**Longitudinal Analysis of HIV Risk and Substance Use Patterns for Men Who Have Sex with Men and Women and Men Who Have Sex with Men Only**

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**Abstract**

Men Who Have Sex with Men and Women (MSMW) experience discrimination from same-sex and heterosexual communities partially because of perceptions they feature high-risk sexual behavior, elevated polysubstance use levels, and constitute an HIV bridge population. We used a longitudinal multivariate generalized linear mixed model comparing sexual risk and substance use patterns for Men Who Have Sex with Men Only (MSMO) with MSMW in the same cohort study. Data consisted of 771 men reporting 3,705 sexual partnerships from 2012-2017. For high-risk sexual behavior multivariate results showed non-significant (*p*>0.05) differences for partner number and commercial sex work, and significantly less (*p*<0.05) HIV prevalence and condomless anal sex. However, MSMW had significantly higher levels of hallucinogen and prescription opioid use, and substance treatment histories. Only one HIV-positive MSMW had a transmittable viral load, negating the concept of an HIV bridge population. Results indicate the need for additional longitudinal studies comparing MSMO and MSMW.

**Keywords**: Sexual health, behaviorally bisexual men, gay men, HIV-risk factors

**Introduction**

Behaviorally bisexual men experience discrimination from both same-sex and heterosexual communities (Armstrong & Reissing, 2014; Dodge et al., 2012). This bias can lead to a lack of social support and negative health differentials, including poor mental health and elevated substance use (Feinstein & Dyer, 2017; Friedman et al., 2014a; Shelton, 2017). Discrimination in part reflects perceptions that behaviorally bisexual men represent high HIV risk and elevated substance use levels. The first is exemplified in the *Bisexualities*: *Indiana Attitudes Scale (BIAS)* (Dodge et al., 2016), measuring bias against bisexual men and women. Important loading factors for both gender-specific *BIAS* sub-scales are statements linking perceived higher HIV risk with behavioral bisexuality. In the sub-scale for bisexual men, these include statements that bisexual men are *slutty, hypersexual, incapable of being faithful,* and *have many sexual partners.* Equally important, this view is prominent in the Beach et al. (2019) analysis of bisexual men and women’s meta-perceptions, i.e. perceptions of what individuals believe others feel about them. Based on a 2015 United States’ national representative sample, the authors derived a five-point Indiana Attitudes Scale-Bisexual (BIAS-b). Exploratory factor analysis identified a one-factor solution with important domains including sexual confusion, HIV/STD risk, incapability of maintaining monogamous relationships, promiscuity, and bisexual instability (“just a phase”) (Beach et al., 2019:191). Additionally, the concept of high HIV risk is explicit in the epidemiological model of behaviorally bisexual men constituting a bridge population linking high HIV prevalence bisexual men with low prevalence female partners (Friedman et al., 2014b, 2017; Jeffries, 2014; Mercer et al., 2009).

Earlier cross-sectional studies supported this perspective when comparing Men Who Have Sex with Men and Women (MSMW) with Men Who Have Sex with Men Only (MSMO). These frequently reported more MSMW sexual partners compared to MSMO (Baldwin et al., 2015; Friedman et al., 2014b; Hequembourg & Dearing, 2013). Similarly, evidence for differential substance use levels came from cross-sectional studies comparing MSMW with MSMO that found higher levels for the latter. Specifically, Nakamura et al. (2011) found MSMW had significantly higher levels of crack, alcohol, marijuana, cocaine, hallucinogens, and heroin use than MSMO. Similarly, Brennan-Ing et al. (2014) reported that bisexual men older than 50 years were significantly more likely to use tobacco, cocaine, crack, and heroin in comparison to same-aged gay men. More recently, Roth et al. (2018a) found MSMW had significantly higher use levels of non-prescription stimulants, prescription opioids, heroin, and Alcohol Dependency.

However, currently there are multiple methodological concerns about some earlier studies. First, Bauer & Brennan (2013) pointed out that behavioral bisexuality classification in survey data requires at minimum two sexual partners, whereas lesbian, gay or heterosexual behavioral classification necessitates only one. This “*de facto promiscuity*” (Friedman et al., 2017, p. 904) is important because partner number is associated with high-risk sexual behavior measures and elevated substance use (Cavazos-Rehg et al., 2011; Mercer et al., 2009), but sometimes is omitted in MSMW and MSMO comparisons (Baldwin et al., 2015; Nakamura et al., 2011). The importance of partner number was shown in a multivariate negative binomial regression analysis of Canadian MSMO and MSMW that recorded significant (*p*<0.05) positive associations between male sexual partner number, condomless anal sex, using sex toys, attending group sex events, working as a sexual escort, and popper, crystal methamphetamine, and MDMA drug use (Armstrong et al., 2018). A second methodological issue is the effect of varying recall periods in determining behaviorally bisexual samples and/or sample sizes (Bowering et al., 2016; Geary et al., 2018). To illustrate this effect using the same Canadian data for men reporting sex with women using six-month, two-year, and lifetime recall periods the corresponding percentage classified as behaviorally bisexual would be 8%, 15%, and 53% (Roth et al., 2019).

These methodological issues may underlie the mixed results reported by two recent meta-analyses comparing MSMO and MSMW sexual risk behaviors. Based on Asian publications, Bowering et al. (2016), found no significant differences in HIV prevalence, recent syphilis infection, and condomless anal intercourse frequency. A second, using United States’ peer-reviewed articles, reported that MSMW were significantly more likely to engage in commercial sex work and sexualized drug use, but significantly less likely to engage in condomless receptive anal sex and be HIV-positive (Friedman et al., 2014b). Furthermore, the majority of research in both meta-analyses consisted of cross-sectional studies. Longitudinal studies comparing MSMO and MSMW remain scarce, and may yield differing results from cross-sectional research. One notable example of this is the Friedman et al. (2017) longitudinal analysis of Multicenter AIDS Cohort Study (MACS) data that found little evidence for MSMW as a bridge population because HIV-positive MSMW reported fewer female partners than HIV-negative MSMW.

Recognizing these issues, we used a longitudinal multivariate model to compare HIV risk and substance use patterns for MSMW and MSMO drawn from a prospective cohort study in Vancouver, British Columbia, Canada. The model included sexual partner number and used a conservative time-period of six months to determine behavioral bisexuality. Analysis addressed two research questions: 1) compared to MSMO, are MSMW HIV high-risk sexual partners and 2) do MSMW have elevated substance use levels compared to MSMO?

**Methods**

*Protocol*

As described in previous publications (Shaw et al., 2019), the cohort study used respondent-driven sampling, developed by Heckathorn (2002) to sample hard-to-reach or “hidden” populations. Study eligibility criteria included being 16 years of age or older, identifying as a man (including trans men), having sex with another man in the previous 6 months, living in the Greater Vancouver Area, being able to understand and complete a questionnaire in English, and being a study seed, directly recruited by a seed, or in a seed’s network. The criterion of recent sex with another man included anal, oral, and/or manual sexual behavior. This meant that at baseline study participants identifying as queer, pansexual or “others”, who are frequently omitted from analysis because of small sample size (Roth et al., 2018a), could be included as either MSMO or MSMW, with the latter consisting of men who reported anal, oral, vaginal, and/or manual sex with a female partner. Eligible participants came to the Vancouver study office where they read and signed Informed Consent Statements. They then completed a computer-assisted self-interview questionnaire, followed by STI tests including point-of-care HIV testing. Every six months they returned to complete the same questionnaire, plus relevant biological testing. Participants received a financial incentive of $50 CAD for each study visit and an additional $15 CAD for each participant they recruited, up to a limit of six. All study procedures received Human Ethics clearances from the research institutions involved.

*Measures*

Independent variables included socio-demographic, sexual, and substance use measures, all referring to the past six months. The first category included questions about age, ethnicity, education, annual income, current health status self-assessment, and the validated Social Support Scale (Lubben et al., 2006, study α = 0.87). Sexual risk assessment used a series of yes/no questions to record different types of sexual behavior including anal, vaginal, oral, and manual sexual stimulation for participants in the past six months. Additional yes/no questions pertaining to condom use, knowledge of partner HIV sero-status, and acting as an escort in this interval allowed us to assess sexual behaviors previously considered high-risk, e.g. condomless anal intercourse with an unknown/sero-discordant partner. Recognizing the importance of sexual partner number in past discussions of MSMW and MSMO sexual health, we asked about total number of sexual partners, both males and females, Because anal sex features higher transmission probabilities than vaginal sex (Baggely et al., 2010), we distinguished the number of male anal sex partners from other sexual partners. Point- of- care testing biologically determined HIV sero-status. To test for the presence of a MSMW HIV-bridge population HIV-positive MSMW participants with HIV viral loads >200 copies per mL at time of visit were classified as Unsuppressed. Those < than 200 per mL as Suppressed, and those with VL<40 mL as Undetectable (Rodger et al., 2018), with the last two classifications considered untransmittable (LeMessurier et al., 2019).

Yes/no responses for substance use in the past six months referred to injection drugs (including steroids), illicit (crack, cocaine) or prescription (Concerta®, Adderall®, Ritalin®) stimulants, hallucinogens (Ecstasy/MDMA, LSD, Ketamine, mushrooms), prescription sedatives (GHB, benzodiazepines, barbiturates), prescription opioids (Morphine, Codeine, Oxycontin®, Percocet®), non-prescription opioids (heroin), erectile drugs (e.g. Viagra®, Cialis®), and poppers (amyl nitrites). We used the Babor et al. (2001) classification of alcohol use based on the original (Saunders et al., 1993) Alcohol Use Disorder Test (AUDIT) scale to group drinkers as: (a) Low Risk Drinkers (AUDIT score 0–7), (b), Hazardous Drinkers (AUDIT score 8–15), (c) Harmful Drinkers (AUDIT score 16–19), or (d) Alcohol Dependent Drinkers (AUDIT score ≥20). Two final questions relating to substance use asked if respondents were currently in a mental health treatment program, or had ever received treatment for substance abuse.

*Statistical Analysis*

Study data represented 10 waves of repeated six-month participant visits from February 2012- February 2017. Missing values constituted less than 2% of the total data. Missing continuous variables were inputted using median values and we removed categorical missing data from analysis. We assessed baseline differences between MSMW and MSMO using Wilcoxon Rank-Sum tests for continuous variables and Chi-Squared tests for categorical variables. A longitudinal generalized linear multivariate mixed model using SAS® 9.5 PROC GLIMMIX that accounted for respondent-driven sampling chains and participant clustering compared MSMO with MSMW. Sexual behavior, i.e. same sex versus bisexual, as defined for each 6-month study visit, was the categorical time-variant dependent variable. After reviewing univariate results, variables of interests were included in a multivariable model selection procedure. A backward selection technique removed the variable with the highest Type III *p*-value sequentially until the model reached the lowest Akaike Information Criterion (Lima et al., 2007).

**Results**

*Baseline Sample Description*

**Table 1** presents bisexual characteristics in the baseline sample of 774 participants. Of these 655 self-identified as gay, 73 as bisexual, and 46 as Queer/Other. As described earlier, we classified the last grouping as either MSMO or MSMW, depending on whether they had sex with men only or men and women. While only 73 men self-identified as bisexual the study questionnaire allowed us to determine bisexuality also by behavior and attraction, representing the three dimensions of bisexuality proposed by Laumann (1994) and Miller et al. (2007). Behavioral bisexuality included men who had sex with a female partner in the past 6 months while the attraction category consisted of participants who reported having sexual fantasies about both men and women (Roth et al., 2018b). As previously reported by Rich et al. (2018), many participants were represented in overlapping categories. For example, a participant could identify as bisexual, have fantasies about men and women, and have sex with men and women, thus being included in all three categories. **Table 1** also shows the number of men who transitioned from male to female (n=1) and female to male (14). In subsequent analyses these distinctions are not included and all participants treated as either MSMO or MSMW. Finally, **Table 1** shows the distribution of behavioral sexuality with females in terms of vaginal (n=24) and anal sex (n=54).

*Baseline Sample Analysis*

**Table 2** presents bivariate analysis of the MSMO versus MSMW samples. At baseline and over the study period, participants reported 3,705 sexual partnerships. Of these 3,548 partnerships were with men and 157 were with both men and women. **Table 2** presents univariate analysis results comparing MSMW and MSMO baseline samples. MSMW featured significantly (*p*<0.05) lower age (*p*=0.007), annual incomes (*p*<0.001), educational attainment (*p*<0.001), and current health status self-assessments (*p*<0.001). They were significantly more likely to be treated currently for mental health concerns, (*p*<0.001), ever have been treated for substance problems (*p*<0.001) and differed significantly with respect to ethnic self-identity (*p*=0.003). For HIV risk factors, MSMW were significantly more likely to act as a sexual escort in the past 6 months (MSMW=13.8%, MSMO = 5.5%, *p*=0.007), yet had significantly fewer male sex partners (MSMW Md. = 3, Q1-Q3 = 2-5, MSMO Md. = 6, Q1-Q3 = 3-15, p<0.001). MSMW were also significantly less likely to be HIV-positive (MSMW = 17.2%, MSMO= 29.7%, *p*=0.001). Furthermore, MSMW reported a significantly distinctive pattern of anal sex (*p*<0.001). Specifically, more MSMW did not engage in any anal sex (MSMW = 23.2%, MSMO = 11.6%) while fewer engaged in condomless anal sex with an HIV unknown and/or sero-discordant partner (MSMW = 28.6%, MSMO= 39.4%).

In contrast, results showed MSMW with overall higher substance use. In particular, they had significantly higher use levels of injection drugs (*p*=0.035), prescription (*p*<0.001) and non-prescription stimulants (*p*<0.001), crystal methamphetamine (*p*=0.006), prescription sedatives (*p*<0.001), hallucinogens (*p*=0.012), prescription opioids (*p*<0.001), and heroin (*p*<0.001). In addition, they scored significantly higher on the AUDIT test (*p*<0.001), with more MSMW classified as Hazardous (MSMW = 32.8%, MSMO = 26.1%), Harmful (MSMW = 10.3%, MSMO=6.9%), and Dependent Drinkers (MSMW = 8.6%, MSMO = 6.1%). The only exceptions to higher MSMW substance use were for poppers (MSMW =25.9%, MSMO = 38.7%, *p*=0.001) and erectile drugs (MSMW=17.2%, MSMO=24.8%, *p*=0.243).

*Univariate and Multivariate GLIMMIX Results*

**Table 3** presents univariate and multivariate longitudinal GLIMMIX results. Multivariate results showed MSMW were significantly younger (aOR = 0.96, 95%CI = 0.94-0.99), and were less likely to earn between $30,000-$59,000 CAD annually (relative to the reference category of <$30,000 CAD/year, aOR =0.54, 95%CI =0.30-0.97). Likewise, they were significantly less likely to self-identify as Asian (compared to the White referent category, AOR = 0.10, 95%CI =0.01-0.80), and have more than a high school education (aOR=0.28, 95%CI= 0.16-0.48). For HIV risk factors, MSMW were significantly less likely to be HIV-positive (aOR=0.42, 95%CI = 0.21-0.86), have condomless anal intercourse with a HIV sero-concordant partner (aOR= 0.24, 95%CI= 0.12-0.50), and have condomless anal intercourse with a sero-discordant/unknown HIV-sero-status partner (aOR = 0.45, 95% CI=0.24-0.84). Substance use variables in the final multivariate model showed MSMW significantly more likely to use prescription opioids (aOR =3.13, 95%CI =1.69-6.02), hallucinogens (aOR =1.62, 95%CI=1.00-2.62), and to have ever received substance use treatment (aOR=2.65, 95%CI =1.29-5.55).

*Frequency and Viral Load Composition of Behavioral Bisexuality*

**Figure 1** shows reported behavioral bisexuality, denoting vaginal, oral, manual and/or anal sex with a female partner, recorded for each six-month visit. Results show behavioral bisexuality never reached 10% of the total partnerships reported in any visit. Linking behavioral bisexuality reports to participants by HIV sero-status revealed seventeen HIV-positive men reporting 26 instances of behavioral bisexuality over the study period. **Table 4** presentsthe distribution of these reports by study visit and viral load classification. This shows only one report of behavioral bisexuality with an unsuppressed viral load (VL>200 copies /mL) over the study period. In addition, all 10 HIV-positive MSMW at baseline had undetectable viral loads. Together this means that 97% (35/36) of all cases of HIV-positive MSMW reporting sex with a female partner featured suppressed or undetectable, that is untransmittable, HIV viral loads.

**Discussion**

This study addressed two research questions: 1) in comparison to MSMO are MSMW high HIV-risk sexual partners and 2) do MSMW have elevated substance use levels compared to MSMO? For the first question, contrary to widespread popular perceptions, and earlier cross-sectional studies, MSMW in this study did not represent HIV high-risk sexual partners in comparison to MSMO. Multivariate results showed MSMW with significantly lower baseline HIV prevalence, and over the study period they were less than half as likely to be HIV-positive (AOR = 0.42, 95%CI = 0.21-0.86) than MSMO. Furthermore, at baseline MSMW had significantly lower number of male sexual partners. They also had non-significantly different total number of male and female and male anal sex sexual partners at baseline and in the longitudinal analysis, despite being significantly more likely in the univariate, but not the multivariate model, to act as sexual escorts. In addition, MSMW engaged in significantly less condomless anal sex and condomless anal sex with an HIV-sero-status unknown/discordant partner. Finally, longitudinal analysis showed no evidence for a bisexual bridge with 35/36 (97%) reports of sex with female partners by HIV-positive MSMW from men with untransmittable viral loads. With respect to substance use patterns, at baseline MSMW reported significantly higher use of multiple substances. Multivariate results indicated far fewer differences, but still higher substance use for MSMW, specifically for hallucinogens and prescription opioids.

The study has limitations. First, the MSMW sample is small in comparison with the MSMO sample. Second with the important exception of HIV biological testing, findings represent self-reported behaviors. As a result, there may be desirability bias, with participants concerned about anticipated stigma associated with condomless anal sex or polysubstance use reporting lower values for these behaviors. However, past studies show computer assisted self-interviewing (CASI), as used here, reduces this bias (Delker et al., 2016). Another limitation, not confined to this paper, is the changing definition of sexual risk. We assessed high-risk sexual behavior using previously defined measures, e.g. number of sexual partners, anal intercourse with and without condoms, condomless anal intercourse with a sero-concordant and/or sero-discordant partner, and commercial sex work. However, new biological Treatment as Prevention (TasP) practices including Active Antiretroviral Treatment (ART) and Pre-Exposure Prophylaxis (PrEP) combined with MSMO and MSMW’s sero-adaptive strategies make risk assessment more difficult. As an example, consider condomless anal intercourse with an HIV sero-discordant partner. Previously this would denote high-risk sexual behavior. Yet presently, in Vancouver’s TasP environment, such a partnership may constitute sero-adaptation, specifically Viral Load Sorting (Card et al., 2017, 2018; Roth et al., 2018b), with HIV-negative men preferring condomless anal sex with HIV-positive partners using ART who have untransmittable viral loads. This example shows that condomless anal sex, whether in insertive, receptive or versatile roles (Shaw et al., 2019), even with an unknown or HIV sero-discordant partner, is no longer an independent measure of HIV-risk (Armstrong et al., 2018; Jin et al., 2015; Vosburg et al., 2012). Currently, even event-level data would necessitate information on TasP use, HIV-disclosure, sexual positioning and behavior, i.e. withdrawal, to calculate a more precise risk estimate for condomless anal intercourse. While the cohort study has some, but not all of these measures for MSMO (Rich et al., 2016; Shaw et al., 2019), they are unavailable for MSMW. As such, the sexual behavior measures used in this study most accurately test the *perception* expressed in *the BIAS-m* sub-scale (Dodge et al., 2016; Friedman et al., 2014a) that MSMW are HIV high-risk sexual partners.

In contrast, the biological data for both HIV determination and viral load measurement provide more concrete risk measures, and are one of the study’s strengths. A second strength is the longitudinal data. This is particularly true for the substance use analysis. Baseline analysis indicated MSMW with significantly higher use levels for a multitude of substances, including alcohol, sedatives, stimulants, hallucinogens and opioids. Yet in the longitudinal analysis only prescription opioid use, hallucinogens, and having ever been in a substance treatment program, remained statistically significant. The overall difference in substance use patterning between the baseline and the longitudinal analysis exemplifies how the two types of analysis may differ.

Overall, we consider this study’s findings important in at least five ways. First, we hope that the sexual behavior results can reduce discrimination directed against MSMW by demonstrating reduced, rather than increased, HIV sexual risk behavior for MSMW compared to MSMO. Second, the viral load analysis negates the idea of a MSMW HIV bridge population and reflects the effectiveness of British Columbia’s (TasP) environment for MSMW as well as MSMO. Previous studies showed that British Columbia’s provision of free HIV testing and treatment to provincial residents living with HIV since 1996 (Lima et al., 2010, 2020; Montaner, 2011) dramatically reduced AIDS-related mortality (Lima et al., 2020) and lowered community viral load levels among Vancouver MSMO and MSMW (Moore et al., 2016). This study indicates that the provincial Treatment as Prevention approach also can reduce HIV transmission from MSMW to their female sexual partners.

Third, both univariate and multivariate results showed MSMW with elevated substance use levels in comparison with MSMO. One previously expressed interpretation for such a finding was that stigma exhibited towards MSMW, rather than bisexuality *per se* underlies MSMW substance patterns (Ebin, 2012; Feinstein & Dyer, 2017; Friedman et al., 2014a). Regardless of whether MSMW’s elevated substance use is a consequence of discrimination or not, these results indicate the need for substance use education and treatment programs specifically dedicated to behaviourally bisexual men. Fourth, both sexual behavior and substance use results again emphasize significant differences between MSMO and MSMW who are frequently analyzed as one group, exemplified by the terms Men Who Have Sex with Men (MSM), or Gay and Bisexual Men Who Have Sex with Men (gbMSM) (Young & Meyer, 2005). While meant to be inclusive, these terms often hide important differences between MSMO and MSMW. Finally, differences between baseline and longitudinal analyses results emphasize the need for more of the latter, which currently remain scarce for MSMW studies.

**Declaration of Interest Statement:** The authors declare they have no conflicts of interest.

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