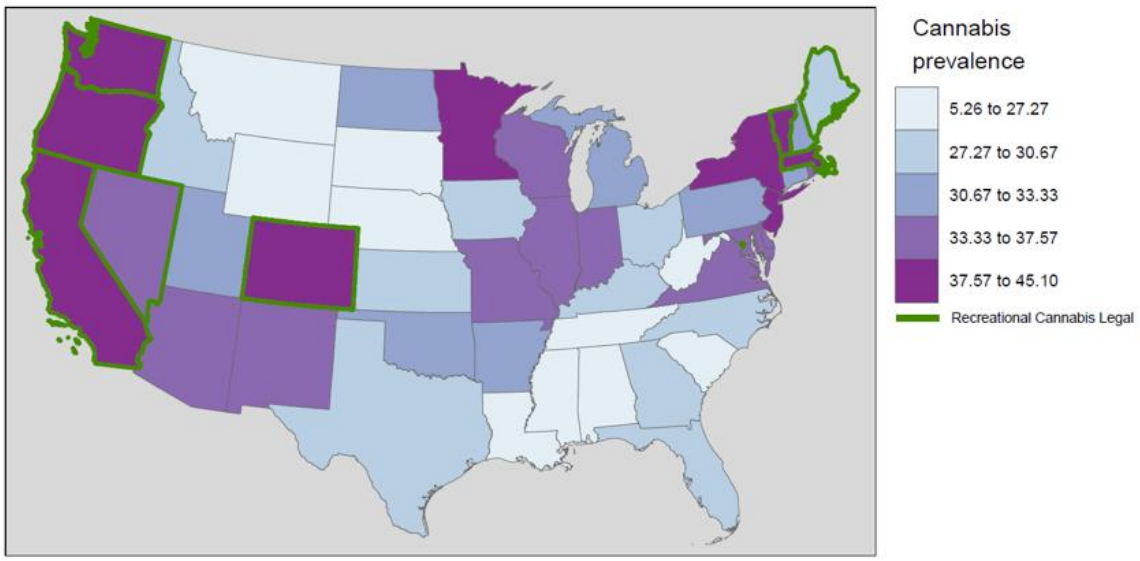
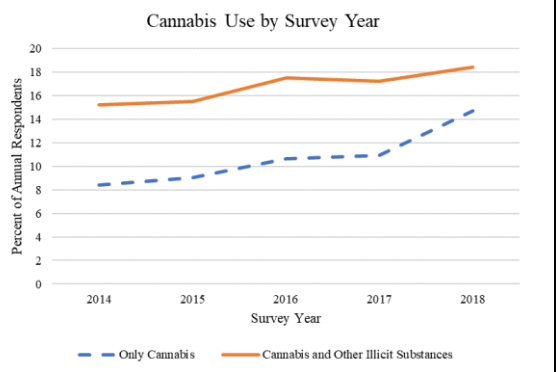
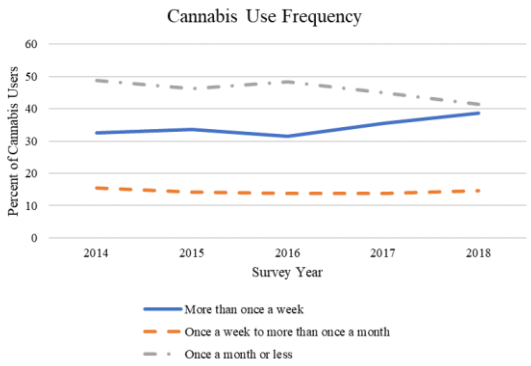
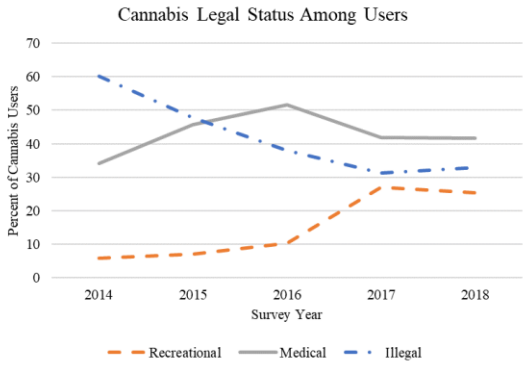
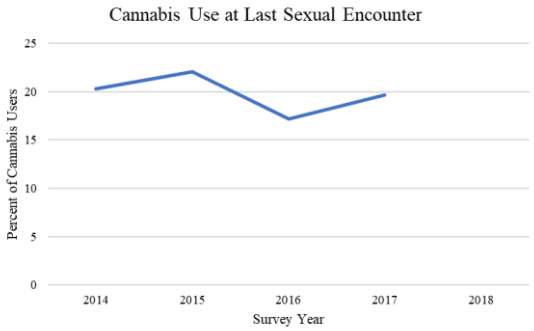


Figure 4. Cannabis usage trends over time, AMIS 2014 – 2018.









Data not collected in 2018 survey cycle

Appendix

Medical cannabis.

Very few participants that reported using legally obtained medical cannabis did not also report illicit substance use, so these participants were not included in respondents that reported cannabis use in the past 12 months.

Legality.

Legal status determined was by looking at when the legalization took effect (i.e. the Colorado law was passed in 2012 but did not take effect until 2014). If the law took effect before July 1, the calculated legality variable is marked as legal for the whole year. If after July 1, legality change is noted in the following calendar year. States that have only legalized CBD oil were not considered states with medical cannabis since this is non-psychoactive and is not likely to directly affect decision-making.

Model for Tables 1 and 2.

$$ln(P(CANNABIS)) = \beta_0 + \beta_1 AGECATEGORY + \beta_2 RACE + \beta_3 EDUCATION + \beta_4 INCOME + \beta_5 SEXUALIDENTITY + \beta_6 HIVSTATUS + \beta_7 RURALURBAN + \beta_8 REGION + \beta_9 OTHERDRUG$$

Models for Table 4.

$$ln(P(OUTCOME)) = \beta_0 + \beta_1 CANNABIS + \beta_2 AGE + \beta_3 RACE + \beta_4 EDUCATION + \beta_5 INCOME + \beta_6 SEXUALIDENTITY + \beta_7 HIVSTATUS + \beta_8 RURALURBAN + \beta_9 REGION + \beta_{10} OTHERDRUG$$

$$ln(P(EXCHANGE\_RECEIVE)) = \beta_0 + \beta_1 CANNABIS + \beta_2 AGE + \beta_3 RACE + \beta_4 EDUCATION + \beta_5 INCOME + \beta_6 SEXUALIDENTITY + \beta_7 HIVSTATUS + \beta_8 RURALURBAN + \beta_9 REGION + \beta_{10} OTHERDRUG + \beta_{11} CANNABIS \times OTHERDRUG$$