Title

Frequency of reported methamphetamine use linked to prevalence of clinical conditions, sexual risk behaviors, and social adversity in diverse men who have sex with men in Los Angeles

Authors

Shoptaw, Steve
Li, Michael J
Javanbakht, Marjan
et al.

Publication Date

2022-03-01

DOI

10.1016/j.drugalcdep.2022.109320

Peer reviewed

HHS Public Access

Author manuscript

Drug Alcohol Depend. Author manuscript; available in PMC 2023 March 01.

Published in final edited form as:

Drug Alcohol Depend. 2022 March 01; 232: 109320. doi:10.1016/j.drugalcdep.2022.109320.

Frequency of reported methamphetamine use linked to prevalence of clinical conditions, sexual risk behaviors, and social adversity in diverse men who have sex with men in Los Angeles

Steve Shoptaw[1,2], **Michael J. Li**[1], **Marjan Javanbakht**[3], **Amy Ragsdale**[3], **David Goodman-Meza**[4], **Pamina M. Gorbach**[3]

[1]David Geffen School of Medicine, Department of Family Medicine, University of California, Los Angeles

[2]David Geffen School of Medicine, Department of Psychiatry and Biobehavioral Sciences, University of California, Los Angeles

[3]Fielding School of Public Health, Department of Epidemiology, University of California, Los Angeles

[4]David Geffen School of Medicine, Department of Medicine, Division of Infectious Diseases, University of California, Los Angeles

Abstract

Objective: This study tested the hypothesis that reported frequency of methamphetamine use is significantly associated with measures of social adversity, sexual risk behaviors, chronic health conditions, bacterial STIs and HIV-related factors among diverse men who have sex with men (MSM).

Methods: Data were 2,428 visits from 515 mSTUDY participants (261 people living with HIV; 254 HIV-negative). mSTUDY is an ongoing longitudinal study of racially/ethnically diverse MSM in Los Angeles County. Logistic regression with random intercepts modeled associations between self-reported past 6-month methamphetamine use (none, monthly or less, weekly or more) with reported adverse social outcomes (unemployment, housing instability, intimate partner violence), sexual risk behaviors, chronic health conditions, and biomarkers of bacterial STIs (chlamydia, gonorrhea, or syphilis) and detectable HIV viral load (among HIV-positive). Models controlled for confirmed HIV-serostatus.

Results: Prevalence of reported monthly or less methamphetamine use was 19%; weekly or more use was 18%. Multivariable models showed escalating odds of adverse social outcomes and sexual risk behaviors (p's < .001) with increased methamphetamine use frequency. Frequency

Corresponding Author: Steve Shoptaw, PhD, UCLA Department of Family Medicine, 10880 Wilshire Blvd, Suite 1800, Los Angeles, CA 90024, sshoptaw@mednet.ucla.edu.

Previous Presentation: A portion of this work was presented as Poster 885, "Methamphetamine Dose, clinical outcomes and HIV status in Diverse MSM in LA," Conference on Retroviruses and Opportunistic Infections, March 6, 2019, Seattle Washington

Conflict of Interest: The authors report no conflicts of interest with this study.

of methamphetamine use associated with increased odds of a positive bacterial STI test ($p < .001$), detectable viral load (in HIV-positive participants) ($p < .001$), renal condition ($p = .047$), neurological condition ($p = .008$), and psychological condition ($p = .001$).

Conclusions: Findings show cross-sectional links between reported methamphetamine use frequency and adverse social and health outcomes among MSM in Los Angeles and suggest there may be fewer social and physical health harms corresponding to less frequent use of methamphetamine in this group.

Introduction

Methamphetamine (MA) use in the United States is low; less than 1% report monthly use (Substance Abuse and Mental Health Services Administration, 2021). Prevalence is much higher in groups who use other drugs (Palamar et al., 2020) and among such disparate groups as people who live in rural areas, youth, men who have sex with men (MSM), shift workers, and sex workers (Brecht et al., 2004). The primary purposes for using methamphetamine in these groups can range from relieving boredom, inducing euphoria, facilitating social interactions, enhancing sexual encounters, focusing attention, increasing productivity at work and home, reducing appetite and weight, reducing inhibition and enhancing performance during sex work, and coping with mood disorders and social adversity such as homelessness, violence, and discrimination (Aguilar and Sen, 2013; Halkitis et al., 2005; Kubicek et al., 2007; Li et al., 2018).

Across these groups and functions, MA use patterns can be thought of as behavioral phenotypes. Use patterns often correspond with the individual's dependence on this highly addictive drug, although many who use MA typically find a preferred and steady "dose." MA can be used on rare occasions per year ("once in a blue moon"), monthly in social and sexual situations, or weekly to daily for regular functioning. People may use MA on rare occasions for recreational reasons (e.g., experimenting at party, rave, or other event) or to enhance performance during a period of stress or high demand (e.g., studying for a college examination) (Wermuth, 2000). People who use MA with moderate frequency often do so specifically in social contexts, such as parties, sexual encounters, or with friends, because of its effects on increased sexual desire, social confidence, and energy (Shoptaw, 2006). People who use MA frequently (weekly to daily) rely on the drug for its functional attributes (increases in energy and focus; increases in productivity in daily tasks and work responsibilities) and its effects on mood (Lende et al., 2007). This heterogeneity in MA use frequency can account for some differences in risk of MA-related health problems, suboptimal responses to treatment (Brensilver, 2013), and potentially, risk of overdose, which is of particular concern given the 5.6 fold rise in MA overdose deaths nationally from 2012 to 2018 (Han et al., 2021).

Behavioral phenotypes of MA use frequency often correspond with outcomes for treatment for MA use disorder. Those seeking treatment and who report more than 15-18 days of use per month have reliably shown poor treatment outcomes in randomized controlled trials (McKetin, 2013, 2014), excepting a recent trial report (Trivedi et al., 2021). In contrast, treatments work best for those who can achieve some amount of abstinence at the start of

treatment. Our group found a monotonic dose-response relationship for participants assigned to placebo condition in medication trials between number of MA-negative urine samples provided in the first two weeks of treatment and being retained and abstinent at the end of treatment (Cook, 2017).

The degree to which ongoing frequency of MA use corresponds in any way with the range and severity of MA-related neurologic, cardiovascular and metabolic adverse events is not known. Is there some measurable health benefit that corresponds to reducing MA use patterns from weekly or more to monthly or less? There is some initial evidence to support this idea. It is well known that the pattern of MA exposure distinguishes therapeutic uses of the drug from illicit use. Low doses (under 30 mg/day for children; under 70 mg/day for adults) of methamphetamine hydrochloride and related d-amphetamine drugs (mixed amphetamine salts, lisdexamfetamine) are used for their therapeutic benefits, often for the indication of ADHD in children and less commonly for obesity in adults. These lower doses in animal models do not initiate the cascade of harmful neurological markers observed at higher doses of MA (Alburges et al., 2015). High, supra-therapeutic doses in illicit use stimulates microglial activation, neuroinflammation and displacement of dopamine from synaptic vesicles in dendrites, which increases oxidative stress and neuronal damage (Fleckenstein A. E., 2009; Fleckenstein et al., 2000; Thomas, 2004). Sustained, frequent MA use also corresponds with development of cardiovascular disease (Darke et al., 2017; Kaye et al., 2007; Kevil et al., 2019), acute and chronic renal damage (Isoardi et al., 2019; Jones and Rayner, 2015), hepatic problems (Halpin et al., 2013; Koriem and Soliman, 2014), and psychiatric conditions and neurological alterations (Rusyniak, 2011; Salo et al., 2011; Sekine et al., 2001; Zweben et al., 2004).

Among people who engage non-prescribed use of MA, there are important behavioral phenotypic differences that have direct bearing on the cumulative exposure to the individual. Using an assumption that purity and potency of non-prescribed MA is relatively high —averaging 97.2% purity and 97.5% potency in the U.S. (U.S. Drug Enforcement Administration, 2021)—those who consume the drug daily risk physical adverse events due to monthly total exposure that can exceed 10 grams per month when using 0.25 gram per day minimum, a moderate amount per episode. Those using MA on two or fewer weekends per month experience monthly total exposure to MA that can be 2-5 times lower than daily users representing a substantial reduction in drug exposure. As well, different naturally occurring patterns of behavior correspond with different levels of MA use frequency. For those who consume MA on two or fewer weekends per month, significant periods of abstinence occur between use weekends underscoring the ability to stop MA use, remain stopped for a significant period, and return to stopped following return to use. Among those who use MA regularly (e.g., daily), there are none of these naturally occurring behavior patterns that are essential to initiating and maintaining drug abstinence. These phenotypic differences in frequency of sustained MA use could reasonably be expected to correspond differently with biological, behavioral and social adverse conditions.

This study analyzes baseline and follow-up visit data from the mSTUDY, a prospective study of diverse MSM aged 18 to 45 to determine whether frequency of MA use is associated with conditions including adverse psychosocial and physical health problems. While the

purposes and the ways in which MA is used by MSM can vary, ultimately more frequent exposure to MA drives risks for adverse health conditions, including acquisition of HIV (Koblin, 2006; Plankey, 2007) and poor virologic control among those living with HIV (Li, 2020). Fortunately, self-reports of how often people use MA can contextualize severity of use and is acceptably valid against urine biomarkers measuring short-term use, with good sensitivity (about 87%) and positive predictive value (about 92%) (Rowe et al., 2018). The objective of this study was to determine whether greater levels of MA use frequency over 6-month periods are significantly associated with adverse social outcomes, poor HIV-related outcomes, sexual risk behaviors and STIs, and chronic clinical conditions in MSM living with and without HIV.

Methods

Study population and design

Participants in this study were those enrolled in the NIH/National Institute of Drug Abuse (NIDA) funded mSTUDY – a longitudinal study designed to assess the epidemiological and immunological impact of substance use and HIV on racial/ethnically diverse MSM. The mSTUDY has been described elsewhere (Fulcher et al., 2018; Javanbakht et al., 2018; Okafor et al., 2017) but briefly, study enrollment started in August 2014 and is ongoing. Participants were recruited from a community-based organization providing a broad spectrum of services for the lesbian, gay, bisexual, and transgender community and a community-based university research clinic both located in the Hollywood area of Los Angeles, CA. All participants in the mSTUDY enrolled between August 2014 and June 2019 were eligible and included in this analysis. Inclusion criteria for this analysis were the same as those for the mSTUDY and were as follows: (1) being aged 18 to 45 years at enrollment, (2) been assigned male at birth, (3) if HIV-negative, reporting condomless anal intercourse with a male partner in the past 6 months, (4) being capable of providing informed consent, and (5) being willing and able to return to the study every 6 months to complete study related activities including questionnaires, clinical assessments, and biological specimen collection. By design, participants were recruited to include half HIV-positive and half HIV-negative men. As well, half of the participants used substances (self-report confirmed by urine drug screen) and half did not use substances at study enrollment.

Study procedures and data collection

Research activities for mSTUDY are approved and overseen by the Human Research Protection Program (IRB) for University of California, Los Angeles. All potential participants received a complete description of the mSTUDY and an opportunity to ask questions about potential risks and benefits. Those who chose to continue provided written informed consent and completed a self-administered, computer assisted survey instrument (CASI) which takes 45-60 minutes to complete. All participants were scheduled to return every six months and the study questionnaire and the laboratory tests were repeated at the follow-up visits.

Measures

Socio-demographic characteristics.—We captured age (in years) and race/ethnicity using CASI. Race/ethnicity was based on a question that asked participants to select a single race/ethnicity "with which you most closely identify" with answer choices including: (1) American Indian or Alaska Native; (2) Asian (Japanese, Korean, Chinese, Vietnamese, Filipino, Hmong, Laotian, Thai, Cambodian, etc.); (3) Asian Indian; (4) Black or African American; (5) Hispanic/Latino/Spanish; (6) Native Hawaiian or Pacific Islander (Guamanian or Chamorro, Samoan, Fijian, etc.); (7) White; and (8) Other race. Given the low frequency distribution for a number of these categories, the race/ethnicity categories for the analysis were collapsed into the 'other' category resulting in the four race/ethnicity categories used in this analysis including African American/Black, Hispanic/Latino, White, and 'Other.'

Substance use.—As part of the CASI, participants self-reported frequency of MA use and substances used concurrently with MA. These included cocaine powder, crack cocaine, ecstasy, heroin, marijuana, MA, poppers, and asked in the past 6 months how frequently they used each drug. For instance, participants were asked "In the last 6 months, how often did you use Crystal (glass, meth, amphetamine, tina, speed)?" Answer choices included daily, weekly, monthly, less often, once, or never. Frequent use was defined as having reported MA use daily or weekly, occasional users were those who reported MA use monthly, less often, or once and non-users were those who reported 'never' using MA in the past 6 months.

Sexual risk behaviors and STIs.—Sexual risk behaviors measured on the CASI focused on recent behaviors (past 6 months) and included information on reports of new sex partners, concurrent sexual partnerships, and exchange sex. Any participant reporting more than zero as a response to the following question, was categorized as having a new sex partner. "Of the men you had anal sex with in the last 6 months, how many of them were new partners, that is, you had sex with them for the first time within the last 6 months? Concurrent sexual partnerships (i.e., sexual partnerships that overlap in time) were assessed based on the following question: "In the last 6 months, was there any time in which you were having sex repeatedly with one person and also having sex with other(s)? In other words, did you have sexual partners that overlapped in time?" Exchange sex was defined as having received money, drugs, shelter, or other goods for sex and was captured with the question: "In the last 3 months, have you been given money/drugs/a place to stay in exchange for anal sex with you?"

STI diagnoses were based on laboratory tests of specimens collected during study visits. Urine samples as well as rectal and pharyngeal swabs were collected for chlamydia and gonorrhea testing using nucleic acid amplification testing (NAAT) technology (Aptima Combo 2®, GenProbe, San Diego, CA). Additionally, blood samples were collected for syphilis. Syphilis testing was conducted using the rapid plasma reagin test (RPR), with confirmatory testing done with the *Treponema pallidum* particle agglutination test (TPPA). Syphilis disposition (i.e., primary, secondary, or early latent syphilis) was obtained for each participant and based on standard of care health department investigation of syphilis cases as specified by the Centers for Disease Control STD prevention and treatment guidelines (Workowski et al., 2015).

HIV-related factors.—We assessed whether HIV positive participants had a detectable viral at their visit and whether HIV-negative participants were currently using pre-exposure prophylaxis (PrEP). HIV-negative participants receive HIV screening at each study visit using the OraQuick Rapid HIV1/2 Antibody Test. In the event of a preliminary positive result, blood draws are taken and sent to a commercial laboratory for confirmatory testing via fourth-generation detection of HIV antibodies and p24 antigens as well as a PCR viral load quantification. For all HIV-positive participants, viral load is quantified from HIV-1 RNA levels in plasma taken at each visit with the threshold for detectability at 20 copies/mL of blood.

Chronic health conditions.—Data on chronic clinical conditions were based on clinical examinations and review of participants' current medical history by a physician or physician extender at each visit. At mSTUDY visits, participants self-report any clinical diagnoses they receive from professionals providing their personal healthcare. If participants reported having an active diagnosis and/or ongoing treatment from their medical provider, they were classified as having any of the following: cardiovascular conditions included hypertension (vital signs confirmed) and hyperlipidemia (self-report during exam); neurologic conditions included neuropathy, tremors, and sciatica (all self-report during exam); psychologic conditions included depression, anxiety, bipolar disorder, PTSD, and schizophrenia (all self-report during exam); renal conditions included kidney stones, dysuria, and urinary tract infections (all lab confirmed, self-report during exam).

Social adversity.—The social adversity measures examined in this study were captured by CASI, and included unemployment, housing instability, experienced intimate partner violence (IPV), and having any history of incarceration. Current employment status was assessed based on the question "Which of the following best describes your current work situation?" with answer choices including (1) disabled; (2) unemployed/not working; (3) working full-time; (4) working part-time; (5) work at home as a caregiver; or (6) full-/part-time student. For the purpose of this analysis, those responding as disabled or unemployed were categorized as 'unemployed.' Participants were categorized as having housing instability if they reported more than zero to the question on their living situation, "Approximately how many days have you not had a regular place to stay in the last 6 months?" Experienced IPV (last 12 months) was assessed with the question, "Have you been hit, kicked or slapped by a lover, boyfriend or girlfriend in the last 12 months? We only mean times when that person meant to hurt you physically. Not when you were just playing around." We assessed for any history of incarceration with the question, "In total over your lifetime, how much total time have you been incarcerated in a jail, prison or detention facility?" Participants could report in units of days, weeks, or months. Anyone reporting one or more days of incarceration was categorized as having a history of criminal justice involvement.

Criterion Variables

Outcomes of interest for regression modeling covered domains of social adversity, sexual risk behaviors and bacterial STI diagnoses, HIV-related factors, and chronic health conditions identified *a priori* per empirical literature. Social adversity included

unemployment, unstable housing (defined as not having a regular place to stay in the past 6 months) and experienced IPV (defined as being hit, kicked, or slapped by a lover, boyfriend or girlfriend when that person meant to hurt the individual physically). Sexual risk behaviors included having a new sex partner (past 6 months), concurrent sexual partners (past 6 months), and engaging in exchange sex (defined as receiving money, drugs, or shelter for sex in the past 6 months). Any prevalent bacterial STI diagnosis was considered as any diagnosis of chlamydia, gonorrhea, or syphilis by laboratory testing, with titers evaluated to confirm new syphilis cases. HIV-related factors included having a detectable viral load in those who were HIV-positive and using PrEP in the past 6 months in those who were HIV-negative. Chronic health conditions encompassed cardiovascular, hepatic, neurologic, psychologic, and renal conditions and abnormalities.

Statistical Analysis

All statistical analyses were conducted using Stata 16. Descriptive statistics including mean, range, and frequency distributions were computed for demographics as well as social, behavioral, and clinical measures.

We fit separate, unadjusted logistic random intercept models—one for each outcome including unemployment, housing instability, experienced IPV, history of incarceration, new anal intercourse partner, exchange sex, concurrent sexual partners, STI diagnosis, hepatic abnormalities, neurologic conditions, psychologic conditions, and renal conditions—each as function of different levels of MA use frequency (none, monthly or less, weekly or more). We accounted for random intercepts and time effects to accommodate the repeated measurements within each participant, allow participant-specific changes in the responses over time, and estimate within-person fixed effects of different levels of MA use frequency on these outcomes. We then conducted adjusted logistic random-intercept models to account both time-variant and time-invariant covariates as noted at each visit. Covariates (age, race/ethnicity, other substance use, smoking, alcohol, and HIV-serostatus) included in the multivariable models were based on bivariable analyses or specified a priori as risk factors based on the existing literature.

We then conducted post hoc marginal analyses, using Stata's "margins" command to compute predicted probabilities of outcomes significantly associated with frequency of MA use in the adjusted models, which were plotted to visually display the escalating probabilities of these outcomes as a function of the levels of MA use frequency—none, monthly or less, or weekly or more MA use.

Results

A total of 515 YMSM contributed visits for these analyses between August 2014 and June 2019. Table 1 reports descriptive statistics for the sample at baseline. The mean age of participants was 31 years. The largest racial ethnic group identified as Black (43%), followed by Latinx (36%), then White (13%). Forty-four percent reported using MA in the past 6 months, and 51% were HIV-positive at baseline. At baseline, 19% had a cardiovascular condition, 7% had a hepatic abnormality, 7% had a renal condition, 14% had a neurological condition, and 50% had a psychological condition. The most common

psychological conditions among participants were depression (39%) followed by anxiety (31%), while less common were bipolar disorder (12%), PTSD (8%), and schizophrenia (4%).

In bivariable analyses (Table 2), increased MA use frequency was associated with increased prevalence of positive bacterial STI tests ($p < .001$) and sexual risk behaviors, including having a new anal intercourse partner in the past 6 months ($p < .001$), concurrent sexual partners in the past 6 months ($p < .001$), and exchange sex in the past 3 months ($p < .001$). Those who reported any MA use, regardless of frequency, were more likely to be of HIV-positive serostatus (68%) than those who reported no MA use (43%) ($p<.001$). Among HIV-positive participants, a greater frequency of MA use was associated with increased percentages of detectable viral loads. Across all participants, greater MA use frequency was linked to increased prevalence of hepatic abnormalities, neurological conditions, and psychological conditions. MA frequency was associated with increased prevalence of social adversity, including unemployment ($p < .001$), housing instability (past 6 months), having ever been incarcerated ($p < .001$), and experienced IPV ($p < .001$).

In multivariable models (Table 3), we tested whether frequency of reported MA use associated with sexual risk behaviors, STIs, HIV-related factors, and clinical conditions adjusting for age, race/ethnicity, other substance use (besides MA) and HIV status. Weekly or more MA use was associated with increased odds of sexual risk behaviors, including having a new anal intercourse partner (AOR = 3.2, 95% CI [2.1, 4.8], $p < .001$), engaging in exchange sex (AOR = 15.5, 95% CI [8.9, 26.9], $p < .001$), and having concurrent sexual partners (AOR= 4.8, 95% CI [3.0, 7.7], $p < .001$) compared to no use. Monthly or less MA use also associated with increased odds of having a new anal intercourse partner (AOR = 1.8, 95% CI [1.2, 2.6], $p = .003$), exchange sex (AOR = 4.8, 95% CI [2.8, 8.1], $p < .001$), and concurrent sexual partners (AOR = 2.0, 95% CI [1.3, 3.0]) compared to non-use, although with a weaker signal compared to the more frequent use comparisons.

When compared to those not using MA, weekly or more use associated with the greatest odds of having an STI diagnosis (AOR = 2.3, 95% CI [1.6, 3.4], $p < .001$). In HIV-positive MSM, weekly or more MA use associated with 3.2 times the odds of having a detectable viral load (> 20 c/mL) as those who do not use (95% CI [1.8, 5.5], $p < .001$). Compared to no MA use, weekly or more MA use was associated with greater odds of having a renal condition (AOR = 2.1, 95% CI [1.0, 4.4], $p = .047$), a neurological condition (AOR = 1.9, 95% CI [1.2, 3.1], $p = .008$), and a psychological condition (95% CI [1.3, 2.8], $p = .001$). Frequency of MA use was not associated with comparatively greater odds of cardiovascular or hepatic conditions in multivariable models. Compared to no MA use, weekly or more use—and to a lesser degree, monthly or less use—were also associated with increased odds of social adversity, including being unemployed ($p < .001$), housing instability, and experienced IPV.

To illustrate the significant associations in the multivariate models described above and reported in Table 3, we plotted in Figure 1 the escalating predicted probabilities and 95% confidence intervals of these outcomes as alongside the escalating levels of MA use frequency.

Discussion

A strong pattern of findings confirmed that as reported frequency of MA use increased, the odds of social adversity, sexual risk behaviors and STIs, and chronic clinical conditions increased as well among MSM in a younger age group (18 to 45), who in general have low prevalence of chronic disease. Bivariable analysis showed greater MA use in older participants, which is consistent with the developmental course of MA use disorder—those who are older would have a longer history of use, and in turn, increased severity over time. Therefore, it is possible that our participants had lower prevalence of chronic disease than a cohort of older MSM not just due to age itself, but lower overall severity of MA use. In bivariable analyses, frequent reported use of MA (weekly or more use) increased the likelihood of adverse social, behavioral, and clinical outcomes; moderately frequent use (monthly or less) predicted moderate probability of adverse outcomes; and no MA use predicted low likelihood of adverse social, behavioral, and clinical markers. Our findings were strikingly consistent with our hypothesized patterns of association, showing that risk of adverse structural, behavioral, and clinical outcomes increases with greater reported frequency of MA use—a marker that conceptually aligns with cumulative exposure to the drug.

The range of variables exhibiting this association is compelling. We observed the pattern for social adversity (unemployment, experienced IPV, housing instability, and lifetime history incarceration), for other drug use prevalence (cigarette smoking, ecstasy, heroin, and poppers), for reported sexual risk behaviors (new anal intercourse partners, concurrent sexual partners, and exchange sex). Higher prevalence of other substance use, in particular cocaine and cannabis, were associated with any mention of MA compared to no MA use. No discernable patterns of binge drinking linked with MA use. In multivariable analyses, greater levels of reported MA use corresponded with escalating risk for being unemployed, housing instability, experienced IPV, new anal intercourse partner, concurrent sexual partners, exchange sex. MA was more strongly associated with exchange sex than other sexual behaviors measured in this study. There are several explanations for this. Because MA use corresponds to socioeconomic challenges such as housing instability and job loss, people experiencing these problems may resort to exchange sex as a source of income or to pay for MA (Semple et al., 2010). In other circumstances, housing and financial instability can precede both MA use and exchange sex, as MA use has been shown to be a survival tool for people marginally housed, such as to avoid violence or loss of property by staying alert or to conform to social norms (Barman-Adhikari et al., 2017; Damon et al., 2019). MA use has also been described as a way to make it easier to engage in exchange sex by reducing inhibitions and detaching from emotions (Semple et al., 2002). MSM who engage in exchange sex should be prioritized for public health programs that promote harm reduction, including substance use treatment and comprehensive HIV care and prevention programs.

What is equally notable are some specific conditions that did not show significant, incremental increases in risk with over the different levels of MA use. The odds of bacterial STIs, having a detectable viral load (< 20 c/ML blood), and having renal, neurological, or psychological conditions were significantly higher in those who used MA weekly or more

compared to those who did not use in the past 6 months, but differences between monthly or less use and no use did not meet significance thresholds. No statistical differences were seen for indicators of underlying cardiovascular conditions by reported severity of MA use. It is possible that the thresholds of consistent methamphetamine use for the appearance of these clinical outcomes are greater than for more proximal, psychosocial and behavioral outcomes, especially given the stage of life for MSM in this sample (i.e., 18 to 45 years of age). It is conceivable that any increased risk from moderate usage (i.e., monthly or less use) and in some cases frequent use do not manifest until later years of life, especially for chronic health conditions that are age-dependent. MA use predicted greater viral load in people living with HIV. There was no difference in current PrEP use by MA use in HIV-negative participants, which is consistent with network trial research of HIV-negative MSM who report substance use (Goodman-Meza et al., 2019; Okafor et al., 2020). Findings support ongoing public health efforts to engage MSM who use substances and are at high risk for HIV in PrEP uptake in Los Angeles County.

These findings provide some of the first consistent evidence that reported frequency of MA use coincides with escalating risk of social, behavioral and clinically confirmed health conditions. Importantly, these relationships involve reported ad libitum use of MA and occur outside an interventional study, but may have direct bearing on primary outcomes measured in clinical trials. In trials of MA addiction treatment being evaluated by the U.S. Food and Drug Administration is preference for sustained abstinence as the primary outcome variable, as there is a lack of research demonstrating that reduced harms correspond with reduced MA use (Marlatt and Witkiewitz, 2010). These findings demonstrate significant and clinically meaningful differences in the prevalence of social adversity, sexual risk behaviors, and clinical conditions that correspond with levels of reported frequency of MA exposure. Many scientists and regulatory agencies may hold to MA abstinence as a conservative and desirable outcome for intervention trials, yet these findings show fewer adverse social and health effects with lower frequency of MA use. Still, it is unclear whether actual reductions in MA use (e.g., from severe to moderate or less use) would necessarily reduce the negative health effects of prior frequent MA use, whether this depends on the condition, or whether this merely has implications for prevention of further risk of chronic disease. Addiction trial research examining whether longitudinal reductions in frequency of MA use coincides with changes in relevant biological endpoints is needed to determine causality.

The link between levels of MA use with social adversity, sexual risk behaviors, and psychologic conditions may be explained by interactions between MA and the brain. Chronic MA use impairs, even damages, dopamine and serotonin axons, inducing gliosis and inflammatory cascades in the striatum, and ultimately decreases gray matter volume, all of which can have lasting effects on cognitive functioning and the development of mood or other psychiatric disorders (Krasnova and Cadet, 2009; Kuhn et al., 2008; Loftis and Janowsky, 2014; Salo et al., 2011; Xu et al., 2005). Behavioral correlates of such MA-induced neurologic changes may include increased risk-taking (e.g., sexual risk behaviors) and impaired daily and social functioning, which in turn contributes to overall disorganization, reduced quality of life, and other health problems (McKetin et al., 2019). Poly-substance use with MA, especially cigarette smoking, may have synergistic negative health effects with MA use. Standardized mortality rates are nearly 17 times higher for HIV-

positive MSM who smoke cigarettes nearly 20 years after treatment for MA dependence compared to a sample of non-drug using men from the general population (Passaro, 2019). Continued research is essential to test whether frequency of MA use (proxy for exposure) corresponds with MA-induced neurological alterations and corresponding behaviors and health measures in broad groups of people who use MA.

There are limitations to these findings. Our findings may only be generalizable to diverse MSM residing in Los Angeles County, as substance use trends are often regional and linked to demography. The MA frequency/exposure variable is self-reported, and it is possible MA use is underreported or does not fall into the phenotype categorized here. However, self-reports show acceptable sensitivity (about 87%) and positive predictive value (about 92%) compared to urine biomarkers and provide detail on severity of use patterns over time that a urine test alone could not (Rowe et al., 2018). Findings estimate associations between reported MA use and indicators of poor health after controlling for use of any other substance. It remains to be explored what combinations of polysubstances interact to further drive the outcomes in our study, though this is beyond the scope and motivation of our analyses. The clinical conditions assessed in this study were also collected via self-report by clinicians, which may be subject to respondent errors or biases. This analysis is also limited in its ability to ascertain temporal precedence between MA use and study outcomes, as comorbid conditions may have been preexisting. As such, there remains the possibility of reverse causality between MA use and study outcomes, especially experiences of social adversity and preexisting HIV-diagnoses.

Conclusions

Findings show that among diverse YMSM in Los Angeles, reported MA use frequency corresponds with self-reported and observed indicators of poor social and health status. Especially important, findings show that consistent moderately higher prevalence of adverse social, behavioral, and clinical outcomes correspond with even moderate levels of use of MA in the setting of young, diverse MSM, a group that already face significant health and economic disparities. Finally, while abstinence from MA links with optimal health status, these findings provide some support for the rationale for defining reductions in MA use as a primary outcome in intervention research and programs.

Acknowledgements:

The authors are most grateful to the National Institute on Drug Abuse (U01DA036267 Gorbach, Shoptaw MPI) (K01DA051329 Li PI), National Institute on Mental Health (P30MH058107 Shoptaw PI), and the National Institutes of Health (UL1TR001881 UCLA CTSI).

References

Aguilar JP, Sen S, 2013. The Culture of Methamphetamine: Reframing Gay Men's Methamphetamine Use. J. Hum. Behav. Soc. Environ 23(3), 370–382.

Alburges ME, Hoonakker AJ, Cordova NM, Robson CM, McFadden LM, Martin AL, Hanson GR, 2015. Effect of low doses of methamphetamine on rat limbic-related neurotensin systems. Synapse 69(8), 396–404. [PubMed: 25963809]

Barman-Adhikari A, Craddock J, Bowen E, Das R, Rice E, 2017. The Relative Influence of Injunctive and Descriptive Social Norms on Methamphetamine, Heroin, and Injection Drug Use Among Homeless Youths: The Impact of Different Referent Groups. Journal of Drug Issues 48(1), 17–35.

Brecht M-L, O'Brien A, von Mayrhauser C, Anglin MD, 2004. Methamphetamine use behaviors and gender differences. Addict. Behav 29(1), 89–106. [PubMed: 14667423]

Brensilver M, Heinzerling KG, Shoptaw S, 2013. Pharmacotherapy of amphetamine-type stimulant dependence: an update. Drug and Alcohol Review 32(5), 449–460. [PubMed: 23617468]

Cook R, Quinn B, Heinzerling K, Shoptaw S , 2017. Dropout in clinical trials of pharmacological treatment for methamphetamine dependence: the role of initial abstinence. Addiction 112(6), 1077–1085. [PubMed: 28107598]

Damon W, McNeil R, Milloy MJ, Nosova E, Kerr T, Hayashi K, 2019. Residential eviction predicts initiation of or relapse into crystal methamphetamine use among people who inject drugs: a prospective cohort study. Journal of Public Health 41(1), 36–45. [PubMed: 29425315]

Darke S, Duflou J, Kaye S, 2017. Prevalence and nature of cardiovascular disease in methamphetamine-related death: A national study. Drug Alcohol Depend. 179, 174–179. [PubMed: 28787694]

Fleckenstein AE, V. TJ, Hanson GR, 2009. Psychostimulant-induced alterations in vesicular monoamine transporter-2 function: Neurotoxic and therapeutic implications. Neuropharmacology 56, 133–138. [PubMed: 18662707]

Fleckenstein AE, Gibb JW, Hanson GR, 2000. Differential effects of stimulants on monoaminergic transporters: pharmacological consequences and implications for neurotoxicity. Eur. J. Pharmacol 406(1), 1–13. [PubMed: 11011026]

Fulcher JA, Shoptaw S, Makgoeng SB, Elliott J, Ibarrondo FJ, Ragsdale A, Brookmeyer R, Anton PA, Gorbach PM, 2018. Brief Report: Recent Methamphetamine Use Is Associated With Increased Rectal Mucosal Inflammatory Cytokines, Regardless of HIV-1 Serostatus. J. Acquir. Immune Defic. Syndr 78(1), 119–123. [PubMed: 29419567]

Goodman-Meza D, Beymer MR, Kofron RM, Amico KR, Psaros C, Bushman LR, Anderson PL, Bolan R, Jordan WC, Rooney JF, Wohl AR, Landovitz RJ, 2019. Effective use of pre-exposure prophylaxis (PrEP) Among stimulant users with multiple condomless sex partners: a longitudinal study of men who have sex with men in Los Angeles. AIDS Care 31(10), 1228–1233. [PubMed: 30894013]

Halkitis PN, Fischgrund BN, Parsons JT, 2005. Explanations for methamphetamine use among gay and bisexual men in New York City. Subst. Use Misuse 40(9-10), 1331–1345. [PubMed: 16048820]

Halpin LE, Gunning III WT, Yamamoto BK, 2013. Methamphetamine causes acute hyperthermia-dependent liver damage. Pharmacol. Res. Perspect 1(1), 1–11.

Han B, Cotto J, Etz K, Einstein EB, Compton WM, Volkow ND, 2021. Methamphetamine Overdose Deaths in the US by Sex and Race and Ethnicity. JAMA Psychiatry 78(5), 564–567. [PubMed: 33471025]

Isoardi KZ, Ayles SF, Harris K, Finch CJ, Page CB, 2019. Methamphetamine presentations to an emergency department: Management and complications. Emerg. Med. Australas 31(4), 593–599. [PubMed: 30592564]

Javanbakht M, Ragsdale A, Shoptaw S, Gorbach PM, 2018. Transactional Sex among Men Who Have Sex with Men: Differences by Substance Use and HIV Status. J. Urban Health 96, 429–441.

Jones ESW, Rayner BL, 2015. Hypertension, end-stage renal disease and mesangiocapillary glomerulonephritis in methamphetamine users. S. Afr. Med. J 105(3), 199–201. [PubMed: 26294827]

Kaye S, McKetin R, Duflou J, Darke S, 2007. Methamphetamine and cardiovascular pathology: a review of the evidence. Addiction 102(8), 1204–1211. [PubMed: 17565561]

Kevil CG, Goeders NE, Woolard MD, Bhuiyan MS, Dominic P, Kolluru GK, Arnold CL, Traylor JG, Orr AW, 2019. Methamphetamine Use and Cardiovascular Disease. Arterioscler. Thromb. Vasc. Biol 39(9), 1739–1746. [PubMed: 31433698]

Koblin BA, Husnik MJ, Colfax G, Huang Y, Madison M, Mayer K, Barresi PJ, Coates TJ, Chesney MA, Buchbinder S, 2006. Risk factors for HIV infection among men who have sex with men. AIDS 20, 731–739. [PubMed: 16514304]

Koriem KM, Soliman RE, 2014. Chlorogenic and caftaric acids in liver toxicity and oxidative stress induced by methamphetamine. J. Toxicol 2014.

Krasnova IN, Cadet JL, 2009. Methamphetamine toxicity and messengers of death. Brain Res. Rev 60(2), 379–407. [PubMed: 19328213]

Kubicek K, McDavitt B, Carpineto J, Weiss G, Iverson EF, Kipke MD, 2007. Making informed decisions: How attitudes and perceptions affect the use of crystal, cocaine, and ecstasy among young men who have sex with men. Journal of Drug Issues 37(3), 643–672. [PubMed: 18852843]

Kuhn DM, Francescutti-Verbeem DM, Thomas DM, 2008. Dopamine disposition in the presynaptic process regulates the severity of methamphetamine-induced neurotoxicity. Ann. N. Y. Acad. Sci 1139, 118. [PubMed: 18991856]

Lende DH, Leonard T, Sterk CE, Elifson K, 2007. Functional methamphetamine use: The insider's perspective. Addiction Research & Theory 15(5), 465–477.

Li MJ, Okafor CN, Gorbach PM, Shoptaw S, 2018. Intersecting burdens: Homophobic victimization, unstable housing, and methamphetamine use in a cohort of men of color who have sex with men. Drug Alcohol Depend. 192, 179–185. [PubMed: 30266002]

Li MJ, Su E, Garland WH, Oksuzyan S, Lee S-J, Kao UH, Weiss RE, Shoptaw SJ, 2020. Trajectories of viral suppression in people living with HIV receiving coordinated care: Differences by comorbidities. J. Acquir. Immune Defic. Syndr 84(4), 387–395. [PubMed: 32598118]

Loftis JM, Janowsky A, 2014. Neuroimmune basis of methamphetamine toxicity, International review of neurobiology. Elsevier, pp. 165–197.

Marlatt GA, Witkiewitz K, 2010. Update on Harm-Reduction Policy and Intervention Research. Annu. Rev. Clin. Psychol 6(1), 591–606. [PubMed: 20192791]

McKetin R, Lubman DI, Baker AL, Dawe S, Ali RL, 2013. Dose-related psychotic symptoms in chronic methamphetamine users: evidence from a prospective longitudinal study. JAMA Psychiatry 70(3), 319–324. [PubMed: 23303471]

McKetin R, Lubman DI, Najman JM, Dawe S, Butterworth P, Baker AL, 2014. Does methamphetamine use increase violent behaviour? Evidence from a prospective longitudinal study. Addiction 109(5), 798–806. [PubMed: 24400972]

McKetin R, Voce A, Burns R, Shanahan M, 2019. Health-related quality of life among people who use methamphetamine. Drug and Alcohol Review 38(5), 503–509. [PubMed: 31144396]

Okafor CN, Gorbach PM, Ragsdale A, Quinn B, Shoptaw S, 2017. Correlates of Preexposure Prophylaxis (PrEP) Use among Men Who Have Sex with Men (MSM) in Los Angeles, California. J. Urban Health 94(5), 710–715. [PubMed: 28600749]

Okafor CN, Hucks-Ortiz C, Hightow-Weidman LB, Magnus M, Emel L, Beauchamp G, Kuo I, Hendrix C, Mayer KH, Shoptaw SJ, 2020. Brief Report: Associations Between Self-Reported Substance Use Behaviors and PrEP Acceptance and Adherence Among Black MSM in the HPTN 073 Study. J. Acquir. Immune Defic. Syndr 85(1), 23–29. [PubMed: 32452970]

Palamar JJ, Han BH, Keyes KM, 2020. Trends in characteristics of individuals who use methamphetamine in the United States, 2015-2018. Drug Alcohol Depend. 213, 108089. [PubMed: 32531703]

Passaro RC, Ramsey K, Segura ER, Lake JE, Reback CJ, Clark JL, Shoptaw S, 2019. Speed kills: Associations between methamphetamine use, HIV infection, tobacco use, and accelerated mortality among gay and bisexual men in Los Angeles, CA 20 years after methamphetamine dependence treatment. Drug Alcohol Depend. 195(164-169).

Plankey MW, Ostrow DG, Stall R, Cox C, Li X, Peck JA, Jacobson LP, 2007. The relationship between methamphetamine and popper use and risk of HIV seroconversion in the multicenter AIDS cohort study. J. Acquir. Immune Defic. Syndr 45(1), 85–92. [PubMed: 17325605]

Rowe C, Vittinghoff E, Colfax G, Coffin PO, Santos G-M, 2018. Correlates of Validity of Self-Reported Methamphetamine Use among a Sample of Dependent Adults. Subst. Use Misuse 53(10), 1742–1755. [PubMed: 29461134]

Rusyniak DE, 2011. Neurologic manifestations of chronic methamphetamine abuse. Neurol. Clin 29(3), 641–655. [PubMed: 21803215]

Salo R, Flower K, Kielstein A, Leamon MH, Nordahl TE, Galloway GP, 2011. Psychiatric comorbidity in methamphetamine dependence. Psychiatry Res. 186(2-3), 356–361. [PubMed: 21055832]

Sekine Y, Iyo M, Ouchi Y, Matsunaga T, Tsukada H, Okada H, Yoshikawa E, Futatsubashi M, Takei N, Mori N, 2001. Methamphetamine-related psychiatric symptoms and reduced brain dopamine transporters studied with PET. Am. J. Psychiatry 158(8), 1206–1214. [PubMed: 11481152]

Semple SJ, Patterson TL, Grant I, 2002. Motivations associated with methamphetamine use among HIV men who have sex with men. J. Subst. Abuse Treat 22(3), 149–156. [PubMed: 12039618]

Semple SJ, Strathdee SA, Zians J, Patterson TL, 2010. Social and behavioral characteristics of HIV-positive MSM who trade sex for methamphetamine. The American Journal of Drug and Alcohol Abuse 36(6), 325–331. [PubMed: 20955106]

Shoptaw S, 2006. Methamphetamine use in urban gay and bisexual populations. Top. HIV Med 14(2), 84–87. [PubMed: 16835463]

Substance Abuse and Mental Health Services Administration, 2021. Key substance use and mental health indicators in the United States: Results from the 2020 National Survey on Drug Use and Health Center for Behavioral Health Statistics and Quality, Rockville, MD.

Thomas DM, Walker PD, Benjamins JA, Geddes TJ, Kuhn DM, 2004. Methamphetamine neurotoxicity in dopamine nerve endings of the striatum is associated with microglial activation. J. Pharmacol. Exp. Ther 311(1), 1–7. [PubMed: 15163680]

Trivedi MH, Walker R, Ling W, Dela Cruz A, Sharma G, Carmody T, Ghitza UE, Wahle A, Kim M, Shores-Wilson K, Sparenborg S, Coffin P, Schmitz J, Wiest K, Bart G, Sonne SC, Wakhlu S, Rush AJ, Nunes EV, Shoptaw S, 2021. Bupropion and Naltrexone in Methamphetamine Use Disorder. N. Engl. J. Med 384(2), 140–153. [PubMed: 33497547]

U.S. Drug Enforcement Administration, 2021. 2020 National Drug Threat Assessment. U.S. Department of Justice, Springfield, VA, p. 24.

Wermuth L, 2000. Methamphetamine Use: Hazards and Social Influences. J. Drug Educ 30(4), 423–433. [PubMed: 11221576]

Workowski KA, Bolan GA, Centers for Disease, C., Prevention, 2015. Sexually transmitted diseases treatment guidelines, 2015. MMWR Recomm. Rep 64(RR-03), 1–137.

Xu W, Zhu JPQ, Angulo JA, 2005. Induction of striatal pre-and postsynaptic damage by methamphetamine requires the dopamine receptors. Synapse 58(2), 110–121. [PubMed: 16088948]

Zweben JE, Cohen JB, Christian D, Galloway GP, Salinardi M, Parent D, Iguchi M, 2004. Psychiatric Symptoms in Methamphetamine Users. Am. J. Addict 13(2), 181–190. [PubMed: 15204668]

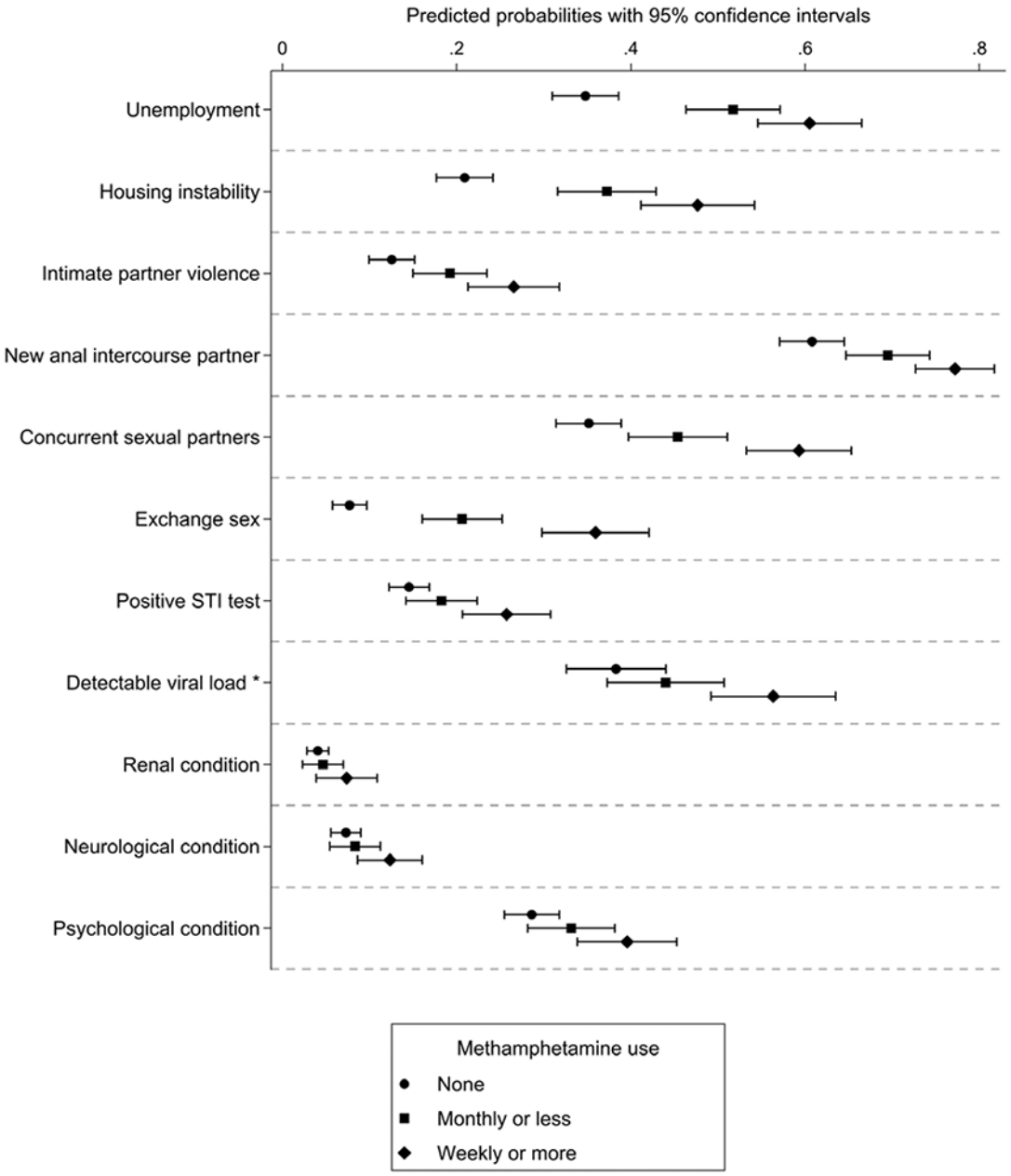

Figure 1.

Predicted probabilities of adverse health outcomes and dose response relationship to methamphetamine use (past 6 months), derived from adjusted logistic random intercept models in Table 3.

* Assessed in HIV-positive participants only.

Table 1.

Baseline characteristics among mSTUDY participants

	Total (n=515) [a]	
	M	**SD**
Socio-demographic		
Age	31.3	6.9
	n	**% [b]**
Race/ethnicity		
Black	220	42.7
Latinx	186	36.1
Other	40	7.8
White	69	13.4
Social adversity		
Unemployment	226	45.2
Housing instability (past 6 mos.)	182	35.3
Ever incarcerated	204	39.6
Intimate partner violence (past 12 mos.)	92	18.3
Substance use (past 6 mos.)		
Methamphetamine	227	44.1
Cocaine/crack	141	27.4
Heroin	22	4.3
Cannabis	302	58.6
Poppers	193	37.5
Binge drinking	305	59.2
Cigarette smoking (current)	160	32.3
Sexual risk behaviors and STIs		
New anal intercourse partner (past 6 mos.)	389	75.5
Concurrent sex partners (past 6 mos.)	234	49.2
Exchange sex (past 3 mos.)	100	19.8
Positive STI test (chlamydia, gonorrhea, and/or syphilis)	98	19.1
HIV-related factors		
HIV-serostatus		
HIV-negative	254	49.3
HIV-positive	261	50.7
Detectable viral load (> 20 c/mL) [a]	124	49.0
PrEP use, past 6 mos. [b]	59	22.6
Chronic health conditions		
Cardiovascular condition	99	19.2
Hepatic abnormality	34	6.6
Renal condition	35	6.8
Neurological condition	71	13.8

	Total (n=515) [a]	
	M	**SD**
Psychological condition	256	49.7

Abbreviations: M = means; SD = standard deviations

[a] Sum of cells may not equal total due to missing responses.

[b] Column percentages reported.

[a] Measured in HIV-positive participants only

[b] Measured in HIV-negative participants only

[c] p-value for Fisher's exact test

Table 2.

Differences in sociodemographic characteristics, experienced social adversity, sexual risk behaviors, and clinical conditions by severity of methamphetamine use across study visits (Aug 2, 2014 to June 5, 2019)

	Methamphetamine use (past 6 mos.) (N_{obs} = 2,428)							
	None (n_{obs} = 1,512)		Monthly or less (n_{obs} = 467 visits)		Weekly or more (n_{obs} = 449)			
	M	SD	M	SD	M	SD	χ^2 [a]	p [a]
Sociodemographic								
Age	32.2	7.0	33.9	6.9	34.8	6.8	30.5	< .001
	n	%	n	%	n	%		
Race/ethnicity							3.7	.302
African American	653	43.2	186	39.8	166	37.0		
Hispanic/Latino	537	35.5	161	34.5	166	37.0		
Other	138	9.1	40	8.6	50	11.1		
White	184	12.2	80	17.1	67	14.9		
Social adversity								
Unemployment	423	29.0	244	55.3	309	71.0	66.8	< .001
Housing instability (past 6 mos.)	215	18.7	129	35.7	166	48.5	70.6	< .001
Ever incarcerated	329	21.8	171	36.6	229	51.0	68.2	< .001
Intimate partner violence (past 12 mos.)	147	9.9	80	17.7	130	30.0	35.6	< .001
Other substance use (past 6 mos.)								
Binge drinking	737	48.7	273	58.5	146	32.5	19.3	< .001
Cigarette smoking (current)	287	24.7	166	40.3	214	53.8	13.6	.001
Cocaine	231	15.3	143	30.6	124	27.6	69.0	< .001
Ecstasy	126	8.3	84	18.0	108	24.1	71.1	< .001
Heroin	10	0.7	21	4.5	48	10.7	47.9	< .001
Cannabis	704	46.6	280	60.0	255	56.8	39.8	< .001
Poppers	351	23.2	166	35.6	225	50.1	91.0	< .001
Sexual risk behaviors and STIs								
New anal intercourse partner (past 6 mos.)	894	59.1	315	67.5	332	73.9	34.3	< .001
Concurrent sexual partners (past 6 mos.)	492	35.2	168	41.4	228	58.0	47.3	< .001
Exchange sex (past 3 mos.)	99	6.8	80	18.4	166	38.4	111.2	< .001
Positive STI test (chlamydia, gonorrhea, and/or syphilis)	205	13.6	85	18.4	112	25.2	26.9	< .001
HIV-related factors								
HIV-serostatus							140.6	< .001
HIV-negative	863	57.1	155	33.2	136	30.3		
HIV-positive	649	42.9	312	66.8	313	69.7		
Detectable viral load (> 20 c/mL) [b]	219	33.7	125	40.2	185	60.7	27.1	< .001
PrEP use (past 6 mos.) [c]	308	35.7	54	34.8	39	28.7	2.55	.280
Chronic health conditions								
Cardiovascular condition	148	9.8	65	13.9	52	11.6	3.5	.061

	Methamphetamine use (past 6 mos.) (N_{obs} = 2,428)							
	None (n_{obs} = 1,512)		Monthly or less (n_{obs} = 467 visits)		Weekly or more (n_{obs} = 449)			
	M	SD	M	SD	M	SD	χ^2 [a]	p [a]
Hepatic abnormality	34	2.3	17	3.6	24	5.4	9.0	.011
Renal condition	66	4.4	19	4.1	21	4.7	1.9	.396
Neurological condition	101	6.7	33	7.1	54	12.0	7.6	.022
Psychological condition	396	26.2	135	28.9	147	32.7	12.5	.002

Abbreviations: M = means; SD = standard deviations; PrEP = pre-exposure prophylaxis

[a] Wald chi-square and corresponding p-value adjust for within-person correlations between repeated measurements

[b] Measured in HIV-positive participants only

[c] Measured in HIV-negative participants only

Table 3.

Adjusted logistic random intercept models of methamphetamine use with outcomes social adversity, sexual risk behaviors and STIs, HIV-related factors, and chronic health conditions among mSTUDY participants (Aug 2, 2014 to June 5, 2019)

	Methamphetamine use (past 6 mos.) [a]					
	Monthly or less			Weekly or more		
Dependent variables	**AOR [b]**	**95% CI**	**p**	**AOR [b]**	**95% CI**	**p**
Social adversity						
Unemployment	3.7	2.4, 5.8	< .001	7.3	4.3, 12.3	< .001
Housing instability (past 6 mos.)	3.4	2.2, 5.3	< .001	6.7	4.1, 11.0	< .001
Intimate partner violence (past 12 mos.)	2.2	1.3, 3.6	.002	4.3	2.5, 7.3	.003
Sexual risk behaviors and STIs						
New anal intercourse partner (past 6 mos.)	1.8	1.2, 2.6	.003	3.2	2.1, 4.8	< .001
Concurrent sexual partners (past 6 mos.)	2.0	1.3, 3.0	.001	4.8	3.0, 7.7	< .001
Exchange sex (past 3 mos.)	4.8	2.8, 8.1	< .001	15.5	8.9, 26.9	< .001
Positive STI test (chlamydia, gonorrhea, and/or syphilis)	1.4	0.9, 2.0	.105	2.3	1.6, 3.4	< .001
HIV-related factors						
Detectable viral load (> 20 c/mL) [c]	1.4	0.8, 2.4	.146	3.2	1.8, 5.5	< .001
PrEP use (past 6 mos.) [d]	1.3	0.7, 2.5	.406	0.7	0.3, 1.6	.402
Chronic health conditions						
Cardiovascular condition	1.4	0.9, 2.2	.130	1.3	0.8, 2.2	.246
Hepatic abnormality	0.8	0.4, 1.8	.596	1.8	0.9, 3.6	.108
Renal condition	1.2	0.6, 2.4	.642	2.1	1.0, 4.4	.047
Neurological condition	1.2	0.7, 1.9	.570	1.9	1.2, 3.1	.008
Psychological condition	1.3	0.9, 1.9	.111	1.9	1.3, 2.8	.001

Abbreviation: AOR = Adjusted odds ratio; CI = Confidence interval

[a] Reference group is “None” or no methamphetamine use

[b] Estimates adjust for age at visit, race, HIV status, current cigarette smoking, binge drinking (past 6 months), and within-person correlations between repeated measurements

[c] Measured in HIV-positive participants only

[d] Measured in HIV-negative participants only