Published in final edited form as:

Addiction. 2018 April ; 113(4): 719–728. doi:10.1111/add.14082.

Cigarette use is increasing among persons with illicit substance use disorders in the United States, 2002–2014: Emerging disparities in vulnerable populations

Andrea H Weinberger, PhD^{1,2}, Misato Gbedemah, MPH³, Melanie M Wall, PhD^{4,5}, Deborah S Hasin, PhD^{5,6,7}, Michael J Zvolensky, PhD^{8,9}, and Renee D Goodwin, PhD, MPH^{3,6,10}

¹Ferkauf Graduate School of Psychology, Yeshiva University, Bronx, NY USA

²Department of Epidemiology & Population Health, Albert Einstein College of Medicine, Bronx, NY USA

³Department of Epidemiology and Biostatistics, Graduate School of Public Health and Health Policy, The City University of New York, New York, NY USA

⁴Department of Biostatistics, Mailman School of Public Health, Columbia University, New York, NY USA

⁵New York State Psychiatric Institute, New York, NY USA

⁶Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY USA

⁷Department of Psychiatry, College of Physicians and Surgeons, Columbia University, New York, NY USA

⁸Department of Psychology, University of Houston, Houston, TX USA

⁹Department of Behavioral Science, MD Anderson Cancer Center, Houston, TX USA

¹⁰Institute for Implementation Science in Population Health, The City University of New York, New York, NY USA

Abstract

Background and aims—While cigarette smoking has declined over time, it is not known whether this decline has similarly occurred among persons with substance use disorders (SUDs). The current study estimated trends in smoking from 2002 to 2014 among United States (US) persons with and without SUDs.

Design—Linear time trends of current smoking prevalence were assessed using logistic regression models.

Setting—USA: data were drawn from the 2002 to 2014 National Household Survey on Drug Use (NSDUH), an annual US cross-sectional study.

Corresponding Author: Renee D. Goodwin, PhD, MPH, Department of Epidemiology, Mailman School of Public Health, Columbia University, 722 West 168th Street, Rm 514, New York, New York 10032, rdg66@columbia.edu.

Declaration of Interest: The authors have no additional declarations of interest to report.

Participants—A representative, population-based sample of US persons age 12 and older (total analytic population: N=723,283).

Measurements—Past-month current smoking was defined as having smoked at least 100 lifetime cigarettes and reporting smoking part or all of at least one cigarette during the past 30 days. Respondents were classified as having any SUD if they met criteria for abuse or dependence for one or more of the following illicit drugs: cannabis, hallucinogens, inhalants, tranquilizers, cocaine, heroin, pain relievers, stimulants, and sedatives. A second SUD variable included all drugs listed above excluding cannabis use disorder (CUD). An additional variable included respondents who met criteria for cannabis abuse or dependence.

Findings—Among those with any SUD, the prevalence of smoking did not change from 2002 to 2014 ($p=0.08$). However, when CUDs were separated from other SUDs, a significant increase in prevalence of smoking was observed among those with SUDs excluding CUDs ($p<0.001$) while smoking decreased among those with CUDs ($p<0.001$). Smoking declined among those without SUDs ($p<0.001$). In 2014, smoking remained significantly more common among those with any SUD (55.5%), SUDs excluding CUDs (63.3%), and CUDs (51.4%) compared with those without these respective disorders (18.2%, 18.6%, and 18.6%; $p<0.001$).

Conclusions—The prevalence of cigarette smoking in the US increased from 2002 to 2014 among people with substance use disorders (SUDs) excluding cannabis use disorders (CUDs) and declined among those with CUDs. In 2014, the prevalence of smoking was multifold higher among those with SUDs, including CUDs, compared with those without SUDs.

Keywords

cigarettes; smoking; substance use disorders; cannabis use disorders; epidemiology; NSDUH

INTRODUCTION

Cigarette smoking is a leading cause of death and disease around the world (1) and the leading preventable cause of death and disease in the United States (US) responsible for at least 480,000 deaths annually (2, 3). Since the mid-1960s, the prevalence of smoking has declined substantially in the US and other countries (2, 4–6). However, several vulnerable groups continue to report significantly higher prevalences of smoking (7, 8). Persons with illicit substance use disorders (SUDs) may be one such group.

Illicit drug use has been increasing over the past decade and recent data suggest that 3.9% of US adults meet criteria for a past-year SUD while 9.9% of US adults meet criteria for a lifetime SUD (9). The prevalence of smoking is high among people with a range of SUDs (7, 9, 10) and SUDs are associated with increased difficulty quitting smoking (10, 11). Further, smoking among persons with SUDs is associated with greater risks of mortality (e.g., (12, 13)). Although the prevalence of cigarette smoking has declined over time in the general adult US population, and there have been research and clinical efforts aimed at promoting smoking cessation among persons with SUDs (e.g., (14, 15)), whether the prevalence of smoking has changed among those with SUDs over time is unknown. Understanding the extent to which cigarette use is common among those who have SUDs is

of critical importance in recognizing what groups may need heightened public health and clinical efforts to reduce smoking.

Globally, cannabis is the most widely used illicit drug (16). Cannabis use disorders (CUDs) are the most prevalent SUDs in the US and there is evidence that CUDs are increasing, though results to date are mixed (11, 17–22). Unlike other illicit drugs, cannabis use is undergoing a changing legalization picture in a number of countries. For example, in the US, an increasing number of states are legalizing medical cannabis and legalizing or decriminalizing the possession of small amounts of cannabis (23). A number of concerns have been raised including the impacts of the changing legalization status of cannabis on cannabis use and harmful consequences (e.g., (24–26)). Based on the global use of cannabis and its changing legal status, it would be informative to estimate the smoking prevalence among persons with CUDs separately from persons with illicit SUDs.

The purpose of the current study was to examine changes in the prevalence of current cigarette smoking over time among persons with SUDs compared to those without SUDs in the US. The first aim of the study was to use recent data (2014) to estimate cigarette smoking prevalence among those with and without SUDs unadjusted and after adjusting for demographics. To assess whether the prevalence of smoking differs among those with CUDs versus other SUDs, smoking prevalence was estimated separately for all SUDs (with CUDs included), SUDs excluding CUDs, and CUDs compared to those without these respective disorders. The second aim of the study was to estimate changes in the prevalence of cigarette smoking from 2002 to 2014 among those with all SUDs, SUDs excluding CUDs, and CUDs compared to those without these respective disorders.

METHODS

Study population

Data for this study came from The National Survey on Drug Use and Health (NSDUH) which collects annual cross-sectional data in multistage representative probability samples of US male and female civilian non-institutionalized persons age 12 and older in each of the 50 states and the District of Columbia. Methods of the NSDUH are described in detail elsewhere (27). For this study, data were extracted from the public data portal (<http://www.icpsr.umich.edu/>) for the years 2002 through 2014. Respondents who reported information on cigarette smoking and SUDs were included in each year's data. The datasets from each year were concatenated adding a variable for the survey year. The analytic sample for 2014 (i.e., Aim 1 analyses) was N=55,271 and the total analytic sample from 2002 to 2014 combined (i.e., Aim 2 analyses) was N=723,283.

Measures

Past-month current smoking—Current smoking was assessed in each annual survey and defined as having smoked at least 100 lifetime cigarettes and reporting smoking part or all of at least one cigarette during the past 30 days. Current daily smoking was defined as ever having smoked 100 or more cigarettes and reporting smoking 30 out of the past 30 days

while nondaily smoking was defined as ever having smoked 100 or more cigarettes and reporting smoking 1 to 29 out of the past 30 days.

Past-year illicit SUDs—Past-year SUDs (abuse or dependence) were assessed in each annual survey by computer-assisted interviewing instrumentation based on criteria from the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV; (28)). For analyses, a respondent was classified as having any SUD if they met criteria for abuse or dependence for one or more of the following illicit drugs: cannabis, hallucinogens, inhalants, tranquilizers, cocaine, heroin, pain relievers, stimulants, and sedatives. For analyses, a second SUD variable was created that included all drugs listed above except cannabis. A third variable was created for CUDs for respondents who met criteria for cannabis abuse or dependence. Detailed abuse and dependence criteria are described in the NSDUH 2014 Codebook Appendix D Recoded Substance Dependence and Abuse Variable Documentation section (27) and are summarized in Supplementary Table 1.

Demographic characteristics—Demographic variables were categorized as follows: age (12 to 17 years old as reference group, 18 to 25 years old, 26 to 34 years old, 35 to 49 years old, 50 years or older), gender (male as reference group, female), race/ethnicity (non-Hispanic White as reference group, non-Hispanic Black, Hispanic, non-Hispanic all other races or more than one race), total annual family income (less than \$20,000 as reference group, \$20,000 to \$49,999, \$50,000 to \$74,999, \$75,000 or more), education (less than high school as reference group, high school graduate, some college, college graduate or above, and 12 to 17 years old), and marital status (married as reference, widowed, divorced or separated, never been married, 12 to 17 years old).

Statistical Analysis

First, to identify potential demographic covariates, logistic regressions tested the association between past-year SUDs (yes versus no), past-year SUDs excluding CUDs (yes versus no), past-year CUDs (yes versus no), and smoking status (current cigarette smoking versus all other categories, i.e., never smokers, former smokers, recent quitters defined as those who reported cigarette smoking in the past year but not in the past 30 days, and respondents with missing information on past 30 day cigarette use) from 2002 to 2014 overall and separately by each level of each demographic variable, controlling for all other demographic and smoking variables. The adjusted prevalence of current smoking from 2002 to 2014 was calculated from the logistic regression using the average marginal prediction approach (29), by past-year SUDs, past-year SUDs excluding CUDs, and past-year CUDs and each demographic characteristic (i.e. age, gender, race/ethnicity, total annual family income, education, marital status). Differential associations were tested with additional logistic regression models including 2-way interactions between each SUD and each demographic variable. All models were mutually adjusted for all other demographic variables. These analyses showed that smoking prevalence differed by SUD status within age, gender, race/ethnicity, total annual family income, education, and marital status (see Supplementary Tables 2–4). These variables were included as covariates in the adjusted analyses described below.

Second, to estimate cigarette smoking prevalence in 2014 by SUD status (Aim 1), logistic regressions tested the association of past-year SUDs (yes versus no), past-year SUDs excluding CUDs (yes versus no), past-year CUDs (yes versus no), and smoking status (current cigarette smoking versus all other categories) unadjusted and adjusted for within age, gender, race/ethnicity, total annual family income, education, and marital status in 2014. Unadjusted and adjusted prevalence of current smoking in 2014 were calculated from the logistic regression using the average marginal prediction approach (16) by past-year SUDs, past-year SUDs excluding CUDs, and past-year CUDs.

Third, to estimate cigarette smoking prevalence from 2002 to 2014 by SUD status (Aim 2), the prevalence of current smoking and associated standard errors among the whole population and stratified by past-year SUDs, past-year SUDs excluding CUDs, and past-year CUDs were calculated for each year from 2002 to 2014. Time trends in the prevalence of current smoking stratified by past-year SUDs, past-year SUDs excluding CUDs, and past-year CUDs were tested using logistic regression with continuous year as the predictor for the linear time trend.

These analyses were conducted twice: first with no covariates (unadjusted) and then while adjusting for age, gender, race/ethnicity, total annual family income, education, and marital status. To determine whether there were differential time trends in current smoking by SUD or CUD status, additional logistic regressions were run that included the 2-way interaction of year by past-year SUD, past-year SUD excluding CUD, and past-year CUD versus their respective comparison group (i.e., no past-year SUD, no past-year SUD excluding CUD, no past-year CUD). In order to more closely examine smoking prevalence among persons with SUDs excluding CUDs, time trend analyses were repeated for daily smoking and nondaily smoking separately while adjusting for covariates. As our analyses used data from 13 NSDUH years, we divided the survey weights by 13 to obtain nationally representative estimates.

All analyses were performed incorporating the NSDUH sampling weights and controlling for the complex clustered sampling using SAS-callable SUDAAN Version 11.0.1 (RTI International, Research Triangle Park, NC; <http://www.rti.org/sudaan/>), which used the Taylor series estimation methods to provide accurate standard errors.

RESULTS

Cigarette smoking prevalence in 2014 by SUD status

In 2014, the prevalence of smoking was 19.16% for the overall population. The odds of smoking for persons with any SUD was more than five times higher than for persons without a SUD (odds ratio (OR)=5.62, 95% confidence interval (CI)=4.98–6.35), and this difference remained significant after adjusting for demographics (adjusted OR (AOR)=5.25, 95% CI=4.47–6.17; see Table 1). For persons with SUDs excluding CUDs, the odds of smoking were more than seven and a half times greater than persons without SUDs excluding CUDs (OR=7.59, 95% CI=6.33–9.09). This difference reduced slightly to six and a half times greater after adjusting for demographics (AOR=6.46, 95% CI=5.18–8.07). When examining CUDs, the odds of current smoking for those with CUDs was four and a half times greater

than for those without CUDs (OR=4.61, 95% CI=3.95–5.38), and this difference remained the same after adjusting for demographics (AOR=4.56, 95% CI=3.75–5.55).

Cigarette smoking prevalence from 2002 to 2014 by SUD status

Any SUD (Table 2)—From 2002 to 2014, the prevalence of smoking decreased significantly among persons with and without SUDs in unadjusted models ($p < 0.05$). After adjusting for age, gender, income, race/ethnicity, education, and marital status, however, this decrease was no longer significant among persons with SUDs ($p = 0.084$). The decrease in smoking prevalence remained significant among persons without SUDs ($p < 0.001$). The prevalence of smoking for persons with SUDs was nearly three times greater than persons without SUDs in every year of the study. The interaction of time by SUD group was significant in unadjusted analyses ($p < 0.05$) but did not retain significant after demographic covariates were included ($p = 0.943$) suggesting that the decline in smoking prevalence did not significantly differ for persons with and without SUDs.

SUDs excluding CUDs (Figure 1 and Supplementary Table 5)—The prevalence of smoking *increased* significantly among persons with SUDs after CUDs were excluded from the variable ($p < 0.05$). In contrast, the prevalence of smoking significantly decreased among persons without SUDs excluding CUDs ($p < 0.001$). Both the increasing trend for persons with SUDs excluding CUDs and the decreasing trend for persons without SUDs excluding CUDs remained significant after adjusting for demographics ($p < 0.05$ and $p < 0.001$ respectively). The prevalence of smoking among persons with SUDs excluding CUDs was more than three times greater than persons without SUDs in every year of the study. The time by SUD group interaction was significant in unadjusted ($p < 0.001$) and adjusted ($p = 0.001$) analyses indicating that the trend in smoking differed significantly for persons with versus without SUDs excluding CUDs.

With regard to daily versus nondaily smoking, persons with SUDs excluding CUDs demonstrated a significant increase in daily smoking prevalence over time (AOR=1.025, 95% CI=1.005–1.045, $t = 2.505$, $p = 0.013$) compared to a significant decrease in daily smoking prevalence over time for those without SUDs excluding CUDs (AOR=0.984, 95% CI=0.981–0.988, $t = -9.296$, $p < 0.001$). For nondaily smoking, persons with SUDs excluding CUDs demonstrated no significant change in nondaily smoking prevalence over time (AOR=1.015, 95% CI=0.995–1.035, $t = -1.479$, $p = 0.141$) compared to a significant decrease in nondaily smoking prevalence over time for those without SUDs excluding CUDs (AOR=0.990, 95% CI=0.986–0.995, $t = -4.098$, $p < 0.001$).

CUDs (Figure 2 and Supplementary Table 6)—Cigarette use decreased significantly over time among both those with and without CUDs ($p < 0.001$). Both trends remained significant after accounting for demographics ($p < 0.001$). The prevalence of smoking for persons with CUDs was just under three times greater than persons without CUDs in every year of the study. The time by CUD group analysis was not significant in unadjusted analyses ($p = 0.166$) but was significant in adjusted analyses ($p < 0.01$) suggesting a greater decrease in smoking prevalence for persons with CUDs compared to those without CUDs.

DISCUSSION

The current study examined changes in cigarette smoking prevalence in the US population from 2002 to 2014 for persons with and without SUDs. Among persons without SUDs, the prevalence of smoking decreased over time consistent with previously reported overall population trends. Smoking prevalence also decreased for persons when all SUDs were combined. Interestingly, this trend differed when CUDs and other SUDs were examined separately. The prevalence of smoking decreased among persons with CUDs, but *increased* for persons with SUDs other than CUDs. Specifically, there was a significant increase in daily smoking and no change in nondaily smoking over time among persons with SUDs other than CUDs. Even though the smoking prevalence decreased over time for people with CUDs, it is important to note that the prevalence of smoking remained significantly higher among people with CUDs relative to those without in every year of the study. In 2014, the prevalence of cigarette smoking was approximately three times higher among persons with any SUD, SUDs excluding CUDs, and CUDs than among persons without these disorders. These findings highlight the dramatic and widening disparity in smoking for persons with SUDs compared to those without SUDs. Public health and interventions efforts are needed to reduce the high smoking prevalence among people with SUDs; especially SUDs for illicit substances other than cannabis for whom the prevalence of smoking has increased over time.

The prevalence of smoking among people in treatment for SUDs is extremely high (30–32) and SUD treatment programs may offer an important opportunity for smoking cessation. Historically, smoking has been viewed as a normative behavior in drug treatment settings and has either been encouraged or not been seen as a target of intervention. For example, there may be concerns that quitting smoking would negatively impact the course of SUD treatment (33), even though tobacco is known as a potential ‘gateway’ into use of other drugs (e.g., (34, 35)). There is mounting evidence, however, to suggest that smoking is associated with poorer outcomes for those in SUD treatment and relapse to SUDs among those in recovery (e.g., (36, 37)). Further, smoking abstinence does not hinder SUD treatment outcomes and may, in fact, be associated with improved outcomes (e.g., (38–44)). Our results extend this literature by showing that cigarette use is disproportionately common among those with SUDs and this is a group among whom cigarette smoking is on the rise in stark contrast to the consistent declines in the general population.

The declines in smoking in the general US population have largely been attributed to public health tobacco control efforts (45, 46). The current results highlight the need to develop both community-oriented and clinical tobacco control measures that will reach persons with SUDs. There are several pharmacological and behavioral smoking treatments that improve abstinence outcomes in community smokers (47). Few studies have tested the efficacy and effectiveness of smoking treatments for persons with SUDs, but several studies have shown promising outcomes especially with pharmacotherapy and contingency management (e.g., (14, 48–50); see also (51)). More research is needed to determine which current and novel smoking treatments would best help persons with SUDs to stop smoking. In addition, there were significant relationships between SUDs and smoking for all demographic subgroups (see Supplementary Tables 2–4). Notably, odds ratios between SUD and smoking the among the youngest age group (ages 12–17) were three to four times higher than in the older age

groups. Directing additional targeted clinical and research attention toward subgroups, such as adolescents, for whom the relationship between SUD and smoking appears to be particularly strong may be needed in order to decrease the smoking prevalence among the most vulnerable groups.

While the number of SUD treatment programs offering smoking cessation services has increased over time (15), research is needed to determine how SUD treatment programs can best integrate smoking treatments into their service delivery. For example, it is important to increase engagement and “buy-in” for smoking treatment among program personnel by reducing perceived barriers, increasing smoking treatment expertise, and providing stop smoking support to staff (52–55). Further, the belief that it is more difficult for persons in SUD treatment to quit smoking is associated with poorer quit outcomes for these patients (56, 57). Therefore, it would be important to address barriers and self-defeating beliefs about quitting smoking held by SUD patients (56, 58). Having staff work with patients to integrate smoking cessation into treatment plans may be beneficial as a recent study of 683 patients receiving SUD treatment found that participants who reported that quitting smoking was part of their treatment plan were more likely to quit smoking than participants without quitting as a goal (59). Persons in SUD treatment report the use of non-cigarette tobacco products and use of other tobacco products is associated with heavier cigarette smoking (60); thus, it will be important for programs to assess and address the use of alternative tobacco products (e.g., e-cigarettes) to improve tobacco treatment outcomes especially as use of non-cigarette tobacco products are on the rise (61).

The present study has several limitations. First, this study analyzed data from US adults; therefore, results may not be generalizable outside the US. As other countries show a similar pattern to the US of higher smoking prevalences among persons with SUDs and other vulnerabilities (e.g., psychiatric disorders) compared to the general population (e.g., (8)), these results may provide information relevant to other countries. Future studies that can examine these relationships in various countries will be informative in understanding whether these linkages are culture/society-specific. Second, cannabis was the only drug that could be examined separately from SUDs in part due to small sample sizes for the other substances. It would be useful for datasets with larger number of persons with SUDs to examine trends in smoking prevalence by specific illicit drugs other than cannabis. This information would allow us to provide a more targeted clinical and public health response toward the specific SUDs that demonstrate an increase in smoking prevalence. Relatedly, while it was beyond the scope of current study to investigate differences between those with CUDs and those with other illicit SUDs (e.g., demographics, mental health variables), understanding factors associated with or influencing the observed increase in smoking among those with illicit SUDs could contribute to the development of more effective public health and clinical efforts for this population. Third, the NSDUH includes annual cross-sectional data from the US population. Longitudinal data that follows the smoking behaviors of individuals with and without SUDs over time would be useful to learn about trajectories of smoking. Fourth, data on smoking and drug use is based on self-report without biochemical confirmation. The reliance on self-reported drug use may lead to underreporting (62, 63). Strengths of the study include the use of repeated annual data from a large

nationally representative sample of the US population and the examination of CUDs separate from other SUDs.

In contrast to substantial declines in smoking in the general US population, the prevalence of daily cigarette smoking has increased significantly from 2002 to 2014 among people with illicit SUDs. This increase in smoking prevalence is specific to people with SUDs other than cannabis and was significantly different from the decreasing trend for smoking prevalence for persons without SUDs excluding CUDs. It is important to note that the prevalence of cigarette smoking remains multifold higher among those with any SUD, as well as those with CUDs, compared to persons without SUDs and CUDs. Those with SUDs appear to be a neglected population in terms of tobacco control, as these efforts do not appear to have reached this growing segment of the population. Efforts to move tobacco control forward may need to consider novel intervention strategies and outreach for the increasing proportion of the US population with SUDs. Further, specific public health efforts to reach persons with SUDs in the community who are not receiving treatment may be needed to provide education about the relationship between tobacco and drug use and treatment options. The potential benefits include an increased chance of remission from SUDs, sustained smoking abstinence, and improved physical and mental health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This work was supported by NIDA (grant R01-DA20892 to Goodwin).

References

1. WHO. WHO Global Report: Mortality attributable to tobacco. Geneva, Switzerland: WHO Press; 2012.
2. USDHHS. The health consequences of smoking—50 years of progress: A report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014.
3. Carter BD, Abnet CC, Feskanich D, Freedman ND, Hartge P, Lewis, et al. Smoking and mortality—beyond established causes. *N Engl J Med*. 2015; 372(7):631–40. [PubMed: 25671255]
4. Jamal A, King BA, Neff LJ, Whitmill J, Babb SD, Graffunder CM. Current cigarette smoking among adults — United States, 2005–2015. *MMWR*. 2016; 65(44):1205–11. [PubMed: 27832052]
5. Ng M, Freeman MK, Fleming TD, Robinson M, Dwyer-Lindgren L, Thomson B, et al. Smoking prevalence and cigarette consumption in 187 countries, 1980–2012. *JAMA*. 2014; 311(2):183–92. [PubMed: 24399557]
6. GBD 2015 Tobacco Collaborators. Smoking prevalence and attributable disease burden in 195 countries and territories, 1990–2015: A systematic analysis from the Global Burden of Disease Study 2015. *Lancet*. 2017; 389(10082):1885–906. [PubMed: 28390697]
7. Smith PH, Mazure CM, McKee SA. Smoking and mental illness in the US population. *Tob Control*. 2014; 23(2):e147–e53. [PubMed: 24727731]
8. Szatkowski L, McNeill A. Diverging trends in smoking behaviors according to mental health status. *Nicotine Tob Res*. 2015; 17(3):356–60. [PubMed: 25180078]

9. Grant BF, Saha TD, Ruan WJ, Goldstein RB, Chou SP, Jung J, et al. Epidemiology of DSM-5 drug use disorder: Results from the National Epidemiologic Survey on Alcohol and Related Conditions-III. *JAMA Psychiatry*. 2016; 73(1):39–47. [PubMed: 26580136]
10. Weinberger AH, Funk AP, Goodwin RD. A review of epidemiologic research on smoking behavior among persons with alcohol and illicit substance use disorders. *Prev Med*. 2016; 92:148–59. [PubMed: 27196143]
11. 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]
12. Hurt RD, Offord KP, Croghan IT, Gomez-Dahl L, Kottke TE, Morse RM, et al. Mortality following inpatient addictions treatment. Role of tobacco use in a community-based cohort. *JAMA*. 1996; 275(14):1097–103. [PubMed: 8601929]
13. Hser YI, McCarthy WJ, Anglin MD. Tobacco use as a distal predictor of mortality among long-term narcotic addicts. *Prev Med*. 1994; 23(1):61–9. [PubMed: 8016035]
14. Ouellet-Plamondon C, Mohamed NS, Sharif-Razi M, Simpkin E, George TP. Treatment of comorbid tobacco addiction in substance use and psychiatric disorders. *Curr Addict Rep*. 2014; 1(1):61–8.
15. Cohn A, Elmasry H, Niaura R. Facility-level, state, and financial factors associated with changes in the provision of smoking cessation services in US substance abuse treatment facilities: Results from the National Survey of Substance Abuse Treatment Services 2006 to 2012. *J Subst Abuse Treat*. 2017; 77:107–14. [PubMed: 28476262]
16. WHO. Cannabis. Geneva, Switzerland: WHO Press; 2017. Accessed from http://www.who.int/substance_abuse/facts/cannabis/en/ on 10/05/2017
17. Grant B, Stinson F, Dawson D, Chou S, Dufour M, 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]
18. 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]
19. Azofeifa A, Mattson ME, Schauer G, McAfee T, Grant A, Lyster 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.
20. 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):579–588. [PubMed: 28445557]
21. Compton WM, Han B, Jones CM, Blanco C, Hughes A. Marijuana use and use disorders in adults in the USA, 2002–2014: analysis of annual cross-sectional surveys. *Lancet Psychiatry*. 2016; 3(10):954–64. [PubMed: 27592339]
22. Grucza RA, Agrawal A, Krauss MJ, Cavazos-Behg PA, Bierut LI. Recent trends in the prevalence of marijuana use and associated disorders in the United States. *JAMA Psychiatry*. 2016; 73(3):300–1. [PubMed: 26864618]
23. Maxwell JC, Mendelson B. What do we know about the impact of the laws related to marijuana? *J Addict Med*. 2016; 10(1):3–12. [PubMed: 26818826]
24. Williams J, Bretteville-Jensen AL. Does liberalizing cannabis laws increase cannabis use? *J Health Econ*. 2014; 36:20–32. [PubMed: 24727348]
25. Hall W, Lynskey M. Evaluating the public health impacts of legalizing recreational cannabis use in the United States. *Addiction*. 2016; 111(10):1764–73. [PubMed: 27082374]
26. Hajizadeh M. Legalizing and regulating marijuana in Canada: Review of potential economic, social, and health impacts. *Int J Health Policy Manag*. 2016; 5(8):453–6. [PubMed: 27694657]
27. SAMHSA. Codebook. Rockville, MD: SAMHSA; 2014. National Survey on Drug Use and Health, 2013.

28. APA. Diagnostic and statistical manual of mental disorders. 4th. Washington DC: American Psychiatric Association; 1994. (DSM-IV)
29. Bieler GS, Brown GG, Williams RL, Brogan DJ. Estimating model-adjusted risks, risk differences, and risk ratios from complex survey data. *Am J Epidemiol*. 2010; 171(5):618–23. [PubMed: 20133516]
30. Guydish J, Passalacqua E, Tajima B, Chan M, Chun J, Bostrom A. Smoking prevalence in addiction treatment: A review. *Nicotine Tob Res*. 2011; 13(6):401–11. [PubMed: 21464202]
31. Guydish J, Passalacqua E, Pagano A, Martínez C, Le T, Chun J, et al. An international systematic review of smoking prevalence in addiction treatment. *Addiction*. 2016; 111(2):220–30. [PubMed: 26392127]
32. Tacke U, Wolff K, Finch E, Strang J. The effect of tobacco smoking on subjective symptoms of inadequacy (“not holding”) of methadone dose among opiate addicts in methadone maintenance treatment. *Addict Biol*. 2001; 14(2):137–45.
33. Blanco C, Okuda M, Wang S, Liu SM, Olfson M. Testing the drug substitution switching-addictions hypothesis. A prospective study in a nationally representative sample. *JAMA Psychiatry*. 2014; 71(11):1246–53. [PubMed: 25208305]
34. Kandel D, Kandel E. The Gateway Hypothesis of substance abuse: Developmental, biological and societal perspectives. *Acta Paediatr*. 2015; 104(2):130–7. [PubMed: 25377988]
35. Brook DW, Brook JS, Zhang C, Cohen P, Witeman M. Drug use and the risk of major depressive disorder, alcohol dependence, and substance use disorders. *Arch Gen Psychiatry*. 2002; 59(11):1039–44. [PubMed: 12418937]
36. Weinberger AH, Platt J, Esan H, Galea S, Erlich D, Goodwin RD. Cigarette smoking is associated with increased risk of substance use disorder relapse: A nationally representative, prospective longitudinal investigation. *J Clin Psychiatry*. 2017; 78(2):e152–e60. [PubMed: 28234432]
37. McClure EA, Campbell AN, Pavlicova M, Hu M, Winhusen T, Vandrey RG, et al. Cigarette smoking during substance use disorder treatment: Secondary outcomes from a National Drug Abuse Treatment Clinical Trials Network study. *J Subst Abuse Treat*. 2015; 53:39–46. [PubMed: 25595301]
38. Lemon SC, Friendmann PD, Stein MD. The impact of smoking cessation on drug abuse treatment outcome. *Addict Behav*. 2003; 28(7):1323–31. [PubMed: 12915172]
39. Baca CT, Yahne CE. Smoking cessation during substance abuse treatment: What you need to know. *J Subst Abuse Treat*. 2009; 36(2):205–19. [PubMed: 18715746]
40. Winhusen TM, Kropp F, Theobald J, Lewis DF. Achieving smoking abstinence is associated with decreased cocaine use in cocaine-dependent patients receiving smoking-cessation treatment. *Drug Alcohol Depend*. 2014; 134:391–5. [PubMed: 24128381]
41. Tsoh JY, Chi FW, Mertens JR, Weisner CM. Stopping smoking during first year of substance use treatment predicted 9-year alcohol and drug treatment outcomes. *Drug Alcohol Depend*. 2011; 114(2–3):110–8. [PubMed: 21050681]
42. Prochaska JJ, Delucchi K, Hall SM. A meta-analysis of smoking cessation interventions with individuals in substance abuse treatment or recovery. *J Consult Clin Psychol*. 2004; 72(6):1144–56. [PubMed: 15612860]
43. McKelvey K, Thrul J, Ramo D. Impact of quitting smoking and smoking cessation treatment on substance use outcomes: An updated and narrative review. *Addict Behav*. 2017; 65:161–70. [PubMed: 27816663]
44. Das S, Hickman NJ, Prochaska JJ. Treating smoking in adults with co-occurring acute psychiatric and addictive disorders. *J Addict Med*. 2017; 11(4):273–9. [PubMed: 28441272]
45. Levy DT, Chaloupka F, Gitchell J. The effects of tobacco control policies on smoking rates: A tobacco control scorecard. *J Public Health Manag Pract*. 2004; 10(4):338–353. [PubMed: 15235381]
46. Ekpu VU, Brown AK. The economic impact of smoking and of reducing smoking prevalence: Review of evidence. *Tob Use Insights*. 2015; 8:1–35. [PubMed: 26242225]
47. Fiore, MC, Jaén, CR, Baker, TB, Bailey, WC, Benowitz, NL, Curry, SJ, et al. Treating tobacco use and dependence: 2008 update. Rockville, MD: U.S. Department of Health and Human Services; 2008.

48. Richter KP, Ahluwalia JS. A case for addressing cigarette use in methadone nad other opioid treatment programs. *J Addict Dis.* 2000; 19(4):35–52.
49. Nahvi S, Ning Y, Segal KS, Richter KP, Arnsten JH. Varenicline efficacy and safety among methadone maintained smokers: a randomized placebo-controlled trial. *Addiction.* 2014; 109(9): 1554–63. [PubMed: 24862167]
50. Rohsenow DJ, Martin RA, Tidey JW, Colby SM, Monti PM. Treating smokers in substance treatment with contingent vouchers, nicotine replacement and brief advice adapted for sobriety settings. *J Subst Abuse Treat.* 2017; 72:72–9. [PubMed: 27658756]
51. Apollonio D, Philipps R, Bero L. Interventions for tobacco use cessation in people in treatment for or recovery from substance use disorders. *Cochrane Database Syst Rev.* 2016; 11: Cd010274. [PubMed: 27878808]
52. Muilenburg JL, Laschober TC, Eby LT. Organizational factors as predictors of tobacco cessation pharmacotherapy adoption in addiction treatment programs. *J Addict Med.* 2014; 8(1):59–65. [PubMed: 24365803]
53. Knudsen HK, Muilenburg J, Eby LT. Sustainment of smoking cessation programs in substance use disorder treatment organizations. *Nicotine Tob Res.* 2013; 15(6):1060–8. [PubMed: 23132659]
54. Pagano A, Tajima B, Guydish J. Barriers and facilitators to tobacco cessation in a nationwide sample of addiction treatment programs. *J Subst Abuse Treat.* 2016; 67:22–9. [PubMed: 27296658]
55. Laschober TC, Muilenburg JL, Eby LT. Factors linked to substance use disorder counselors' (non)implementation likelihood of tobacco cessation 5 A's, counseling, and pharmacotherapy. *J Addict Behav Ther Rehabil.* 2015; 4(1):134. [PubMed: 26005696]
56. Martin RA, Cassidy RN, Murphy CM, Rohsenow DJ. Barriers to quitting smoking among substance dependent patients predict smoking cessation treatment outcome. *J Subst Abuse Treat.* 2016; 64:7–12. [PubMed: 26979552]
57. Rohsenow DJ, Tidey JW, Kahler CW, Martin RA, Colby SM, Sirota AD. Intolerance for withdrawal discomfort and motivation predict voucher-based smoking treatment outcomes for smokers with substance use disorders. *Addict Behav.* 2015; 43:18–24. [PubMed: 25531536]
58. McHugh RK, Votaw VR, Fulciniti F, Connery HS, Griffin ML, Monti PM, et al. Perceived barriers to smoking cessation among adults with substance use disorders. *J Subst Abuse Treat.* 2017; 74:48–53. [PubMed: 28132700]
59. Campbell BK, Le T, Tajima B, Guydish J. Quitting smoking during substance use disorders treatment: Patient and treatment-related variables. *J Subst Abuse Treat.* 2017; 73:40–6. [PubMed: 28017183]
60. Guydish J, Tajima B, Pramod S, Le T, Gubner NR, Campbell B, et al. Use of multiple tobacco products in a national sample of persons enrolled in addiction treatment. *Drug Alcohol Depend.* 2016; 166:93–9. [PubMed: 27449271]
61. Wang TW, Kenemer B, Tynan MA, Singh T, King B. Consumption of combustible and smokeless tobacco — United States, 2000–2015. *MMWR.* 2016; 65:1357–63. [PubMed: 27932780]
62. Gorber SC, Schofield-Hurwitz S, Hardt J, Levasseur G, Tremblay M. The accuracy of self-reported smoking: A systematic review of the relationship between self-reported and cotinine-assessed smoking status. *Nicotine Tob Res.* 2009; 11(1):12–24. [PubMed: 19246437]
63. Fendrich M, Johnson TP, Wislar JS, Hubbell A, Spiehler V. The utility of drug testing in epidemiological research: Results from a general population survey. *Addiction.* 2004; 99(2):197–208. [PubMed: 14756712]

Figure 1.
Prevalence of current cigarette smoking from 2002 to 2014 for persons with and without past-year illicit substance use disorders (excluding cannabis use disorders).

Figure 2.
Prevalence of current cigarette smoking from 2002 to 2014 for persons with and without past-year cannabis use disorders.

Table 1

The association of current smoking with past-year SUDs, SUDs excluding CUDs, and CUDs in 2014 (NSDUH, aged 12+; n=55,271)

	2014 only			
	Unadjusted percent (s.e.) reporting current smoking	Crude OR (95%CI)	T-test (p-value)	Adjusted percent (s.e.) reporting current smoking
Past-year SUD diagnosis ³				
Yes	55.48 (1.55)	5.62 (4.98, 6.35)	28.01 (<0.001)	48.05 (1.76)
No	18.16 (0.25)	1.00 (Ref.)	Ref.	18.30 (0.25)
Adjusted OR+ (95%CI)				
				5.25 (4.47, 6.17)
T-test (p-value)				
				20.32 (<0.001)
Past-year SUD diagnosis excluding CUDs ⁴				
Yes	63.34 (2.15)	7.59 (6.33, 9.09)	22.08 (<0.001)	52.80 (2.33)
No	18.55 (0.25)	1.00 (Ref.)	Ref.	18.66 (0.25)
Adjusted OR+ (95%CI)				
				6.46 (5.18, 8.07)
T-test (p-value)				
				16.60 (<0.001)
Past-year CUD diagnosis ⁵				
Yes	51.37 (1.96)	4.61 (3.95, 5.38)	19.62 (<0.001)	45.70 (2.11)
No	18.64 (0.25)	1.00 (Ref.)	Ref.	18.71 (0.25)
Adjusted OR+ (95%CI)				
				4.56 (3.75, 5.55)
T-test (p-value)				
				15.31 (<0.001)

Key: CUD, cannabis use disorder; SUD, substance use disorder; NSDUH, National Survey on Drug Use and Health; OR, odds ratio; Ref., reference s.e., standard error

¹ OR compares current smoking versus all other categories (i.e., never smokers, former smokers, recent quitters defined as those who reported cigarette smoking in the past year but not in the past 30 days, and those with missing information on past 30 day cigarette use).

² Adjusted for age (12 to 17, 18 to 25, 26 to 34, 35 to 49, 50+ years old); gender (male, female); total annual family income (\$20,000, \$20,000–\$49,999, \$50,000–\$74,999, \$75,000); race/ethnicity (White, Black, Hispanic, Other); education (<high school, high school graduate, some college, college graduate, 12 to 17 years old), marital status (married, widowed, separated or divorced, 12 to 17 years old), and categorical year.

³ Met criteria for past-year abuse or dependence one or more of the following illicit substances: cannabis, hallucinogens, inhalants, tranquilizers, cocaine, heroin, pain relievers, stimulants, and sedatives.

⁴ Met criteria for past-year abuse or dependence one or more of the following illicit substances: hallucinogens, inhalants, tranquilizers, cocaine, heroin, pain relievers, stimulants, and sedatives.

⁵ Met criteria for past-year cannabis abuse or dependence.

Prevalence of current smoking for persons with and without past-year SUDs from 2002 to 2014 (NSDUH, age 12+)

Table 2

	Total	2002 ¹	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Linear trend			
	Prevalence of current smoking (unweighted n, weighted %, weighted s.e.)														Unadjusted OR ² (95%CI)	T-test (p-value)	Adjusted OR ^{2,3} (95%CI)	T-test (p-value)
Total sample size (n)	723,283	54,079	55,230	55,602	55,905	55,279	55,435	55,110	55,234	57,313	58,397	55,268	55,160	55,271				
Total current smoker (n)	150,343	12,761	12,969	12,599	12,435	11,979	11,936	11,491	11,366	11,254	11,169	10,420	9,926	10,038				
%	21.49	23.85	23.2	22.79	22.9	22.79	22.05	21.63	21.39	20.9	19.97	20.16	19.24	19.16	0.977 (0.974, 0.980)	t=-16.448 (<0.001)	0.986 (0.983, 0.989)	t=-9.367 (<0.001)
s.e.	0.10	0.35	0.34	0.29	0.37	0.31	0.33	0.39	0.33	0.33	0.36	0.33	0.30	0.25				
With past year SUDs ⁴ (n)	19,702	1,669	1,688	1,740	1,648	1,572	1,572	1,608	1,572	1,539	1,456	1,345	1,235	1,058	0.988 (0.978, 0.998)	t=-2.342 (0.020)	0.989 (0.980, 1.001)	t=-1.736 (0.084)
%	59.47	59.37	61.62	59.13	60.25	61.72	60.16	60.79	59.5	59.74	60.94	56.69	58.03	55.48				
s.e.	0.43	1.76	1.49	1.40	1.49	1.55	1.70	1.67	1.61	1.84	1.86	1.70	2.08	1.55				
Without past year SUDs ⁴ (n)	130,641	11,092	11,281	10,859	10,787	10,407	10,364	9,883	9,794	9,715	9,713	9,075	8,691	8,980	0.976 (0.974, 0.979)	t=-16.370 (<0.001)	0.986 (0.983, 0.989)	t=-9.341 (<0.001)
%	20.39	22.74	22.06	21.63	21.86	21.65	20.97	20.5	20.28	19.79	18.89	19.1	18.2	18.15				
s.e.	0.10	0.33	0.37	0.28	0.37	0.31	0.34	0.39	0.32	0.32	0.37	0.34	0.31	0.25				
Differential time trend															Unadjusted Wald F(p-value) Wald F(1)=4.795(0.030)		Adjusted Wald F(p-value) Wald F(1)=0.005(0.943)	
Differential time trend: year as continuous × illicit drug abuse or dependence																		

Key: NSDUH, National Survey on Drug Use and Health; OR, odds ratio; Ref., reference; s.e., standard error; SUDs, substance use disorders

¹2002 as the reference year

²OR compares current smoking versus all other categories (i.e., never smokers, former smokers, recent quitters defined as those who reported cigarette smoking in the past year but not in the past 30 days, and those with missing information on past 30 day cigarette use).

³Adjusted for age (12 to 17, 18 to 25, 26 to 34, 35 to 49, 50+ years old); gender (male, female); total annual family income (\$20,000, \$20,000–\$49,999, \$50,000–\$74,999, \$75,000); race/ethnicity (White, Black, Hispanic, Other); education (<high school, high school graduate, some college, college graduate, 12 to 17 years old), marital status (married, widowed, separated or divorced, 12 to 17 years old).

⁴Met criteria for past-year abuse or dependence one or more of the following illicit substances: cannabis, hallucinogens, inhalants, tranquilizers, cocaine, heroin, pain relievers, stimulants, and sedatives.

Note: Linear trends were assessed using logistic regression models for current smoking versus all other categories, with a linear term for the year. An odds ratio above 1.0 indicates an increase in current smoking over time, whereas an odds ratio below 1.0 indicates a decrease. T-test showed significance of linear trend.