

UCSF

UC San Francisco Previously Published Works

Title

Prevalence and correlates of hazardous alcohol consumption and binge drinking among men who have sex with men (MSM) in San Francisco

Permalink

<https://escholarship.org/uc/item/1972q8f3>

Journal

PLOS ONE, 13(8)

ISSN

1932-6203

Authors

Santos, Glenn-Milo

Rowe, Christopher

Hern, Jaclyn

et al.

Publication Date

2018

DOI

10.1371/journal.pone.0202170

Copyright Information

This work is made available under the terms of a Creative Commons Attribution License, available at <https://creativecommons.org/licenses/by/4.0/>

Peer reviewed

RESEARCH ARTICLE

Prevalence and correlates of hazardous alcohol consumption and binge drinking among men who have sex with men (MSM) in San Francisco

Glenn-Milo Santos^{1,2*}, Christopher Rowe^{1,3}, Jaclyn Hern⁴, John E. Walker¹, Arsheen Ali¹, Marcial Ornelaz¹, Maximo Prescott^{1,3}, Phillip Coffin^{1,5}, Willi McFarland^{1,6}, H. Fisher Raymond⁷

1 Center for Public Health Research, San Francisco Department of Public Health, San Francisco, California, United States of America, **2** Department of Community Health Systems, School of Nursing, University of California San Francisco, San Francisco, California, United States of America, **3** School of Public Health, University of California Berkeley, Berkeley, California, United States of America, **4** The Henry M. Jackson Foundation for the Advancement of Military Medicine, Bethesda, Maryland, United States of America, **5** Division of HIV, ID & Global Medicine, University of California, San Francisco, California, United States of America, **6** Department of Epidemiology and Biostatistics, School of Medicine, University of California San Francisco, San Francisco, California, United States of America, **7** Department of Epidemiology, Rutgers School of Public Health, Piscataway, New Jersey, United States of America

* Current address: San Francisco, California
* glenn-milo.santos@ucsf.edu



OPEN ACCESS

Citation: Santos G-M, Rowe C, Hern J, Walker JE, Ali A, Ornelaz M, et al. (2018) Prevalence and correlates of hazardous alcohol consumption and binge drinking among men who have sex with men (MSM) in San Francisco. PLoS ONE 13(8): e0202170. <https://doi.org/10.1371/journal.pone.0202170>

Editor: Yu Liu, University of Rochester School of Medicine and Dentistry, UNITED STATES

Received: August 16, 2017

Accepted: July 30, 2018

Published: August 17, 2018

Copyright: ©2018 Santos et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: Anonymized dataset with information necessary to replicate results provided in the supporting information files.

Funding: This study is funded by a grant from the National Institutes of Health, Office of the Director (grant # DP5OD019809; url:https://projectreporter.nih.gov/project_info_description.cfm?aid=9142091&icde=35508575&ddparam=&ddvalue=&ddsub=&cr=2&csb=default&cs=ASC&pball=). The funder had no role in study design, data

Abstract

Objectives

To describe heavy alcohol use patterns and correlates in a diverse sample of MSM.

Methods

We used respondent-driven sampling (RDS) to enroll 252 alcohol-using MSM in San Francisco from March 2015-July 2017. We examined heavy alcohol use patterns and conducted RDS-adjusted multivariable analyses to characterize correlates of hazardous alcohol consumption and binge drinking.

Results

RDS-adjusted prevalence of weekly and at least weekly binge drinking was 24.9% and 19.3%, respectively. Hazardous consumption was common; prevalence of mid- and high-levels of hazardous drinking was 11.4% and 29.9%, respectively. In multivariable analyses, identifying as Hispanic/Latino or mixed/other race; being moderately or extremely interested in reducing alcohol use; ever receiving alcohol treatment; using ecstasy; reporting syphilis diagnosis; and having more than 5 male partners were independently associated with hazardous alcohol consumption. Less hazardous consumption was associated with having a bachelor's degree or completing post-graduate studies; and not being in a relationship. Reporting chlamydia infection; being somewhat, moderately or extremely interested in

collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors of this article declare no conflicts. Co-author Phillip Coffin has directed NIH-funded studies that have received donated medications from Alkermes (2013-2015) to treat methamphetamine dependence and Gilead (2016-2017) to treat Hepatitis C infections. This does not alter our adherence to PLOS ONE policies on sharing data and materials.

reducing alcohol use; and having multiple male sex partners were associated with higher odds of at least weekly binge drinking. Lower odds of binge drinking were associated with completing post-graduate studies. Moreover, for the outcomes of hazardous alcohol consumption and binge-drinking, we observed significant interaction effects between race/ethnicity and interest in reducing alcohol, past receipt of alcohol treatment, use of ecstasy, syphilis diagnosis, and number of male partners.

Conclusion

Among alcohol-using MSM in San Francisco, heavy drinking patterns were common and independently associated with greater number of male sexual partners and sexually transmitted infections (STI). Moreover, significant racial/ethnic and socioeconomic disparities related to heavy alcohol use were observed and race/ethnicity modified the effect of the risk factors associated with these outcomes. These findings underscore the need to develop more MSM-specific interventions that jointly address heavy alcohol use and HIV/STI risk, as well as culturally-tailored and targeted strategies to alleviate health disparities.

Introduction

Heavy alcohol use, including binge drinking (i.e., five or more drinks in a single occasion for men) and hazardous alcohol consumption (i.e., as classified by the alcohol use disorders identification test [AUDIT]), has been linked to a wide range of negative health problems [1,2] and is the fourth leading lifestyle-related cause of death in the United States (US) [3]. Nevertheless, identification and screening for heavy alcohol use remains insufficient; the Centers for Disease Control and Prevention estimate that only one in three US adults are asked about binge drinking, and one in three binge drinkers are screened and advised about harmful drinking by their health providers [4]. Furthermore, uptake of evidence-based alcohol interventions are persistently low: less than one-fourth of individuals with alcohol use disorders receive treatment and fewer than ten percent receive pharmacotherapy [5,6]. Therefore, evaluating the prevalence and correlates of heavy alcohol use is of high public health importance, particularly for high-risk populations.

Studies have described the prevalence and examined the demographic, social and clinical correlates of alcohol use disorders for the general adult population using large epidemiologic surveys. These analyses were guided by the exploratory data analysis conceptual framework with the goal of identifying potential health disparities among racial/ethnic and age groups, identify comorbidities related to heavy alcohol use, and ultimately inform the planning and delivery of public health services [6,7]. For men who have sex with men (MSM), multiple epidemiologic studies have shown a high prevalence of heavy alcohol use [8,9]. Furthermore, heavy alcohol consumption patterns are independently associated with condomless anal intercourse [10,11] and HIV infection among MSM [12–14]. Nevertheless, despite the high prevalence of heavy alcohol consumption and its linkages with HIV infection, few studies have recruited exclusive samples of alcohol-using MSM outside of treatment settings [15]. Most studies involve comparisons between drinkers versus non-drinkers or sub-group analyses of alcohol users, and typically capture limited information on alcohol use patterns [16–18]. Furthermore, we are unaware of MSM-specific studies that have explored the demographic, social, and clinical correlates of heavy alcohol use patterns, similar to those conducted among the

adult general population. More empirical studies are needed to further explore the wide range of drinking patterns among alcohol-using MSM, and inform planning and delivery of services for these individuals.

In addition, the majority of studies evaluating alcohol use among MSM to date have used convenience or venue-based samples that may oversample participants from alcohol-serving venues [15,16], which tend to have heavier alcohol users. For example, National HIV Behavioral Surveillance (NHBS) data among MSM in San Francisco observed that men recruited in venues that serve alcohol report greater frequency of binge drinking, number of drinking days, and number of drinks in a typical drinking day [8]. Another concern with venue-based recruitment is the decline in attendance at “physical gay spaces”, such as clubs and bars, as increasing number of MSM turn to “virtual gay communities” (e.g., social-networking spaces within internet and mobile applications)[19–21]. Additionally, recruiting diverse MSM samples in studies has proved challenging for researchers, who have reported difficulties in enrolling youth and men of color, limiting external validity [22]. Taken together, these issues highlight the increasing need to employ a variety of recruitment approaches to reach diverse groups of alcohol-using MSM.

Respondent-driven sampling (RDS) can generate more diverse study populations and has recruited MSM and substance-using populations, whom may be hard to reach and for whom sampling frames do not exist [23–27]. RDS uses peer-recruitment chains to tap into the social networks of study participants [27]. Specifically, it leverages social connections between members of a target study population to communicate study goals and recruit peers into the study. Hence, RDS may mitigate recruitment challenges by potentially reaching members of MSM networks who may not attend traditional physical venues where recruitment has historically occurred [8,28]. Although RDS methods have been used to recruit specific sub-groups, including among alcohol- and drug-using youth [29], ecstasy users [30], illicit stimulant drug users in rural settings [31], and different MSM subpopulations (e.g., MSM international travelers, black MSM, and young MSM [24–26,32]), we are not aware of any RDS studies conducted exclusively among alcohol-using MSM.

The objectives of this study were: 1) to evaluate the prevalence of heavy alcohol use patterns, and 2) explore correlates of heavy alcohol consumption, specifically hazardous drinking and binge drinking, in a diverse sample of alcohol-using MSM recruited by RDS. The second objective involved exploratory analyses to assess which demographic (e.g., age, race/ethnicity), social (e.g., education, income), behavioral (e.g., sexual risk behaviors) and clinical characteristics (e.g., sexually transmitted diseases, depressive symptoms) are associated with heavy alcohol use. Consistent with prior studies completed among the general adult population [6,7], the second objective was guided by the need to identify sub-populations who may have higher burden of harmful drinking patterns and therefore would be ideal for more targeted screening and referrals to evidence-based interventions. Additionally, we sought to also explore whether certain negative health conditions and behaviors are associated with harmful drinking, which may inform the development of programs to address the needs for heavy drinkers.

Methods

RDS recruitment

We recruited participants in a cross-sectional study, entitled *The SEEDS Study*, for alcohol-using MSM using RDS. Initial RDS study “seeds”—the participants who initiate peer-recruitment for their networks—were selected to reflect a diverse sample of MSM across age, race/ethnicity, education, and income ($n = 11$). As recruitment slowed, additional seeds were identified and added ($n = 13$) to sustain enrollment, which is consistent with RDS methodology

and other MSM studies [25–27]. Seeds were screened during an in-person interview and were invited to participate based on their willingness to recruit and motivate their peers to participate in the RDS study. Eligible seeds were given recruitment coupons and were asked to recruit as many as 5 participants, who in turn were asked to recruit a subsequent wave of participants, and so on, until sample size was reached and equilibrium was achieved on key variables. Recruitment coupons included unique tracking numbers that allowed the study to link which seed/participants referred new participants. All seeds and participants who utilized all their coupons were offered additional coupons (no more than 8 total, including the initial coupons distributed; this higher coupon limit is consistent with another MSM study [25]). As recruitment progressed, coupon distribution was adjusted based on accrual of demographic subgroups in the study (i.e., race/ethnicity and neighborhood) and the stage of the study recruitment (i.e., final wave of study participants received 0 coupons).

Study procedures

Study participants (including seeds) were screened for eligibility before enrollment. Individuals were eligible if they reported (1) their sex assigned at birth as male or current gender identity as male, (2) having sex with at least 1 man in the past 12 months, (3) being aged 18 years or older, (4) alcohol use in the past 12 months, and (4) living in the San Francisco Bay Area. If eligible, staff obtained signed consent using an institutional research board (IRB)-approved form. After consenting, participants completed behavioral surveys lasting approximately 30 minutes using audio computer assisted self-interview (ACASI). After completing the ACASI, study staff provided participants with referral coupons and provided participants with basic peer-recruitment techniques. Participants received \$30 for their enrollment visit and received an additional \$10 for each person they referred into the study who completed the enrollment visit. Participants who successfully enrolled their peers into the RDS study were also entered into monthly raffles, with prizes ranging from \$50–100 gift cards, consistent with incentives strategies used in another MSM RDS study in San Francisco [25]. All study procedures and study materials were reviewed and approved by the University of California San Francisco IRB (IRB study #14–14481).

Behavioral questionnaire

ACASI was used to standardize data collection and minimize reporting bias for a range of demographic, social, and behavioral measures, including alcohol use and sexual risk behaviors [33–35]. Hazardous alcohol consumption was evaluated using the World Health Organization's Alcohol Use Disorders Identification Test (AUDIT), a 10-item measure used to screen for hazardous alcohol use. AUDIT scores were calculated and dichotomized based on a cut-off of 16; individuals with a score of 16 or greater are considered to have a mid- to high-level risk of problem drinking (“hazardous”)[36]. Participants were also asked to respond to a range of questions related to their alcohol use patterns, goals they may have pertaining to their alcohol use (if any), and alcohol treatment history. Participants who reported at least weekly binge drinking and expressed interest in cutting down their alcohol use were subsequently invited to screen for another ongoing pharmacotherapy study to reduce heavy episodic alcohol use conducted at the San Francisco Department of Public Health [37]. Data in [S1 File](#).

Data analyses

We conducted analyses using STATA version 14 (College Station, TX) and a statistical program for analyzing RDS study data, RDS Analyst (RDS-A) version 0.42 [38]. In RDS-A, we generated individualized sampling weights using the RDS-II estimator. The RDS-II estimators

use a Markov chain model to create weight estimates for the probability of inclusion of each individual into the study, based on their reported social network size [39]. Social network size was imputed as the median (median = 20) for individuals with missing network size ($n = 19$). RDS-adjusted prevalence and 95% CI of the participant characteristics were estimated in RDS-A bootstrapped models, except when prevalence estimates only applied for sub-group of study participants (e.g., types of alcohol treatment received among those who reporting receiving treatment). For the latter case, RDS-adjusted prevalence were estimated in STATA using exported sampling weights from RDS-A.

For bivariate and multivariable analyses, individualized RDS-II weights were exported from RDS-A and merged with the ACASI dataset in STATA. We then used the weights in STATA to conduct RDS-adjusted bivariate and multivariable logistic regression analyses to explore the demographic, behavioral, and clinical correlates for the following heavy alcohol use outcomes of interest: (1) hazardous alcohol consumption and (2) at least weekly binge drinking. For model building, characteristics that had a p -value < 0.25 in bivariate models were considered for the full multivariable models, which were then finalized using a stepwise, backward elimination approach. The final model retained correlates with overall p -values < 0.25 as assessed using Wald Tests, as well as key potential demographic and clinical confounders (race/ethnicity, age, education, and having clinically significant depressive symptoms). Race/ethnicity, age, education, and depressive symptoms were selected for inclusion *a priori* because there are established associations between these characteristics and alcohol use [40,41].

Because there are documented differences in alcohol use patterns as well as disparities in health and social consequences of alcohol use by race/ethnicity [41,42], we also assessed interaction effects between race/ethnicity and key participant characteristics. Specifically, we included interaction terms between race/ethnicity and each characteristic that was significantly associated with the outcome in the main multivariable models. Interaction effects between race/ethnicity and each significant characteristic were assessed in separate models due to data sparsity that would result from the inclusion of multiple sets of interaction terms in a single model. Models included all covariates that were included in the main multivariable model for each respective outcome. The overall significance of the interaction effects between race/ethnicity and each individual participant characteristic for a given outcome was assessed using Wald Tests; for overall interaction effects that were significant at $p < 0.25$, we calculated race/ethnicity specific effects for the appropriate participant characteristic. Interaction effects were assessed for both hazardous alcohol consumption and weekly or more binge drinking. Due to a lack of outcome variability among specific race/ethnicity-covariate combinations, “not” and “somewhat” interested in reducing amount of alcohol consumed were collapsed and used as the reference level in the model assessing interaction effects on hazardous alcohol consumption and zero and one male sex partners were collapsed and used as the reference level in the model assessing interaction effects on weekly or more binge drinking. There were no significant differences between the collapsed categories in the relevant multivariable model.

Results

Seed and recruitment chain characteristics

Including the 24 seed participants, the final crude sample consisted of 252 alcohol-using MSM. We provide detailed characteristics of seeds in Table 1. The majority of seeds had a bachelor's degree ($n = 13$) and were between the ages of 18–34 ($n = 19$) years.

As in many RDS studies, the majority of recruitment stemmed from a few seeds [25,43]. As shown in the social network diagram in Fig 1, seed H produced the majority of recruits ($n = 122$), seed S produced 31 recruits, and seed V produced 28 recruits. These 3 chains were

Table 1. Seed characteristics, alcohol-using men who have sex with men: San Francisco, CA; March 2015—June 2017 (n = 24).

Seed ID	Race/Ethnicity	Age, Years	Education	Income, \$	Recruits, No.	Waves, No.
A	Hispanic/Latino	18–34	Bachelor’s Degree	\$40,000–\$74,999	9	2
B	Black/African American	18–34	Some College or 2 Year Degree	\$0–\$9,999	2	1
C	White	34–50	Bachelor’s Degree	\$75,000+	1	1
D	Hispanic/Latino	18–34	Some College or 2 Year Degree	\$75,000+	0	0
E	Asian/Pacific Islander	34–50	Bachelor’s Degree	\$75,000+	13	4
F	White	18–34	Any Post-Graduate Studies	\$75,000+	3	2
G	White	34–50	Bachelor’s Degree	\$75,000+	1	1
H	Mixed/Other	18–34	Some College or 2 Year Degree	\$20,000–\$39,000	122	19
I	Asian/Pacific Islander	18–34	Any Post-Graduate Studies	\$75,000+	0	0
J	White	18–34	Bachelor’s Degree	\$40,000–\$74,999	2	1
K	Asian/Pacific Islander	18–34	Bachelor’s Degree		0	0
L	Hispanic/Latino	18–34	Bachelor’s Degree	\$75,000+	1	1
M	Black/African American	18–34	Bachelor’s Degree	\$40,000–\$74,999	0	0
N	White	18–34	Bachelor’s Degree	\$75,000+	0	0
O	Hispanic/Latino	18–34	High School or GED	\$20,000–\$39,000	7	2
P	White	18–34	Any Post-Graduate Studies	\$40,000–\$74,999	0	0
Q	White	18–34	Bachelor’s Degree	\$20,000–\$39,000	0	0
R	Hispanic/Latino	34–50	Some College or 2 Year Degree	\$75,000+	5	2
S	Asian/Pacific Islander	18–34	Bachelor’s Degree	\$75,000+	31	7
T	Hispanic/Latino	18–34	Some College or 2 Year Degree	\$40,000–\$74,999	0	0
U	White	18–34	Bachelor’s Degree	\$40,000–\$74,999	0	0
V	Mixed/Other	51+	Some College or 2 Year Degree	\$40,000–\$74,999	28	8
W	Hispanic/Latino	18–34	Bachelor’s Degree	\$75,000+	0	0
X	White	18–34	Any Post-Graduate Studies	\$10,000–\$19,999	3	1

<https://doi.org/10.1371/journal.pone.0202170.t001>

reasonably long at 19, 7, and 8 waves, respectively. The mean network size reported by race/ethnicity is shown in Table 2. Excluding missing values that were imputed to the median, mean network size by race/ethnicity ranged from 18.3 to 81.7, for African Americans and Mixed/Other race, respectively.

Recruitment of the entire sample occurred between March 2015 and July 2017 with a mean of 3.7 recruitment waves for active seeds (range = 1–19). The overall coupon return rate was 33.6%; excluding unproductive seeds, the coupon return rate was 35.7%. A total of 268 individuals were presented with a recruitment coupon (i.e., non-seeds) and screened; of these, 228 (85.1%) were eligible and enrolled, 22 (8.2%) were eligible and lost to follow-up, one (0.4%) was eligible and declined to participate, and 17 (6.3%) were ineligible. We examined recruitment patterns for key variables (e.g., race/ethnicity, age, education) and found that in general the sample converged on the final sample composition and we found no evidence of bottlenecks.

Participant characteristics

Study participants were diverse with respect to race/ethnicity, age, and sociodemographic characteristics, as shown in Table 3. Most participants were MSM of color (RDS-adjusted prevalence: 46.6% African American, 10.8% Hispanic/Latino; 7.5% Asian and Pacific Islander), had some college (37.2%), and were ages 18–50 (age 18–34 = 28.4%; 35–50 = 36.2%). Most participants were HIV-negative (61.5%), only had sex partners who were male (65.1%), had condomless anal intercourse in the past 6 months (58.1%), and were single/not in a relationship (66.4%).

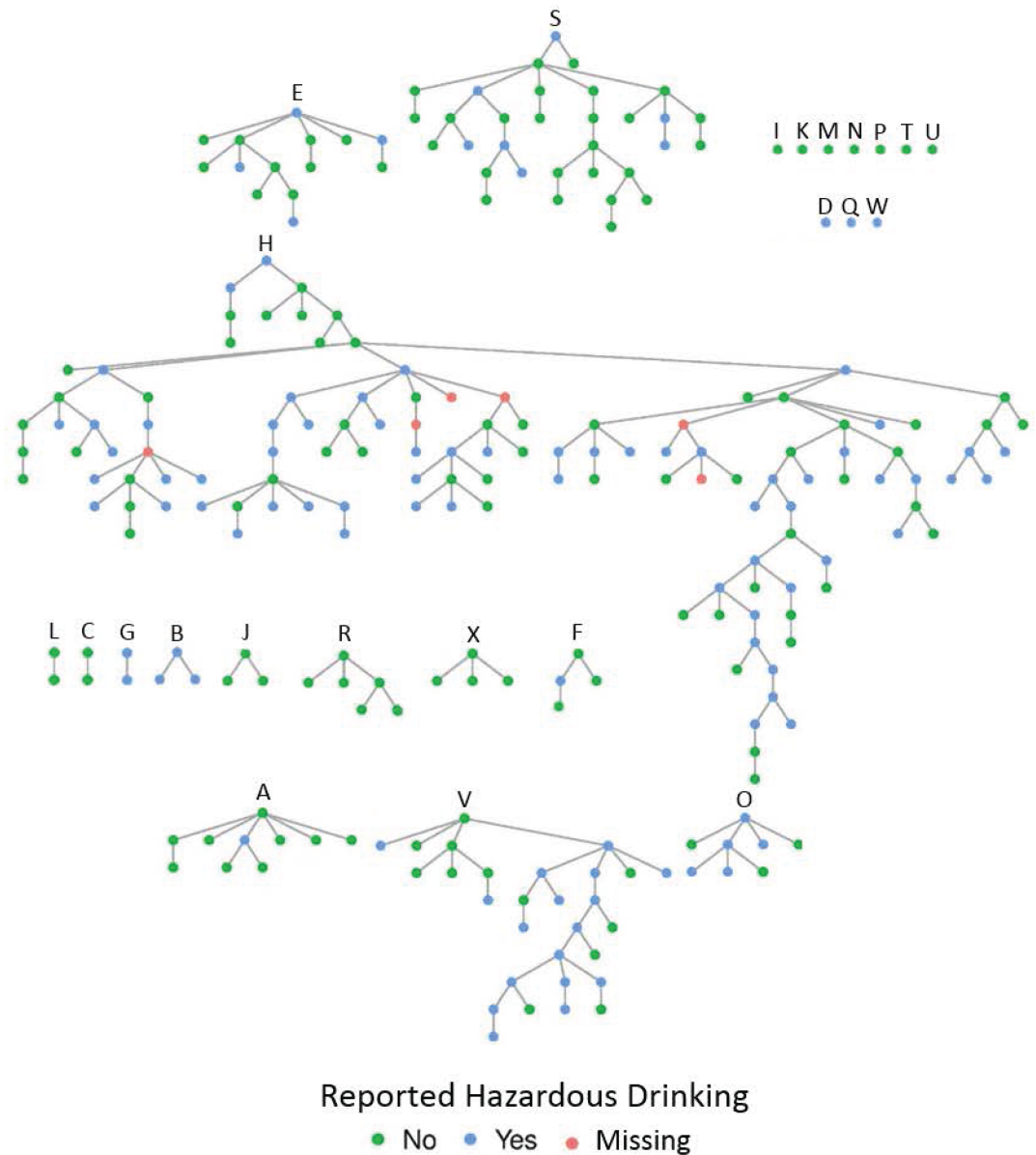


Fig 1. Participant recruitment chain of alcohol-using men who have sex with men in San Francisco in The SEEDS Study (n = 252). Letters (A-X) correspond with 24 initial participants (“seeds”) selected by study staff to initiate peer-recruitment (see Table 1 for characteristics of seeds). Hazardous drinking defined using a score cut-off of 16 in the alcohol use disorders identification test (AUDIT).

<https://doi.org/10.1371/journal.pone.0202170.g001>

Alcohol and other substance use

In the past year, many participants consumed alcohol at least 4 times per week (39.7%), and most reported binge drinking at least weekly (24.9% weekly, 19.3% more than weekly). Hazardous alcohol consumption was common in the study; the RDS-adjusted prevalence of men with mid- (AUDIT score 16–19) to high-level (AUDIT score 20–40) of hazardous drinking in the sample were 11.4% and 29.9%, respectively.

Many participants reported that their current goal regarding their alcohol use was “to use alcohol in a controlled manner” (44.1%), while a considerable proportion reported that they

Table 2. Seed, sample, and estimated population proportions, and mean network size, by race/ethnicity, alcohol-using men who have sex with men: San Francisco, CA; March 2015—June 2017.

Race/Ethnicity	Seeds, %	Sample, %	Estimated Population, %	Network Size, Mean
Asian/Pacific Islander	16.7%	13.1%	7.5%	68.0
Black/African American	8.3%	31.0%	46.6%	18.3
White	37.5%	32.9%	31.2%	44.7
Hispanic/Latino	29.2%	15.1%	10.8%	71.3
Mixed/Other	8.3%	7.9%	4.0%	81.7

<https://doi.org/10.1371/journal.pone.0202170.t002>

had “no clear goal” (28.8%). A minority reported permanent abstinence as their goal (6% permanent abstinence with expected possibility of relapse; 4.5% permanent abstinence with no expected possibility of relapse). In addition, the majority of participants expressed interest in wanting to reduce the amount of alcohol they consumed (38.3% were somewhat interested, 15.8% moderately interested, and 14% extremely interested). The majority (65.1%) reported a lifetime history of trying to stop or reduce their alcohol use, although only 36.3% had ever received treatment for alcohol use.

In the overall sample, the most common alcohol treatment program used was mutual-support groups (e.g., Alcoholics Anonymous), followed by behavioral treatments (e.g., psychotherapy), which were reported by 22.8% and 14% of participants, respectively. Few participants reported using medications (pharmacotherapy) for alcohol treatment (3.5%). Among the subset of participants who received alcohol treatment, 62.8% (95% CI: 45.6%-77.2%) reported participating in mutual support groups, 38.6% (24.4%-55.0%) reported receiving behavioral treatment, and 9.5% (4.7%-18.3%) reported utilizing pharmacotherapy. Among the subset of participants with hazardous alcohol consumption, 55.4% (40.8%-69.1%) had received treatment for alcohol use, with 6.9% (3.2%-14.2%) having received pharmacotherapy (data not shown in table).

In the past 6 months, 25% of alcohol-using MSM reported injecting drugs. Moreover, many MSM reported using other non-injection substances recreationally in the past 6 months, including: marijuana (54%), cigarettes (48.7%), methamphetamine (38.7%), poppers (28.5%), cocaine (22.5%); crack (19.7%); ecstasy (17.4%), sildenafil (Viagra) (16.8%), e-cigarettes (14.6%), GHB (11.2%), and ketamine (8.5%).

Bivariate analyses

As shown in Table 4, hazardous alcohol consumption was correlated ($p < 0.05$ for at least one category) for race/ethnicity, education, income, housing status, interest in reducing the amount of alcohol consumed, substance use (cocaine, crack, ecstasy), receiving substance use treatment, depressive symptoms, reporting sexually transmitted infection (STI) diagnoses (syphilis or any STI), number of sexual partners, and male sexual partners in bivariate analyses. In addition, at least weekly binge drinking was correlated with race/ethnicity, education, interest in reducing the amount of alcohol consumed, HCV status, recent STI diagnoses (syphilis, chlamydia, or any STI diagnosis), number of sexual partners, and male sexual partners in bivariate analyses.

Multivariable analyses for hazardous alcohol consumption

In RDS-adjusted multivariable analyses, participants who identified as Hispanic/Latino (adjusted odds ratio [AOR] = 6.27; 95% CI = 1.29–30.63), and mixed or other race (AOR = 15.22; 95% CI = 1.31–121.58) had significantly greater odds of hazardous drinking

Table 3. Crude and RDS-weighted characteristics among alcohol using men who have sex with men: San Francisco, CA; March 2015—June 2017 (n = 252).

Characteristic	Crude n (%)	Weighted % (95% CI)
Total	252	
DEMOGRAPHIC CHARACTERISTICS		
Race/Ethnicity		
Asian/Pacific Islander	33 (13.1)	7.5 (0.0, 20.3)
Black/African American	78 (31.0)	46.6 (40.4, 52.8)
White	83 (32.9)	31.2 (23.0, 39.4)
Hispanic/Latino	38 (15.1)	10.8 (0.0, 21.9)
Mixed/Other	20 (7.9)	4.0 (0.0, 12.9)
Age, y		
18–34 (Millennials)	102 (40.5)	28.4 (16.9, 40.0)
35–50 (Generation X)	75 (29.8)	36.2 (24.6, 47.9)
51+ (Baby Boomers)	75 (29.8)	35.3 (23.5, 47.2)
Education		
< High school	20 (7.9)	14.1 (10.5, 17.7)
High School or GED	53 (21.0)	26.2 (11.0, 41.4)
Some College or 2 Year Degree	83 (32.9)	37.2 (36.4, 38.1)
Bachelor’s Degree	61 (24.2)	14.3 (8.0, 20.6)
Any Post-Graduate Studies	33 (13.1)	5.9 (0.0, 15.3)
Employment status		
Not employed	124 (49.2)	65.3 (62.3, 68.3)
Employed	115 (45.6)	28.9 (14.9, 43.0)
Student, with or without part-time employment	10 (4.0)	3.4 (0.2, 6.6)
Field of Employment		
Healthcare and social assistance	25 (9.9)	5.5 (2.7, 8.3)
Technology	21 (8.3)	3.9 (2.7, 5.1)
Accommodation and Food Services	10 (4.0)	2.7 (0.0, 10.6)
Educational Services	7 (2.8)	1.3 (0.0, 11.2)
Finance and Insurance	6 (2.4)	0.6 (0.0, 2.1)
Retail	6 (2.4)	0.6 (0.0, 5.3)
Other	47 (18.7)	17.1 (13.0, 21.3)
Income (yearly), \$		
< 10,000	82 (32.5)	44.0 (31.8, 56.2)
10,000–19,999	39 (15.5)	18.7 (10.3, 27.0)
20,000–39,999	42 (16.7)	16.0 (6.9, 25.1)
40,000–74,999	28 (11.1)	10.4 (3.2, 17.5)
≥ 75,000	51 (20.2)	7.8 (1.8, 13.8)
Born in the United States		
	231 (91.7)	91.4 (91.2, 91.6)
Currently homeless		
	69 (27.4)	34.1 (34.1, 34.1)
Relationship status		
In a relationship	85 (33.7)	31.2 (19.1, 43.2)
Single	158 (62.7)	66.4 (62.2, 70.6)
Other	8 (3.2)	2.2 (0.0, 4.7)
Alcohol-using MSM network size (quartiles)		
Quartile 1: 1–8	60 (23.8)	66.7 (56.5, 76.9)
Quartile 2: 9–20	67 (26.6)	20.8 (14.0, 27.7)

(Continued)

Table 3. (Continued)

Characteristic	Crude n (%)	Weighted % (95% CI)
Total	252	
Quartile 3: 21–50	52 (20.6)	6.3 (0.0, 13.5)
Quartile 4: 51–800	54 (21.4)	2.2 (0.0, 9.8)
ALCOHOL USE		
Frequency of alcohol consumption, past 12 mo		
Monthly or less	14 (5.6)	15.7 (11.0, 20.4)
2–4 times per month	44 (17.5)	21.7 (9.1, 34.3)
2–3 times per week	94 (37.3)	23.0 (9.4, 36.5)
4 or more times per week	100 (39.7)	39.7 (27.6, 51.7)
Frequency of binge alcohol consumption, past 12 mo		
Never	28 (11.1)	12.9 (6.7, 19.1)
Less than monthly	59 (23.4)	29.0 (20.4, 37.7)
Monthly	46 (18.3)	13.7 (7.2, 20.2)
Weekly	78 (31.0)	24.9 (24.5, 25.2)
Daily or almost daily	40 (15.9)	19.3 (16.1, 22.5)
AUDIT Score (Risk Level)		
0–7 (Zone I)	46 (18.3)	20.9 (12.5, 29.4)
8–15 (Zone II)	96 (38.1)	36.3 (26.6, 45.9)
16–19 (Zone III)	36 (14.3)	11.4 (4.1, 18.7)
20–40 (Zone IV)	68 (27.0)	29.9 (26.6, 33.2)
Severity of Dependence Score of 3 or above		
	116 (46.0)	51.7 (51.7, 51.7)
Used alcohol delivery mobile application, past 12 mo		
	25 (9.9)	15.8 (15.7, 15.9)
Alcohol use during any sex, past 4 wk		
Never	62 (24.6)	24.5 (19.4, 29.6)
1–25% of the time	95 (37.7)	40.4 (34.6, 46.2)
26–50% of the time	34 (13.5)	12.9 (5.7, 20.2)
51–75% of the time	16 (6.3)	4.1 (0.0, 12.2)
76–100% of the time	28 (11.1)	13.0 (4.1, 21.8)
No recent anal sex	16 (6.3)	4.9 (4.9, 4.9)
Current alcohol-related goal		
No clear goal	77 (30.6)	28.8 (23.9, 33.7)
Use alcohol in controlled manner	102 (40.5)	44.1 (39.3, 48.9)
Temporary abstinence	15 (6.0)	7.7 (5.9, 9.6)
Occasional but not habitual alcohol use	13 (5.2)	3.8 (0.0, 15.4)
Permanent abstinence, with expected possibility of relapse	20 (7.9)	6.0 (4.0, 8.1)
Permanent abstinence, with no expected possibility of relapse	10 (4.0)	4.5 (0.4, 8.5)
Other	12 (4.8)	4.4 (0.0, 10.3)
Interest in reducing amount of alcohol consumed		
Not interested	71 (28.2)	31.7 (26.8, 36.7)
Somewhat interested	91 (36.1)	38.3 (37.1, 39.5)
Moderately interested	47 (18.7)	15.8 (6.2, 25.4)
Extremely interested	42 (16.7)	14.0 (6.3, 21.7)
Ever had an alcohol-related hospitalization		
	52 (20.6)	21.1 (21.1, 21.1)
Ever tried to stop or reduce alcohol use		
	179 (71.0)	65.1 (64.7, 65.4)
Ever received treatment for alcohol use		
	83 (32.9)	36.3 (35.8, 36.8)
Type of treatment for alcohol use reported		

(Continued)

Table 3. (Continued)

Characteristic	Crude n (%)	Weighted % (95% CI)
Total	252	
Behavioral Treatments	34 (13.5)	14.0 (14.0, 14.0)
Medication/pharmacotherapy	15 (6.0)	3.5 (2.8, 4.1)
Mutual-support groups	57 (22.6)	22.8 (22.5, 23.0)
Other	14 (5.6)	4.2 (2.9, 5.5)
Type of medication/pharmacotherapy for alcohol use reported		
Oral naltrexone	5 (2.0)	1.1 (1.1, 1.1)
Injectable naltrexone	3 (1.2)	0.7 (0.6, 0.8)
Disulfiram	6 (2.4)	1.5 (1.4, 1.6)
OTHER SUBSTANCE USE		
Injected drugs, past 6 mo	41 (16.3)	24.8 (20.6, 29.0)
Use of specific substances, past 6 mo		
Methamphetamine	83 (32.9)	38.7 (36.1, 41.2)
Powdered Cocaine	87 (34.5)	22.5 (22.1, 22.8)
Crack Cocaine	42 (16.7)	19.7 (19.7, 19.7)
Ecstasy	68 (27.0)	17.4 (15.3, 19.5)
GHB	41 (16.3)	11.2 (11.2, 11.2)
Ketamine	31 (12.3)	8.5 (8.5, 8.5)
Poppers	87 (34.5)	28.5 (28.5, 28.5)
Viagra	61 (24.2)	16.8 (13.0, 20.6)
Marijuana	156 (61.9)	54.0 (52.4, 55.5)
Cigarettes	125 (49.6)	48.7 (37.4, 60.1)
E-cigarettes	48 (19.0)	14.6 (3.5, 25.7)
Ever received treatment for drug use	94 (37.3)	46.1 (43.7, 48.5)
MENTAL AND PHYSICAL HEALTH		
Clinically Significant Depressive Symptoms	126 (50.0)	54.1 (53.8, 54.4)
HIV status, self-report		
Positive	71 (28.2)	32.6 (32.2, 32.9)
Negative	174 (69.0)	61.5 (52.6, 70.4)
Unknown	6 (2.4)	5.8 (5.6, 5.9)
Undetectable Viral Load	24 (9.5)	11.1 (2.4, 19.6)
Number of HIV tests, past 2 yr		
Zero	48 (19.0)	22.6 (12.8, 32.3)
One to three	81 (32.1)	34.0 (25.9, 42.1)
Four or more	112 (44.4)	36.3 (31.3, 41.3)
Currently taking PrEP	45 (17.9)	16.8 (14.6, 18.9)
HCV status, self-report		
Positive	27 (10.7)	10.5 (9.2, 11.8)
Negative	221 (87.7)	86.8 (86.6, 87.0)
Ever had a sexually transmitted infection, past 6 mo	58 (23.0)	16.8 (13.2, 20.4)
Type of sexually transmitted infection, past 6 mo		
Syphilis	15 (6.0)	6.3 (5.4, 7.2)
Gonorrhea	32 (12.7)	6.4 (2.9, 9.8)
Chlamydia	23 (9.1)	4.6 (0.8, 8.4)
Herpes (HSV)	4 (1.6)	0.8 (0.0, 2.6)
Genital warts (HPV)	9 (3.6)	3.2 (2.7, 3.8)

(Continued)

Table 3. (Continued)

Characteristic	Crude n (%)	Weighted % (95% CI)
Total	252	
SEXUAL BEHAVIORS		
Gender of sexual partners		
Men	201 (79.8)	65.1 (55.3, 75.0)
Both Men and Women	51 (20.2)	34.9 (25.0, 44.7)
Number of sex partners, past 6 mo		
Zero	8 (3.2)	4.2 (0.0, 16.8)
One	40 (15.9)	15.9 (10.6, 21.3)
2–5	102 (40.5)	50.2 (49.4, 50.9)
6+	97 (38.5)	26.7 (26.1, 27.3)
Number of male sex partners, past 6 mo		
Zero	10 (4.0)	8.6 (0.0, 21.3)
One	45 (17.9)	14.8 (12.1, 17.4)
2–5	103 (40.9)	54.0 (53.2, 54.8)
6+	89 (35.3)	19.6 (18.7, 20.5)
Any condomless anal intercourse, past 6 mo	171 (67.9)	58.1 (58.1, 58.1)
Any insertive condomless anal intercourse, past 6 mo	156 (61.9)	53.8 (53.8, 53.8)
Any receptive condomless anal intercourse, past 6 mo	138 (54.8)	48.4 (48.1, 48.6)
Any serodiscordant condomless anal intercourse, past 6 mo	83 (32.9)	30.0 (27.3, 32.7)

<https://doi.org/10.1371/journal.pone.0202170.t003>

compared to white MSM (Table 5). In addition, those who reported being moderately (AOR = 11.57; 95% CI = 2.62–51.05) or extremely interested (AOR = 14.68; 95% CI = 1.66–130.03) in reducing their alcohol consumption, ever receiving treatment for alcohol use (AOR = 6.97; 95% CI = 1.61–30.26), using ecstasy (AOR = 8.13; 95% CI = 1.67–39.47), reporting a recent diagnosis of syphilis (AOR = 142.14; 95% CI = 20.15–1002.57), and having more than 5 male sexual partners (AOR = 10.27; 95% CI = 1.02–103.47) had greater odds of hazardous alcohol consumption. Lower odds of hazardous alcohol consumption was significantly associated with higher educational attainment (bachelor’s degree AOR = 0.12; 95% CI = 0.02–0.98; any post-graduate studies AOR = 0.01; 95% CI = 0.00–0.22, compared to those who did not complete high school) and not being in a relationship (AOR = 0.29; 95% CI = 0.09–0.95).

In the interaction models, there were significant interaction effects between race/ethnicity and interest in reducing alcohol use, past receipt of treatment for alcohol use, use of ecstasy, and reporting a recent diagnosis of syphilis (S1 Table). Specifically, there were strong associations between having high interest in reducing the amount of alcohol consumed among white (moderately interested AOR = 370.21; 95%CI = 26.22–5226.39; extremely interested AOR = 531.90; 95%CI = 30.63–9236.86) and Asian/Pacific Islander participants (extremely interested AOR = 119.63; 95%CI = 3.81–3758.25), but not among Black/African American or Hispanic/Latino participants. In addition, past receipt of treatment was associated with hazardous alcohol consumption among Black/African American participants (AOR = 18.74; 95% CI = 2.43–144.46) but not among other racial/ethnic groups and ecstasy use was associated with hazardous alcohol consumption among both Black/African American (AOR = 49.29; 95%CI = 1.74–1397.43) and Hispanic/Latino participants (AOR = 84.71; 95%CI = 8.07–889.65) but not among other groups. Lastly, reporting a recent diagnosis of syphilis was associated with hazardous alcohol consumption among white participants (AOR = 171.42; 95% CI = 1680.28) but not among Hispanic/Latino participants.

Table 4. RDS-Weighted bivariate associations with hazardous alcohol consumption and weekly or more frequent binge drinking among alcohol using men who have sex with men: San Francisco, CA; March 2015—June 2017.

Characteristic	Hazardous Alcohol Consumption			Weekly or More Frequent Binge Drinking		
	OR (95% CI)	p-value	Wald p-value	OR (95% CI)	p-value	Wald p-value
DEMOGRAPHIC CHARACTERISTICS						
Race/Ethnicity						
White	Reference		0.002	Reference		0.018
Black/African American	1.39 (0.51–3.74)	0.517		0.80 (0.31–2.11)	0.657	
Asian/Pacific Islander	0.13 (0.03–0.48)	0.002		0.14 (0.04–0.54)	0.004	
Hispanic/Latino	2.01 (0.60–6.73)	0.258		1.85 (0.55–6.22)	0.32	
Mixed/Other	2.73 (0.68–10.98)	0.155		1.42 (0.32–6.42)	0.644	
Age, y						
18–34 (Millennials)	Reference		0.148	Reference		0.053
35–50 (Generation X)	1.83 (0.61–5.51)	0.280		1.22 (0.42–3.55)	0.710	
51+ (Baby Boomers)	2.67 (1.00–7.12)	0.050		2.96 (1.14–7.73)	0.027	
Education						
< High school	Reference		0.004	Reference		0.015
High School or GED	0.84 (0.15–4.73)	0.842		0.90 (0.15–5.38)	0.909	
Some College or 2 Year Degree	0.70 (0.13–3.73)	0.672		0.60 (0.11–3.40)	0.562	
Bachelor's Degree	0.18 (0.03–1.20)	0.076		0.22 (0.03–1.51)	0.122	
Any Post-Graduate Studies	0.05 (0.01–0.42)	0.007		0.11 (0.01–0.78)	0.02	
Employment status						
Not employed	Reference		0.147	Reference		0.285
Employed	0.60 (0.25–1.47)	0.264		0.86 (0.35–2.11)	0.740	
Student, not employed	0.17 (0.02–1.20)	0.076		0.21 (0.03–1.45)	0.113	
Income (yearly), \$						
< 10,000	Reference		0.005	Reference		0.400
10,000–19,999	0.83 (0.26–2.66)	0.756		0.80 (0.25–2.51)	0.698	
20,000–39,999	1.14 (0.38–3.42)	0.821		0.85 (0.29–2.53)	0.773	
40,000–74,999	0.12 (0.01–1.18)	0.070		0.44 (0.07–2.64)	0.366	
≥ 75,000	0.14 (0.04–0.47)	0.001		0.34 (0.11–1.05)	0.062	
Born outside the United States	0.41 (0.10–1.60)	0.198	0.198	0.44 (0.12–1.67)	0.228	0.228
Currently homeless	3.06 (1.25–7.47)	0.014	0.014	2.07 (0.85–5.02)	0.108	0.108
Relationship status						
In a relationship	Reference		0.091	Reference		0.169
Single	0.62 (0.24–1.64)	0.334		0.74 (0.29–1.92)	0.536	
Other	4.40 (0.64–30.53)	0.133		3.85 (0.61–24.54)	0.153	
ALCOHOL USE						
Interest in reducing amount of alcohol consumed						
Not interested	Reference		0.003	Reference		0.022
Somewhat interested	2.73 (0.90–8.30)	0.077		2.08 (0.73–5.91)	0.168	
Moderately interested	7.21 (2.20–23.64)	0.001		3.50 (1.11–10.98)	0.032	
Extremely interested	7.48 (2.10–26.66)	0.002		6.29 (1.85–21.34)	0.003	
Ever received treatment for alcohol use	4.32 (0.79–10.38)	0.001	0.001	1.80 (0.78–4.18)	0.168	0.168
OTHER SUBSTANCE USE						
Injected drugs, past 6 mo	1.97 (0.70–5.49)	0.196	0.196	1.45 (0.53–3.94)	0.463	0.463
Use of specific substances, past 6 mo						
Methamphetamine	3.13 (1.30–7.52)	0.011	0.011	1.73 (0.74–4.03)	0.201	0.201
Powdered Cocaine	2.89 (1.15–7.29)	0.025	0.025	1.49 (0.59–3.72)	0.394	0.394

(Continued)

Table 4. (Continued)

Characteristic	Hazardous Alcohol Consumption			Weekly or More Frequent Binge Drinking		
	OR (95% CI)	p-value	Wald p-value	OR (95% CI)	p-value	Wald p-value
Crack Cocaine	4.22 (1.54–11.59)	0.005	0.005	1.67 (0.63–4.46)	0.304	0.304
Ecstasy	2.88 (1.10–7.57)	0.032	0.032	1.47 (0.54–4.03)	0.452	0.452
GHB	1.50 (0.46–4.96)	0.501	0.501	0.70 (0.23–2.13)	0.533	0.533
Ketamine	1.31 (0.27–6.47)	0.735	0.735	0.59 (0.15–2.36)	0.450	0.450
Poppers	1.65 (0.69–3.94)	0.261	0.261	0.68 (0.29–1.61)	0.378	0.378
Viagra	1.62 (0.60–4.36)	0.336	0.336	1.10 (0.42–2.94)	0.841	0.841
Marijuana	1.43 (0.60–3.41)	0.418	0.418	1.16 (0.49–2.72)	0.737	0.737
Cigarettes*	2.26 (0.89–5.73)	0.087	0.087	1.71 (0.69–4.19)	0.242	0.242
E-cigarettes*	2.52 (0.93–6.82)	0.070	0.070	0.87 (0.32–2.36)	0.790	0.790
Ever received treatment for drug use	3.05 (1.33–7.02)	0.009	0.009	2.06 (0.91–4.67)	0.083	0.083
MENTAL AND PHYSICAL HEALTH						
Clinically Significant Depressive Symptoms	3.28 (1.38–7.78)	0.007	0.007	1.54 (0.67–3.55)	0.310	0.310
HIV status, self-report						
Negative	Reference		0.621	Reference		0.634
Positive	1.34 (0.56–3.22)	0.504		1.03 (0.44–2.41)	0.946	
Unknown	0.49 (0.05–4.82)	0.539		0.34 (0.03–3.30)	0.350	
Undetectable viral load*	0.67 (0.15–2.93)	0.590	0.590	0.46 (0.11–1.97)	0.292	0.292
Number of HIV tests, past 2 yr						
Zero	Reference		0.294	Reference		0.887
One to three	2.29 (0.78–6.75)	0.133		1.30 (0.45–3.72)	0.626	
Four or more	1.34 (0.45–3.99)	0.598		1.14 (0.39–3.31)	0.810	
Currently taking PrEP	0.80 (0.22–2.92)	0.732	0.732	0.61 (0.17–2.21)	0.449	0.449
HCV positive status, self-report	2.59 (0.85–7.88)	0.094	0.094	4.19 (1.29–13.60)	0.017	0.017
Ever had a sexually transmitted infection, past 6 mo	3.31 (1.37–7.96)	0.008	0.008	2.76 (1.13–6.72)	0.025	0.025
Type of sexually transmitted infection, past 6 mo						
Syphilis	13.66 (3.48–53.54)	<0.001	<0.001	6.28 (1.64–24.10)	0.008	0.008
Gonorrhoea	0.87 (0.26–2.89)	0.825	0.825	1.67 (0.57–4.92)	0.347	0.347
Chlamydia	1.29 (0.34–4.88)	0.709	0.709	4.21 (1.27–14.01)	0.019	0.019
Herpes (HSV)	1.06 (0.07–15.57)	0.967	0.967	1.10 (0.08–15.77)	0.943	0.943
Genital warts (HPV)	1.56 (0.28–8.70)	0.611	0.611	N/A†		
SEXUAL BEHAVIORS						
Gender of sexual partners						
Men	Reference			Reference		
Both Men and Women	1.99 (0.75–5.27)	0.167	0.167	1.20 (0.47–3.09)	0.703	0.703
Number of sex partners, past 6 mo						
Zero	Reference		0.011	Reference		0.022
One	2.88 (0.27–30.70)	0.390		4.71 (0.48–45.89)	0.181	
2–5	8.42 (1.14–62.43)	0.037		10.72 (1.44–79.59)	0.210	
6+	16.77 (2.23–126.24)	0.006		17.19 (2.29–129.07)	0.006	
Number of male sex partners, past 6 mo						
Zero	Reference		0.013	Reference		0.006
One	13.22 (1.83–95.57)	0.011		11.06 (1.53–79.78)	0.017	
2–5	15.08 (2.46–92.52)	0.004		21.85 (3.55–134.38)	0.001	
6+	20.93 (3.44–127.46)	0.001		21.64 (3.56–131.42)	0.001	
Any condomless anal intercourse, past 6 mo	0.66 (0.27–1.59)	0.349	0.349	0.58 (0.24–1.41)	0.229	0.229

(Continued)

Table 4. (Continued)

Characteristic	Hazardous Alcohol Consumption			Weekly or More Frequent Binge Drinking		
	OR (95% CI)	p-value	Wald p-value	OR (95% CI)	p-value	Wald p-value
Any insertive condomless anal intercourse, past 6 mo	0.75 (0.32–1.78)	0.519	0.519	0.53 (0.23–1.25)	0.147	0.147
Any receptive condomless anal intercourse, past 6 mo	0.65 (0.28–1.49)	0.305	0.305	0.67 (0.29–1.53)	0.337	0.337
Any serodiscordant condomless anal intercourse, past 6 mo	1.72 (0.73–4.07)	0.218	0.218	1.23 (0.53–2.86)	0.626	0.626

*Use of cigarettes and e-cigarettes only asked for a subset of participants (n = 208); undetectable viral load only available for HIV-positive participants who reported their most recent viral load (n = 66).

†Odds ratio not calculable due to no outcome variability in all strata of participant characteristic.

<https://doi.org/10.1371/journal.pone.0202170.t004>

Multivariable analyses for binge drinking

As shown in Table 6, in RDS-adjusted multivariable analyses, reporting a recent chlamydia diagnosis (AOR = 4.19; 95% CI = 1.04–16.90), having interest in reducing the amount of alcohol consumed (somewhat interested AOR = 3.54; 95% CI = 1.15–10.90; moderately interested AOR = 4.76; 95% CI = 1.34–16.91; extremely interested AOR = 10.01; 95% CI = 2.24–44.68), and greater number of male sex partners (having 2–5 male partners AOR = 29.78; 95% CI = 2.83–313.90; having more than 5 male partners AOR = 24.05; 95% CI = 2.05–282.18) were associated with at least weekly binge drinking. In addition, lower odds of at least weekly binge drinking were associated with having any post-graduate studies (AOR = 0.06; 95% CI = 0.01–0.56).

In the interaction models, there were significant interaction effects between race/ethnicity and number of recent male sex partners (S2 Table). Specifically, the relationship between number of male sex partners and odds of reporting weekly or more binge drinking was positive among Black/African American (2–5 partners AOR = 45.55; 95%CI = 5.11–406.13; 6+ partners AOR = 53.55; 95%CI = 5.20–551.13) and mixed or other race participants (2–5 partners AOR = 118.91; 95%CI = 2.16–6547.14; 6+ partners AOR = 229.31; 95%CI = 4.32–12174.01), negative among Hispanic/Latino participants (2–5 partners AOR = 0.01; 95%CI = 0.00–0.41; 6+ partners AOR = 0.01; 95%CI = 0.00–0.44), and null among white and Asian/Pacific Islander participants.

Discussion

This study aimed to evaluate the prevalence of heavy alcohol use patterns, and explore correlates of heavy alcohol consumption in a diverse sample of alcohol-using MSM recruited by RDS. We observed a high prevalence of hazardous alcohol consumption and binge drinking. These results are broadly consistent with the high rates of binge drinking observed in National HIV Behavioral Surveillance (NHBS) data (NHBS did not measure AUDIT scores), which observed that binge drinking at least weekly was reported by 43% of MSM in San Francisco [8]. Taken together, these consistent findings highlight how heavy alcohol use remains a major public health issue among MSM.

Of note, our study also observed that while the majority of alcohol-using MSM (65%) had tried to stop or reduce their alcohol consumption in their lifetime, only one-third had ever utilized alcohol use disorder treatment. Moreover, a high percentage of alcohol-using MSM had reported having a goal to reduce alcohol in a controlled manner, and being interested in reducing their alcohol consumption, which was in turn, independently associated with both hazardous consumption and at least weekly binge-drinking. The ubiquity of heavy drinking patterns

Table 5. RDS-weighted multivariable associations with hazardous alcohol consumption among alcohol using men who have sex with men: San Francisco, CA; March 2015–June 2017 (n = 239).

Characteristic	Hazardous Alcohol Consumption		
	OR (95% CI)	p-value	Wald p-value
DEMOGRAPHIC CHARACTERISTICS			
Race/Ethnicity			
White	Reference		0.037
Black/African American	2.68 (0.76–9.48)	0.125	
Asian/Pacific Islander	0.74 (0.09–5.89)	0.776	
Hispanic/Latino	6.27 (1.29–30.63)	0.023	
Mixed/Other	15.22 (1.31–121.58)	0.010	
Age, y			
18–34 (Millennials)	Reference		0.974
35–50 (Generation X)	0.91 (0.18–4.74)	0.913	
51+ (Baby Boomers)	0.84 (0.18–3.92)	0.822	
Education			
< High school	Reference		0.058
High School or GED	0.27 (0.04–1.81)	0.177	
Some College or 2 Year Degree	0.45 (0.10–1.94)	0.281	
Bachelor’s Degree	0.12 (0.02–0.98)	0.048	
Any Post-Graduate Studies	0.01 (0.00–0.22)	0.005	
Clinically Significant Depressive Symptoms	1.16 (0.39–3.42)	0.793	0.793
Relationship status			
In a relationship	Reference		0.113
Single	0.29 (0.09–0.95)	0.041	
Other	0.88 (0.02–43.89)	0.949	
Interest in reducing amount of alcohol consumed			
Not interested	Reference		0.007
Somewhat interested	3.27 (0.79–13.54)	0.102	
Moderately interested	11.57 (2.62–51.05)	0.001	
Extremely interested	14.68 (1.66–130.03)	0.016	
Ever received treatment for alcohol use	6.97 (1.61–30.26)	0.010	0.010
Used crack cocaine, past 6 mo	2.29 (0.67–7.87)	0.185	0.185
Used ecstasy, past 6 mo	8.13 (1.67–39.47)	0.010	0.010
Contracted Syphilis, past 6 mo	142.14 (20.15–1002.57)	<0.001	<0.001
Number of male sex partners, past 6 mo			
Zero	Reference		0.156
One	4.29 (0.24–76.9)	0.321	
2–5	6.08 (0.69–53.43)	0.103	
6+	10.27 (1.02–103.47)	0.048	

<https://doi.org/10.1371/journal.pone.0202170.t005>

among alcohol-using MSM, and the level of interest in reducing alcohol consumption suggest that there’s a great need to expand current alcohol intervention strategies among MSM, particularly heavy drinking MSM, beyond traditional substance use disorder treatment settings. One strategy that remains underutilized and underexplored is the use and development of pharmacotherapy for MSM. We observed that only 6% of alcohol-using MSM with hazardous alcohol consumption had used pharmacotherapy, which is lower than uptake of medically assisted alcohol treatment among individuals with alcohol use disorders in the United States, estimated at just below 10% [4,5]. It is unclear why use of pharmacotherapy among hazardous MSM

Table 6. RDS-weighted multivariable associations with weekly or more frequent binge drinking among alcohol using men who have sex with men: San Francisco, CA; March 2015–June 2017 (n = 243).

Characteristic	Weekly or More Frequent Binge Drinking		
	OR (95% CI)	p-value	Wald p-value
DEMOGRAPHIC CHARACTERISTICS			
Race/Ethnicity			
White	Reference		0.464
Black/African American	0.83 (0.30–2.30)	0.721	
Asian/Pacific Islander	0.36 (0.08–1.63)	0.182	
Hispanic/Latino	1.82 (0.34–9.78)	0.485	
Mixed/Other	1.81 (0.32–10.35)	0.503	
Age, y			
18–34 (Millennials)	Reference		0.857
35–50 (Generation X)	0.75 (0.22–2.56)	0.643	
51+ (Baby Boomers)	0.99 (0.32–3.09)	0.985	
Education			
< High school	Reference		0.083
High School or GED	0.73 (0.14–3.68)	0.699	
Some College or 2 Year Degree	0.38 (0.08–1.75)	0.215	
Bachelor’s Degree	0.21 (0.03–1.31)	0.094	
Any Post-Graduate Studies	0.06 (0.01–0.56)	0.014	
Clinically Significant Depressive Symptoms	0.84 (0.34–2.05)	0.703	
Interest in reducing amount of alcohol consumed			
Not interested	Reference		0.010
Somewhat interested	3.54 (1.15–10.90)	0.028	
Moderately interested	4.76 (1.34–16.91)	0.016	
Extremely interested	10.01 (2.24–44.68)	0.003	
HCV positive status, self-report	2.54 (0.52–12.38)	0.246	0.246
Contracted Syphilis, past 6 mo	5.06 (0.83–30.67)	0.078	0.078
Contracted Chlamydia, past 6 mo	4.19 (1.04–16.90)	0.044	0.044
Number of male sex partners, past 6 mo			
Zero	Reference		0.017
One	7.67 (0.50–117.58)	0.143	
2–5	29.78 (2.83–313.90)	0.005	
6+	24.05 (2.05–282.18)	0.012	

<https://doi.org/10.1371/journal.pone.0202170.t006>

drinkers is less common. We speculate that the high proportion of MSM who prioritized goals related to reducing alcohol use over abstinence may play a role. Indeed, MSM may be less likely to completely abstain from alcohol than heterosexual men [44], emphasizing the need to consider alternative treatment outcomes including reductions in drinking. Future pharmacotherapy intervention trials should consider alternate treatment goals consistent with their target study populations. To date, limited pharmacotherapy trials have explored this harm-reduction approach among MSM with treatment goals pertaining to reduction of use. A double-blind, placebo-controlled pilot study among dual methamphetamine and binge-drinking MSM showed that the use of oral naltrexone on an as-needed, intermittent basis is significantly associated with reductions in binge drinking days among participants who took their medications at least thrice weekly [45]. An efficacy trial, entitled “The Say When Study” is currently underway to evaluate intermittent naltrexone’s efficacy to address binge drinking and alcohol-

associated sexual risk behaviors among binge-drinking MSM [37]. Ultimately, efforts to develop different types of evidence-based interventions, including pharmacotherapy, with reduction end-points may be needed for alcohol-using MSM in order to effectively reduce the morbidity and mortality associated with heavy alcohol use.

Notably, we also observed significant racial/ethnic and sociodemographic health disparities with heavy alcohol use. Hispanic/Latino MSM, as well as other race/mixed race MSM had greater odds of hazardous alcohol use, while lower educational attainment was associated with greater odds of both hazardous alcohol use and binge drinking. Moreover, we observed significant interaction effects between race/ethnicity and interest in reducing alcohol, past receipt of alcohol treatment, use of ecstasy, syphilis diagnosis, and number of male partners. These findings highlight the differential effects of behavioral and clinical characteristics in different racial/ethnic groups with respect to heavy alcohol use. These findings are broadly consistent with other analyses for the general adult population. In light of these disparities, efforts for targeted screening may be needed to help alleviate the disproportionate burden of heavy alcohol use observed in these subpopulations. Moreover, developing culturally-tailored interventions specific to the needs of different racial/ethnic groups may be needed, given the fact that the characteristics associated with hazardous alcohol use and binge drinking was moderated by race/ethnicity.

Additionally, we found significant associations between increased hazardous alcohol consumption, binge drinking, and HIV risk, including recent STIs and multiple sexual partners. Our findings corroborate linkages observed between heavy alcohol use patterns and HIV-related risk factors among MSM [10,11,18,35,46–59]. As MSM comprise the majority of new HIV infections in the United States, and evidence supports the important role heavy alcohol use plays in HIV-related risk behaviors, research jointly addressing alcohol use and HIV risk among MSM should be expanded. For example, one study among substance-using MSM found that a brief behavioral intervention involving personalized cognitive counseling may help reduce sexual risk among a sub-group of MSM who are not dependent on alcohol and other substances, while also having collateral benefits in reducing alcohol use [60]. Additional efforts to develop and evaluate interventions that aim to address the overlap between alcohol use and HIV risk interventions for MSM are therefore immensely needed.

We also observed unexpected correlates of heavy alcohol use. For example, MSM in relationships had greater odds of hazardous drinking. Unfortunately, we did not collect information on the duration of relationships and the cross-sectional design does not provide the temporal sequence between hazardous drinking and relationship status. It is plausible that some heavy alcohol using participants have developed relationships with partners who are also heavy drinkers. Concordance in drinking patterns in relationships have been associated with greater time spent drinking with partners and greater levels of happiness in some samples [61]. Qualitative and other empirical explorations are needed on the drinking patterns of partners of alcohol-using MSM to establish whether concordance is highly prevalent and how drinking concordance impacts hazardous alcohol use.

This study has several limitations. The prevalence of white participants and college-educated participants was lower than broader MSM samples in San Francisco [8]. It is plausible that the study eligibility criteria for recent alcohol use may have led to recruitment of a population that is demographically different from broader MSM samples. Indeed, in NHBS, the prevalence of binge drinking was lower among white MSM (44% versus 52% for African American and 58% for Latino MSM) and college-educated MSM (50% versus 54% for MSM with a high school diploma or less)[8]. Furthermore, our study may have included individuals who are more marginalized, have fewer resources, and/or have more time to participate in the study. Prior RDS studies noted greater recruitment of participants with lower education or income [62,63]

compared to non-RDS samples. Indeed, researchers have observed challenges in using RDS to recruit MSM with higher socioeconomic status (SES) in San Francisco and elsewhere [23,25]. Empirical comparisons between RDS, time location sampling, and snowball sampling studies for MSM have noted that RDS is able to recruit greater number of participants with lower SES than these other study designs [64]. Another RDS study among black MSM in San Francisco also resulted in a sample that was primarily comprised of participants (RDS-adjusted prevalence: 61%) with annual income less than \$10,000 [32]. Comparison between traditional RDS and “Web-based RDS”, whereby all study procedures—including behavioral assessment and recruitment—occurred on the Web, observed that Web-based RDS generally recruited participants from higher SES backgrounds [62]. Future studies exploring and comparing the utility of Web-based RDS may be worthwhile among alcohol-using MSM, to establish whether one method is more effective than the other for recruiting more representative samples of this population.

Another limitation is self-reported data, which are prone to social desirability and recall bias; however, we employed ACASI in an effort to mitigate these biases [34]. Additionally, our findings may not be generalizable to other MSM populations who do not use alcohol and to those who live outside of the San Francisco Bay Area. Moreover, we observed wide confidence intervals for some point estimates in our multivariable analyses due to the sample size of our study (e.g., reporting recent syphilis diagnoses and odds of hazardous alcohol consumption). Those findings should be interpreted with caution. Studies with larger sample sizes may be needed to confirm and estimate with greater precision the relationships between our outcomes and the correlates we identified in our study.

Despite limitations, this study expands our understanding of alcohol use patterns and correlates of problematic alcohol use in a population that has been noted to have high morbidity associated with alcohol use. Moreover, this study corroborates the known linkages between HIV-related sexual risk behaviors, highlighting the immense need to develop more interventions for MSM that jointly address heavy alcohol use and HIV/STI risk, as this population may doubly benefit from such interventions. Finally, our study documented significant racial/ethnic and sociodemographic health disparities and significant interaction effects between race/ethnicity and different risk factors, emphasizing the importance of expanding culturally-tailored and targeted screening and intervention strategies to address heavy alcohol use across disproportionately impacted communities.

Supporting information

S1 Table. RDS-weighted multivariable associations with hazardous alcohol consumption by race/ethnicity among alcohol using men who have sex with men: San Francisco, CA; March 2015—June 2017.

(DOCX)

S2 Table. RDS-weighted multivariable associations with weekly or more frequent binge drinking by race/ethnicity among alcohol using men who have sex with men: San Francisco, CA; March 2015—June 2017.

(DOCX)

S1 File. Anonymized study dataset.

(CSV)

Acknowledgments

This study was funded by a grant from the National Institutes of Health, Office of the Director (grant # DP5OD019809). The funder had no role in study design, data collection and analysis,

decision to publish, or preparation of the manuscript. We would like to thank the participants of The SEEDS Study, for their time. Additionally, we thank our study staff for their efforts on this study (Jason Euren, Danielle Jennings, Mathew Sommers, Anna DeMartini, John Farley, Tim Matheson, Caitlin Turner, Todd Liou, John Rivie, Theresa Ick, Selvin Marroquin, and Julia Jung).

Author Contributions

Conceptualization: Glenn-Milo Santos, H. Fisher Raymond.

Data curation: Jaclyn Hern, John E. Walker, Arsheen Ali, Marcial Ornelaz.

Formal analysis: Christopher Rowe, Maximo Prescott.

Funding acquisition: Glenn-Milo Santos.

Investigation: Glenn-Milo Santos.

Methodology: Willi McFarland, H. Fisher Raymond.

Project administration: Glenn-Milo Santos, Jaclyn Hern.

Supervision: Glenn-Milo Santos.

Writing – original draft: Glenn-Milo Santos.

Writing – review & editing: Glenn-Milo Santos, Christopher Rowe, Jaclyn Hern, John E. Walker, Arsheen Ali, Marcial Ornelaz, Maximo Prescott, Phillip Coffin, Willi McFarland, H. Fisher Raymond.

References

- Centers for Disease C, Prevention (2012) Vital signs: binge drinking prevalence, frequency, and intensity among adults—United States, 2010. *MMWR Morb Mortal Wkly Rep* 61: 14–19. PMID: [22237031](https://pubmed.ncbi.nlm.nih.gov/22237031/)
- Bouchery EE, Harwood HJ, Sacks JJ, Simon CJ, Brewer RD (2011) Economic costs of excessive alcohol consumption in the U.S., 2006. *Am J Prev Med* 41: 516–524. <https://doi.org/10.1016/j.amepre.2011.06.045> PMID: [22011424](https://pubmed.ncbi.nlm.nih.gov/22011424/)
- Mokdad AH, Marks JS, Stroup DF, Gerberding JL (2004) Actual causes of death in the United States, 2000. *JAMA* 291: 1238–1245. <https://doi.org/10.1001/jama.291.10.1238> PMID: [15010446](https://pubmed.ncbi.nlm.nih.gov/15010446/)
- McKnight-Eily LR, Okoro CA, Mejia R, Denny CH, Higgins-Biddle J, et al. (2017) Screening for Excessive Alcohol Use and Brief Counseling of Adults—17 States and the District of Columbia, 2014. *MMWR Morb Mortal Wkly Rep* 66: 313–319. <https://doi.org/10.15585/mmwr.mm6612a1> PMID: [28358798](https://pubmed.ncbi.nlm.nih.gov/28358798/)
- Jonas DE, Amick HR, Feltner C, Bobashev G, Thomas K, et al. (2014) Pharmacotherapy for adults with alcohol use disorders in outpatient settings: a systematic review and meta-analysis. *JAMA* 311: 1889–1900. <https://doi.org/10.1001/jama.2014.3628> PMID: [24825644](https://pubmed.ncbi.nlm.nih.gov/24825644/)
- Hasin DS, Stinson FS, Ogburn E, Grant BF (2007) Prevalence, correlates, disability, and comorbidity of DSM-IV alcohol abuse and dependence in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry* 64: 830–842. <https://doi.org/10.1001/archpsyc.64.7.830> PMID: [17606817](https://pubmed.ncbi.nlm.nih.gov/17606817/)
- Grant BF, Chou SP, Saha TD, Pickering RP, Kerridge BT, et al. (2017) Prevalence of 12-Month Alcohol Use, High-Risk Drinking, and DSM-IV Alcohol Use Disorder in the United States, 2001–2002 to 2012–2013: Results From the National Epidemiologic Survey on Alcohol and Related Conditions. *JAMA Psychiatry* 74: 911–923. <https://doi.org/10.1001/jamapsychiatry.2017.2161> PMID: [28793133](https://pubmed.ncbi.nlm.nih.gov/28793133/)
- Santos GM, Jin H, Raymond HF (2015) Pervasive Heavy Alcohol Use and Correlates of Increasing Levels of Binge Drinking among Men Who Have Sex with Men, San Francisco, 2011. *J Urban Health* 92: 687–700. <https://doi.org/10.1007/s11524-015-9958-z> PMID: [25895622](https://pubmed.ncbi.nlm.nih.gov/25895622/)
- Hess KL, Chavez PR, Kanny D, DiNenno E, Lansky A, et al. (2015) Binge drinking and risky sexual behavior among HIV-negative and unknown HIV status men who have sex with men, 20 US cities. *Drug Alcohol Depend* 147: 46–52. <https://doi.org/10.1016/j.drugalcdep.2014.12.013> PMID: [25555622](https://pubmed.ncbi.nlm.nih.gov/25555622/)

10. Vosburgh HW, Mansergh G, Sullivan PS, Purcell DW (2012) A Review of the Literature on Event-Level Substance Use and Sexual Risk Behavior Among Men Who Have Sex with Men. *AIDS Behav.*
11. Woolf SE, Maisto SA (2009) Alcohol use and risk of HIV infection among men who have sex with men. *AIDS Behav* 13: 757–782. <https://doi.org/10.1007/s10461-007-9354-0> PMID: 18236149
12. Read TR, Hocking J, Sinnott V, Hellard M (2007) Risk factors for incident HIV infection in men having sex with men: a case-control study. *Sex Health* 4: 35–39. PMID: 17382036
13. Koblin BA, Husnik MJ, Colfax G, Huang Y, Madison M, et al. (2006) Risk factors for HIV infection among men who have sex with men. *AIDS* 20: 731–739. <https://doi.org/10.1097/01.aids.0000216374.61442.55> PMID: 16514304
14. Sander PM, Cole SR, Stall RD, Jacobson LP, Eron JJ, et al. (2013) Joint effects of alcohol consumption and high-risk sexual behavior on HIV seroconversion among men who have sex with men. *AIDS* 27: 815–823. <https://doi.org/10.1097/QAD.0b013e32835cfff4b> PMID: 23719351
15. Irwin TW, Morgenstern J (2005) Drug-use patterns among men who have sex with men presenting for alcohol treatment: differences in ethnic and sexual identity. *J Urban Health* 82: i127–133. <https://doi.org/10.1093/jurban/jti032> PMID: 15738312
16. Jones-Webb R, Smolenski D, Brady S, Wilkerson M, Rosser BR (2013) Drinking settings, alcohol consumption, and sexual risk behavior among gay men. *Addict Behav* 38: 1824–1830. <https://doi.org/10.1016/j.addbeh.2012.11.011> PMID: 23261495
17. Martinez O, Wu E, Levine EC, Munoz-Laboy M, Spadafino J, et al. (2016) Syndemic factors associated with drinking patterns among Latino men and Latina transgender women who have sex with men in New York City. *Addict Res Theory* 24: 466–476. <https://doi.org/10.3109/16066359.2016.1167191> PMID: 28077938
18. Reisner SL, Mimiaga MJ, Bland S, Skeer M, Cranston K, et al. (2010) Problematic alcohol use and HIV risk among Black men who have sex with men in Massachusetts. *AIDS Care* 22: 577–587. <https://doi.org/10.1080/09540120903311482> PMID: 20336557
19. White Hughto JM, Pachankis JE, Eldahan AI, Keene DE (2017) "You Can't Just Walk Down the Street and Meet Someone": The Intersection of Social-Sexual Networking Technology, Stigma, and Health Among Gay and Bisexual Men in the Small City. *Am J Mens Health* 11: 726–736. <https://doi.org/10.1177/1557988316679563> PMID: 27885147
20. Simon Rosser BR, West W, Weinmeyer R (2008) Are gay communities dying or just in transition? Results from an international consultation examining possible structural change in gay communities. *AIDS Care* 20: 588–595. <https://doi.org/10.1080/09540120701867156> PMID: 18484330
21. Grov C, Breslow AS, Newcomb ME, Rosenberger JG, Bauermeister JA (2014) Gay and bisexual men's use of the Internet: research from the 1990s through 2013. *J Sex Res* 51: 390–409. <https://doi.org/10.1080/00224499.2013.871626> PMID: 24754360
22. Jenkins RA (2012) Recruiting substance-using men who have sex with men into HIV prevention research: current status and future directions. *AIDS Behav* 16: 1411–1419. <https://doi.org/10.1007/s10461-011-0037-5> PMID: 22016329
23. Forrest JI, Lachowsky NJ, Lal A, Cui Z, Sereda P, et al. (2016) Factors Associated with Productive Recruiting in a Respondent-Driven Sample of Men who Have Sex with Men in Vancouver, Canada. *J Urban Health* 93: 379–387. <https://doi.org/10.1007/s11524-016-0032-2> PMID: 26960428
24. Kuhns LM, Kwon S, Ryan DT, Garofalo R, Phillips G 2nd, et al. (2015) Evaluation of respondent-driven sampling in a study of urban young men who have sex with men. *J Urban Health* 92: 151–167. <https://doi.org/10.1007/s11524-014-9897-0> PMID: 25128301
25. Truong HM, Grasso M, Chen YH, Kellogg TA, Robertson T, et al. (2013) Balancing theory and practice in respondent-driven sampling: a case study of innovations developed to overcome recruitment challenges. *PLoS One* 8: e70344. <https://doi.org/10.1371/journal.pone.0070344> PMID: 23990901
26. Mimiaga MJ, Reisner SL, Cranston K, Isenberg D, Bright D, et al. (2009) Sexual mixing patterns and partner characteristics of black MSM in Massachusetts at increased risk for HIV infection and transmission. *J Urban Health* 86: 602–623. <https://doi.org/10.1007/s11524-009-9363-6> PMID: 19466554
27. Heckathorn DD (1997) Respondent-driven sampling: a new approach to the study of hidden populations. *Soc Probl* 44: 174–199.
28. Santos GM, Coffin PO, Das M, Matheson T, DeMicco E, et al. (2013) Dose-response associations between number and frequency of substance use and high-risk sexual behaviors among HIV-negative substance-using men who have sex with men (SUMSM) in San Francisco. *J Acquir Immune Defic Syndr* 63: 540–544. <https://doi.org/10.1097/QAI.0b013e318293f10b> PMID: 23572012
29. Bauermeister JA, Zimmerman MA, Johns MM, Glowacki P, Stoddard S, et al. (2012) Innovative recruitment using online networks: lessons learned from an online study of alcohol and other drug use utilizing

- a web-based, respondent-driven sampling (webRDS) strategy. *J Stud Alcohol Drugs* 73: 834–838. PMID: [22846248](https://pubmed.ncbi.nlm.nih.gov/22846248/)
30. Wang J, Carlson RG, Falck RS, Siegal HA, Rahman A, et al. (2005) Respondent-driven sampling to recruit MDMA users: a methodological assessment. *Drug Alcohol Depend* 78: 147–157. <https://doi.org/10.1016/j.drugalcdep.2004.10.011> PMID: [15845318](https://pubmed.ncbi.nlm.nih.gov/15845318/)
 31. Wang J, Falck RS, Li L, Rahman A, Carlson RG (2007) Respondent-driven sampling in the recruitment of illicit stimulant drug users in a rural setting: findings and technical issues. *Addict Behav* 32: 924–937. <https://doi.org/10.1016/j.addbeh.2006.06.031> PMID: [16901654](https://pubmed.ncbi.nlm.nih.gov/16901654/)
 32. Fuqua V, Chen YH, Packer T, Dowling T, Ick TO, et al. (2012) Using social networks to reach Black MSM for HIV testing and linkage to care. *AIDS Behav* 16: 256–265. <https://doi.org/10.1007/s10461-011-9918-x> PMID: [21390535](https://pubmed.ncbi.nlm.nih.gov/21390535/)
 33. Metzger DS, Koblin B, Turner C, Navaline H, Valenti F, et al. (2000) Randomized controlled trial of audio computer-assisted self-interviewing: utility and acceptability in longitudinal studies. HIVNET Vaccine Preparedness Study Protocol Team. *Am J Epidemiol* 152: 99–106. PMID: [10909945](https://pubmed.ncbi.nlm.nih.gov/10909945/)
 34. Ghanem KG, Hutton HE, Zenilman JM, Zimba R, Erbeding EJ (2005) Audio computer assisted self interview and face to face interview modes in assessing response bias among STD clinic patients. *Sex Transm Infect* 81: 421–425. <https://doi.org/10.1136/sti.2004.013193> PMID: [16199744](https://pubmed.ncbi.nlm.nih.gov/16199744/)
 35. Colfax G, Vittinghoff E, Husnik MJ, McKimman D, Buchbinder S, et al. (2004) Substance use and sexual risk: a participant- and episode-level analysis among a cohort of men who have sex with men. *Am J Epidemiol* 159: 1002–1012. PMID: [15128613](https://pubmed.ncbi.nlm.nih.gov/15128613/)
 36. Babor TF, Higgins-Biddle JC, S J.B., Monteiro MG (2001) *The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Care*. World Health Organization.
 37. San Francisco Department of Public Health (2014) *Say When: Targeting Heavy Alcohol Use With Naltrexone Among MSM (Say When)*. In: *Trials.gov C*, editor.
 38. Handcock MS, Fellows IE, Giles KJ (2014) *RDS Analyst: Software for the Analysis of Respondent-Driven Sampling Data*. 0.42 ed.
 39. Volz E, Heckathorn DD (2008) Probability Based Estimation Theory for Respondent Driven Sampling. *Journal of Official Statistics* 24: 79–97.
 40. Conner KR, Pinquart M, Gamble SA (2009) Meta-analysis of depression and substance use among individuals with alcohol use disorders. *J Subst Abuse Treat* 37: 127–137. <https://doi.org/10.1016/j.jsat.2008.11.007> PMID: [19150207](https://pubmed.ncbi.nlm.nih.gov/19150207/)
 41. Substance Abuse and Mental Health Services Administration (2017) *Results from the 2016 National Survey on Drug Use and Health: Detailed Tables*. Rockville, MD.
 42. Witbrodt J, Mulia N, Zemore SE, Kerr WC (2014) Racial/ethnic disparities in alcohol-related problems: differences by gender and level of heavy drinking. *Alcohol Clin Exp Res* 38: 1662–1670. <https://doi.org/10.1111/acer.12398> PMID: [24730475](https://pubmed.ncbi.nlm.nih.gov/24730475/)
 43. Rapues J, Wilson EC, Packer T, Colfax GN, Raymond HF (2013) Correlates of HIV infection among transfemales, San Francisco, 2010: results from a respondent-driven sampling study. *Am J Public Health* 103: 1485–1492. <https://doi.org/10.2105/AJPH.2012.301109> PMID: [23763398](https://pubmed.ncbi.nlm.nih.gov/23763398/)
 44. Bux D (1996) The epidemiology of problem drinking in gay men and lesbians: A Critical Review. *Clinical Psychology Review* 16: 277–298.
 45. Santos GM, Coffin P, Santos D, Huffaker S, Matheson T, et al. (2016) Feasibility, Acceptability, and Tolerability of Targeted Naltrexone for Nondependent Methamphetamine-Using and Binge-Drinking Men Who Have Sex with Men. *J Acquir Immune Defic Syndr* 72: 21–30. <https://doi.org/10.1097/QAI.0000000000000922> PMID: [26674372](https://pubmed.ncbi.nlm.nih.gov/26674372/)
 46. Irwin TW, Morgenstern J, Parsons JT, Wainberg M, Labouvie E (2006) Alcohol and sexual HIV risk behavior among problem drinking men who have sex with men: An event level analysis of timeline followback data. *AIDS Behav* 10: 299–307. <https://doi.org/10.1007/s10461-005-9045-7> PMID: [16482407](https://pubmed.ncbi.nlm.nih.gov/16482407/)
 47. Prestage G, Grierson J, Bradley J, Hurley M, Hudson J (2009) The role of drugs during group sex among gay men in Australia. *Sex Health* 6: 310–317. <https://doi.org/10.1071/SH09014> PMID: [19917200](https://pubmed.ncbi.nlm.nih.gov/19917200/)
 48. Benotsch EG, Nettles CD, Wong F, Redmann J, Boschini J, et al. (2007) Sexual risk behavior in men attending Mardi Gras celebrations in New Orleans, Louisiana. *J Community Health* 32: 343–356. <https://doi.org/10.1007/s10900-007-9054-8> PMID: [17922205](https://pubmed.ncbi.nlm.nih.gov/17922205/)
 49. Benotsch EG, Mikytuck JJ, Ragsdale K, Pinkerton SD (2006) Sexual risk and HIV acquisition among men who have sex with men travelers to Key West, Florida: a mathematical modeling analysis. *AIDS Patient Care STDS* 20: 549–556. <https://doi.org/10.1089/apc.2006.20.549> PMID: [16893324](https://pubmed.ncbi.nlm.nih.gov/16893324/)

50. Lambert G, Cox J, Hottes TS, Tremblay C, Frigault LR, et al. (2011) Correlates of unprotected anal sex at last sexual episode: analysis from a surveillance study of men who have sex with men in Montreal. *AIDS Behav* 15: 584–595. <https://doi.org/10.1007/s10461-009-9605-3> PMID: 20033763
51. Vanable PA, McKirnan DJ, Buchbinder SP, Bartholow BN, Douglas JM Jr., et al. (2004) Alcohol use and high-risk sexual behavior among men who have sex with men: the effects of consumption level and partner type. *Health Psychol* 23: 525–532. <https://doi.org/10.1037/0278-6133.23.5.525> PMID: 15367072
52. Folch C, Esteve A, Zaragoza K, Munoz R, Casabona J (2010) Correlates of intensive alcohol and drug use in men who have sex with men in Catalonia, Spain. *Eur J Public Health* 20: 139–145. <https://doi.org/10.1093/eurpub/ckp091> PMID: 19564240
53. Reisner SL, Mimiaga MJ, Case P, Johnson CV, Safren SA, et al. (2009) Predictors of identifying as a barebacker among high-risk New England HIV seronegative men who have sex with men. *J Urban Health* 86: 250–262. <https://doi.org/10.1007/s11524-008-9333-4> PMID: 19051039
54. NYCDOHMH (2008) Alcohol use and risky sex in New York City. New York City: New York City Department of Health and Mental Hygiene.
55. Mackesy-Amiti ME, Fendrich M, Johnson TP (2010) Symptoms of substance dependence and risky sexual behavior in a probability sample of HIV-negative men who have sex with men in Chicago. *Drug Alcohol Depend* 110: 38–43. <https://doi.org/10.1016/j.drugalcdep.2010.01.016> PMID: 20219291
56. Mimiaga MJ, Thomas B, Mayer KH, Reisner SL, Menon S, et al. (2011) Alcohol use and HIV sexual risk among MSM in Chennai, India. *Int J STD AIDS* 22: 121–125. <https://doi.org/10.1258/ijsa.2009.009059> PMID: 21464447
57. Nelson KM, Simoni JM, Pearson CR, Walters KL (2011) 'I've had unsafe sex so many times why bother being safe now?': the role of cognitions in sexual risk among American Indian/Alaska Native men who have sex with men. *Ann Behav Med* 42: 370–380. <https://doi.org/10.1007/s12160-011-9302-0> PMID: 21887585
58. Rowe C, Liou T, Vittinghoff E, Coffin PO, Santos GM (2016) Binge drinking concurrent with anal intercourse and condom use among men who have sex with men. *AIDS Care* 28: 1566–1570. <https://doi.org/10.1080/09540121.2016.1191616> PMID: 27241085
59. Brown RE, Turner C, Hern J, Santos GM (2017) Partner-level substance use associated with increased sexual risk behaviors among men who have sex with men in San Francisco, CA. *Drug Alcohol Depend* 176: 176–180. <https://doi.org/10.1016/j.drugalcdep.2017.02.016> PMID: 28549302
60. Coffin PO, Santos GM, Colfax G, Das M, Matheson T, et al. (2014) Adapted personalized cognitive counseling for episodic substance-using men who have sex with men: a randomized controlled trial. *AIDS Behav* 18: 1390–1400. <https://doi.org/10.1007/s10461-014-0712-4> PMID: 24510401
61. Meiklejohn J, Connor JL, Kypri K (2012) Drinking concordance and relationship satisfaction in New Zealand couples. *Alcohol Alcohol* 47: 606–611. <https://doi.org/10.1093/alcalc/ags042> PMID: 22542708
62. Hildebrand J, Burns S, Zhao Y, Lobo R, Howat P, et al. (2015) Potential and Challenges in Collecting Social and Behavioral Data on Adolescent Alcohol Norms: Comparing Respondent-Driven Sampling and Web-Based Respondent-Driven Sampling. *J Med Internet Res* 17: e285. <https://doi.org/10.2196/jmir.4762> PMID: 26704736
63. McCreesh N, Copas A, Seeley J, Johnston LG, Sonnenberg P, et al. (2013) Respondent driven sampling: determinants of recruitment and a method to improve point estimation. *PLoS One* 8: e78402. <https://doi.org/10.1371/journal.pone.0078402> PMID: 24205221
64. Kendall C, Kerr LR, Gondim RC, Werneck GL, Macena RH, et al. (2008) An empirical comparison of respondent-driven sampling, time location sampling, and snowball sampling for behavioral surveillance in men who have sex with men, Fortaleza, Brazil. *AIDS Behav* 12: S97–104. <https://doi.org/10.1007/s10461-008-9390-4> PMID: 18389357