**Factors Associated with Cessation or Reduction of Methamphetamine Use Among Gay, Bisexual, and other Men Who Have Sex with Men (gbMSM) in Vancouver, Canada**

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**Background:** Methamphetamine (MA) use among gay, bisexual, and other men who have sex with men (gbMSM) is a pervasive issue, associated with detrimental health outcomes. We identified factors associated with discontinuation or reduction in MA among a subset of gbMSM reporting frequent (at least weekly) use, with a specific focus on symptoms of anxiety and depression.

**Methods:** We recruited sexually-active gbMSM aged ≥16 years in Vancouver, Canada into a prospective-cohort study using respondent-driven sampling. Participants completed study visits once every six months. We used generalized linear mixed models to identify factors associated with reductions in MA use following a visit where participants previously reported using MA at least weekly.

**Results:** Of 584 cohort participants with at least one follow-up visit, 67 (11.5%) reported frequent MA use at baseline or in follow-up visits. Of these, 46 (68.7%) had at least one subsequent study visit where they transitioned to less frequent (monthly or less) or no MA use. In multivariable models, reduced MA use was less likely for those who spent >50% of social time with other gbMSM (aRR=0.49, 95%CI:0.28-0.85), gave or received drugs in exchange for sex (aRR=0.34, 95%CI:0.13-0.87), injected drugs (aRR=0.35, 95%CI:0.18-0.68), or used gamma-hydroxybutyrate (GHB) (aRR=0.41, 95%CI:0.21-0.78). Symptoms of anxiety or depression were not associated with reductions in MA use.

**Conclusions:** Social connection and drug-related factors surrounding MA use were associated with reductions, but anxiety and depressive symptomatology were not. Incorporating socialization and polysubstance-related components with MA reduction may help in developing efficacious interventions towards reducing MA use for gbMSM.

**Keywords:** Methamphetamines; gay, bisexual and other men who have sex with men (gbMSM); substance use reduction; anxiety; depression

**Introduction**

Prevalence of methamphetamine (MA) use in gay, bisexual, and other men who have sex with men (gbMSM) has been estimated to be more than ten to twenty times greater than that of the general population (Colfax & Shoptaw, 2005; Melendez-Torres & Bourne, 2016; Mimiaga et al., 2018). Previous literature has identified MA use among gbMSM as a dual epidemic with HIV, as these public health concerns are closely intertwined (Haddad et al., 2018).

MA is known to enhance sexual confidence, endurance and intimacy (Lea et al., 2017), which may increase the likelihood of engaging in sexual risk-taking behaviours such as condomless anal intercourse (Forrest et al., 2010; Halkitis et al., 2014), injection drug needle-sharing (Hopwood et al., 2015), and having higher numbers of sexual partners (Forrest et al., 2010). From a social perspective, MA is often used in the context of group sex events (Rich et al., 2016) and is associated with heightened confidence (Halkitis, 2009). Further, Colyer et al. (2018) found that MA initiation is associated with escort work in the past six months and higher escape motivation (which assesses how much being under the influence of one or more substances might be related to sexual risk-taking) (Colyer et al., 2018). Qualitative interviews with gbMSM provide further evidence of the association between escape expectancies of drugs and sexual risk (McKirnan et al., 2001). Taken together, these risk factors exacerbate the disproportionate rate of HIV transmission in gbMSM (Beyrer et al., 2012).

GbMSM living with HIV are more likely to use MA than their HIV-negative counterparts (Forrest et al., 2010; Schwarcz et al., 2007). MA use among HIV-positive gbMSM is associated with lower antiretroviral therapy adherence (Marquez et al., 2009), decreased access to health care services (Marshall et al., 2011), increased likelihood of unsuppressed viral load (Moore et al., 2016), elevated levels of sexually transmitted infections (Reback & Fletcher, 2018), and immunosuppressive effects (Tallóczy et al., 2008). These implications present concerns at both the individual and community level in curbing the HIV epidemic among gbMSM.

Research regarding targeted interventions to reduce MA among gbMSM are limited but have found some promising results. Using motivational interviewing, Zule et al. (2012) found a significant reduction in self-reported MA use; during the previous 60 days, a decrease from an average of 9.4 days at baseline to 3.3 days at follow-up (p<0.023) was observed among gbMSM who were not in drug treatment (Zule et al., 2012). More recently, Reback et al. (2019) applied an interactive text-message based intervention among gbMSM using MA and found significant reductions in MA use (coef.=− 0.10) (Reback et al., 2019). Moreover, MA intervention trials among gbMSM have found reductions of MA use to be associated with significant reductions in depressive symptoms, risky sexual behaviour (Mimiaga et al., 2012), and psychological distress (Lea et al., 2017). Correspondingly, significant improvements in psychosocial functioning (Lea et al., 2017) and increases in health-promoting behaviours (e.g., making appointments with health care providers, enrolling in educational programs, maintaining employment) have been related to reductions in MA use in trials involving treatment (e.g., contingency management and individual counseling) for substance use (Lea et al., 2017; Reback et al., 2010). However, most studies focused on gbMSM have involved individuals who were already motivated to reduce their MA use. Less is known about the trajectories of MA use and the determinants of reductions in use among the general gbMSM population who are using MA.

Generally, MA users report higher levels of anxiety and depression than non-users (Glasner-Edwards et al., 2010b, 2010a). MA use has been identified as a coping mechanism for discrimination and stigmatization, and as an escape from feelings of internalized homophobia (Halkitis et al., 2016).Studies have shown that individuals with fewer depressive symptoms are more likely to be motivated to change their MA-using behavior (Starks et al., 2017), and that both clinically-diagnosed anxiety (Glasner-Edwards et al., 2010b) and depressive (Glasner-Edwards et al., 2010a) disorders have been associated with reduced likelihood of MA abstinence among individuals undergoing substance use treatment. Thus, it appears that mental health symptomatology may have important impacts on the likelihood of reduction or cessation of MA use. However, research has yet to examine these associations among cohorts of gbMSM who may not be seeking treatment and who may not view their MA use as problematic.

To help guide the development of treatment programs for gbMSM with MA use disorder, we sought to identify factors related to reduction or cessation of MA use in frequent users (i.e., those who report use at least weekly). We hypothesized that lower symptomatology of anxiety and depression among gbMSM would be associated with greater likelihood of MA reduction and discontinuation.

**Methods**

***Study Design and Participants***

We analyzed data drawn from the [BLINDED FOR REVIEW], a bio-behavioural, prospective cohort study of gbMSM in Metro Vancouver, Canada. Participants were recruited from February 2012 to February 2015 using respondent-driven sampling (RDS), a formalized chain-referral sampling method which utilizes the social networks of participants to allow recruitment from minority populations which would otherwise be difficult to access (Heckathorn, 1997). With RDS, the recruitment process is started with purposeful selection of “seed” participants. In the present study, these individuals were given up to 6 study invitation vouchers to offer to eligible members of their social or sexual networks, initiating chains of peer recruitment; subsequent recruits were likewise given up to 6 invitations to recruit members of their social and sexual networks. Full details on the study procedures are published elsewhere (Moore et al., 2016). This dataset utilized additional recruitment to recruit more HIV-positive gbMSM into the sample.

Eligibility criteria included: being at least 16 years of age, gender-identifying as male (including transmen), reporting sex with another male-identifying individual in the past six months, currently living in Metro Vancouver, and being able to complete the questionnaire in English. Further, individuals must have received an invitation voucher or have been an initial “seed” to enter the study. Participants were also offered optional entry into the longitudinal cohort study (including follow-up visits every six months). For each visit, participants received an honorarium of $50 (all figures in Canadian dollars) and an additional compensation of $10 for each eligible recruit. All participants signed an informed consent form about the study and their involvement.

At all study visits, participants completed a computer-assisted self-interview (CASI) which asked questions about the past six month time-frame, assessing demographics, sexual behaviours and risk, and substance use. HIV bloodwork and STI screening was completed by the study nurse who also administered a clinical questionnaire about history of diagnosed medical conditions and treatment, including mental health and substance use disorders.

The [BLINDED FOR REVIEW] received ethical approval from the Research Ethics Boards of [BLINDED FOR REVIEW]. The present analysis utilizes data collected from study visits up to February 2018.

***Dependent Variable***

At each study visit, participants were asked whether they had used a list of various substances, including MA, and at what frequency if they had used them in the past six months (e.g., less than once a month, monthly, weekly, more than weekly, daily or almost daily).Participants who reported at least weekly MA use at one study visit had all subsequent visits available for inclusion in the analysis, where they could either be classified has having reduced their MA use (i.e., monthly use, less than monthly or no use) or continued frequent use (i.e., at least weekly).

***Independent Variables***

The primary explanatory variable of interest was symptomatology of anxiety and depression. Other key independent variables for this analysis included substance use behaviors, mental health, other psychosocial factors, and sexual behavior.

Mental health factors of anxiety and depressive symptomatology were measured using the Hospital Anxiety & Depression Scale (HADS). Scores for each of the two separate 7-item subscales range from 0 to 21 (anxiety subscale α = 0.87; depression subscale α = 0.84) with the following categorizations corresponding to level of anxiety/depression: normal (0-7), borderline (8-10), and abnormal (11-21) (Zigmond & Snaith, 1983). Participants self-reported symptomatology by providing responses using various 4-point scales to statements designed to assess anxiety and depression (e.g., “I get a sort of frightened feeling as if something awful is about to happen”) (Zigmond & Snaith, 1983).

Other psychosocial factorswere measured withthe Gay/Bisexual Self-Esteem Scale (Greene et al., 1995), Escape Motivation Scale (McKirnan et al., 2001), Sexual Sensation Seeking Scale (Kalichman & Rompa, 1995), and Lubben Social Network Scale (Lubben et al., 2006). The HIV Treatment Optimism-Skepticism Scale (Van de Ven et al., 2000), Sexual Altruism Scale (Nimmons & Folkman, 1999; O’Dell et al., 2008), and Loneliness Scale for Emotional and Social Loneliness (de Jong Gierveld & Tilburg, 2006) were also administered.

Sexual history was obtained as participants were asked to describe the number of male partners (in the past six months), frequency of any condomless anal sex, use of the internet or mobile apps to seek sex, and any exchange of drugs for sex. Use of HIV prevention and risk reduction strategies (such as consistent condom use) was also measured.

Substance use behaviours were measured by inquiring about recent use in the past six months of injection drugs and various substances including amyl nitrites (poppers), gamma-hydroxybutyrate (GHB), ecstasy, tobacco, cannabis, cocaine, ketamine, crack and heroin.

Clinical information asked about history of diagnoses with mental health (depression, anxiety disorder/panic attacks, bipolar, schizophrenia) or substance use disorders (alcohol dependency, other substance use dependency). Responses were “No”, “Unknown”, “Yes, in the past six months”, and “Yes, but more than six months ago”. If participants selected yes, they were then asked about year of first diagnosis. Additionally, those who answered affirmatively were further asked to describe their treatment, if any.

Sociodemographic information included age, sexual orientation, ethnicity, relationship status, and income level.

***Statistical Analyses***

We reported descriptive statistics of cohort participants who reported using MA at least weekly at baseline. Our primary explanatory variables of interest were scores on the HADS subscales for anxiety and depression, which were examined as both categorical and continuous variables. For the categorical variables, we dichotomized scores into normal or borderline scores (<11) and abnormal (≥11) based on the original validation studies of HADS scoring (Zigmond & Snaith, 1983). Independent variables were tested across all categories of the dependent variable. Bivariate analyses (Fisher’s Exact Test, Wilcoxon Rank Sum) were performed to compare participants who reduced MA use with those who did not. We used multi-level hierarchical generalized linear mixed models with log-linkage to examine associations between reduced MA use and various sociodemographic, psychosocial, and behavioural factors accounting for RDS recruitment chain and respondents’ multiple visits (i.e., study visits per one participant). We did not include sexual behaviour variables in the modeling process as we expected that these were more likely to be outcomes rather than determinants of reductions in MA use. Variables in the univariable models with a *p*-value <0.2 were included for consideration in the multivariable models. The final models were selected using a backward selection technique based on two criteria (Akaike Information Criterion (AIC) and Type III *p*-values), whereby the least significant (i.e., highest Type III *p*-value) variable was dropped until the final models reached the optimal (minimum) AIC (Lima et al., 2007). All analyses were performed using SAS® Version 9.4 (SAS Corporation Cary, North Carolina, United States).

**Results**

***Descriptive Characteristics of Study Population at Enrollment***

774 participants completed enrollment visits and 698 (90.2%) consented to join the prospective cohort. Of these, 584 (83.7%) attended at least one follow-up visit, up to February 2018. The median follow-up time was 3.5 years and participants completed a median of 7 (Q1-Q3: 4-7) visits. At enrollment, 140 (20.1%) participants reported any MA use in the previous six months and of these, 61 participants (43.6%) used MA less than once a month, 29 (20.7%) used monthly, 21 (15.0%) used weekly, 11 (7.9%) used more than weekly, and 18 (12.9%) used daily or more than daily. Of the 50 potential participants eligible for this analysis, 29 had at least one follow-up visit and were included, as were another 38 participants who later reported at least weekly MA use at subsequent study visits (and had at least one study visit completed after that visit). Thus, our total analytic sample was 67 participants. Among these, 46 (68.7%) ever quit frequent MA use, 34 (50.7%) quit once, 10 (14.9%) quit twice and 2 (3.0%) quit three times during their follow-up visits; the remaining 21 (31.3%) reported continued frequent use. Of the 220 visits contributed by the analytic sample, 60 visits (27.3%) exhibited a reduction in MA use. Lastly, among the 46 participants who reported subsequent reductions in frequent MA use, 24 (52.2%) later reinitiated frequent use while 32 (69.6%) reported no use at their last study visit.

At enrollment, the analytic sample had a median age of 45 years (Q1-Q3: 34-51), 80.6% self-identified as gay, 79.1% were living with HIV, 88.1% were born in Canada, and 76.1% earned annual incomes of <$30,000. Most were White (85.1%); other ethnicities included Asian (4.5%) and Indigenous (10.5%). For clinical diagnoses, 6 (9.0%) participants reported having been diagnosed with a substance use disorder, 8 (11.9%) reported previous depression diagnosis, and 5 (7.5%) reported a previous anxiety diagnosis; no participants indicated that they were receiving treatment for any of these mental health or substance use disorders. Full demographic findings can be found in Table 1.

***Bivariate Results for gbMSM who reduced MA use vs. no reductions***

Bivariate analyses of factors associated with MA use reduction versus no reduction are shown in Table 2. Participants who did not reduce their MA use were less likely to be living with HIV (61.9% vs. 87.0%; p=0.027), but more likely to have attended a group sex event (52.4% vs. 23.9%; p=0.028), and to have engaged in barebacking (i.e., condomless anal sex) at group sex events (33% vs. 7.1%; p=0.012) compared to those who reduced their use. Socially, gbMSM who did not reduce their MA use were more likely to use mobile apps (42.9% vs. 17.4%; p=0.036) or the internet to seek sex partners (47.6% vs. 21.7%; p=0.045) more than once per month. These participants were also more likely to spend more than 50% of their social time with other gbMSM (76.2% vs. 39.1%; p=0.008) compared with gbMSM who reduced their use. Lastly, gbMSM who did not reduce their MA use were more likely to have given or received drugs for sex (47.6% vs. 8.7%; p=0.001) in the past six months, and more likely to have engaged in any injection drug use (excluding steroids) (57.1% vs. 19.6%; p=0.004).

***Univariable and Multivariable results for MA Use Reduction***

In our univariable analyses (Table 3), MA reduction was not significantly related to HADS scores for clinically-significant symptoms of anxiety (score 11+) (RR=0.84, 95%CI:0.43-1.63) or depression (RR=0.93, 95%CI:0.40-2.15) compared with scores <11; in a post-hoc sensitivity analysis, continuous observations were also not statistically significant.

From the univariable analysis, participants who were born in Canada were found to be less likely to reduce MA use (RR=0.45, 95%CI:0.22-0.91) compared to those where were not. Individuals perceiving themselves to be in good, fair, or poor current health were less likely to have reduced MA use than those who reported excellent or very good health (RR=0.47, 95%CI:0.28-0.82). Other factors related to less MA reduction included use of mobile apps (RR=0.42, 95%CI:0.19-0.92) or the internet (RR=0.43, 95%CI:0.22-0.85) to seek sex more than once per month, greater HIV Treatment Optimism-Skepticism Scale scores (higher antiretroviral therapy optimism) (RR=0.94, 95%CI:0.90-0.99), and receiving drugs for sex in the past six months (RR=0.31, 95%CI:0.11-0.88). Specific substances whose recent use was associated with lower MA reduction likelihood included poppers (RR=0.53, 95%CI:0.29-0.96), ecstasy (RR=0.46, 95%CI:0.24-0.89), and ketamine (RR=0.37, 95%CI:0.18-0.76). Injection method of MA use at last high frequency use was not significant (RR=0.72, 95%CI:0.39~~-~~1.31).

Factors that were significantly associated with a lower likelihood of MA reduction in the multivariable model (Table 4) included spending at least 50% of total social time with other gbMSM (aRR=0.49, 95%CI:0.28-0.85), giving/receiving drugs for sex in the past six months (aRR=0.34, 95%CI:0.13-0.87), reporting the use of any injection drugs (excluding steroids) in the past six months (aRR=0.35, 95%CI:0.18-0.68), and use of GHB in the past six months (aRR=0.41, 95%CI:0.21-0.78).

**Discussion**

Among a community sample of gbMSM in Vancouver, Canada, approximately two-thirds of gbMSM who reported frequent use of MA later reported reduced or no use in subsequent visits. Contrary to our hypothesis, we did not find that symptoms of anxiety or depression were associated with reductions in use either continuously or dichotomously. However, we did find several associations for MA reduction among gbMSM. First, participants who spent more than 50% of their social time with other gbMSM had a lower likelihood of reducing MA. Second, we observed that reporting exchanging drugs for sex and engaging in injection drug use were associated with a lower likelihood of reducing MA. Lastly, reporting GHB use in the past six months was associated with a lower likelihood of reducing MA.

Our observed lack of clinically-significant symptoms of anxiety and depression related to reduction of MA use is in contrast to previous intervention studies, which have generally found that individuals are more likely to stop using MA when they have fewer symptoms of mental illness (Starks et al., 2017). However, most studies exploring the association between mental health and MA have observed MA reduction in interventions with treatment-seeking gbMSM. For example, it has been found that among MA-dependent adults undergoing treatment for use, having a diagnosed anxiety disorder was associated with reduced likelihood of MA reduction (Glasner-Edwards et al., 2010b). Moreover, intervention trials have found associations between lower depressive symptoms and reduced MA use (Jaffe et al., 2007). The focus of our study on a general cohort of gbMSM highlights the nuances between broader populations. Moreover, while anxiety symptoms were high (25%), depressive symptoms were much lower (12%); the latter may be due to limited statistical power to identify associations. These findings are inverse with existing research on anxiety and depression among substance-using gbMSM, which have found higher prevalence of depression and lower prevalence of anxiety (Prestage et al., 2018). However, our study focused specifically on MA reduction, and previous literature indicates that substance use reduction may exacerbate anxiety (Smith & Randall, 2012). We hypothesize this is the reason why anxiety symptoms were more than double that of depressive symptoms in our sample.

Our findings of increased social time with other gbMSM and associations with MA reduction are consistent with previous literature which has identified the socialized nature of MA, particularly in building social-sexual networks based on drug use (Isaiah Green & Halkitis, 2006). This significant relationship may be explained using minority stress theory, which hypothesizes that sexual minorities face direct and indirect stressors based on their sexual minority status. As such, gbMSM are more likely to seek social support from other sexual minority peers (Frost et al., 2016). Thus, socialization among gbMSM who use MA may in turn normalize MA use. Among a sample of MA-using Black gbMSM in New York City, Jerome and Halkitis (2009) found that MA use was associated with a sense of community belonging with other Black gbMSM who use MA, stemming from experiences of racism, homophobia and hegemonic image of Black masculinity (Jerome & Halkitis, 2009). Taken together, these findings suggest that broader social connections beyond only gbMSM may assist gbMSM in reducing their MA use. Additionally, network-based interventions among gbMSM should be explored.

Our findings regarding exchanging sex for drugs are consistent with previous literature, which has found associations between escort work and MA use among gbMSM (Colyer et al., 2018). Moreover, these findings complement existing literature on associations between trading sex for drugs and injection drug use, binge use of MA, and increased likelihood of sexual risk-taking behaviours (Semple et al., 2010). Taken together, our findings encourage support services for gbMSM who exchange sex for drugs. Examples include financial support such as housing or utilities support, life-skills mentoring, and counseling. Given the synergistic relationship between exchanging sex for drugs and MA use, supportive services for sex work should be paired with substance use reduction interventions to maximize efficacy. Moreover, our findings suggest that MA treatment programs should also consider economic factors to improve efficacy.

Effects of GHB are associated with sexual disinhibition and heightened sex drive, and GHB is commonly used in combination with other stimulants, particularly MA (Brennan & Van Hout, 2014; Liechti et al., 2006; Sumnall et al., 2008). As a depressant, many gbMSM may use the relaxant effect of GHB to “come down” from the elevation of the MA stimulant (Liechti et al., 2006). Thus, the use of GHB likely reflects a concomitant association of using both substances together, rather than a cause and effect relationship. As such, clinicians and healthcare providers must consider polysubstance use when targeting MA reduction. Further, previous studies have found that those who used injection as the route of MA administration (as opposed to smoking or intranasal use)had the most severe consequences of psychological and medical impairment, as well as the heaviest drug use and lowest treatment adherence (Rawson et al., 2007). Our study found that not engaging in injection drug use in the past six months (excluding steroids) was significantly associated with greater odds of MA reduction. Thus, encouraging smoking, snorting, or hooping drugs as opposed to injecting may be a useful harm reduction approach for MA users wanting to reduce or discontinue use.

This study was subject to a number of limitations. First, our study was limited by a relatively small sample size (n=67) of gbMSM who reported frequent MA use. However, the longitudinal nature of our study provided multiple data points for the same participant with a median follow-up time of 3.5 years, ensuring reasonable statistical power for analyses. Second, we did not specifically ask participants to report how they felt about their MA use (e.g., problematic or not) and if they were actively trying to reduce their use. Very few participants reported having been diagnosed with a substance use disorder and none reported as being on treatment for this. We attempted to approximate “problematic substance use” by restricting inclusion in the study sample to only those using MA at least weekly. Finally, the temporality of associations found in the analysis may be a limitation of our results. Although the longitudinal design provides strength in our data collection, it allows for uncertainty in interpreting whether factors are associated with MA reduction because of the time they were measured (i.e., the current study visit) or because of prior events that happened in the past (e.g., self-reported health). Lastly, only 2 participants identified as transgender (1 participant reported ever quitting MA, 1 participant reporting never quitting MA). This prevented performance of separate analyses to compare factors of use reduction affecting transgender versus cisgender men.

**Conclusions**

Our study sought to explore how depression and anxiety were associated with MA reduction. While we did not find significant associations for depression and anxiety, our study found multiple social, sexual and substance use factors associated with MA reduction among a cohort of non-treatment seeking gbMSM in Metro Vancouver. Collectively, our findings provide insight for developing tailored and targeted MA reduction and treatment interventions for gbMSM. These interventions should encourage both substance use and sexual harm reduction, while promoting positive social supports to efficaciously address MA reduction and discontinuation. Although anxiety and depression may not be associated with MA reduction, addressing mental health disparities among MA-using gbMSM may further elicit health and wellbeing. Finally, future efforts are warranted to integrate social, substance and sexual health services to improve prevention and harm reduction among gbMSM.

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**Footnotes**

All authors have approved the final manuscript.

**Conflicts of Interest**

The authors of this study have no conflicts of interest to disclose.

**References**

BC Centre for Disease Control. (2018). *HIV in British Columbia: Annual Surveillance Report 2016.* http://www.bccdc.ca/search?k=hiv annual report

Beyrer, C., Baral, S. D., van Griensven, F., Goodreau, S. M., Chariyalertsak, S., Wirtz, A. L., & Brookmeyer, R. (2012). Global epidemiology of HIV infection in men who have sex with men. *Lancet (London, England)*, *380*(9839), 367–377. https://doi.org/10.1016/S0140-6736(12)60821-6

Brennan, R., & Van Hout, M. C. (2014). Gamma-Hydroxybutyrate (GHB): A Scoping Review of Pharmacology, Toxicology, Motives for Use, and User Groups. *Journal of Psychoactive Drugs*, *46*(3), 243–251. https://doi.org/10.1080/02791072.2014.921746

Colfax, G., & Shoptaw, S. (2005). The methamphetamine epidemic: implications for HIV prevention and treatment. In *Current HIV/AIDS reports* (Vol. 2, Issue 4, pp. 194–199). Curr HIV/AIDS Rep. https://doi.org/10.1007/s11904-005-0016-4

Colyer, S. P., Lachowsky, N. J., Cui, Z., Zhu, J., Armstrong, H. L., Taylor, M., Edward, J., Olarewaju, G., Hogg, R. S., Roth, E. A., & Moore, D. M. (2018). HIV treatment optimism and crystal methamphetamine use and initiation among HIV-negative men who have sex with men in Vancouver, Canada: A longitudinal analysis. *Drug and Alcohol Dependence*, *185*, 67–74. https://doi.org/10.1016/j.drugalcdep.2017.12.004

de Jong Gierveld, J., & Tilburg, T. Van. (2006). A 6-Item Scale for Overall, Emotional, and Social Loneliness. *Research on Aging*, *28*(5), 582–598. https://doi.org/10.1177/0164027506289723

Forrest, D. W., Metsch, L. R., LaLota, M., Cardenas, G., Beck, D. W., & Jeanty, Y. (2010). Crystal methamphetamine use and sexual risk behaviors among HIV-positive and HIV-negative men who have sex with men in South Florida. *Journal of Urban Health*, *87*(3), 480–485. https://doi.org/10.1007/s11524-009-9422-z

Frost, D. M., Meyer, I. H., & Schwartz, S. (2016). Social support networks among diverse sexual minority populations. *American Journal of Orthopsychiatry*, *86*(1), 91–102. https://doi.org/10.1037/ort0000117

Glasner-Edwards, S., Mooney, L. J., Marinelli-Casey, P., Hillhouse, M., Ang, A., Rawson, R. A., & Methamphetamine Treatment Project Corporate Authors, T. M. T. P. C. (2010a). Psychopathology in methamphetamine-dependent adults 3 years after treatment. *Drug and Alcohol Review*, *29*(1), 12–20. https://doi.org/10.1111/j.1465-3362.2009.00081.x

Glasner-Edwards, S., Mooney, L. J., Marinelli-Casey, P., Hillhouse, M., Ang, A., Rawson, R., & Methamphetamine Treatment Project Corporate Authors, the M. T. P. C. (2010b). Anxiety disorders among methamphetamine dependent adults: association with post-treatment functioning. *The American Journal on Addictions*, *19*(5), 385–390. https://doi.org/10.1111/j.1521-0391.2010.00061.x

Greene, B., Herek, G. M., & Society for the Psychological Study of Lesbian and Gay Issues. (1995). *AIDS, identity, and community : the HIV epidemic and lesbians and gay men*. Sage Publications.

Haddad, N., Li, J. S., Totten, S., & Mcguire, M. (2018). *SURVEILLANCE HIV in Canada-Surveillance Report, 2017*. *6*, 12. https://doi.org/10.14745/ccdr.v44i12a03

Halkitis, P. N. (2009). *Methamphetamine addiction: Biological foundations, psychological factors, and social consequences.* American Psychological Association. https://doi.org/10.1037/11883-000

Halkitis, P. N., Levy, M. D., Moreira, A. D., & Ferrusi, C. N. (2014). Crystal Methamphetamine Use and HIV Transmission Among Gay and Bisexual Men. *Current Addiction Reports*, *1*(3), 206–213. https://doi.org/10.1007/s40429-014-0023-x

Halkitis, P. N., Levy, M. D., & Solomon, T. M. (2016). Temporal relations between methamphetamine use and HIV seroconversion in gay, bisexual, and other men who have sex with men. *Journal of Health Psychology*, *21*(1), 93–99. https://doi.org/10.1177/1359105314522675

Heckathorn, D. D. (1997). Respondent-Driven Sampling: A New Approach to the Study of Hidden Populations. *Social Problems*, *44*(2), 174–199. https://doi.org/10.2307/3096941

Hopwood, M., Lea, T., & Aggleton, P. (2015). Drug, sex and sociality: Factors associated with the recent sharing of injecting equipment among gay and bisexual men in Australia. *International Journal of Drug Policy*, *26*(2), 210–213. https://doi.org/10.1016/j.drugpo.2014.10.013

Isaiah Green, A., & Halkitis, P. N. (2006). Crystal methamphetamine and sexual sociality in an urban gay subculture: An elective affinity. *Culture, Health & Sexuality*, *8*(4), 317–333. https://doi.org/10.1080/13691050600783320

Jaffe, A., Shoptaw, S., Stein, J. A., Reback, C. J., & Rotheram-Fuller, E. (2007). Depression ratings, reported sexual risk behaviors, and methamphetamine use: Latent growth curve models of positive change among gay and bisexual men in an outpatient treatment program. *Experimental and Clinical Psychopharmacology*, *15*(3), 301–307. https://doi.org/10.1037/1064-1297.15.3.301

Jerome, R. C., & Halkitis, P. N. (2009). Stigmatization, Stress, and the Search for Belonging in Black Men Who Have Sex With Men Who Use Methamphetamine. *Journal of Black Psychology*, *35*(3), 343–365. https://doi.org/10.1177/0095798409333620

Kalichman, S. C., & Rompa, D. (1995). Sexual Sensation Seeking and Sexual Compulsivity Scales: Validity, and Predicting HIV Risk Behavior. *Journal of Personality Assessment*, *65*(3), 586–601. https://doi.org/10.1207/s15327752jpa6503\_16

Lea, T., Kolstee, J., Lambert, S., Ness, R., Hannan, S., & Holt, M. (2017). Methamphetamine treatment outcomes among gay men attending a LGBTI-specific treatment service in Sydney, Australia. *PloS One*, *12*(2), e0172560. https://doi.org/10.1371/journal.pone.0172560

Liechti, M. E., Kunz, I., Greminger, P., Speich, R., & Kupferschmidt, H. (2006). Clinical features of gamma-hydroxybutyrate and gamma-butyrolactone toxicity and concomitant drug and alcohol use. *Drug and Alcohol Dependence*, *81*(3), 323–326. https://doi.org/10.1016/J.DRUGALCDEP.2005.07.010

Lima, V. D., Geller, J., Bangsberg, D. R., Patterson, T. L., Daniel, M., Kerr, T., Montaner, J. S., & Hogg, R. S. (2007). The effect of adherence on the association between depressive symptoms and mortality among HIV-infected individuals first initiating HAART. *AIDS*, *21*(9), 1175–1183. https://doi.org/10.1097/QAD.0b013e32811ebf57

Lubben, J., Blozik, E., Gillmann, G., Iliffe, S., von Renteln Kruse, W., Beck, J. C., & Stuck, A. E. (2006). Performance of an abbreviated version of the Lubben Social Network Scale among three European community-dwelling older adult populations. *The Gerontologist*, *46*(4), 503–513. https://doi.org/10.1093/geront/46.4.503

Marquez, C., Mitchell, S. J., Hare, C. B., John, M., & Klausner, J. D. (2009). Methamphetamine use, sexual activity, patient-provider communication, and medication adherence among HIV-infected patients in care, San Francisco 2004-2006. *AIDS Care*, *21*(5), 575–582. https://doi.org/10.1080/09540120802385579

Marshall, B. D. L., Wood, E., Shoveller, J. A., Patterson, T. L., Montaner, J. S. G., & Kerr, T. (2011). Pathways to HIV risk and vulnerability among lesbian, gay, bisexual, and transgendered methamphetamine users: a multi-cohort gender-based analysis. *BMC Public Health*, *11*, 20. https://doi.org/10.1186/1471-2458-11-20

McKirnan, D. J., Vanable, P. A., Ostrow, D. G., & Hope, B. (2001). Expectancies of sexual escape and sexual risk among drug and alcohol-involved gay and bisexual men. *Journal of Substance Abuse*, *13*(1–2), 137–154. http://www.ncbi.nlm.nih.gov/pubmed/11547615

Melendez-Torres, G. J., & Bourne, A. (2016). Illicit drug use and its association with sexual risk behaviour among MSM: more questions than answers? *Current Opinion in Infectious Diseases*, *29*(1), 58–63. https://doi.org/10.1097/QCO.0000000000000234

Mimiaga, M. J., Pantalone, D. W., Biello, K. B., Glynn, T. R., Santostefano, C. M., Olson, J., Pardee, D. J., Hughto, J. M. W., Garcia Valles, J., Carrico, A. W., Mayer, K. H., & Safren, S. A. (2018). A randomized controlled efficacy trial of behavioral activation for concurrent stimulant use and sexual risk for HIV acquisition among MSM: project IMPACT study protocol. *BMC Public Health*, *18*(1), 914. https://doi.org/10.1186/s12889-018-5856-0

Mimiaga, M. J., Reisner, S. L., Pantalone, D. W., O’Cleirigh, C., Mayer, K. H., & Safren, S. A. (2012). A pilot trial of integrated behavioral activation and sexual risk reduction counseling for HIV-uninfected men who have sex with men abusing crystal methamphetamine. *AIDS Patient Care and STDs*, *26*(11), 681–693. https://doi.org/10.1089/apc.2012.0216

Moore, D. M., Cui, Z., Lachowsky, N., Raymond, H. F., Roth, E., Rich, A., Sereda, P., Howard, T., McFarland, W., Lal, A., Montaner, J., Corneil, T., Hogg, R. S., & Momentum Health Study team. (2016). HIV Community Viral Load and Factors Associated With Elevated Viremia Among a Community-Based Sample of Men Who Have Sex With Men in Vancouver, Canada. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *72*(1), 87–95. https://doi.org/10.1097/QAI.0000000000000934

Nimmons, D., & Folkman, S. (1999). Other-Sensitive Motivation for Safer Sex Among Gay Men: Expanding Paradigms for HIV Prevention. *AIDS and Behavior*, *3*(4), 313–324. https://doi.org/10.1023/A:1025437418276

O’Dell, B. L., Rosser, B. R. S., Miner, M. H., & Jacoby, S. M. (2008). HIV Prevention Altruism and Sexual Risk Behavior in HIV-Positive Men Who Have Sex with Men. *AIDS and Behavior*, *12*(5), 713–720. https://doi.org/10.1007/s10461-007-9321-9

Prestage, G., Hammoud, M., Jin, F., Degenhardt, L., Bourne, A., & Maher, L. (2018). Mental health, drug use and sexual risk behavior among gay and bisexual men. *International Journal of Drug Policy*, *55*, 169–179. https://doi.org/10.1016/j.drugpo.2018.01.020

Rawson, R. A., Gonzales, R., Marinelli-Casey, P., & Ang, A. (2007). Methamphetamine Dependence: A Closer Look at Treatment Response and Clinical Characteristics Associated with Route of Administration in Outpatient Treatment. *American Journal on Addictions*, *16*(4), 291–299. https://doi.org/10.1080/10550490701389864

Reback, C. J., & Fletcher, J. B. (2018). Elevated HIV and STI Prevalence and Incidence Among Methamphetamine-Using Men Who Have Sex With Men in Los Angeles County. *AIDS Education and Prevention : Official Publication of the International Society for AIDS Education*, *30*(4), 350–356. https://doi.org/10.1521/aeap.2018.30.4.350

Reback, C. J., Fletcher, J. B., Swendeman, D. A., & Metzner, M. (2019). Theory-Based Text-Messaging to Reduce Methamphetamine Use and HIV Sexual Risk Behaviors Among Men Who Have Sex with Men: Automated Unidirectional Delivery Outperforms Bidirectional Peer Interactive Delivery. *AIDS and Behavior*, *23*(1), 37–47. https://doi.org/10.1007/s10461-018-2225-z

Reback, C. J., Peck, J. A., Dierst-Davies, R., Nuno, M., Kamien, J. B., & Amass, L. (2010). Contingency management among homeless, out-of-treatment men who have sex with men. *Journal of Substance Abuse Treatment*, *39*(3), 255–263. https://doi.org/10.1016/j.jsat.2010.06.007

Rich, A. J., Lachowsky, N. J., Cui, Z., Sereda, P., Lal, A., Birch, R., Montaner, J., Moore, D., Hogg, R. S., & Roth, E. A. (2016). Substance use, sexual behaviour and prevention strategies of Vancouver gay and bisexual men who recently attended group sex events. *Culture, Health & Sexuality*, *18*(4), 361–376. https://doi.org/10.1080/13691058.2015.1084649

Schwarcz, S., Scheer, S., McFarland, W., Katz, M., Valleroy, L., Chen, S., & Catania, J. (2007). Prevalence of HIV infection and predictors of high-transmission sexual risk behaviors among men who have sex with men. *American Journal of Public Health*, *97*(6), 1067–1075. https://doi.org/10.2105/AJPH.2005.072249

Semple, S. J., Strathdee, S. A., Zians, J., & Patterson, T. L. (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. https://doi.org/10.3109/00952990.2010.505273

Smith, J. P., & Randall, C. L. (2012). Anxiety and alcohol use disorders: Comorbidity and treatment considerations. *Alcohol Research: Current Reviews*, *34*(4), 414–431.

Starks, T. J., Millar, B. M., Lassiter, J. M., & Parsons, J. T. (2017). Preintervention Profiles of Information, Motivational, and Behavioral Self-Efficacy for Methamphetamine Use and HIV Medication Adherence Among Gay and Bisexual Men. *AIDS Patient Care and STDs*, *31*(2), 78–86. https://doi.org/10.1089/apc.2016.0196

Sumnall, H. R., Woolfall, K., Edwards, S., Cole, J. C., & Beynon, C. M. (2008). Use, function, and subjective experiences of gamma-hydroxybutyrate (GHB). *Drug and Alcohol Dependence*, *92*(1–3), 286–290. https://doi.org/10.1016/J.DRUGALCDEP.2007.07.009

Tallóczy, Z., Martinez, J., Joset, D., Ray, Y., Gácser, A., Toussi, S., Mizushima, N., Nosanchuk, J. D., Nosanchuk, J., Goldstein, H., Loike, J., Sulzer, D., & Santambrogio, L. (2008). Methamphetamine inhibits antigen processing, presentation, and phagocytosis. *PLoS Pathogens*, *4*(2), e28. https://doi.org/10.1371/journal.ppat.0040028

Van de Ven, P., Crawford, J., Kippax, S., Knox, S., & Prestage, G. (2000). A scale of optimism-scepticism in the context of HIV treatments. *AIDS Care*, *12*(2), 171–176. https://doi.org/10.1080/09540120050001841

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica*, *67*(6), 361–370. http://www.ncbi.nlm.nih.gov/pubmed/6880820

Zule, W. A., Poulton, W. E., Coomes, C. M., Mansergh, G., Charania, M., Wechsberg, W. M., & Jones, H. E. (2012). Results of a Pilot Study to Reduce Methamphetamine Use and Sexual Risk Behaviors Among Methamphetamine-Using Men Who Have Sex with Men (MSM) Not Currently in Treatment. *Journal of Psychoactive Drugs*, *44*(5), 351–358. https://doi.org/10.1080/02791072.2012.73679

**Table 1: Demographic characteristics of gbMSM in Vancouver, Canada who reported frequent methamphetamine use at enrollment or at subsequent study visit between 2012-2015 (n=67)**

|  |  |  |
| --- | --- | --- |
|  | **n or (median)** | **% or (Q1, Q3)** |
| **Age** | (45) | (34, 51) |
| **HIV Sero-Status** |  |  |
| Negative | 14 | 20.9 |
| Positive | 53 | 79.1 |
| **Sexual Orientation** |  |  |
| Gay | 54 | 80.6 |
| Bisexual/Other | 13 | 19.4 |
| **Gender Identity** |  |  |
| Cisgender Man | 65 | 97.0 |
| Transgender Man | 2 | 3.0 |
| **Ethnicity** |  |  |
| White | 57 | 85.1 |
| Asian | 3 | 4.5 |
| Indigenous | 7 | 10.5 |
| **Born in Canada** |  |  |
| No | 8 | 11.9 |
| Yes | 59 | 88.1 |
| **Diagnosed with Depression Ever** |  |  |
| No | 59 | 88.1 |
| Yes | 8 | 11.9 |
| **Diagnosed with Anxiety Ever** |  |  |
| No | 62 | 92.5 |
| Yes | 5 | 7.5 |
| **Diagnosed with Substance Use Disorder Ever** |  |  |
| No | 61 | 91.0 |
| Yes | 6 | 9.0 |

*gbMSM = gay and bisexual men who have sex with men; Q1,Q3 = first quartile, third quartile values*

**Table 2: Bivariate analysis of associations of methamphetamine use reduction versus no reduction among gbMSM who reported frequent use between 2012-2015 in Vancouver, Canada (n=67)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Participants** | | **Never reduced** | | **Ever reduced** | |  |
|  | **67** |  | **21** |  | **46** |  |  |
| **Categorical Variables** | **n** | % | **n** | % | **n** | % | ***p*** |
| ***Psychosocial Factors*** |  |  |  |  |  |  |  |
| **HADS Anxiety Sub-Scale (α=0.87)** |  |  |  |  |  |  |  |
| <11 | 46 | 74.2 | 16 | 76.2 | 30 | 73.2 | 1.000 |
| 11+ | 16 | 25.8 | 5 | 23.8 | 11 | 26.8 |  |
| **HADS Depression Sub-Scale (α=0.84)** |  |  |  |  |  |  |  |
| <11 | 54 | 87.1 | 20 | 95.2 | 34 | 82.9 | 0.247 |
| 11+ | 8 | 12.9 | 1 | 4.8 | 7 | 17.1 |  |
| **How important is it to you to be connected to and involved in the gay community?** |  |  |  |  |  |  |  |
| Very/Somewhat Important | 37 | 55.2 | 12 | 57.1 | 25 | 54.4 | 1.000 |
| Not very/Not at all important | 30 | 44.8 | 9 | 42.9 | 21 | 45.7 |  |
| ***HIV Prevention Practices and Risk Behaviours*** |  |  |  |  |  |  |  |
| **Consistent Condom Use** |  |  |  |  |  |  |  |
| No | 49 | 74.2 | 15 | 71.4 | 34 | 75.6 | 0.767 |
| Yes | 17 | 25.8 | 6 | 28.6 | 11 | 24.4 |  |
| **Self-Perceived Likelihood of HIV Transmission/Acquisition** |  |  |  |  |  |  |  |
| Unlikely (< 40%) | 51 | 77.3 | 14 | 66.7 | 37 | 82.2 | 0.303 |
| Somewhat Likely (40-60%) | 12 | 18.2 | 6 | 28.6 | 6 | 13.3 |  |
| Likely (> 60%) | 3 | 4.6 | 1 | 4.8 | 2 | 4.4 |  |
| **Attend Gay Bars/Clubs** |  |  |  |  |  |  |  |
| About once per month or less | 61 | 91.0 | 17 | 81.0 | 44 | 95.7 | 0.072 |
| More than once per month | 6 | 9.0 | 4 | 19.1 | 2 | 4.4 |  |
| **Used Apps to Seek Sex** |  |  |  |  |  |  |  |
| About once per month or less | 50 | 74.6 | 12 | 57.1 | 38 | 82.6 | **0.036** |
| More than once per month | 17 | 25.4 | 9 | 42.9 | 8 | 17.4 |  |
| **Used Internet to Seek Sex** |  |  |  |  |  |  |  |
| About once per month or less | 47 | 70.2 | 11 | 52.4 | 36 | 78.3 | **0.045** |
| More than once per month | 20 | 29.9 | 10 | 47.6 | 10 | 21.7 |  |
| **Social Time with other gbMSM** |  |  |  |  |  |  |  |
| 50% or less of total social time | 33 | 49.3 | 5 | 23.8 | 28 | 60.9 | **0.008** |
| at least 50% | 34 | 50.8 | 16 | 76.2 | 18 | 39.1 |  |
| **Received/Given Drugs for Sex in P6M** |  |  |  |  |  |  |  |
| No | 53 | 79.1 | 11 | 54.4 | 42 | 91.3 | **0.001** |
| Yes | 14 | 20.9 | 10 | 47.6 | 4 | 8.7 |  |
| **Escort Work in P6M** |  |  |  |  |  |  |  |
| No | 55 | 82.1 | 16 | 76.2 | 39 | 84.8 | 0.495 |
| Yes | 12 | 17.9 | 5 | 23.8 | 7 | 15.2 |  |
| **Condomless Anal Sex (CAS) in P6M** |  |  |  |  |  |  |  |
| No anal sex | 12 | 18.2 | 4 | 19.1 | 8 | 17.8 | 0.341 |
| No CAS | 10 | 15.2 | 1 | 4.8 | 9 | 20.0 |  |
| CAS | 12 | 18.2 | 3 | 14.3 | 9 | 20.0 |  |
| CAS with unknown or serodiscordant status partner | 32 | 48.5 | 13 | 61.9 | 19 | 42.2 |  |
| **Attended Group Sex Event in P6M** |  |  |  |  |  |  |  |
| No | 45 | 67.2 | 10 | 47.6 | 35 | 76.1 | **0.028** |
| Yes | 22 | 32.8 | 11 | 52.4 | 11 | 23.9 |  |
| ***Substance Use Behaviours*** |  |  |  |  |  |  |  |
| **Method of MA use at Last High Frequency Use** |  |  |  |  |  |  |  |
| Use without injection | 40 | 59.7 | 12 | 57.1 | 28 | 60.9 | 0.794 |
| Injection | 27 | 40.3 | 9 | 42.9 | 18 | 39.1 |  |
| **Any Injection Drug Use in P6M, excluding steroids** |  |  |  |  |  |  |  |
| No | 46 | 68.7 | 9 | 42.9 | 37 | 80.4 | **0.004** |
| Yes | 21 | 31.3 | 12 | 57.1 | 9 | 19.6 |  |
| **Binge Drinking Frequency (5+ Drinks on One Occasion)** |  |  |  |  |  |  |  |
| Never/Less than monthly/Monthly | 55 | 87.3 | 19 | 90.5 | 36 | 85.7 | 0.708 |
| Weekly/Daily or almost daily | 8 | 12.7 | 2 | 9.5 | 6 | 14.3 |  |
| **Used Tobacco in P6M (Ref: No)** | 40 | 59.7 | 15 | 71.4 | 25 | 54.4 | 0.283 |
| **Used Cannabis in P6M (Ref: No)** | 43 | 64.2 | 17 | 81.0 | 26 | 56.5 | 0.061 |
| **Used Poppers in P6M (Ref: No)** | 28 | 41.8 | 12 | 57.1 | 16 | 34.8 | 0.112 |
| **Used GHB in P6M (Ref: No)** | 23 | 34.3 | 13 | 61.9 | 10 | 21.7 | **0.002** |
| **Used Ecstasy in P6M (Ref: No)** | 25 | 37.3 | 14 | 66.7 | 11 | 23.9 | **0.001** |
| **Used Cocaine in P6M (Ref: No)** | 15 | 22.4 | 8 | 38.1 | 7 | 15.2 | 0.057 |
| **Used Ketamine in P6M (Ref: No)** | 19 | 28.4 | 10 | 47.6 | 9 | 19.6 | **0.039** |
| **Used Crack in P6M (Ref: No)** | 9 | 13.4 | 5 | 23.8 | 4 | 8.7 | 0.126 |
| **Used Heroin in P6M (Ref: No)** | 10 | 14.9 | 6 | 28.6 | 4 | 8.7 | 0.060 |
| **Continuous Variables** | **Median** | **(Q1, Q3)** | **Median** | **(Q1, Q3)** | **Median** | **(Q1, Q3)** | ***p*** |
| **HIV Treatment Optimism Scale (α=0.81)** | 31 | (27, 33) | 31 | (29, 34) | 31 | (27, 33) | 0.407 |
| **Sexual Sensation Seeking Scale (α=0.77)** | 33 | (31, 36) | 33 | (31, 36) | 33 | (31, 36.5) | 1.000 |
| **Escape Motive Scale (α=0.90)** | 32 | (26, 36) | 32 | (28, 35) | 32 | (26, 37) | 0.983 |
| **Gay/Bisexual Self Esteem Scale (α=0.90)** | 13 | (10, 17) | 12 | (9, 15) | 13.5 | (11, 18) | 0.150 |
| **Social Support Score (α=0.84)** | 10 | (6, 11) | 10 | (8, 12) | 9 | (6, 11) | 0.379 |

*Q1,Q3 = first quartile, third quartile values, HADS = Hospital Anxiety & Depression Scale; gbMSM = gay and bisexual men who have sex with men; P6M = past 6 months; MA = methamphetamine; Ref = referent category; poppers = amyl nitrites; GHB = gamma-hydroxybutyrate; Data with* ***bold emphasis*** *indicates statistical significance at P<0.05.*

**Table 3: Univariable analysis of factors associated with methamphetamine use reduction among gbMSM who reported frequent use between 2012-2015 in Vancouver, Canada (n=46)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **60 MA-reduced visits vs. 160** | | | |
|  | **RR** | **95% CI** | | ***p*** |
| ***Demographic Information*** |  |  |  |  |
| **Age** | 1.01 | 0.98 | 1.04 | 0.603 |
| **HIV Sero-Status** |  |  |  |  |
| Negative | Ref |  |  |  |
| Positive | 1.49 | 0.67 | 3.32 | 0.326 |
| **Sexual Orientation** |  |  |  |  |
| Gay | Ref |  |  |  |
| Bisexual/Other | 1.00 | 0.49 | 2.04 | 0.995 |
| **Ethnicity** |  |  |  |  |
| White | Ref |  |  |  |
| Asian | 2.13 | 0.55 | 8.19 | 0.268 |
| Indigenous | 0.71 | 0.25 | 1.97 | 0.504 |
| **Born in Canada (Ref: No)** | **0.45** | **0.22** | **0.91** | **0.026** |
| **Self-Perceived Current Health** |  |  |  |  |
| Excellent/Very good | Ref |  |  |  |
| Good/Fair/Poor | **0.47** | **0.28** | **0.82** | **0.007** |
| ***Anxiety and Depression*** |  |  |  |  |
| **HADS Anxiety Sub-Scale** |  |  |  |  |
| <11 | Ref |  |  |  |
| 11+ | 0.84 | 0.43 | 1.63 | 0.602 |
| **HADS Depression Sub-Scale** |  |  |  |  |
| <11 | Ref |  |  |  |
| 11+ | 0.93 | 0.40 | 2.15 | 0.860 |
| ***HIV Prevention Practices and Risk Behaviours*** |  |  |  |  |
| **Used Apps to Seek Sex** |  |  |  |  |
| About once per month or less | Ref |  |  |  |
| More than once per month | **0.42** | **0.19** | **0.92** | **0.031** |
| **Used Internet to Seek Sex** |  |  |  |  |
| About once per month or less | Ref |  |  |  |
| More than once per month | **0.43** | **0.22** | **0.85** | **0.015** |
| **Social Time with other gbMSM** |  |  |  |  |
| 50% or less of total social time | Ref |  |  |  |
| at least 50% | 0.57 | 0.32 | 1.03 | 0.061 |
| **Received/Given Drugs for Sex in P6M (Ref: No)** | **0.34** | **0.13** | **0.87** | **0.026** |
| ***Substance Use Behaviours*** |  |  |  |  |
| **Method of MA use at Last High Frequency Use** |  |  |  |  |
| Use without Injection | Ref |  |  |  |
| Injection | 0.72 | 0.39 | 1.31 | 0.276 |
| **Any Injection Drug Use in P6M, excluding steroids (Ref: No)** | **0.29** | **0.14** | **0.57** | **0.000** |
| **Binge Drinking Frequency (5+ Drinks on One Occasion)** |  |  |  |  |
| Never/Less than monthly/Monthly | Ref |  |  |  |
| Weekly/Daily or almost daily | 2.03 | 0.90 | 4.57 | 0.088 |
| **Used Tobacco in P6M (Ref: No)** | 0.65 | 0.37 | 1.12 | 0.121 |
| **Used Poppers in P6M (Ref: No)** | **0.53** | **0.29** | **0.96** | **0.037** |
| **Used GHB in P6M (Ref: No)** | **0.26** | **0.14** | **0.49** | **<.0001** |
| **Used Ecstasy in P6M (Ref: No)** | **0.46** | **0.24** | **0.89** | **0.021** |
| **Used Cocaine in P6M (Ref: No)** | 0.60 | 0.28 | 1.25 | 0.169 |
| **Used Ketamine in P6M (Ref: No)** | **0.37** | **0.18** | **0.76** | **0.007** |
| **Used Crack in P6M (Ref: No)** | 0.53 | 0.23 | 1.23 | 0.138 |
| **Used Heroin in P6M (Ref: No)** | 0.46 | 0.19 | 1.09 | 0.079 |
| ***Continuous Variables*** |  |  |  |  |
| **Number of MSM Known** | 1.00 | 0.99 | 1.00 | 0.601 |
| **HIV Treatment Optimism Scale** | **0.94** | **0.90** | **0.99** | **0.022** |
| **HADS Anxiety Sub-Scale (continuous)** | 0.96 | 0.89 | 1.03 | 0.218 |
| **HADS Depression Sub-Scale (continuous)** | 0.99 | 0.92 | 1.06 | 0.750 |

*RR = relative risk; 95% CI = 95% confidence interval; MA = methamphetamine; Ref = referent category; HADS = Hospital Anxiety & Depression Scale; gbMSM = gay and bisexual men who have sex with men; P6M = past 6 months; poppers = amyl nitrites; GHB = gamma-hydroxybutyrate; Data with* ***bold emphasis*** *indicates statistical significance at P<0.05.*

**Table 4: Multivariable analysis of factors associated with methamphetamine use reduction among gbMSM who reported frequent use between 2012-2015 in Vancouver, Canada (n=46)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **60 MA-reduced visits vs 160** | | | |
|  | **aRR** | **95% CI** | | ***p*** |
| ***HIV Prevention Practices and Risk Behaviours*** |  |  |  |  |
| **Social Time with other gbMSM** |  |  |  |  |
| 50% or less of total social time | **Ref** |  |  |  |
| at least 50% | **0.49** | **0.28** | **0.85** | **0.012** |
| **Received/Given Drugs for Sex in P6M (Ref: Yes)** | **0.34** | **0.13** | **0.87** | **0.026** |
| ***Substance Use Behaviours*** |  |  |  |  |
| **Any Injection Drug Use in P6M, excluding steroids (Ref: Yes)** | **0.35** | **0.18** | **0.68** | **0.002** |
| **Used GHB in P6M (Ref: Yes)** | **0.41** | **0.21** | **0.78** | **0.007** |

*aRR = adjusted relative risk; 95% CI = 95% confidence interval; MA = methamphetamine; Ref = referent category; gbMSM = gay and bisexual men who have sex with men; P6M = past 6 months; GHB = gamma-hydroxybutyrate; Data with* ***bold emphasis*** *indicates statistical significance at P<0.05.*