HIV AMONG MEN WHO HAVE SEX WITH MEN AND WOMEN (MSMW): PREVALENCE ESTIMATES, ACQUISITION AND TRANSMISSION RISKS, AND IMPLICATIONS FOR INTERVENTIONS

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Men who have sex with men and women (MSMW) have unique HIV-related public health disparities when compared with men who have sex with men only (MSMO) and men who have sex with women exclusively (MSWE) in the United States. This dissertation characterizes these disparities, first by conducting a literature review, which contextualizes disparities found among MSMW across the domains of childhood adversities, psychosocial health conditions, and HIV risk behaviors; this review also reports estimates of the population percentage of MSMW. A meta-analysis of HIV prevalence in men was conducted: findings show that MSMW are significantly less likely to be HIV positive than MSMO but significantly more likely to be HIV positive than MSWE. Trajectory analyses of biomedical, psychosocial, and behavioral health conditions were then estimated using longitudinal data from a prospective cohort of sexually active MSM. Results indicated that MSMW are more likely to be depressed; and, among HIV positive men, more likely to have higher viral load levels unresolved over time, but also unlikely to transmit HIV to main female partners. A secondary data analysis was conducted among substance-using MSMO and MSMW; results demonstrated that MSMW were more likely to engage in transactional sex and have anal sex with men while high. Taken together, findings show that MSMW are subject to profound HIV-related public health disparities that deserve theoretical attention and public health intervention design and delivery attuned to their specific needs.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Compared with men who have sex with women (MSW), men who have sex with men (MSM) have been found to suffer profound health disparities. These health disparities include mental health problems, such as depression, illicit substance use, anxiety, and suicidality (Mills et al, 2004; Cochran and Mays, 2009; Marshal et al, 2008; Ostrow and Stall, 2008); risky sexual behaviors, such as unprotected anal intercourse with multiple partners of serodiscordant or unknown HIV status, sex work, and concurrent stimulant use and sex (Friedman et al, 2008; Ostrow et al, 2009); sexually transmitted infections (STI), particularly syphilis and gonorrhea (Valdiserri, 2008; CDC, 2010); and HIV infection (CDC, 2010; Sullivan and Wolitski, 2008). Disparate rates of childhood and current adversity among MSM, such as peer-based bullying, physical and sexual violence, and hate crimes (Herek and Sims, 2008; Purcell et al, 2008; Friedman et al, 2011), may increase feelings of social marginalization and further contribute to future HIV risk behavior (Herrick et al, 2012).

Contemporary health behavior theories, for example Minority Stress Theory, postulate that social marginalization and internalized homophobia contribute to these health disparities by compelling MSM into stress-induced, self-destructive behaviors such as substance abuse and risky sex (Meyer, 1995; Stall & Purcell, 2000). Syndemics Theory for MSM posits that epidemics of violence victimization, psychosocial health problems, and HIV/STI infections interact synergistically, working together to exacerbate each other's prevalence within MSM communities (Stall et al, 2008). The HIV epidemic's devastation of American gay communities in the late 20th century impelled public health researchers to engage in descriptive and analytic research into risk and protective factors affecting MSM. This has led to the creation, evaluation, and refinement of HIV prevention interventions relevant to MSM communities. This evolution of public health research into sexual minority communities can be understood as an approach that spans three distinct research generations, wherein the first generation

includes formative, descriptive research that attempts to demonstrate health disparities suffered by the subpopulation in question; the second includes analytic, comparative research that establishes a more sophisticated understanding of why these health disparities might exist, by probing mediators and moderators; and the third generation attempts to develop health interventions informed by research findings from these previous iterations (Stall et al, 2008). HIV-related research on American MSM has spanned these generations: current work that highlights developing interventions to remediate health disparities (generation three) is based on risk and protective mechanisms that have been identified through examination of mediators and moderators that explain the disparities (generation two) after substantial formative research has been undertaken to indicate the disparities described above (generation one).

The scientific literature on MSM largely conflates two groups: men who have sex with men exclusively (MSMO) and men who have sex with men and women (MSMW). However, research into health disparities on MSM has primarily focused on those men who identify as gay, relying largely on convenience samples obtained from gay-affiliated venues; only recently have some nationally representative samples begun to offer measures for sexual identity and/or behavior. While a great majority of research studies into MSM health disparities report findings on "gay and bisexual" men, a very limited number disaggregate MSMO from MSMW in their findings, ostensibly for statistical power reasons (Dodge and Sandfort, 2007). Public health literature demonstrates that *both* MSMO and MSMW, in fact, suffer significant health disparities compared with men who have sex with women exclusively (MSWE). However, when we consider relevant public health responses to these disparities, we should distinguish between MSMW and MSMO for four important reasons. First, there are strong indications that MSMW suffer some significant HIV-related health disparities *above and beyond* those suffered by MSMO. Second, MSMW appear to face *subtly different* HIV-related health disparities than MSMO, which may be influenced by subtly different stressors. Third, by having sex with both men and women, MSMW are at risk for acquiring and transmitting HIV and other sexually transmitted infections (STI) *across different sexual networks* than those inhabited by MSMO. Fourth, just as bisexually-behaving

men might not be effectively reached by messages targeting communities of exclusively heterosexually-behaving men, MSMW may also be *ineffectively reached* by messages directed toward MSMO (Miller et al, 2007); bisexually-behaving men may thus require unique techniques for recruitment into public health research and interventions. For these four reasons, public health responses to health disparities among MSM should not be assumed to work with equal effectiveness for both MSMO and MSMW.

This literature review will contextualize previous findings of HIV-related health and risk disparities among MSMW, using the Syndemics Theory framework to examine adverse childhood events (sexual violence, physical violence, and peer harassment/bullying); psychosocial conditions (depression, suicidality, loneliness, anxiety, and substance use); HIV risk behavior (concurrent substance use and sex, unprotected sex with male and female partners, transactional sex, and other factors such as disclosure of HIV positive status to partners); and incidence and prevalence of HIV and other STI. Mediating and moderating factors that have been shown to help explain these conditions among MSMW will also be analyzed. We will address theories that attempt to contextualize the unique experiences of MSMW for their responsiveness to HIV-related health disparities and their utility in informing intervention development. Finally, we will explore implications for further research and intervention design. But first, we will examine more generally what we know about MSMW. Who are these men?

1.1 BISEXUAL IDENTITY/BEHAVIOR DISCORDANCE

HIV-related public health literature contains a large number of studies that assess bisexuality through identity only (Millett et al, 2005; Marshal et al, 2008; Dodge and Sandfort, 2007). Bisexual identity can be seen to be correlated with bisexual behavior (McKirnan et al, 1995), but it is a fallible proxy measure. Heterosexually-identified men can also have sex with men; bisexually-identified men can have sex only with men, or only with women, depending on the nature of their relationships and the timeframe assayed;

gay-identified men can have sex with female partners; and members of all three of these sexual orientations can be asexual, celibate or abstinent, or have sex with transgender people, for whom data points are rarely created. All of these discordant permutations hold true for more historical sexual orientation measures, such as Kinsey's 7-point continuum; Klein's 21-point grid; more recent 5-point identity measures that include "mostly heterosexual" and "mostly homosexual" as valid categories; and culturally colloquial identity measures such as "queer," "down-low," and "same-gender loving" (Austin et al, 2004; Klein et al, 1990; Kinsey et al, 1948; Millett et al, 2005; Lever et al, 2000; Russell et al, 2009).

Behavior/identity discordance has been extensively documented in the literature especially as it relates to so-called non-gay-identified MSM, or homosexually-experienced heterosexuals (Cochran and Mays, 2009). For example, a Seattle-based health department found that 34.3% of HIV positive straight-identified MSM had male and female partners within the last year, compared with 35.2% of HIV positive bisexual-identified MSM and 1.6% of gay-identified HIV positive MSM (Wood et al, 1993). A community health survey in New York City demonstrated that, among sexually active men in the preceding year, 3.9% of gay-identified men had sex *only with women* and 1.6% had sex with male and female partners; 42.9% of bisexual-identified men had sex only with women, and 28.6% had sex only with men; and 7.5% of straight-identified men had sex *only with men*, while 0.7% had sex with both male and female partners (Pathela et al, 2006). A street outreach sample that analyzed sexual identity/behavior concordance in the preceding 3 months found that it varied across race/ethnicity among males, with Asians the most concordant (78%) and whites the least concordant (36%); the largest discordant subgroup was Hispanic bisexually-identified men, of whom 35% had sex only with women in the last 3 months, indicating that the proximal sexual behavior measure exacerbated discordance between identity and behavior (Ross et al, 2003). Survey data taken as part of the *Playboy* Readers' Sex Survey in 1992 indicated that while 4.6% of men identified as bisexual, 12.5% had engaged in bisexual activity as adults: this included 9% of heterosexually-identified males, 79.1% of bisexually-identified males, and 17.1% of gay-identified males, who were clearly reading *Playboy* for more than just the articles (imputation from

Lever et al, 2000). Data from the Massachusetts Youth Risk Behavior Survey indicated that, among adolescent males, MSMW behavior was especially discordant with sexual identity: 30.6% of MSMW identified as heterosexual, 11.1% as gay, 35.2% as bisexual, and 23.2% as unsure/none of the above (Goodenow et al, 2002). A gay- or bisexual-identified subset of MSM from the California Health Interview Survey was determined to constitute just 9% of all previous-year MSMW; the other 91% were heterosexually-identified (Xia et al, 2006). An analysis of MSM-IDU in San Francisco determined that heterosexually-identified men were as likely as bisexually-identified men to have had female sexual partners, although they were significantly more likely to have had sex with women than gay-identified men were (Kral et al, 2005). A study of HIV positive MSM in New York and San Francisco reported that only 54% of past-year MSMW actually *identified* as bisexual (O'Leary et al, 2007); this confirmed a study of Black men in Los Angeles, among whom only 49% of those who were bisexually-identified were also MSMW within the past year (Myers et al, 1997). Further confusing things, "down-low" has also been described as a recent sexual identity taken on by men. Though men who identify as "down-low" are more likely to be MSMW than those who do not identify as such, the meaning of "down-low" is contextually fluid, varying across individuals, communities, and media and research sources (Wolitski et al, 2006).

The substantial concordance variations across studies make it clear that sexual identity is an unreliable proxy measure for sexual behavior in the United States, and can be even less reliable when behavior is assessed within a short time frame; with groups of adolescents exploring sexual expression; and with men who are not Asian-American. As one researcher put it: "Important distinctions must always be drawn between bisexual behaviors and bisexual identities. While the former may be relatively common, only rarely are they accompanied by any sense of bisexual identity" (Aggleton, 1996). Research framed around bisexual identities is a valid construct as long as it situated within identity-related risk, such as experience of and response to minority stress specific to bisexual identity; it should not serve as a reliable measure of HIV transmission risk behavior with both men and women or as a valid

assessment of behavior-related minority stress. Research framed around bisexual behavior more effectively targets a population of men who have not been effectively reached by HIV interventions (Miller et al, 2007; Mimiaga et al, 2009); for whom specific data is not typically collected by state and national HIV surveillance systems; and who are at particular risk of acquiring HIV and other STI from high prevalence communities and transmitting them to low prevalence communities. For these reasons, this critical literature review will focus on bisexual behavior rather than identity.

1.2 PREVALENCE OF MALE BISEXUAL BEHAVIOR

Estimates vary on how common male bisexual behavior is in the United States, depending on the sample taken and the measure used. In the last 20 years, several studies have used representative samples to calculate sexual behavior by partner gender. Table 1 organizes these findings by the proximal measure used to assess MSMW behavior (i.e., whether men had sex with both men and women in the past year; in the past 5 years; or over the lifespan).

Table 1. Proportions of MSMW and MSMO among males in representative samples, U.S.

Authors(s)	Study site	Sampling strategy	Measure (timeframe)	MSMW prevalence	MSMO prevalence
Rogers and Turner (1991)	U.S. (General Social Survey, 1989 and 1990)	Household national probability sample, age 18+	Sexual partners, past year	0.3%	0.9%
Laumann et al (1994)	U.S. (National Health and Social Life Survey)	Stratified cluster national probability sample, age 18-59	Sexual partners, past year	0.7%	2.0%

(Table 1 continued)

Smith (2006)	U.S. (General Social Survey, 1991-2004)	Household national probability sample, age 18+ (sexually active sub-sample)	Sexual partners, past year	0.3%-1.2% (varying by GSS year)	1.1%-3.8% (varying by GSS year)
Jeffries and Dodge (2007)	U.S. (National Survey of Family Growth 2002)	Household area probability sample, ages 15-44 (sexually active sub-sample)	Sexual partners, past year	1.6%	3.8%
Udry and Chantala (2002)	U.S. youth (National Adolescent Longitudinal Health Survey)	School-based national probability sample (sexually active sub-sample)	Romantic partners, past 18 months	1.4%	0.9%
Laumann et al (1994)	U.S. (National Health and Social Life Survey)	Stratified cluster national probability sample, age 18-59	Sexual partners, past 5 years	2.1%	2.0%
Smith (2006)	U.S. (General Social Survey, 1991-2004)	Household national probability sample, age 18+ (sexually active sub-sample)	Sexual partners, last 5 years	0.5%-1.9% (varying by GSS year)	1.6%-3.3% (varying by GSS year)
Billy et al (1993)	U.S. (National Survey of Men)	Stratified cluster national probability sample, age 20-39	Sexual partners, past 10 years	1.2%	1.1%
Laumann et al (1994)	U.S. (National Health and Social Life Survey)	Stratified cluster national probability sample, age 18-59	Sexual partners since age 18	4.0%	0.9%
Laumann et al (1994)	U.S. (National Health and Social Life Survey)	Stratified cluster national probability sample, age 18-59	Sexual partners since puberty	5.8%	0.6%

(Table 1 continued)

Rogers and Turner (1991)	U.S. (General Social Survey, 1989 and 1990)	Household national probability sample, age 18+	Sexual partners, lifetime	2.2%	0.7%
Eisenberg and Weschler (2003)	U.S. colleges (College Alcohol Study 1999)	Nested random probability sample (sexually active sub-sample)	Sexual partners, lifetime	2.0%	2.7%
Levin et al (2009)	Seattle, WA (2003 Seattle Sex Survey)	RDD area probability sample, ages 18-39 (sexually active sub-sample)	Sexual partners, lifetime	8.9%	6.0%
Pathela and Schillinger (2010)	New York City youth (Youth Risk Behavior Survey 2007)	School-based area probability sample (sexually active sub-sample)	Sexual partners, lifetime	3.7%	3.2%
Zellner et al (2009)	San Diego County (Latino community)	Time-location sampling	Sexual partners, lifetime	6.0%	5.4%

While it is difficult to discern trends over time given the varied sampling frames and fluctuating proximal estimates of the sexual behavior measure, the findings above are remarkably consistent. Overall, when assessed using past-year proximal measures, MSMW have constituted between 0.3% and 1.6% of males in the sampling frames and were somewhat less prevalent than MSMO (0.9%-3.8%), with an intra-study ratio of 2.4 to 3.2 MSMO for every MSMW. When assessed using intermediate proximal measures (18 months to 10 years), MSMW constituted 1.4%-2.1% of males in the sampling frame and overlapped prevalence of MSMO (0.9%-3.3%), with an intra-study ratio of 0.6 to 1.7 MSMO for every MSMW. Over the lifespan, more men behaved bisexually (2.0%-8.9% across samples) than exclusively

homosexually (0.6%-6.0%) in all but one (college-based) study, with an intra-study ratio of 0.1 to 1.4 MSMO per MSMW. These U.S.-based estimates also compare favorably with research on male sexual behavior in 10 countries in Europe, wherein 8.6% of males overall reported bisexual behavior in their lifetime and 0.6% were MSMW within the past year (Sandfort, 1998).

Within certain HIV risk groups that have been sampled purposively, male bisexual behavior is quite common, especially among men who have sex with men, men who are HIV positive, injection drug users (IDU), and men engaged in sex work. Findings from these targeted samples demonstrate that public health research has typically recruited substantial proportions of MSMW into HIV-related research, whether intentionally or not. This is particularly evident within studies of MSM, wherein MSMW have comprised 8%-56% of men in samples assessing partner gender over spans of 12 months or less; and from 33%-87% of men in samples assessing partner gender over spans of 5 years or more. Intra-study ratios of MSMO/MSMW ranged from 0.8 to 12.1, measuring sexual behavior over 1 year or less; 2.0 to 5.8, measuring sexual behavior over 5 years; and 0.1 to 1.8, measuring sexual behavior over spans greater than 5 years – see Table 2, below.

Table 2. Proportions of MSMW in public health research on MSM, U.S.

Authors(s)	Target population (site)	Sampling strategy	Measure, timeframe	% who are MSMW
Wolitski et al (2006)	Black, white, Hispanic MSM, sexually active (12 U.S. cities)	Convenience	Sexual partners, past month	11%
Kanouse et al (2005)	Substance-using MSM, 18+, sexually active (Los Angeles)	Convenience	Sexual partners, past month	19%

(Table 2 continued)

Fuller et al (2005)	Substance-using MSM, 15-40 (New York City)	Targeted	Sexual partners, past 2 months	49%
Jones et al (2008)	Black MSM (North Carolina, three cities)	Convenience (d-Up! intervention prototype)	Sexual partners, past 2 months	17%
Flores et al (2009)	Young MSM (U.S., 13 cities)	Time-location sampling	Sexual partners, past 3 months	15%
Latkin et al (2011)	Black MSM (Baltimore)	Convenience	Sexual partners, past 3 months	34%
Wheeler et al (2008)	Black MSM (Philadelphia and New York City)	Respondent-driven sampling	Sexual partners, past 3 months	27%
Jimenez (2003)	Black and Latino MSM, 50+ (Chicago)	Convenience	Sexual partners, past 3 months	36%
Lauby et al (2008)	Black MSM (Philadelphia)	Respondent-driven sampling	Vaginal sex and male-male anal sex, past 3 months	20%
Wold et al (1998)	MSM (Boston)	Convenience	Sexual partners, past 6 months	10%
Munoz-Laboy et al (2005)	Latino MSM (New York City)	Convenience	Sexual partners, past 6 months	8%
Mimiaga et al (2009)	Black MSM (Boston)	Respondent-driven sampling	Sexual partners, past year	39%
Kalichman et al (1998)	MSM (Milwaukee)	Convenience	Sexual partners, past year	23%
Wold et al (1998)	MSM (Boston)	Convenience	Sexual partners, past year	18%

(Table 2 continued)

Deren et al (2001)	MSM crack-smokers and/or MSM-IDU (5 U.S. cities)	Convenience	Sexual partners, past year	56%
Sanchez et al (2006)	MSM subset (U.S.: National HIV Behavioral Surveillance)	Nationally representative sample	Sexual partners, past year	14%
Bernstein et al (2008)	MSM subset (New York City MSA: part of NHBS)	Multistage venue-based	Sexual partners, past year	17%
Catania et al (2001)	MSM, 18+ (NYC, Los Angeles, San Francisco, Chicago)	Probability sample (RDD)	Sexual partners, past 5 years	14%
Binson et al (1995)	MSM subset (U.S.: National HIV Behavioral Surveillance Survey)	Nationally representative sample	Sexual partners, past 5 years	33%
Torian et al (2002)	MSM in STD clinics (New York State)	STD surveillance	Sexual partners, unknown timeframe	36%
Ahrens, et al (2006)	MSM (San Francisco)	TLS (Random intercept survey)	Sexual partners (male and female/transgender), unknown timeframe	12%
Lehner et al (1998)	MSM in STD clinics (Bronx, New York)	STD surveillance	Sexual partners since 1978	87%
Reinisch et al (1988)	Gay-identified men	Undisclosed	Sexual partners, lifetime	62%-79%
Wold et al (1998)	MSM (Boston)	Convenience	Sexual partners, lifetime	54%
Valleroy et al (2000)	Young MSM 15-22 years old (7 U.S. cities	Time-location sampling	Sexual partners, lifetime	61%

(Table 2 continued)

Jones et al (2008)	Black MSM (North Carolina, three cities)	Convenience (d-Up! intervention prototype)	Sexual partners, lifetime	62%

Within MSM populations, there is significant variation in MSMW behavior by race/ethnicity. Black and Latino MSM have consistently been found more likely than white MSM to be bisexually active. Binson found that 57% of Black MSM behaved bisexually in the last 5 years, compared with 29% of white MSM and 34% of Latino MSM (Binson et al, 1995). 34% of Black HIV positive MSM reported bisexual behavior, compared with 26% of Hispanic MSM and 13% of white MSM (Montgomery et al, 2003); HIV positive MSMW were found more likely to be Black than MSMO in a study based in New York and San Francisco (O'Leary et al, 2007). Black MSM attending New York City STD clinics were significantly more likely to report bisexual behavior than other races/ethnicities (Torian, 2002); Black MSM in Milwaukee had a higher probability of having female partners and a higher number of female partners than white MSM (Heckman et al, 1999); and older Black MSMW in Chicago reported three times as many female partners as Latino MSMW (Jimenez, 2003). A critical literature review found that Black men "more likely than MSM of other races and ethnicities to identify themselves as bisexual and to be bisexually active" (Millet et al, 2005). Cultural differences are frequently cited for this discrepancy, generally relating to higher levels of homophobia in Black communities that may impel MSM to "pass" as heterosexual by continuing to have sex with female partners (Millett et al, 2005; Miller et al, 2005), and norms in the Latino community that minimize stigma inflecting same-gender sexual behavior as long as one takes an active (top) role in sex (Diaz, 1998; Finlinson et al, 2006; Almaguer et al, 1993; Agronick et al, 2004; Reinisch et al, 1988; Davila, 2000); interestingly, one study found that Latino MSM who had sex with transgender women were also significantly more likely to have sex with biological women (Bockting et al, 2007). Engagement in sex work with male paying partners may also elevate MSMW

prevalence in poor minority communities, for example in sexual tourism zones among males who might not without remuneration choose male partners for sex (Padilla, 2008; Finlinson et al, 2006; Friedman, 2003).

We were unable to find any meta-analyses from the United States that attempt to aggregate MSMW proportions from MSM studied. However, a recent meta-analysis of studies of MSM in China indicates that 31.2% have been bisexually active (Yun et al, 2011). The community-based studies of MSM cited above were all conducted within the academic realm of HIV/AIDS research. It is important to note that very few HIV-related health studies have recruited for MSMW specifically, and that MSM have generally been recruited from gay-affiliated environments. For these reasons, the vast majority of existing research on MSMW relies on MSM-constituted samples in which many MSMW – for instance, those who are non-gay-identified, or who are predominately heterosexual in their behavior – will be underrepresented (Rust, 2000).

Findings from HIV/AIDS surveillance data and convenience samples of HIV positive subgroups illustrate that MSMW form small but substantial proportions of the male population of people living with HIV/AIDS (PLWHA). As within the general population and samples of MSM, the proportion of male PLWHA who reported bisexual behavior was larger given wider temporal frames of assaying sexual partner gender: 5.4% to 17.4% of male PLWHA were MSMW in timeframes of one year or less, while 17.5% to 73.8% of male PLWHA were MSMW in timeframes of 5 years or longer – see Table 3, below.

Table 3. Proportions of MSMW among males in studies targeting PLWHA, U.S.

Author(s)	Target population, site	Sampling strategy	Measure, timeframe	% MSMW	% MSMO	% MSWE
Nakamura et al (2011)	HIV+ MSM, 18+, meth users (San Diego)	Convenience	Sexual partners, past 2 months	16.7%	83.3%	__

(Table 3 continued)

Knight et al (2007)	HIV+ IDU, 18+, sexually active (4 U.S. cities)	Convenience	Sexual partners, past 3 months	17.4%	13.3%	69.2%
Ibanez et al (2005)	HIV+ MSM, 18+ (NYC and SF)	Convenience	Sexual partners, past 3 months	5.8%	94.2%	__
Pinkerton et al (2000)	HIV+ (Atlanta)	Convenience	Sexual partners, past 6 months	14.4%	64.9%	20.7%
Spikes et al (2009)	HIV+, sexually active Black men (12 Health Departments, U.S.)	HIV/AIDS surveillance	Sexual partners, past year	5.4%	36.4%	58.2%
O'Leary et al (2007)	HIV+ MSM, 18+ (New York City and San Francisco)	Convenience	Sexual partners, past year	10.2%	89.8%	__
Poppen et al (2004)	HIV+ MSM, Latino, 18+ (NYC and Washington, D.C.)	Convenience	Sexual partners, past year	10.3%	<85.8%*	__
Montgomery et al (2003)	HIV+ MSM, 18+ (12 Health Departments, U.S.)	HIV/AIDS surveillance	Sexual partners, past 5 years	22%	78%	__
Diaz et al (1993)	AIDS-diagnosed sexually-active men (11 Health	HIV/AIDS surveillance	Sexual partners, past 5 years	17.5%	61.2%	21.3%

(Table 3 continued)						
Chu et al (1992)	AIDS-diagnosed MSM (U.S.)	HIV/AIDS surveillance	Sexual partners since 1978	26%	74%	__
Crepaz and Marks (2003)	HIV+ men, sexually active, 18+ (Los Angeles)	Semi-random convenience	Sexual partners, unknown timeframe	38.1%	42.9%	19%
Solorio et al (2003)	HIV+ youth, 13-23 years old (4 U.S. cities)	Convenience	Sexual partners, lifetime	60%	40%	__
Nawar et al (2005)	HHV-8+ MSM with AIDS (U.S., 24 treatment centers)	Convenience	Sexual partners, lifetime	73.8%	26.2%	__

**In this study, no estimate of MSMO was given; 86% of MSM reported past-year sex with a man.*

Studies that have targeted injection drug users and male sex workers also report relatively high prevalence of bisexual behavior. A study of sexually active, injection drug-using men in San Francisco found that 12.5% of IDU had male and female sexual partners within the last 5 years, compared to 11.6% who had only male partners (Lewis and Watters, 1994); others report that MSMW prevalence among IDU is as low as 4% when measuring sexual behavior over the past 6 months (Wolitski et al, 1992) and as high as 91% (among MSM-IDU) when measuring over the lifespan (Bacon et al, 2006). An RDS sample of male IDU in Atlanta found that 10% were MSMW, who in turn were significantly more likely than MSWE-IDU to engage in transactional sex (Salazer et al, 2010). Bisexuality among male sex workers may be vocationally reinforced: one New York City study found that while 48% of male sex workers had engaged in heterosexual activity for pleasure in the last 3 months, 32% of the sample had been paid for sex by both men and women (Pleak and Meyer-Bahlburg, 1990). 11.6% of male sex workers in Atlanta

had both male and female non-paying partners within just the last month (Boles and Elifson, 1994), and 42% of male street prostitutes in New Orleans reported having a wife, steady girlfriend, or female significant other (in this case, bisexual behavior was assessed indirectly – see Morse et al, 1991). Almost half (48%) of MSM sex workers in Vancouver had both male and female partners within the past year, compared with only 8% of MSM not involved in sex work (Weber et al, 2001). There may also be significant intersectionality between IDU, sex work, and MSMW behaviors. High proportions of injection drug-using male sex workers who have female sexual partners have been found in Houston, Long Beach, and Denver; in these populations, HIV risk was manifold, through IDU, MSM, and heterosexual activity (Williams et al, 2003; Rietmeijer et al, 1998).

Despite important definitional and sampling differences, the rates of male bisexual behavior are stable across samples and cultures, with small but significant and corroborated variation across ethnic groups. These background findings show that MSMW constitute a population nearly as large, or even larger (depending on the timeframe and the subgroup of interest) than men who have sex with men exclusively. Moreover, the rates of male bisexual behavior in groups with, or at high risk for, HIV/AIDS, are substantial. As such, MSMW are worthy of greater attention in public health service and research efforts.

1.3 HIV/AIDS PREVALENCE AMONG MSMW

In a review of the national literature, 23 studies were found that assessed HIV prevalence among MSMW. Across these studies, published over the wide range of 1995-2011, HIV prevalence among MSMW ranged from a low of 0.6% (among young MSMW 15-25 years old who self-reported their HIV status – see Flores et al, 2009) to a high of 43% (among STD clinic attendees – see Torian et al, 2002). Not included in these tables – because numbers were not provided – are estimates from Los Angeles County

HIV Surveillance Data that, among Latinos, MSMW were more than 9 times as likely as MSMO and 12 times as likely as MSWE to be HIV positive; and, among Blacks, MSMW were more than twice as likely as MSMO and more than 30 times more likely as MSWE to be HIV positive (Brooks et al, 2003).

Table 4. HIV prevalence of MSMW, compared with MSMO and MSWE, U.S. samples

Author (date)	Target population	Sampling strategy	Measure, timeframe	% HIV+, MSMW	% HIV+, MSMO	% HIV+, MSWE	HIV measure
Fuller et al (2005)	Substance-using MSM, 15-40 (New York City)	Targeted	Sexual partners, past 2 months	4.3%	45.8%	__	Blood (non-identified)
Wheeler et al (2008)	Black MSM, 18+ (Philadelphia and New York City)	Respondent-driven sampling (RDS)	Sexual partners, past 3 months	40.7%	60.1%	__	OraQuick / Western blot
Lauby et al (2008)	Black MSM (New York City and Philadelphia); MSMW sub-sample	RDS	Vaginal sex and male-male anal sex, past 3 months	23.6%	__	__	Self-report
Flores et al (2009)	Young MSM 15-25 (U.S., 13 cities)	Time-location (TLS)	Sexual partners, past 3 months	0.6%	1.6%	__	Self-report

(Table 4, continued)

Latkin et al (2011)	Black MSM (Baltimore)	Convenience	Sexual partners, past 3 months	30.4%	52.3%	__	OraQuick or documentation of HIV+ status
Kral et al (2005)	MSM-IDU, 18+ (San Francisco)	Targeted	Sexual partners, past 6 months	20%	35%	__	Blood
Gorbach et al (2009)	MSM and MSW substance users and partners, 18+ (L.A.)	RDS	Sexual partners, past 6 months	12%	64%	4.4%	OraQuick / Western blot
Williams et al (2009)	MSM and MSW substance users and partners (Chicago)	RDS	Sexual partners, past 6 months	11.4%	53.6%	4.7%	Blood
Zule et al (2009)	MSM and MSW substance users, 18+ (Raleigh-Durham)	RDS	Sexual partners, past 6 months	12.1%	37.9%	4.9%	OraQuick / Western blot
Myers et al (1997)	Black men, 18-50 (Los Angeles	Convenience	Sexual partners,	58%	74.6%	6.8%	ELISA/ Western

(Table 4, continued)

	County)		past year				blot
Kalichman et al (1998)	MSM (unspecified sites, U.S. and British Columbia)	Convenience	Sexual partners, past year	5.4%	19.7%	__	Self-report
Schrimshaw et al (2010)	MSMW, 18+, non-gay-identified, non-behavior-disclosing (NYC)	Targeted (semi-random)	Sexual partners, past year	20%	__	__	Self-report
Maulsby et al (2011)	MSM, 18+ (Baltimore)	TLS	Sexual partners, past year	28.2%	31.4%	__	Blood
Shoptaw et al (2009)	Black MSM, 18-30 (Los Angeles)	RDS	Sexual partners, past year	4.3%	29.8%	__	Oral rapid test
Salazar et al (2010)	IDU, 18+, sexually active (Atlanta MSA)	RDS	Sexual partners, past year	26.3%	__	7.1%	Self-report
McKirnan et al (1995)	MSMW, 18-30, Black or white (Chicago)	Convenience	Sexual partners, past 3 years	6.9%	__	__	Self-report
Catania et al (2001)	MSM, 18+ (NYC, LA, Chicago, San Francisco)	Probability (RDD)	Sexual partners, past 5 years	10%	19%	0%	Self-report & ELISA/Western

(Table 4, continued)

Torian et al (2002)	MSM in STD clinics (New York State)—*using 1997 data*	STD surveillance	Sexual partners, unknown timeframe	43%	47%	__	ELISA/ Western blot
Torian et al (2002)	MSM in STD clinics (New York State) – *using 2001 data*	STD surveillance	Sexual partners, unknown timeframe	14%	18%	__	ELISA/ Western blot
Lehner et al (1998)	STD clinic attendees (Bronx, New York)	Convenience	>1 male and >0 female partners, since 1978	35%	70%	17%	ELISA/ Western blot
Bacon et al (2006)	MSM-IDU (San Francisco)	Convenience	Sexual partners, lifetime	9%	43%	__	EIA/West ern blot
Valleroy et al (2000)	Young MSM 15-22 years old (7 U.S. cities	TLS	Sexual partners, lifetime	7.9%	6.2%	__	ELISA/ Western blot
Levin et al (2009)	Sexually active, 18-39 (Seattle)	RDD area probability	Sexual partners, lifetime	8.3%	21%	0%	Self-report
Zellner et al (2009)	San Diego County (Latino community)	TLS	Sexual partners, lifetime	9.7%	0%	2.6%	Self-report

Comparing across studies, 832 MSMW were HIV positive from 7384 total MSMW, an 11.3% HIV prevalence rate. Of these 23 studies, 20 also calculated HIV prevalence rates for men who have sex with men exclusively. In these 20 studies, MSMW had an HIV prevalence rate of 11.1% (744/6725) and MSMO had an HIV prevalence rate of 13.8% (2211/16036). Nine of these 23 studies also reported HIV prevalence rates for men who have sex with women exclusively; across these nine studies, 16.2% of MSMW (276/1704) were HIV positive, compared with 6% of MSWE (244/4045) and 29.9% of MSMO (950/3172).

There are significant limitations to comparison across studies when sampling procedures, proximal operationalization of sexual behavior measurements, HIV status determination, geographical location, and subpopulation of interest are so uniquely varied. For instance, some of the original 23 studies relied on self-reported HIV status, while others used blood-based ELISA and Western Blot assays; some studies used respondent-driven sampling of street IDU networks, while others recruited attendees from STD clinics; and researchers examined bisexual behavior across a wide range, from intervals of three months to lifetime experiences. Because of this, I further analyzed only the 14 studies that used established biomarkers (HIV antibody testing) to calculate HIV prevalence rates. In these studies, 14.7% of MSMW were HIV positive (684/4661), compared with 34.6% of MSMO (1548/4477). Five studies also analyzed HIV biomarkers among MSWE; in this subset, 18.8% of MSMW were HIV positive (227/1207) compared with 58.7% of MSMO (521/887) and 5.8% of MSWE (177/3062) – the alarmingly high HIV prevalence rates among men in these five studies must take into account the sampling procedures, which often recruited very high risk groups from STD clinics, RDS networks, and street-based substance users including IDU. It is apparent that HIV prevalence among MSMW is understudied and, especially in comparison to MSWE, disproportionately high. It also appears likely that men who have sex exclusively with men have significantly higher HIV prevalence than MSMW: in several studies, having sex with women was a protective factor against being HIV positive (for example, see Bacon et al,

2006 – in this study, having 6-100 female partners was highly protective against being HIV positive, though this may not be a factor suitable for scaling up during intervention design).

Although HIV incidence studies specific to MSMW were not unearthed in this review, encouraging trend data provided by New York City Health Department researchers demonstrated that HIV prevalence rates at STD clinics diminished drastically between 1997 and 2001 (Torian et al, 2002) for all populations, including MSMO and MSMW, coincident with the highly active antiretroviral therapy (HAART) era. Unfortunately, even as HIV prevalence among Black MSMW decreased by 42% from 1997 to 2001, this group still accounted for the lowest reduction in HIV prevalence in these years of any other group measured. No meta-analytic data from the United States on HIV prevalence among MSMW was found in this review, though a meta-analysis from China indicated that HIV prevalence among Chinese MSMW (5.4%) was significantly higher than for Chinese MSMO (3.8%) in 12 studies (Yun et al, 2011).

1.4 HIV/AIDS INCIDENCE AMONG MSMW

There is very little information publically available that focuses on HIV and/or AIDS incidence among MSMW. Again, this is likely due to federal categorization of HIV transmission risk groups into five hierarchical behavioral realms. These include four realms -- MSM, heterosexual, IDU, or MSM-IDU – which can each be bridged by any individual MSMW. National HIV/AIDS surveillance reports acknowledge that these behavioral risk groups are not mutually exclusive in theory. In practice, though, the CDC-developed HIV risk hierarchy dictates conflation of MSMW and MSMO under the risk category MSM (or MSM-IDU, if a male subject also uses injection drugs): if a male receiving HIV CTRS reported 1000 female sexual partners and 1 male sexual partner since 1978, for instance, he would be categorized solely as an MSM. Due to this institutionalized risk hierarchy, there are no national surveillance data

available that estimate HIV incidence among MSMW (see CDC, 2008; and all years prior). This represents a serious flaw in the HIV/AIDS surveillance system that obscures the interpretation of many studies, including some reported in this review.

We found only one study that examined AIDS incidence within American MSMW. Accumulating numbers of incident AIDS cases, this study suggested that bisexually behaving men suffered the third-highest cumulative AIDS incidence rate of any risk group from 1981-1987 (375.7 per 1,000,000); this was less than one-third as high as AIDS incidence among "homosexual" men and almost as high (92%) as AIDS incidence among male and female IDU (Curran et al, 1988). We were unable to find any HIV incidence estimates specific to MSMW. Additionally, none of the HIV prevalence studies cited in the previous section that included MSMW were prospective; cross-sectional studies cannot accurately estimate incidence.

1.5 STI PREVALENCE AMONG MSMW

As we have noted when analyzing HIV prevalence data, there is also very little MSMW-specific information available for STI prevalence. The vast majority of studies purporting to report on STI among gay and bisexual men conflate the two groups into one MSM category, which is aligned with CDC reporting requirements; or they report data based on identity rather than behavior. An early exception to this was the *Playboy* Readers' Sex Survey, which categorized bisexual behavior into three groups: predominately heterosexual, some homosexuality, and predominately homosexual (with separate categories for exclusively homosexual and heterosexual respondents). Results showed that self-reports of STD in the last five years increased significantly by category: 9.8% of exclusively heterosexual men reported any STD, compared to 17.6%-22.6% of behaviorally bisexual men (depending on category) and 35% of exclusively homosexual men (Lever et al, 2000). One American study reports on syphilis rates

specific to MSMW, estimating that 11.8% of HIV positive MSMW in North Carolina were co-infected with syphilis; though this was not significantly higher than the syphilis rate among HIV positive MSMO (9.1%), it was significantly higher than the syphilis rate (4.3%) among HIV positive MSWE (Hightow et al, 2006; also see Tabet et al, 2002, for a study that comes to similar conclusions and concludes that Peruvian MSMW may be effective transmitters of syphilis between MSMO and heterosexual women). Similar findings have also been reported using nationally representative data: both MSMW and MSMO were significantly more likely to have any history of HPV, herpes, and/or syphilis than MSWE (Jeffries, 2010). MSMW-IDU in Atlanta were significantly more likely than MSWE-IDU (AOR=2.9) to report any STI history (Salazar et al, 2010).

In New York City, a study of HIV positive MSM determined that MSMW were no more likely than MSMO to be diagnosed with any new STI (Torian et al, 2002). (Internationally, similar non-significant findings in syphilis between MSMO and MSMW were reported in Kenya – see Sanders et al, 2007 – and China – see Yun et al, 2011). An RDS sample of MSM, hard drug users, and their sexual partners recruited in North Carolina detected no significant differences between proportions of MSMW, MSMO, and MSWE (5.1% vs. 10.3% vs. 6.3%, respectively) with positive biomarkers for syphilis, gonorrhea, and chlamydia taken together (Zule et al, 2009). In the same study, no significant differences were found comparing hepatitis C prevalence between MSMW (21.9%), MSMO (14%), and MSWE (18.9%) – all three groups had high HCV infection rates. In a random digit dialing sample of Seattle adults, comparisons were made only between MSMW and MSWE on self-reported history of STI infection: MSMW reported significantly higher rates of human papillomavirus (22% vs. 3.3%) and gonorrhea (11% vs. 1.9%), as well as all STI taken together (33% vs. 12%). Though no statistical comparison was made, MSMW did not appear to significantly differ from MSMO (35%) in their reports of total STI history (Levin et al, 2009). Similar non-discrepant findings were reported in a study of Black MSM in New York City and Philadelphia, wherein 62% of MSMW reported ever having an STD diagnosis, compared to 63.4% of MSMO (Wheeler et al, 2008); and in a multinational study based in the

United States, Brazil, and Mexico (Lu et al, 2011) that looked for differences in serologically-determined human papillomavirus (HPV), and reported that MSMW and MSMO prevalence rates for HPV were both significantly higher than those for MSWE (59.4% and 65.6% vs. 31.2%, respectively) but did not differ from each other (also see Huhn et al, 2008, for similar findings among bisexually-*identified* men and MSM).

STI data from young people tell a different story, one of greater disparities among MSMW. The 1999 Massachusetts Youth Risk Behavior Survey indicate that adolescent MSMW were significantly more likely to have ever been diagnosed with an STI than adolescent males who were exclusively heterosexual in behavior; in this study, adolescent males who had sex only with other males did not differ significantly in STI self-report than adolescent males who had only female partners, suggesting a major STI disparity among young MSMW (Goodenow, et al 2002). An analysis of the Baltimore subset of the Young Men's Survey determined that YMSM with a lifetime history of 3 or more female sexual partners suffered more than twice the odds (AOR=2.3) of herpes simplex 2 infection, with no effect for greater numbers of male partners noted (Mark et al, 2005).

Within MSMW, a study of non-gay and non-bisexually identified Black men in Oakland found that 27.8% reported an STI diagnosis or symptoms in the last year, and 19.4% reported an STI diagnosis or symptoms in the past 3 months (Operario et al, 2010); and among Latinos in San Diego County, heterosexually-identified MSMW were likelier than all other subgroups, including bisexually-identified MSMW, to report ever having an STI (Zellner et al, 2009). We were unable to find any data modeling STI incidence among American MSMW.

1.6 THE BISEXUAL BRIDGE HYPOTHESIS: MSMW AS HIV INFECTION VECTORS

HIV researchers have hypothesized that MSMW are important infection vectors, transferring HIV and other STI from the not-so-discrete population of MSM to the general population of heterosexuals, via their female sexual partners (Ekstrand et al, 1994; Morse, et al 1991; Doll and Beeker, 1996; Hightow et al, 2006). A study conducted in the first decade of the HIV/AIDS epidemic estimated that 18% of American women with heterosexually acquired AIDS reported bisexual male partners as their only risk factor, with 25.7% of female sexual partners of HIV positive MSMW also testing positive (Curran et al, 1988). Soon after, other researchers downsized the estimate of the proportion of AIDS cases among heterosexual women that were attributable to sex with an MSMW to 11% (Chu et al, 1992). A report based on HIV/AIDS surveillance data noted that a similarly low percentage of HIV positive women (9%) reported having an MSMW partner (Montgomery et al, 2003). One population-based national estimate calculated that only 400 new HIV cases were annually attributable to infections transmitted from MSMW to their female partners, constituting just 1% of domestic incidence; this analysis did not consider how many infections among MSM were attributable to MSMW, nor MSMW-IDU transmission through needle-sharing (Kahn et al, 1997). Another study calculated that MSMW posed higher secondary HIV transmission risks than *any other population* studied; in the researchers' estimation, each MSMW would go on to transmit HIV to 2.13 sexual partners, 21 times as many as an exclusively heterosexual man, and 3.4 times as many as an MSMO (Pinkerton et al, 2000).

According to a study conducted in San Francisco, HIV behavioral risk among local MSMW increased in the late 1990s and then decreased in the early 2000s; the authors suggested that female acquisition of HIV from bisexually behaving men might explain elevated HIV prevalence among heterosexual Black women, although they noted that white heterosexual women in San Francisco experienced little HIV infection, perhaps due to higher MSMW prevalence among Black MSM than

among white MSM (Prabhu et al, 2004). HIV positive Latina and Black women were less likely to report having a bisexual male partner (6%) than HIV positive white women (14%); since a greater proportion of Black and Latino MSM have sex with women than white MSM, and since cultural norms in domestic heterosexual Black and Latino communities promote assortative sexual partnerships by race/ethnicity, non-disclosure of same-sex behavior may significantly vary across cultural bounds and increase infection risk for minority heterosexual women who are not fully informed of their MSMW partners' risks (Kennamer, 2000; Montgomery, 2003; Shehan et al, 2003). In a sample of HIV-positive Latino MSM in Washington, D.C. and New York City, 10.3% reported sex with women in the past 12 months; the majority of those reported unprotected anal or vaginal sex with women (Poppen et al, 2004).

A review of domestic AIDS cases from 2000-2004 found that 1,576 women reported their primary risk factor as sex with a bisexually behaving man, amounting to only 4.5% of all heterosexually-acquired female AIDS cases during those years; however, the AIDS rate attributable to heterosexual sex with bisexual men varied significantly by race and was 13 times higher for Black women compared with white women (Satcher et al, 2007 – the researchers note that knowledge of male partners' bisexuality may be limited and that the attributable rate may well be under-reported; also see Cunningham, 2006). In another example, 5% of AIDS cases among Hispanic women were attributed to sex with a bisexually behaving male, but 43% of cases were classified as "sex with an HIV/AIDS positive male with unknown risk factors" (Davila, 2000). Other analyses have suggested that heterosexual Black women do face substantial risk from non-disclosing MSMW partners, but may be just as likely to acquire HIV from male sexual partners who are IDU and high-risk heterosexuals (Millett et al, 2005; Gorbach et al, 2009). This may also be the case for syphilis infection risk: one Baltimore-based study reported that MSMW formed a small proportion of new syphilis diagnoses among men, calculating that MSMW comprised only 3.5% of new male syphilis cases – *MSWE comprised 69.3%* – but still identified this group as an important infection vector for women (Cunningham et al, 2006)!

Recent studies have suggested that MSMW significantly increase the density and breadth of social and sexual networks, thereby potentially increasing HIV transmission across communities (Hightow et al, 2006; O'Leary and Jones, 2006; Adimora and Fullilove, 2006). This indicates that interventions may need to be designed at a social network, rather than individual, level (Mimiaga et al, 2009). One study demonstrated that inclusion of MSMW into sexual networks played an essential role in socio-sexually connecting students, and potentially transmitting HIV infection, at several North Carolina colleges; this study also identified a small proportion (55 men, or 34%) of MSMW who had a large number (66) of HIV positive partners, both new and previously diagnosed, of whom 15% were women (Hightow et al, 2006). DIS investigation of syphilis outbreaks in Baltimore calculated that between 3.9% and 11% of females newly diagnosed with syphilis had MSMW partners (Cunningham et al, 2006). Lack of knowledge of HIV/STI status may serve to increase HIV/STI acquisition and transmission risk: one study of YMSM in 12 U.S. cities calculated that young MSMW were just as likely to be HIV-positive and unaware of their status as young MSMO (MacKellar et al, 2005).

Unfortunately, these domestic data are insufficient to provide larger estimations of HIV/STI transmission risk. (Data analysis from a national probability sample in the United Kingdom yielded the conclusion that bisexually behaving men in Britain "do provide some potential for bridging between high-risk and low-risk populations in terms of STI and HIV transmission," but numeric estimates of infections attributable to MSMW were not provided – see Mercer et al, 2009. The risk of MSMW serving as an infection vector has also been recently discussed in other countries, such as Pakistan and China, but without estimates for transmission counts – see Chow et al, 2011, and Khanani et al, 2011.) We have seen a surge of attention paid to "down-low" men and their risk of infecting female partners in the last several years (Malebranche et al, 2008). Save two studies conducted in the late 1990s that estimate HIV transmission only from MSMW to their sexual partners, there exist scant data modeling the number and proportion of HIV acquisitions and transmissions attributable to MSMW via sex with both male and female partners and through MSMW-IDU risk behaviors. Accounts in the popular press and the scientific

literature that sensationalize bisexually-behaving men's risk to women (Millett et al, 2005; Malebranche et al, 2008; Saleh and Operario, 2009; Rust, 2000) are, for these reasons, severely under-informed.

1.7 HIV RISK BEHAVIOR DISPARITIES AMONG MSMW

We have seen that MSMW suffer HIV prevalence disparities when compared with males whose sexual behavior is exclusively heterosexual. We might then also expect to find HIV risk behavior disparities among MSMW compared with MSWE (although this is not always the case: research has shown that HIV risk behavior differences among Black MSM compared to white MSM are non-significant, and do not account for elevated HIV prevalence and incidence among Black MSM – see Millett et al, 2006). A generally accepted set of hypotheses have been advanced to explain HIV prevalence disparities between populations. These hypotheses include biological differences (i.e., differences in biological predisposition to HIV infection); differences in background HIV prevalence between populations (i.e., higher community viral load, or CVL, in populations that have higher HIV prevalence); differences in other infectious contributory factors to HIV infection (i.e., higher prevalence of STI associated with HIV seroconversion); and differences in rates of engagement in HIV risk behavior (i.e., higher unprotected intercourse rates).

To our knowledge, there are no studies that have attempted to find biological differences between MSMW and other populations; in any case, it does not appear theoretically plausible that bisexually-behaving men should be biologically different from exclusively heterosexual men in any way that could predispose them to HIV infection, all other factors being equal. We were unable to find any studies that attempted to model CVL in MSMW communities; however, this must be considered an important explanatory factor in their HIV acquisition and transmission risks, as MSM communities almost certainly exhibit higher CVL than heterosexual communities in the United States given their higher HIV

prevalence. Our review of STI prevalence among MSMW has provided some limited information suggesting that MSMW experience elevated rates of STI compared with MSWE; while this finding may account for some additional increase in HIV infection risk, no quantitative estimates have yet been put forth. What about HIV risk behavior? In this section, we will examine the following domains of risk behavior shown to be associated with new HIV seroconversion: transactional sex involvement; concurrent substance use and sex; unprotected anal and vaginal intercourse with male and female partners; and disclosure of HIV positive status to partners. This section will critically examine disparities in risk behavior between MSMW and MSWE, while also attending to subtly different risk behaviors between MSMW and MSMO that might confer protective factors for MSMW and/or uncover behavioral risk domains for MSMW that could serve as promising intervention loci.

We have noted previously the large proportion of MSMW within studies of male sex workers. Conversely, studies of MSMW have uncovered a substantial amount of transactional sex involvement: trading sex for money or drugs, trading money or drugs for sex, or both. In 8 of 9 studies reporting comparative rates of sex work involvement between MSMW, MSWE and/or MSMO, bisexually active males were significantly more likely to report having sold sex. The one outlier study (Levin et al, 2009) was also the only study to assay both sex work involvement and bisexual behavior using lifetime timeframes. Across the other 8 studies, MSMW were between 5% and 38.6% more likely than MSMO to engage in sex work. In the 7 studies that also provided sex work estimates for exclusively heterosexual males, MSMW were between 8.3% and 45.4% more likely to engage in sex work than MSWE; in contrast, differences in sex work proportion within studies between MSMO and MSWE varied only from 0.9% to 17.7% (see Table 5, below).

Table 5. Sex work prevalence among MSMW, compared with MSMO and MSWE, U.S.

Author (date)	Target population (site)	Sampling strategy	msmw recall window	% sex work, MSMW	% sex work, MSMO	% sex work, MSWE	Sex work measure, timeframe
Knight et al (2007)	HIV+ IDU, 18+, sexually active (4 U.S. cities)	Convenience	Sexual partners, past 3 months	81.4%	42.8%	36%	Exchanged sex for money or drugs, past 3 months
Wheeler et al (2008)	Black MSM, 18+ (Philadelphia and New York City)	Respondent-driven sampling	Sexual partners, past 3 months	61.1%	38.9%	__	Exchanged sex for money, food, or drug, past 3 months
Gorbach et al (2009)	MSM and MSW substance users and partners, 18+ (Los Angeles)	Respondent-driven sampling	Sexual partners, past 6 months	34.3%	18.3%	17.4%	Received drugs or money for sex, past 6 months
Zule et al (2009)	MSM and MSW substance users, 18+ (Raleigh-Durham)	Respondent-driven sampling	Sexual partners, past 6 months	47.4%	28.9%	19.4%	Received drugs, money, or other goods for sex, past 6 months

(Table 5, continued)

Spikes et al (2009)	HIV+ Black men (23 U.S. health departments)	HIV/AIDS surveillance, sexually active sub-sample	Sexual partners, past year	56%	32.7%	15%	Received money or drugs in exchange for sexual intercourse, past year
Friedman et al (2012)	Substance-using MSM (Miami and Fort Lauderdale)	Targeted	Sexual partners, past year	34.9%	20.9%	__	Trade sex for money, drugs, or gifts, past 3 months
Jeffries & Dodge (2007)	General (U.S., National Survey of Family Growth 2002)	Household area probability sample, ages 15-44 (sexually active sub-sample)	Sexual partners, past year	19.3%	8.5%	1.3%	Traded sex for money or drugs, past year
Diaz et al (1993)	AIDS-diagnosed (U.S., 11 Health Departments)	HIV/AIDS surveillance (non-IDU sub-sample)	Sexual partners, past 5 years	9%	4%	3%	Received money for sex, past 5 years
Levin et al (2009)	Sexually active, 18-39 (Seattle)	RDD area probability sample	Sexual partners, life	14%	21%	5.7%	Exchanged sex for money, lifetime

Not included in the tables above (because studies did not distinguish between buying sex and selling sex in their transactional sex measures) are findings that young HIV positive MSMW in North Carolina were more likely to have transactional sex partners than their MSMO peers (Hightow et al, 2006); this was also the case for young Black MSMW in Baltimore, compared to Black MSMO (Latkin et al, 2011) and Black MSMW in Los Angeles, compared with Black MSMO and MSWE (Wyatt et al, 1999). Finally, researchers calculated from nationally representative youth data that bisexually active 16-year-old boys are significantly more likely to have sold sex than their heterosexually active – though not their homosexually active – male peers (Udry and Chantala, 2002: no proportions provided).

In almost all studies we found that assessed comparative rates of sex work, across national probability, HIV/AIDS surveillance, and high-risk community and network samples, transactional sex rates among MSMW were significantly higher than those for MSMO and MSWE. It is important to note that some of these findings may be definitional, artifacts of a generally accepted – though not fully corroborated – premise that male sex work is fueled by demand from male, and not female, clients (Pedersen and Hegna, 2003; Friedman, 2003). Recent studies demonstrate that male transactional sex engagement is associated with significant childhood adversities, mental health disparities, and other HIV risk behavior; male sex work involvement has also been shown to exacerbate future depression and substance use (Friedman et al, 2011), and high numbers of male paying partners are associated with HIV positive status (Bacon et al, 2006). Male sex work involvement has been shown to mediate the relationship between bisexual behavior and unprotected anal intercourse with partners of serodiscordant/unknown status among MSM substance users in South Florida; this study also found that MSMW were significantly more likely to sell sex (AOR=1.8), buy sex (AOR=2.4), and both sell and buy sex (AOR=2.5) than MSMO (Friedman et al, 2012; also see Bobashev et al, 2009, for further evidence of the greater likelihood of MSMW to purchase sex). Sex work has been associated with higher rates of unprotected anal insertive intercourse (UIAI) among both MSMO and MSMW in a study of HIV positive Black men, but it was only associated with higher rates of unprotected anal receptive intercourse (URAI)

among MSMO, suggesting that preferential sexual positioning may be a protective factor among Black MSMW sex workers (Spikes et al, 2009).

Within MSMW, male sex work has been associated with other HIV risk behaviors, including IDU and inconsistent condom use with casual female partners (Reitmiejer et al, 1998). Black MSMW have occasionally been found significantly more likely than white MSMW to sell sex and to purchase sex, with both male and female partners (McKirnan et al, 1995). During qualitative research with Black MSMW, it emerged that for many, sex work has served an introduction to same-gender sex, and that the sex work milieu could be seen as a closely intertwined, mixed-gender scene where substance use and sexual needs could be met: sex work served as motivator and enabler of concurrent sexual and substance use behaviors (Harawa et al, 2008; Wheeler, 2006; Rhodes et al, 1999). These findings validate those from a qualitative study of Black male bisexuality in rural Alabama, which contextualized sex work as particularly enticing for poor youth and older, straight-identified crack smokers (Lichtenstein, 2000). Previous research has suggested that bisexually-behaving males may use the exchange component of sex work to psychologically smooth over their same-gender desires while still engaging in same-gender sexual behaviors (Boyer, 1989; Friedman, 2003). Few other explanations for this HIV risk behavior disparity have been offered. Further research should be undertaken to determine the correlates of transactional sex within MSMW networks and to explore mediators and moderators that may help explain this relationship, as well as relationships between MSMW sex work and current and future HIV-related risk behavior.

Concurrent sexual and substance use behavior (i.e., having sex under the influence of drugs and alcohol), especially stimulant use, has been shown to be an important predictor of HIV seroconversion among MSM (Ostrow et al, 2009). Data from the 2002 National Survey of Family Growth demonstrates that, compared with MSWE and MSMO, a significantly higher proportion of MSMW (9.6% vs. 15.6% vs. 35.9%, respectively) reported being high during sex at least 50% of the time (Jeffries and Dodge, 2007). These findings are corroborated by the 2005-2007 New York City YRBS (Pathela and Schillinger, 2010), which shows that a significantly higher proportion of MSMW reported alcohol/drugs at last sexual

intercourse (42.4%) than MSMO (18.9%) or MSWE (16.4%). Among sexually active male youth responding to the Massachusetts YRBS from 1995-1999, MSMW were significantly more likely to report alcohol or drug use at most recent sexual intercourse than MSWE (59.7% vs. 26.8%, respectively); there was no disparity between exclusively heterosexually and homosexually behaving youth (Goodenow et al, 2002). The 2003 Seattle Sex Survey found that MSMW were significantly more likely than MSWE – but not MSMO – to report using drugs to enhance sexual experience (Levin et al, 2009). In a national surveillance study of HIV positive Black men, MSMW were significantly more likely use drugs during last sexual episode with casual female and male partners than MSWE or MSMO, respectively, and significantly more likely to use drugs during last sexual episode with steady male partners than MSMO (Spikes et al, 2009). In a convenience sample of Latino YMSM in New York City, MSMW were significantly more likely than MSMO to have been high on drugs or alcohol during their last sexual contacts with both main and non-main male partners (Agronick et al, 2004); Latino MSMW in San Diego who identified as heterosexual were more likely than Latino MSMO to report having sex while under the influence of alcohol or other drugs (Zellner et al, 2009). MSMW were also found significantly more likely than MSMO to report using stimulants before sex (AOR=1.9) in a targeted sample of substance-using MSM in Miami and Fort Lauderdale (Friedman et al, 2012). Within a population of Black MSMW in Oakland, researchers found that concurrent substance use and sex was associated with 5 times the rate of unprotected sex with transgender partners and 10 times the rate of unprotected sex with men, though it was not associated with unprotected sex with women (Operario et al, 2011). Of the studies we found that assessed comparative rates of concurrent substance use and sex, consistently robust disparities for MSMW were uncovered when compared with their exclusively heterosexual peers; and there is substantial – though not in every instance corroborative – evidence that a higher proportion of MSMW have concurrent substance use and sex than their exclusively homosexual peers. Within MSMW, qualitative research has shown that substance use before sex can serve important dissociative purposes, allowing sexual contact between men to happen while allowing participants to buffer the stigma against these activities (Zea et al, 2003; Wheeler, 2006).

A relatively rich stream of research has been conducted on MSMW condom use with male and female partners, and comparative data is available at both population and community levels. In the case of unprotected sex, evidence for HIV risk disparities is murkier than for other conditions we have so far described. Key findings for the 22 studies we have found on condom use differences between MSMW, MSMO, and MSWE are organized by MSMW proximal measure in Table 6 (see below).

Table 6. Unprotected sex among MSMW, compared with MSMO and MSWE, U.S.

Author (date)	Target population	Sampling strategy	MSMW measure, timeframe	HIV risk behavior: key findings
Nakamura et al (2011)	HIV+ MSM, 18+, meth users (San Diego)	Convenience	Sexual partners, past 2 months	MSMW have significantly less UAI when high on meth, less RAI when high on meth, and higher condom use intentions than MSMO
Knight et al (2007)	HIV+ IDU, 18+, sexually active (4 U.S. cities)	Convenience	Sexual partners, past 3 months	MSMW-IDU significantly less likely to engage in URAI with partners of negative/unknown HIV status than MSMO-IDU; equally likely to engage in UIAI with these partners; significantly more likely to engage in UVI and UIAI with female partners of negative/unknown status than MSWE-IDU
Wheeler et al (2008)	Black MSM (Philadelphia and New York City)	RDS	Sexual partners, past 3 months	MSMW significantly less likely to report URAI in last 3 months than MSMO; equally likely to report UIAI

(Table 6, continued)

Agronick et al (2004)	Latino YMSM, gay/bi identified (New York City)	Time-location sampling (TLS)	Sexual partners, past 3 months	MSMW report significantly more UIAI with non-main male partners and significantly less URAI with main male partners than MSMO
Latkin et al (2011)	Black MSM (Baltimore)	Convenience	Sexual partners, past 3 months	MSMW are significantly associated with always using condoms within their sexual networks, whereas MSMO are not
Flores et al (2009)	Young MSM (U.S., 13 cities)	TLS	Sexual partners, past 3 months	MSMW significantly less likely to engage in UAI than MSMO
Wold et al (1998)	MSM (Boston)	Convenience	Sexual partners, past 6 months	MSMW significantly more likely to have unprotected sex with female partners than with their male partners; significantly less likely to report UAI with men than MSMO
Williams et al (2009)	MSM and MSW substance users and partners, 18+ (Chicago)	Respondent-driven sampling (RDS)	Sexual partners, past 6 months	MSMW not significantly different in unprotected intercourse rates than MSWE substance users or MSMO; but MSMW less likely than MSMO to engage in URAI
Zule et al (2009)	MSM and MSW substance-users and partners, 18+ (Raleigh-	RDS	Sexual partners, past 6 months	MSMW not significantly different in general unprotected intercourse rates than MSWE substance users or MSMO; but MSMW less likely than MSMO to engage in URAI

Table 6, continued

	Durham)			
Munoz-Laboy and Dodge (2007)	Latino MSM (New York City)	Convenience	Sexual partners, past 6 months	MSMW significantly associated with increased numbers of both UIAI and URAI partners than MSMO, and ejaculation inside male partners
Jeffries and Dodge (2007)	15-44 years old, sexually active subsample (U.S.)	Household area probability	Sexual partners, past year	MSMW significantly more likely to use condoms at last sexual encounter with woman than MSWE; equally likely to use condoms at last sexual encounter with man as MSMO
Kalichman et al (1998)	MSM (Milwaukee)	Convenience	Sexual partners, past year	MSMW not significantly different than MSMO in percentage of unprotected anal sex acts; MSMW had significantly lower perceived safer sex norms than MSMO
Hays et al (1997)	YMSM, 15-29 (San Francisco)	Multi-stage area probability	Sexual partners, past year	MSMW significantly less likely to engage in UAI than MSMO
Spikes et al (2009)	HIV+, sexually active Black men (12 Health Departments, U.S.)	HIV/AIDS surveillance	Sexual partners, past year	MSMW significantly more likely to have UVI with a main female partner than MSWE; equally likely to have UAI with main or casual male partners as MSMO
Bockting et al (2007)	Latino MSM (U.S.)	Convenience (Internet)	Sexual partners, past 3 years	MSMW significantly associated with recent UVI and UAI
Crepaz and Marks	HIV+ men, sexually	Semi-random	Sexual partners,	MSMW not significantly less likely use condoms at sexual encounter than

(Table 6, continued)

(2003)	active, 18+ (L.A.)	convenience	unknown time frame	MSMO and MSWE (25% vs. 36% vs. 15%, respectively)
Wyatt et al (1999)	Black males (Los Angeles)	Convenience	Undisclosed	MSMW significantly more likely to use condoms with casual partners than MSMO and MSWE
Goodenow (2002)	Youth (Mass.)	School-based area probability	Sexual behavior, lifetime	MSMW significantly less likely to use condoms at last sexual intercourse than MSMO and MSWE (32.5% vs. 65.6% vs. 61.1%)
Pathela and Schillinger (2010)	Youth (New York City)	School-based area probability	Sexual behavior, lifetime	MSMW significantly less likely to use condoms at last sexual intercourse than MSWE; less likely than MSMO, but not significantly
Zellner et al (2009)	Latinos (San Diego County)	TLS	Sexual partners, lifetime	Heterosexually-identified MSMW significantly more likely to report recent unprotected intercourse with female partners than MSWE
Solorio et al (2003)	HIV+ youth, 13-23 years old (4 U.S. cities)	Convenience	Sexual partners, lifetime	MSMW not significantly different than MSMO in condom use frequency after HIV diagnosis
Bacon et al (2006)	MSM-IDU (San Francisco)	Convenience	Sexual partners, lifetime	MSMW-IDU and MSMO-IDU use condoms at significantly higher rate than MSWE-IDU; not significantly different from each other

What can we make of these findings? In these 22 studies are four findings that MSMW reported significantly more UAI than MSMO; nine findings that MSMW reported significantly less UAI than MSMO; and 12 findings that MSMW report non-significant differences in protected sex with men than

MSMO (some studies report more than one finding, i.e. for casual and main male partners). Compared with MSWE, these studies report five findings that MSMW are significantly more likely to report unprotected vaginal or anal intercourse with female partners; three studies report non-significant differences; and three studies report that MSMW are significantly more likely to use condoms with their female partners than MSWE. Ultimately, there appears to be no preponderance of evidence that rates of condom use among bisexually behaving men are, in general, disparate relative to those for exclusively homosexually or heterosexually behaving men.

There are, however, findings that shed some light on *distinct condom use differences* among MSMW. First, at the population level, MSMW youth have been shown in YRBS samples to report less condom use at last sexual encounter than their peers; however, this was not confirmed in the 2002 National Survey of Family Growth. It is possible that the age difference in the NSFG sample (15-44) compared to YRBS samples (12-19) explains this discrepancy: MSMW may become more likely over time, given greater sexual education and exposure to safer sex messages, to use condoms with more regularity. As an example, young MSMW in Add Health perceived significantly less risk of getting HIV/AIDS than MSWE or MSMO (Udry and Chantala, 2002). Similarly, MSMW were also shown to have less intention to use condoms than MSMO and perceive lower peer norms related to safer sex in a sample of gay bar patrons during the early years of the HIV epidemic (Heckman et al, 1995). Secondly, data from these 22 studies indicate that MSMW have unique unprotected intercourse risks: they may be generally less likely than MSMO to engage in unprotected receptive anal intercourse (URAI), and more than or equally likely as MSMO to engage in unprotected insertive anal intercourse (UIAI).

Within groups of MSMW, a Chicago-based study noted no differences in UAI between white men and black men (McKirnan et al, 1995). Within MSMW in Milwaukee, being in a primary relationship with a woman was, predictably, protective against UAI with a man: perhaps one can only have so much sex on the side (Kalichman et al, 1998). Within Black MSMW in New York City and Philadelphia, significant correlates of UIAI included sex work (OR=5.65) and negative and unknown HIV

status; oddly, drug use in the last 3 months was a protective factor, (OR=0.33) and there were no significant correlates beyond sexual identity for URAI (Wheeler et al, 2008). Within Black MSMW in Oakland, correlates of unprotected sex with female partners included having children and IDU; correlates of unprotected sex with male partners included having been tested for HIV, cocaine use, injection drug use, and concurrent substance use and sex (protective factors included barbiturate use and non-prescription methadone use); and correlates of unprotected sex with transgender partners included being younger than 50, using cocaine, and concurrent substance use and sex (Operario et al, 2011). Qualitative research has shown that Black MSMW might avoid using condoms with female primary partners to safeguard against being suspected of extra-relational sex, including same-gender sex (Wheeler, 2006). Within MSMW in North Carolina, UVI was significantly predicted by heterosexual identity (OR=2.6) and URAI with male partners; HIV status, race, other sexual identities, and coming out to female partners did not significantly contribute to predicting UVI (Zule et al, 2009). In a sample of HIV positive MSMW in Los Angeles, negative condom attitudes were a risk factor for not disclosing HIV status to male partners before engaging in UAI, while high disclosure self-efficacy was a protective factor (Mutchler et al, 2008), indicating that HIV prevention with MSMW at risk for transmitting HIV could benefit from attention to helping these men negotiate conversations about disclosing HIV status.

Finally, other issues related to HIV risk behavior have been noted among MSMW that may have some bearing on their HIV risk practices. One study reports that MSMW-IDU are significantly more likely than MSWE-IDU to share needles and cookers, and were far more likely (AOR=10.5) to self-report being HIV positive (Salazar et al, 2010). Several studies propose that MSMW are less likely than MSMO to have received recent HIV CTRS (Hays et al, 1997; Guo et al, 2011; Wheeler et al, 2008; Flores et al, 2009; Jeffries, 2010). This may be linked to both internal and external factors. Higher internalized homophobia has been shown to be associated with less uptake of HIV CTRS (Shoptaw et al, 2009), which may apply to MSMW who struggle with their same-sex desires and behaviors: in one study of HIV positive MSM, higher internalized homophobia significantly predicted MSMW status (O'Leary et al,

2007 – however, it should be noted the scale in question did not gauge biphobia and may not have been relevant to MSMW for this reason). Researchers in New York City found that only 16.9% of past-year MSMW had disclosed their same-sex attractions to their health care providers, compared to 70% of MSMO; in this study, MSMW behavior was the most significant independent predictor of same-sex attraction non-disclosure to health care providers, potentially delimiting the chances of MSMW being recommended HIV CTRS consistently (Bernstein et al, 2008). Sexual identity may mediate the relationship between MSMW and HIV CTRS uptake: MSMW who *identified* as bisexual in a nationally representative sample were less likely to have ever received HIV tests (Jeffries, 2010). Because MSMW may be less likely to avail themselves of HIV CTRS in gay community sites, and less likely to come out to health care providers, alternative testing procedures could benefit them. Researchers in San Francisco found that MSMW comprised a significantly higher proportion of males receiving home-based HIV test kits (33.8%) than males receiving HIV testing at publicly-funded sites (28.3%) in that city (McQuitty et al, 1999). A nationwide study found that bisexually behaving men made up significant proportions of those accessing home-based HIV testing, and accounted for 38% of all HIV positive results (Branson, 1998).

Additional background disparities that may play a role in increasing HIV risk among MSMW include earlier sexual debut (Goodenow et al, 2002; Levin et al, 2009; Wyatt et al, 1999); higher proportions of multiple sexual partners in the time frame assessed by individual studies (Wyatt et al, 1999; Knight et al, 2007; Levin et al, 2007; Jeffries and Dodge, 2007; Goodenow et al, 2002; Li et al, 2009; Latkin et al, 2011; Parkes et al, 2011; Spikes et al, 2009); and greater likelihood of having sex with transgender partners, which was highly associated with recent UVI and UAI (Bockting et al, 2007). Data on sex partner number disparities must be interpreted with caution: MSMW have generally been classified as such only if they had sex with at least one male and one female in the timeframes assessed, while MSMO and MSWE have been categorized as such with only one sexual partner. As such, MSMW in studies with tighter proximal frames may be subject to a type of *de facto* promiscuity bias. (We should

note that this is not particular to multiple sex partners: it is possible that disparities in other health conditions assessed throughout this review may be biased in similar fashion, as people who have more than one partner may be at more global risk for health disparities.) Perhaps the best approach to examining HIV risk behavior disparities is one that is multifactorial, taking into account such varied behaviors as transactional sex, UVI and UAI with single and multiple partners, and concurrent substance use and sex. Researchers who used this method with Black men in Los Angeles demonstrated that multifactorial sexual risk behavior was significantly predicted by MSMW status, and not by MSMO or MSWE status (Myers et al, 2003).

1.8 HIV PREVENTION INTERVENTIONS FOR MSMW

Beyond the media firestorm created by sensationalism over "down-low" men in the early 2000s, there have been few HIV prevention campaigns targeting either MSMW or bisexually-identified men (Miller et al, 2007; Mimiaga et al, 2009). The CDC has compiled a list of evidence-based HIV prevention interventions as part of the Diffusion of Evidence-Based Interventions (DEBI) project. Of the 29 interventions currently listed, none have been designed to target MSMW (CDC, 2012). None of the DEBIs promoted by the CDC for MSM place issues related to male bisexual behavior within their curricula. None of the DEBIs promoted by the CDC have modules addressing bisexual behavior that can be inserted into existing material. Moreover, researchers have argued convincingly that existing HIV prevention campaigns initiated by community based organizations for purportedly gay and bisexual men focus quite specifically on recruitment from gay-affiliated venues and do not effectively reach MSMW, who may have less gay community connections (Miller et al, 2007; Operario, 2010; Rust, 2000). Even as public health researchers have somehow recruited substantial proportions of MSMW into studies, bisexually behaving men report significantly less exposure to HIV prevention interventions than MSMO

(Flores et al, 2009). This does not appear to result from any lack of interest in enrolling: at least one study has shown that MSM with primary female partners were no more likely to be HIV intervention non-participators (Orellana et al, 2006). MSMW involvement in interventions is not typically presented in outcome evaluation data that denotes an MSMW subgroup or includes outcomes for sexual risks with female partners (for example, see Jones et al, 2008, who recruited substantial proportions of MSMW for a d-Up! demonstration project but do not report any MSMW-specific or heterosexual risk behavior outcomes). A survey of bisexual men in Ontario, Canada, demonstrated that reported rates of unprotected intercourse with men were significantly lower in communities where HIV prevention programming existed; however, no effect on rates of unprotected intercourse with women were noted, perhaps because existing interventions did not address heterosexual risk behavior among MSMW (Leaver et al, 2004). Thus, there is a tremendous missed opportunity that can be remediated by informed intervention design attending to needs particular to MSMW.

Recently, two interventions have been designed and piloted with specific populations of MSMW in mind. These two, *Hombres Sanos* and the Bruthas Project, are intended to reach Latino and Black MSMW, respectively. The Bruthas Project, an individual-level intervention, was designed after substantial qualitative research with Black MSMW in Oakland. It consists of 4 risk reduction sessions, with HIV CTRS provided; it was initiated within a community-based participatory research (CBPR) framework, and its theoretical underpinnings include the AIDS Risk Reduction Model and the information-motivation-behavior skills model of HIV preventive behavior change (Operario et al, 2010). Evaluation was conducted using a pre-test/post-test (3-month follow-up) design. Preliminary risk behavior outcomes from 36 Black MSMW found significant reductions in UIAI with male partners; URAI with male partners; numbers of male and female unprotected sex partners; and sex while under the influence of drugs. Psychosocial health outcomes included significantly higher social support and self-esteem, and significantly reduced loneliness. Rates of UVI with female partners, URAI and UIAI with

transgender partners, number of transgender sex partners, and sex while under the influence of alcohol were not significantly affected.

Hombres Sanos, a social marketing campaign to increase awareness of HIV risk and uptake of HIV prevention among Latino MSMW in North San Diego County, was also developed as a result of formative research with community members (Martinez-Donate et al, 2010). This seven-month campaign distributed safer-sex and HIV CTRS-themed print materials (brochures, flyers) and condoms, with radio ads, sponsorships, and promotional event components. Although Latino MSMW were the target audience, the campaign was disseminated across the larger Latino male heterosexual community, and advertised a free comprehensive male health exam at a local clinic friendly to the Latino community. Effectiveness was assessed through the distribution of repeated cross-sectional intercept surveys to men congregating at Latino community venues. A preliminary evaluation based on exposure to the campaign demonstrated that 6% (68/1137) of survey respondents were MSMW; the rest were exclusively heterosexual. MSMW were significantly more likely than MSWE to have gotten tested for HIV and to have thought of ways to reduce HIV/AIDS risk as a result of exposure to the campaign (Martinez-Donate et al, 2009). Post-campaign evaluation indicated that MSMW who were exposed to *Hombres Sanos* social marketing significantly reduced their UAI with male partners within a 60-day period, and were marginally more likely to have taken an HIV test. Interestingly, exclusively heterosexual Latino men showed greater positive benefit from the campaign: this could be a result of a higher numbers of survey respondents, increasing statistical power for the MSWE subgroup; an artifact of current HIV prevention not reaching heterosexual Latino men, so that they stood to benefit more from increased knowledge; or an effect of the campaign's messages for the broader Latino male community diluting its effects on a target population that has not seen much dedicated attention from health providers.

1.9 PSYCHOSOCIAL HEALTH DISPARITIES AMONG MSMW

A growing body of evidence demonstrates that people with gay, lesbian, bisexual, and transgender identities suffer severe psychosocial health disparities compared to the general population (Cochran and Mays, 2008). These disparities, which include depression, anxiety, substance abuse, and suicidality, have been theorized and demonstrated to contribute to HIV risk among MSM (Stall et al, 2008). Minority Stress Theory argues that individuals whose identities (including sexual identities) and/or behaviors (including sexual behaviors) are outside the mainstream are bullied, ostracized, alienated, and marginalized by their larger communities, causing minorities significant stress and exacerbating self-harm behaviors (Meyer, 2003). Bisexuals have reported experiencing social marginalization from both straight and gay/lesbian communities (a unique stigma that is termed "biphobia") which may estrange them from potentially supportive socio-sexual environments (Weinberg et al, 2005; Rust, 2000; Dodge and Sandfort, 2007). In fact, researchers concluded that (self-identified) bisexual males were rated the most negatively of any other sexuality, race, religious, or ethnic group, by a nationally representative sample of heterosexuals (Herek et al, 2002). Negative attitudes toward bisexuals may be driven by the general population's fears that they are non-monogamous and/or promiscuous; that they are confused about their sexuality; that they are vectors of HIV/STI infection; and/or that they threaten the dominant cultural notion of sexuality as a binary (gay/straight) construct (Ochs, 1996; Herek, 2002; Rust, 2000; Paul, 1996; Dodge and Sandfort, 2007). The additional stigma that bisexuals face from the gay and lesbian community related to their identities and sexual behaviors has been hypothesized to increase homonegativity – negative feelings about same-sex relationships – within bisexuals (Ochs, 1996). This increased homonegativity can be seen to compel high levels of substance use, whether as a form of acting out or as self-medication.

We can conceive the experiences of MSMW to be similar to those of MSM, but with some important distinctions. First, MSMW may have less access to minority strengths than men who have sex exclusively with men. Second, MSMW may have less success resolving sexual identities because of the liminal status of bisexuality in a culture that emphasizes binary categories over continua. As a result, they may be more susceptible to using substances – for reasons of escape, belonging, sexual disinhibition, and self-destruction. On the other hand, sexual partnerships with women offer MSMW the opportunity to "pass" as heterosexual, potentially mitigating some minority stress effects. Qualitative research has examined the experience of mental health issues among bisexuals: focus groups in the United States and Canada have reported frustrations with "invisible" identities and biphobic harassment from both gay/lesbian and straight communities and partners, which can substantially inflect mental health (Ross et al, 2010; Weinberg, 2005; Nakamura 2011). Given this context, it is perhaps unsurprising that bisexual-identified and "mostly heterosexual"-identified adolescents have been shown to suffer significantly higher rates of substance use than their peers (see Corliss et al, 2008; Coker et al, 2010; Marshal et al, 2008; and Ziyadeh et al, 2007). Higher substance use has also been demonstrated among heterosexually-identified MSM relative to gay-identified MSM, suggesting that incongruency between sexual identity and behavior may predict higher substance use (Greenwood et al, 2001).

With this in mind, we will analyze domestic findings on psychosocial health disparities among MSMW by first looking at substance use. Data from a national probability sample demonstrated that male adolescents who had romantic relationships with members of both genders smoke cigarettes more frequently; drink alone more; have more problems caused by drinking; and use more drugs than males who had only had same-sex relationships (Russell et al, 2002). Since young MSM have been found to have significant substance use disparities compared with young MSW in nationally representative samples, the researchers surmised that these effects could be driven by bisexually behaving males via including both MSMW and MSMO within one MSM group. Similar disparities for cocaine use and marijuana use among bisexually behaving youth (boys and girls combined, and not controlled by gender)

have also been found using YRBS data (Robin et al, 2002). Further exploring Add Health data, researchers developed a model predicting risk for a given 16-year-old boy who was MSMW, MSMO, or MSWE: a given MSMW boy had significantly higher odds of trying drugs and smoking than an exclusively heterosexual boy and (likely) an exclusively homosexual boy, though no difference in drinking (Udry and Chantala, 2002). The Seattle Sex Survey did not report on substance use other than using drugs to enhance sexual experience: 57% of MSMW responded affirmatively, significantly higher proportions than the 27% of men who have sex with women exclusively (41% of men who have sex with men exclusively, but this difference was not empirically tested – see Levin, 2009). However, a national college health study found no differences in binge drinking or tobacco smoking among male college students with same-gender, opposite-gender, or both same- and opposite-gender partners (Eisenberg and Wechsler, 2003); and a recent study based on a school-based national probability sample conducted in the United Kingdom shows no substance use differences between heterosexually-, bisexually-, and homosexually-behaving male youth (Parkes et al, 2011).

Smaller, more targeted samples make the case for additional MSMW substance use disparities above and beyond those suffered by MSMO, who have themselves been recognized as bearing significantly higher substance use rates compared to their heterosexual peers. In health department samples of PWLHA in 11 cities, IDU-MSMW were more likely to also use crack than IDU-MSMO or IDU-MSWE, although other substance use did not significantly vary by population (Diaz et al, 1993). MSMW PLWHA have reported using injection drugs at higher rates than their MSMO peers (Chu et al, 1992; O'Leary et al, 2007; Ibanez et al, 2005). A study of HIV positive male IDU in 4 cities found that MSMW were significantly more likely to report alcohol use and non-injection drug use than MSWE-IDU and MSMO-IDU; more likely than MSWE-IDU to use non-injected stimulants (crack, cocaine, methamphetamine) and other drugs; and more likely than MSMO-IDU to use crack and cocaine (Knight et al, 2007). Corroborating these findings, a San Diego study of HIV positive methamphetamine-using men discerned significantly higher crack use, IDU, alcohol, marijuana, crack, cocaine, hallucinogen, and

heroin use among bisexually behaving men; MSMO were significantly more likely to use poppers and GHB (Nakamura et al, 2011). Crack use was also significantly higher in 4 cities among HIV positive MSMW compared to their HIV positive MSMO peers; though cigarette, marijuana and amphetamine use trended much higher among MSMW, they did not reach statistical significance, and other substance use did not significantly differ (Solorio et al, 2003). The Supplemental HIV and AIDS Surveillance Project further argued the case for disparities among HIV positive MSMW, who used significantly more non-injection drugs – though no more alcohol or injection drugs – than HIV positive MSMO and MSWE (Spikes et al, 2009). On the other hand, a North Carolina DIS network analysis showed no significant disparities in drug use for HIV positive MSMW compared with MSMO or MSWE (Hightow et al, 2006), and a study of HIV positive MSM suggested that recreational Viagra and testosterone use was more likely to occur among MSMO than MSMW (Purcell et al, 2005).

Substance use disparities among MSMW are not limited to the general population and HIV positive sub-groups. A convenience-based sample from Chicago found that bisexually behaving men casually used marijuana more often than the comparison group, which can be loosely described as neither gay nor straight nor MSMW (Stokes et al, 1993); a similar sample from Boston found higher rates of problem drinking among MSMW compared to MSMO (Wold et al, 1998). Among poor, mostly Black MSM in Los Angeles, African-American MSMW were more likely than MSMO to use cocaine and to have higher internalized homophobia scores (Shoptaw et al, 2009); a similar RDS study of Black MSM in New York and Philadelphia discerned significantly higher alcohol use and illicit drug use among MSMW compared to MSMO (Wheeler et al, 2008). In this latter sample, no significant differences by HIV status were found for substance use variables within the MSMW group (Lauby, 2008 et al). A North Carolina RDS-recruited study found that MSMW had higher rates of using methamphetamine, speedballs, crack, heroin, and injection drugs than both MSMO and even substance-using MSWE; controlling for sociodemographics, MSMW had significantly higher odds of IDU and stimulant use than men who had sex exclusively with men (Zule et al, 2009). These robust substance use disparities are also not specific to

MSMW in America: bisexually behaving men in Thailand and China have also been shown to use substances at higher rates than their MSMO peers (Li et al, 2009; Liao et al, 2011). The formative research on substance use rates of bisexually behaving men is remarkably consistent, steadily illustrating significantly elevated proportions of MSMW using illicit drugs like marijuana, cocaine, crack, and meth, and limited evidence of differences in tobacco and alcohol use.

Theories have been presented that argue that elevated substance use rates among MSMW are indicators of severe marginalization from both straight and gay/lesbian communities, and that biphobia is a specific construct unique from homophobia (Rust, 2000). Second generation research to develop and implement scales that can reliably measure phobia and stress specific to bisexual behavior is essential to test the theory that elevated substance use rates among MSMW result from internal and external stressors particular to this population. We were unable to find any studies that empirically attempted to explain the relationship between bisexual behavior and substance use disparities. Until studies are conducted that explore psychosocial factors mediating and moderating this pathway, we will not be able to develop appropriate intervention loci, and might just as easily theorize that MSMW simply exhibit personalities that are more prone to behavioral experimentation over a wide range of fronts, including sexual expression and substance use.

Outside the domain of substance use, relatively few studies have assessed psychosocial health disparities among MSMW. Studies have found higher rates of depression and suicidality among people who *identify* as bisexual than those who identify as gay or as straight (Paul et al, 2002), with evidence that bisexual boys are at increasing risk of suicidality disparities, perhaps due to a reduction in homophobia without an equal reduction in biphobia in school settings in recent years (Saewyc et al, 2007). A study of Vermont and Massachusetts YRBS data noted substantial differences between bisexually-behaving youth compared to youth with same-sex partners in models controlling for gender: bisexually-behaving youth were much more likely to be depressed and attempt suicide (Robin et al, 2002). Similar findings were reported in a large-scale meta-analysis of sexual minority status and suicidality (Marshal et al, 2011).

Results indicated that bisexuality was a significant moderator of the relationship between sexual minority status and suicidality: the association between the two conditions was weakest among exclusively homosexual youth and strongest among exclusively heterosexual youth. However, bisexuality did not significantly moderate the relationship between sexual minority status and depression, indicating that LGB youth faced similar (and similarly disparate, compared to heterosexual youth) depression profiles. These findings aggregate both gender and varied bisexual behavior measures in their analyses and so should be interpreted with caution when applying them specifically to MSMW.

One formative study concluded that Chicago MSMW had lower depression and higher self-esteem than the comparison group; but these conclusions are complicated by the comparison group's composition, loosely described as MSM who identified neither as gay nor bisexual and were also not MSMW (Stokes et el, 1993). Interestingly, follow-up work determined that MSMW in this study who had "changed to a more homosexual self-rating" presented significantly *higher* levels of anxiety. A study of HIV positive methamphetamine-using MSM found that MSMW had significantly more depressive symptoms on the Beck Depression Index than MSMO (Nakamura et al, 2011); however, a study of HIV positive MSM in New York and San Francisco found no significant differences between MSMO and MSMW in depression or anxiety (O'Leary et al, 2007 – interestingly, in this study MSMW had significantly higher rates of hostility and sexual compulsivity). On the other hand, Udry and Chantala's (regressed) model 16-year-old boy did not have a higher probability of being depressed or having suicidal thoughts compared with a model 16-year-old exclusively heterosexual boy in an analysis of Add Health data; a model MSMO boy *did* have significantly higher odds of depression – though not suicidal ideation – than a model MSWE boy (Udry and Chantala, 2002). Among Black MSM in New York and Philadelphia, MSMW and MSMO also shared similar levels of depression; it is possible that such RDS-based network samples are imperfectly designed to accurately assess sub-group differences, as network affinities – shared behaviors and personality traits – may predominate (Wheeler et al, 2008).

Other factors may serve to increase risk for, or protect against, psychosocial health problems among MSMW. A study from Milwaukee found that MSMW were less likely than MSMO to disclose their same-sex behaviors to family and friends, suggesting that they received less emotional support for their sexual expression (Kalichman et al, 1998; also see Myers et al, 2003). Within a sample of MSMW, Black men were less likely to disclose their same-sex sexual behaviors to others, compared with white men (McKirnan et al, 1995); within a sample of Black MSM, MSMW were less likely than MSMO to disclose same-gender sexual behavior to at least one person (Wheeler et al, 2008). A study from Los Angeles linked higher internalized homophobia among Black MSMW to lesser disclosure of their same-gender sexual activities to female partners (Shoptaw et al, 2009). Among young HIV positive MSM, MSMW were less likely than their exclusively homosexually-behaving peers to disclose their sexuality to family and friends (Solorio et al, 2003). An analysis of Minnesota Student Surveys demonstrated that young MSMW had significantly lower levels of family connectedness, liking school, and school connectedness than both young MSWE and MSMO; these findings were essentially corroborated in similar samples from British Columbia (Saewyc et al, 2009) and in 13 cities in the U.S., where young MSMW rated their social support levels much lower than young MSMO rated theirs (Flores et al, 2009). Since these background factors have been shown to help explain the relationship between sexual minority status and mental health disparities (Eisenberg and Resnick, 2006; Ueno, 2005), they are important to account for when developing interventions for MSMW.

1.10 CHILDHOOD ADVERSITY AMONG MSMW

Substantial evidence exists that, compared with their peers, LGB people face severe childhood adversities; these adverse conditions include bullying, harassment, and sexual and physical violence, and are linked to the development of future mental health problems and HIV risk behaviors (Bontempo and

D'Augelli, 2002; Garofolo et al, 1998; Blake et al, 2001; Friedman et al, 2008; Friedman et al, 2006). Recent research makes a very strong case that bisexual male youth may face the most adverse childhood conditions. A large-scale meta-analysis of population-based studies that also conducted retrospective data analysis from YRBS surveys illustrates this disparity. Across 5 YRBS surveys from 1992-2007, young MSMW were significantly more likely to have been victims of forced sexual activity compared with young heterosexually exclusive males; the effect size ranged from 4.95 to 7.57 over this span and was consistently higher than that for other males and females of *all other gender-partner groups* (Friedman et al, 2011). These data are supported by findings from YRBS studies in Massachusetts, wherein young MSMW had more than twice the rate than young MSMO of being forced to have sex against their will, and eight times the rate of MSWE (Goodenow et al, 2002). At the network level, an RDS sample of high risk men in North Carolina reported that MSMW were more likely to have had their first sexual encounter be forced (13.1%) than MSWE (4.4%); MSMO (23.7%), however, had the highest rate (Zule, 2009). Similarly, another RDS-recruited study of Black MSM in New York City and Philadelphia found that MSMO were more likely than MSMW to have been victims of forced sex – this was a lifetime measure, however, and could be describing current rather than childhood adversity (Wheeler et al, 2008).

Physical violence disparities have also been demonstrated among MSMW. Minnesota YRBS data from 1992-2007 show that young MSMW suffer significantly disparate rates of being physically abused by a parent or guardian, with odds ratios ranging from 2.1 to 2.84 compared with exclusively heterosexual male youth (Friedman et al, 2011). In these samples, higher effect sizes were consistently noted for MSMW compared to MSMO. Intimate partner violence was also reported by significantly higher proportions of young MSMW compared with their MSMO and MSWE peers (34.8% vs. 13.2% vs. 6.0%, respectively) in New York City YRBS surveillance (Pathela and Schillinger, 2011). Beyond YRBS samples, little information is available in the literature related to MSMW experiencing childhood physical violence, although corroborative evidence for disparities in physical violence victimization

among the wider LGB population abounds (Corliss et al, 2002; Bontempo and D'Augelli et al, 2002; Friedman et al, 2011).

Young MSMW also report disproportionate rates of suffering peer harassment. Data from three population-based Minnesota Student Surveys completed between 2001 and 2007 indicate that MSMW had 143% to 204% the odds of reporting being threatened or injured with a weapon or otherwise assaulted, compared to their exclusively heterosexual male peers; they were 24% to 57% more likely to suffer this bullying than young MSMO. In addition, young MSMW were consistently more than three times more likely than young MSWE, and more than 100% more likely than MSMO, to skip school because they felt scared (Friedman et al, 2011). These results provide context to findings cited earlier that MSMW felt less school connectedness than their male peers. Data from a YRBS survey conducted in Massachusetts confirm these reports: young MSMW were significantly more likely than both MSMO and MSMW peers to skip school because they felt unsafe (Goodenow et al, 2002). Finally, data from Add Health suggest that a 16-year-old MSMW was significantly more likely to have been in a physical fight in the last year than a 16-year-old boy with exclusively female sexual partners; interestingly, a 16-year-old MSMO was no more likely to have been in a fight than his exclusively heterosexual male peers (Udry and Chantala, 2002).

Disparate peer bullying suffered by bisexually behaving males may also explain why they often are shown as adults to have lower educational attainment than their exclusively heterosexual and homosexual peers recruited into research (Jeffries and Dodge, 2007; Maulsby et al, 2011; Wheeler et al, 2008). However, we should note that population-based data do not always accurately reflect the experiences of high-risk sub-groups. A study of HIV positive male youth reported similar levels of peer bullying experiences (Solorio et al, 2003) between MSMW and MSMO; a study of HIV positive Black men found that MSMW had more education than MSWE, though less than MSMO (Spikes et al, 2009). Other community-based studies have found no significant educational disparities between bisexually-behaving men and men with only same-gender partners (Kalichman et al, 1998).

1.11 SUMMARY OF FINDINGS

In the mountain of studies conducted on American sexual behavior, there is a thin seam of data that describes the domestic prevalence of male bisexual behavior at population and subgroup levels. Taken together, these data indicate that (a) bisexually-behaving men, though a small fraction of the general male population, may be as or more common at the population level as exclusively homosexual men, depending on the proximal measures used to demarcate sexual partnerships; (b) there is significant discordance between bisexual identity and bisexual behavior for American males, suggesting that identity is a poor proxy measurement for sexual risk behavior in HIV-related research for this population; and (c) certain subgroups of males with high HIV acquisition and transmission risks, such as male sex workers, HIV positive men, Black and Latino MSM, and injection drug users, host higher proportions of MSMW. Males who engage in sex with both males and females can fit any number of categories: married men; gay men who occasionally have sex with women; sex workers who only have sex with men for money; young people who are exploring sexuality; and men who live openly bisexual lives, just to give a few examples.

HIV-related health risks faced and posed by MSMW are important to understand contextually, even (or, one could say, especially) as the prevailing narrative in American society has trended toward a theme of contamination, wherein secretive MSMW willfully infect their innocent female sexual partners with dangerous pathogens, as seen in the sensationalist depictions of so-called “men on the down-low” (Millett et al, 2005; Malebranche et al, 2008). This literature review has illustrated that, particularly when compared with their MSWE peers, MSMW suffer consistent and severe disparities across a broad spectrum of HIV-related health and social conditions. These disparities include childhood adversity experiences, such as childhood sexual and physical abuse and peer bullying; psychosocial health

conditions, such as substance use, depression, and suicidality; HIV risk behaviors, such as concurrent substance use and sex, high numbers of partners, early sexual debut, and transactional sex; and HIV and other sexually transmitted infections. For many background conditions (for example, childhood adversity, substance use, transactional sex, and concurrent substance use and sex), MSMW exhibit rates even above and beyond those found for MSMO. Why does this happen, and what does it mean? In this section, we will briefly summarize our findings and explore directions for future research and implications for intervention design.

First and foremost, there is a major need for meta-analyses and longitudinal studies centered on HIV prevalence and incidence among MSMW. Existing domestic HIV/AIDS surveillance systems collect and report data inadequate to accurately discern HIV/AIDS acquisition and transmission levels attributable to MSMW. There is an additional major need to conduct more formative research on HIV prevalence within high-risk MSMW subgroups such as Blacks and Latinos. Because of the strong tendency of HIV prevalence research among MSM to aggregate MSM and MSMW (and gay and bisexual identities), it is unusual even to find the single behavioral category "sex with women" in HIV prevalence studies, let alone to find adequate subgroup data within MSMW to analyze. As mentioned earlier, "MSMW" is not a federal risk transmission category for HIV and so is generally not presented in federal, state, or local HIV/AIDS surveillance data. Conducting a systematic literature review on HIV prevalence among MSMW is an intricate task that involves searches with multiple keywords followed by assiduous data mining and tabular imputation. Accounting for the wildly varied proximal measures that delimit MSMW status presents statistical dilemmas. Thus, conducting HIV prevalence (and other HIV risk-related) meta-analyses among American MSMW presents challenges. In order to effectively determine risk for HIV acquisition and transmission, categories that represent MSMW and MSMW-IDU must be developed and utilized. In lieu of federal transmission group re-categorizations, existing longitudinal studies of HIV infection that include MSMW must be re-analyzed – or new longitudinal studies that are

MSMW-specific must be implemented – if we are to accurately assess their HIV incidence rates. Modeling community viral load within MSMW networks might then be possible.

Limited data are available describing STI prevalence among American men who have sex with men and women. Studies to date have demonstrated that, compared to men who have sex exclusively with women, MSMW suffer significantly higher burdens of syphilis, gonorrhea, HPV, and hepatitis C; and young MSMW appear to suffer higher STI than their peers with exclusive same- or opposite-gender partners. Unlike HIV, which consistent and substantial evidence indicates is more prevalent among men who have sex with men exclusively, comparative data do not consistently demonstrate STI disparity between MSMW and MSMO. As in HIV surveillance systems, MSMW and MSMO are conflated under the umbrella transmission category of MSM in STI reporting at federal and state levels. Until new data collection measures are established and appropriately used, discerning MSMW-specific transmission and acquisition of STI will be challenging. Estimation of STI prevalence and infection transmission rates for MSMW might be modeled through population estimation techniques, interpolating MSMW proportions in populations of MSM and MSW; through comprehensive meta-analyses that might uncover relevant data that we were unable to find in this literature review; or through sophisticated network analyses and subsequent community modeling, perhaps enabled by examining health department DIS records and recruiting social and sexual networks associated with new STI diagnoses. It is also essential to begin exploring STI incidence rates among American MSMW; however, these can only be properly examined through prospective studies that utilize established biomarkers.

We have demonstrated that, compared with men with only female partners and men with only male partners, bisexually behaving men suffer some consistent HIV risk behavior disparities. These are starkest for transactional sex involvement, injection drug use, and concurrent substance use and sex. There is substantial population-based evidence that MSMW youth are comparatively more likely to have unprotected sex than their MSWE peers. Results from network and community samples of adults are mixed for condom use disparities among MSMW, but there is evidence that bisexually behaving men use

condoms with their female partners in higher proportions than exclusively heterosexually behaving men do, suggesting that some HIV prevention messages – though rarely targeting this population – have filtered through. Results consistently show that MSMW are significantly less likely to engage in unprotected receptive anal sex – and receptive anal intercourse in general – than their MSMO counterparts; this may explain their commensurately lower rates of HIV infection, all other risks so far examined being equal or greater. More research should be undertaken to explore the role of seropositioning in the sexual lives of MSMW, whether as preferential sexual positioning or behavior designed to protect themselves and/or their other partners. It is also of major public health concern to conduct further second generation research that explores mediators and moderators that can explain the alarmingly high rates of transactional sex involvement and concurrent substance use and sex among MSMW. Both formative qualitative research and longitudinal quantitative research are necessary to better contextualize the nature of these risk behaviors in bisexually behaving men's lives. It is apparent that HIV prevention interventions that hope to reach MSMW will not be maximally efficacious unless they address HIV risk behavior disparities uniquely relevant to MSMW.

Consistent formative research exists demonstrating that men who have sex with men and women suffer some significant mental health disparities compared to both men who have sex with men exclusively and men who have sex with women exclusively. These disparities are especially robust for levels of illicit substance use, while there is more limited evidence for elevated rates of depression and disparate suicidality. Higher rates of substance use and depression in this population may be driven by significantly poorer levels of family and school connectedness among MSMW, which may result from a higher fear and stigmatization related to disclosing bisexual behavior to loved ones. Strikingly, we were unable to find any comparative research on rates of anxiety, distress, and loneliness. Further first generation research on MSMW must be conducted for these health domains, and to substantiate findings on suicidiality and depression. Additional second generation research that can identify risk and protective factors that explain the relationship between MSMW and mental health disparities must be undertaken in

order to develop salient interventions that effectively remediate these profound inequities. Understanding the social context of substance use and abuse among bisexually-behaving men and its causative factors has important implications for public health interventions. If substance use is occurring early in adolescence as a result of biphobia and marginalization, for instance, school-based structural interventions may be indicated. If substance use is occurring in young adulthood as an escape from stigma encountered from gay and lesbian communities, then community-level interventions that attempt to reduce biphobia levels in LGBT communities may be appropriate. If substance use is occurring concomitantly with same-gender sexual behavior as a way to reduce internalized biphobia, then individual-level interventions centered on increasing self-acceptance of same-gender sexual desire may help MSMW reduce their HIV-related substance use risks. In order to develop targeted interventions for substance use disparities among bisexually-behaving men, there is a clear need for second-generation social epidemiology research into psychosocial mediators and moderators and experiential contexts that are related to MSMW substance use disparities.

Finally, MSMW have been shown to suffer consistent and robust disparities in childhood adversity compared to youth whose sexual behavior is exclusively homosexual or heterosexual. These disparities, which include experiencing childhood sexual abuse, childhood physical abuse, and bullying, have been soundly demonstrated by population-based surveys and comprehensive meta-analyses. Further first generation research that explores these differences within MSMW subgroups, such as Blacks and Latinos, is necessary to further our understanding of the experiences they face. Likewise, second generation research must be conducted examining risk and protective correlates of childhood adversity among MSMW in order to develop appropriate prevention and coping strategies.

1.12 IMPLICATIONS FOR FUTURE RESEARCH

With so much to explore, where should the field first go from here? Interventions designed for MSMW are most likely to work when they address underlying factors that drive risky health behaviors. First steps might include formative research into mental health domains that have not been adequately measured for MSMW: what are their levels of depression, loneliness, anxiety, and distress, and how are they implicated in risky behaviors? What psychosocial factors are associated with their high levels of substance abuse and concurrent substance use and sex? Understanding the psychosocial mechanisms that drive concurrent substance use and sex among MSMW might also help explain other of their HIV risk disparities, such as sex work involvement and risky sexual behavior.

Second-generation, longitudinal research on MSMW is also necessary to undertake; the only longitudinal research so far reported on bisexual men has been qualitative in nature, and measured only by identity (Weinberg et al, 2005). There is a pressing need to study trajectories of HIV-related risk behavior among MSMW, to research what factors mediate and moderate relationships between bisexuality and risk. Identification of factors that exacerbate and/or protect against HIV-related risk behavior within MSMW samples will invaluably inform any targeted intervention development.

Finally, third-generation intervention development should be based on results from the first- and second-generation paths outlined above and better theoretical understanding of health contexts particular to MSMW. Given the findings of this critical literature review, we can imagine promising areas for HIV prevention interventions to emphasize consistent uptake of HIV CTRS; safer sex work guidance; substance use counseling; and discussions about condom use during unprotected intercourse. With appropriate MSMW involvement and support in all phases from planning to evaluation, a network-level intervention that focuses on these messages could well have significant effects on HIV risk behavior, by increasing consistent HIV CTRS; reducing transactional sex involvement and/or increasing frequencies of

protected commercial sex; decreasing rates of concurrent substance use and sex; and increasing frequencies of protected insertive and receptive intercourse. These effects could substantially raise the health levels of MSMW by lowering their HIV and STI incidence rates, while creating safer conditions for their sexual partners.

1.13 OVERVIEW OF DISSERTATION AND SPECIFIC AIMS

1.13.1 Overview of dissertation.

This dissertation will explore factors related to HIV acquisition and transmission among bisexually behaving men by examining three interconnected issues that we have found to be specific to HIV acquisition and transmission risks of MSMW. Our overarching research question is: What are the HIV acquisition and transmission risks of MSMW in the United States? We will answer this question by a) providing estimates of HIV prevalence among MSMW while coincidentally estimating the prevalence of bisexual behavior among MSM; b) exploring longitudinal trajectories of HIV-related acquisition and transmission risks (biological, behavioral, and psychosocial) among MSMW; and c) exploring psychosocial correlates of HIV risk behavior disparities (concurrent substance use and sex, and transactional sex) noted among high-risk MSMW. Findings across these three domains will then be analyzed for relevance to HIV prevention intervention design; contextualized for their contribution to the field; and assessed for the direction they indicate for further research. In this way, we will allow our findings to recommend an agenda for HIV risk-reduction development that speaks to this population's unique needs.

1.13.2 Specific aim 1.

Determine the prevalence of HIV infection among MSMW in the U.S. and estimate the prevalence of bisexual behavior among MSM.

Hypothesis for aim 1 (a): MSMW suffer significantly higher HIV infection prevalence than MSWE and significantly lower HIV infection prevalence than MSMO. Data source: Meta-analysis of published studies.

Hypothesis for aim 1 (b): Relative proportions of MSMW in studies assessing HIV prevalence vary according to MSMW proximal measure (i.e., length of recall window). Data source: Meta-analysis of published studies.

1.13.3 Specific aim 2.

Determine the prevalence and stability of male bisexual behavior, trajectory differences of HIV-related acquisition and transmission risks over time among MSMW, and background psychosocial disparities among MSMW in a cohort of high-risk MSM.

Hypothesis for aim 2(a): Among MSMW, overall sexual behavior with men and women is stable in adulthood (slope of percentage of female partners is not significantly different from zero); within MSMW, proportion of female partners varies significantly by minority race/ethnicity (overall effect is significant). Data source: Multicenter AIDS Cohort Study (MACS), waves 38-50.

Hypothesis for aim 2(b): Among HIV positive MSM, trajectories of viral load are significantly different between MSMO and MSMW (slope and intercept). Data source: MACS, waves 38-50.

Hypothesis for aim 2(c): Trajectories of depression are significantly different between MSMO and MSMW (slope and intercept: CES-D score). Data source: MACS, waves 38-50.

Hypothesis for aim 2(d): Background HIV-related psychosocial risk (syndemic burden and IHP levels among MSMW) is significantly higher among MSMW compared with MSMO (logistic regression: 2 or more syndemic conditions, childhood and adult IHP). Data source: MACS, waves 49-50.

1.13.4 Specific aim 3.

Determine the psychosocial correlates of risk behaviors most associated with unprotected anal intercourse (UAI) with partners of serodiscordant/unknown HIV status among very high-risk MSMW (substance-using MSMW in a high HIV/AIDS catchment area).

Hypothesis for aim 3 (a): MSMW conjointly engage in concurrent substance use and sex and transactional sex at significantly higher rates than MSMO.

Hypothesis for aim 3 (b): Among MSMW, conjointly engaging in concurrent substance use and sex and transactional sex significantly predicts UAI with partners of serodiscordant/unknown HIV status.

Hypothesis for aim 3 (c): Among MSMW, the number of syndemic psychosocial conditions significantly predicts conjoint engagement in transactional sex and concurrent substance use and sex.

2.0 HIV INFECTION AND SEXUAL RISK AMONG MEN WHO HAVE SEX WITH MEN AND WOMEN (MSMW): A SYSTEMATIC REVIEW AND META-ANALYSIS

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2.1 INTRODUCTION

Since the early days of the epidemic, HIV transmission researchers have suggested that men who have sex with both men and women (MSMW) are integral viral bridges, responsible for the spread of HIV and other sexually transmitted infections from a discrete population – men who have sex with men, or MSM – to the general population of heterosexuals (Morse, et al 1991; Ekstrand et al, 1994; Doll and Beeker,

1996; Hightow et al, 2006). Studies have indicated that a substantial amount of HIV/AIDS diagnoses among American women may be attributable to bisexually-behaving male partners, though proportional estimates are widely varied, ranging from 1% to 18% (Curran et al, 1988; Chu et al, 1992; Montgomery et al, 2003; Kahn et al, 1997). Others have calculated that MSMW pose exceptionally high secondary HIV transmission risks, with each bisexually behaving man responsible for transmitting HIV to 3.4 times as many partners as an MSMO and 21 times as many partners as an MSWE (Pinkerton et al, 2000); that sexual transmission of HIV from MSMW may especially elevate HIV prevalence among Black heterosexual women (Prabhu et al, 2004); and that MSMW increase both the breadth and density of socio-sexual networks, potentiating the spread of HIV across communities (Hightow et al, 2006; O'Leary and Jones, 2006; Adimora and Fullilove, 2006).

To estimate the number of HIV infections among MSMW, it is necessary to estimate both the percentage of MSMW in the population and the HIV prevalence of MSMW. Nationally representative population-based surveys have consistently estimated that men who report having both male and female partners in the last year comprise 0.3% to 1.6% of all males (Jeffries and Dodge, 2007; Rogers and Turner, 1991; Smith, 2006; Laumann et al, 1994). The composition of MSMW in these surveys is somewhat less than the proportion of men who have sex with men only (MSMO), albeit variable according to length of recall window of bisexual behavior: looking through 5-year windows, the estimated proportions of these two distinct groups of MSM roughly equalize (Laumann et al, 1994; Smith et al, 2006). To date, however, estimates of HIV incidence and prevalence among MSMW are unavailable via the HIV/AIDS Surveillance System, which does not distinguish bisexual behavior from exclusively homosexual behavior in its reporting, though current federally-promoted HIV Counseling and Testing forms functionally collect these data (see CDC, 2008; and all years prior). Meaningful national estimates of MSMW-specific HIV/AIDS transmission and acquisition have been subject to significant recall bias limitations when reliant on largely retrospective secondhand information about the presumptive extra-relational sexual behaviors of one's sexual partners (Satcher et al, 2007; Cunningham, 2006). Knowledge of male partners' past bisexuality may be limited and, therefore, uncertainly reported

(Kennamer, 2000; Montgomery, 2003; Shehan et al, 2003). Few studies have attempted to model the number and proportion of HIV acquisitions and transmissions attributable to MSMW via sex with male and female partners. Press accounts sensationalizing bisexual men's risk to women have, therefore, been under-informed (Millett et al, 2005; Malebranche et al, 2008; Saleh and Operario, 2009; Rust, 2000). To utilize the reliable reports we have on the prevalence of male bisexual behavior in order to estimate their number of HIV infections, we elected to conduct a meta-analysis of published studies to determine their HIV prevalence.

In order to address the literature gap related to HIV acquisition and transmission among bisexually behaving men, we undertook to answer the following five research questions. First, do MSMW in the United States have significantly lower HIV prevalence than men who have sex with men only (MSMO)? Second, do MSMW in the United States have significantly higher HIV prevalence than men who have sex with women exclusively (MSWE)? Third, what moderating factors among MSMW in the United States significantly affect their HIV prevalence effect size compared with MSMW? Fourth, what is the proportion of men in the United States who engage in bisexual behavior in studies that have assessed HIV prevalence among males? Finally, do MSMW engage in risky sexual behavior in different proportions than MSMO and MSWE that might help explain HIV prevalence effect size differences between these populations? We conducted a systematic review of the literature and comprehensive meta-analysis to determine comparative rates of HIV infection among males in the United States by gender status of sexual partners and, coincidentally, rates of bisexual behavior among males in the United States recruited into research that assessed HIV prevalence.

2.2 METHODS

2.2.1 Search strategy.

Four search strategies were implemented to systematically identify reports of HIV prevalence among MSMW in the United States. First, in November-December 2011, we undertook a background review of

the scientific literature by examining the databases PubMed and Google Scholar. Independent subject searches for "MSMW," "men who have sex with men and women," "bisexual sex," "bisexual behavior," "female partners," "sex with females," and "non-gay identified" were used to identify relevant studies that included bisexually behaving males. Each independent subject keyword search was matched with each of the following Boolean condition terms: "'HIV' or 'AIDS'"; "'sexually transmitted diseases' or 'sexually transmitted infections' or 'STD' or 'STI'"; and "sexual behavior." Articles that either reported or contexualized previous reports on HIV-related health conditions among bisexually-behaving men were kept for reference. Second, in August 2012, two doctoral-level researchers and a health sciences librarian coordinated a search of the PubMed database using the following keywords to identify articles that were peer-reviewed, published in English, and referenced bisexuality and associated MESH terms; and HIV infections/epidemiology: ((("Bisexuality"[MeSH])) OR (bisexual*[tiab] OR MSMW[tiab]))) AND ("HIV infections/epidemiology"[Mesh]). Third, articles that presented findings on MSMW and the health conditions of interest were explored for references; citations that met our criteria were then explored for their own references, until no new studies were found meeting our criteria. Finally, we supplemented the PubMed search with parallel keyword searches of PsycINFO and Google Scholar ("bisexual" AND "HIV") to detect articles missed by PubMed.

Articles and reports were then analyzed to see whether findings were presented for men who had sex with men and women. Studies were included in this review if they were peer-reviewed full articles; published in English; and provided quantitative data on HIV prevalence among behaviorally-identified MSMW in the United States, whether comparative or not. Studies that did not meet these criteria (for instance, those that reported data only for bisexually-identified males or only for AIDS cases) were excluded. Studies that qualitatively or quantitatively assessed other factors related either to the population prevalence of MSMW, the prevalence of HIV infection among MSMW, the prevalence of sexual risk behavior among MSMW, or the prevalence of STI among MSMW were kept on hand for contextual purposes.

2.2.2 Data extraction/coding.

Bisexuality was operationalized using a definition of male bisexual behavior over any time frame (behavior recall window) assessed by researchers. Two doctoral-level reviewers independently coded for the following variables: lead author; publication date; dates of data collection; location of data collection; target population of study; sample characteristics; comparison groups (MSMO and/or MSWE); sampling procedures; recall window of bisexual behavior; basis for HIV assessment; numbers of group members who were assessed in each study; numerators and denominators of members of each of the three sexual behavior groups assessed for HIV, STI infection, and HIV risk behavior; and if each study contained race/ethnicity subgroup data by sexual behavior group in samples as a whole and for each outcome domain. Disagreements that occurred between researchers during data extraction and coding were resolved through discussion.

When multiple articles based on the same study were identified, the most comprehensive study was chosen for meta-analytic inclusion. When a single study presented data for more than one sample, we considered it as more than one study. Codes were conceived of as fitting one of four categories: 1) predictor variables (gender of sexual partners); 2) outcome variables (prevalence of HIV infection; prevalence of bisexual behavior; prevalence of STI infection; prevalence of sexual risk behavior); 3) potential moderator variables (recall window of bisexual behavior; study location; sampling procedure; target population; basis of reported HIV status); and 4) effect size data. Additional variables were created to reflect whether each study location represented one of the 12-highest HIV/AIDS prevalence zones, as defined by CDC (CDC, 2011) and whether each study was conducted predominately among racial/ethnic minority populations (i.e. 90% or more of participants were Black and/or Latino).

2.2.3 Analytic approach.

First, weighted mean percentages and 95% CI were calculated for our outcome variables and stratified by our predictors, using SPSS v.20.0.0. We then conducted meta-analyses according to methods described in Lipsey and Wilson (2000), using NIH-supported software (Borenstein et al, 2005). Three primary meta-analyses were conducted: (1) comparing HIV prevalence among MSMW with HIV prevalence

among MSMO; (2) comparing HIV prevalence among MSMW with HIV prevalence among MSWE; (3) comparing proportions of MSMO with proportions of MSMW. HIV infection, STI infection, bisexual behavior, and risky sexual behavior prevalence rates (weighted mean percentages) were estimated and 95% confidence intervals (CI) were calculated for each of these domains. We multiplied the proportion of cases reporting HIV positive status in each study by its corresponding weight (inverse variance) in order to calculate a weighted percentage. Weighted percentages of HIV prevalence were then summed across all studies. To compute the weighted mean percentage, the sum of the weighted percentages was divided by the sum of the weights. We assessed heterogeneity by calculating an I-square index value and Q statistic to evaluate how much between-study heterogeneity was due to chance. We used mixed effects models to test differences in pooled prevalence estimates, employing a fixed-effects approach across subgroups and a random-effects model within subgroups (Borenstein et al, 2009).

Differences in HIV prevalence and bisexual behavior might vary substantially due to methodological issues that could serve to increase heterogeneity and influence pooled outcomes. For this reason, we conducted subgroup analyses for each of our meta-analytic domains in which relevant subgroup data was provided for three or more studies. For domains one and two (HIV prevalence differences between MSMW and MSMO, and between MSMW and MSWE, respectively), subsidiary meta-analyses were conducted for the following subgroups: dates of data collection (pre-2000 and post-2000, coincident with the advent of highly active antiretroviral therapy); locale (CDC-defined high HIV/AIDS prevalence zone vs. zone not defined as such); sampling strategy (convenience vs. random sampling); target population; recall windows of bisexual behavior; and procedure of assessing HIV status (self-report vs. blood). We conducted moderation analyses to formally test for differences in effect sizes that were related to these differing study methodologies. We then conducted sensitivity analyses examining the effect of outliers, using an approach that compared the weighted mean percentage of HIV prevalence between groups with estimates obtained after iterations using k - 1 findings, where k is equal to the number of studies (i.e., removing a finding and re-calculating the weighted mean percentage; then, repeating that process until each finding was separately removed and results re-calculated). To

investigate potential publication bias, we utilized Egger's regression test and examined the symmetry of funnel plots; and conducted an Orwin's fail-safe n test to estimate how many additional studies would need to be included make effect sizes insignificant. Finally, we used weighted mean percentages of HIV prevalence among MSMW, bisexual behavior among MSM, and HIV positive MSMW among HIV positive MSM and paired them with HIV/AIDS surveillance data, standard estimates of proportions of bisexual men in the United States, and Census data to estimate HIV/AIDS acquisition and transmission attributable to MSMW.

2.3 RESULTS

2.3.1 Search results.

977 unique reports were initially identified. 578 reports were excluded because they reported on studies outside of the United States. 222 reports were excluded because they did not include data that reflected bisexual behavior. Of the 177 reports remaining, 163 were excluded because they reflected only qualitative research; and/or they did not assess HIV status generally; and/or they did not assess HIV status among MSMW; and/or the study participants were all HIV negative or HIV positive by design; and/or they were duplicative reports. 10 additional reports were included after citation searches. In total, 24 unique reports were included in our analysis (see Figure 1). Two of these articles reported on data collected in different waves and years; these articles were then disaggregated. The final dataset for this meta-analysis thus contained 26 distinct samples (see Tables 7 and 8).

2.3.2 HIV prevalence.

Across these 26 studies, the weighted mean HIV prevalence within MSMW was 0.12 (95% CI: 0.06, 0.18), compared with 0.17 among MSMO (95% CI: 0.03, 0.32; 22 studies) and 0.07 among MSWE (95% CI: 0.04, 0.10; 9 studies). In the 19 studies that assessed HIV serologically, the weighted mean HIV prevalence within MSMW was 0.15 (95% CI: 0.08, 0.23). We found significant differences in HIV prevalence and sexual partner gender: MSMW were less likely to be HIV infected compared with MSMO

(OR = 0.36, 95% CI: 0.26, 0.49), while more likely to be HIV infected compared with MSWE (OR = 5.4, 95% CI: 3.1, 9.3) (see Figures 2-3). Tests for moderation indicated a significant difference in HIV prevalence effect size between MSMW and MSMO by survey decade pre- and post- advent of highly active antiretroviral therapy (HAART): the effect size for MSMW surveyed post-1999 was smaller relative to MSMO than when groups were surveyed before 2000. No significant moderation was found for the following variables: >90% minorities within a survey; recall window of bisexual behavior; study location; basis of HIV assessment; or and sampling strategy (see Table 9). In the overall mixed effect model comparing HIV prevalence among MSMW and MSMO and moderated by HIV test basis, Egger's regression test did not illustrate significant asymmetry (1-tailed p-value=0.12). The between-group Q statistic was 0.99, which did not indicate significant heterogeneity. Sensitivity analyses conducted with one study removed did not significantly change the overall effect significance. The Orwin's fail-safe n test indicated that an additional 320 missing studies with a mean odds ratio of 1.0 would need to be uncovered in order for the odds ratio in the overall model comparing MSMW and MSMO to approach non-significance, assuming an OR=0.95 (95% CI: 0.90, 1.00) overall value and interval for a null finding.

We found only one paper that presented data that compared HIV infection between MSMW of different races, and only one other paper presented data comparing HIV infection between Hispanic and non-Hispanic MSMW. Only two studies compared proportions of MSMW within MSM by race/ethnicity; and only two studies compared risk behavior among MSMW by race/ethnicity. No studies within this meta-analysis reported data comparing STI infection in MSMW by race/ethnicity. Given the lack of subgroup data, we were not able to perform separate meta-analyses on the prevalence of HIV, STI, risk behavior by race/ethnicity; nor we were able to analyze the prevalence of bisexual behavior within MSM of different races/ethnicities.

2.3.3 Prevalence of bisexual behavior and population estimation.

The weighted mean prevalence of bisexual behavior within the larger population of men who have sex with men (MSM) sampled across 22 studies was 0.25 (95% CI: 0.11, 0.40), and 0.19 (95% CI: 0.10, 0.29) across 13 studies that assessed bisexual behavior over a time frame of one year or less. We used these

estimates and the HIV prevalence estimates from the previous section to calculate that a small proportion of MSM – (0.19)*(0.15), or 2.85% – engaged in recent bisexual activity and were also HIV positive. Using the CDC estimate that 4% of the male population are MSM, we calculated that (0.0285)*(0.04), or 0.11% of the U.S. male population is both recently bisexually active and HIV positive (Purcell et al, 2010). Given that there are currently 104,411,352 U.S. males aged 15-64 (CIA, 2012), we can estimate that 122,203 American males are currently both HIV positive and bisexually active. We then attempted to validate this estimate by calculating the weighted mean prevalence of HIV positive MSMW within HIV positive MSM. Across the 19 studies assessing HIV serologically, this was estimated to be 0.20 (95% CI: 0.08, 0.32). We used the CDC estimate that 580,000 MSM were currently living with HIV to predict that 20% of those, or 116,000, were past-year MSMW (CDC, 2011).

2.3.4 STI and sexual risk behavior prevalence.

As Table 10 shows, two studies that assessed HIV prevalence among MSMW also assessed STI prevalence among MSMW, MSMO, and MSWE. There were no significant differences between groups in these studies (OR=0.9, 95% CI: 0.7, 1.2, compared with MSMO; OR=1.6, 95% CI: 0.9, 2.6, compared with MSWE). MSMW were found to have lower HIV risk behaviors than MSMO: of the three studies that assessed UAI and URAI, MSMW were significantly less likely to engage in these behaviors than MSMO (OR = 0.65, 95% CI: 0.58, 0.74 for UAI; OR = 0.33, 95% CI: 0.25, 0.43 for URAI). Compared with MSWE, MSMW were equally likely (OR=1.0: 0.8, 1.3; 95% CI) to have reported unprotected vaginal intercourse and more likely to have reported unprotected insertive anal intercourse with women (OR=1.8: 1.4, 2.4; 95% CI). Subsidiary tests of moderation on STI and sexual risk behavior were not performed due to the small numbers of relevant studies (3 or less per each comparison) reporting these variables.

2.4 DISCUSSION

This study, insofar as we are aware, is the first meta-analysis of HIV prevalence among bisexually behaving men in the United States. It provides valuable information about their risk of HIV infection relative to men who have sex exclusively with either men or women. The large effect sizes we report here place MSMW squarely between MSMO and MSWE in HIV prevalence. These results are robust even using conservative mixed effects models, and are not significantly affected by methodological moderator variables except for post-HAART data collection dates, which indicates that prevalence rates among MSMW may be declining faster than among MSMO, perhaps due to a combination of fewer URAI exposures among a pool of MSM whose collective viremia is steadily decreasing. It is not surprising to have found that MSMW have higher rates of HIV compared with MSWE, given that they engage in risk behaviors (URAI) that MSWE do not engage in, and that their male sexual partners have a far higher rate of HIV infection than the female sexual partners of MSWE. It may be surprising, however, to have found MSMW to host such substantially reduced odds of HIV infection compared with MSMO. There is little evidence in the literature to suggest that MSMW have fewer male sex partners than MSMO (Munoz-Laboy and Dodge, 2007; Friedman et al, in preparation) or multiple sex partners in general (Wyatt et al, 1999; Knight et al, 2007; Levin et al, 2007; Jeffries and Dodge, 2007; Goodenow et al, 2002; Li et al, 2009; Latkin et al, 2011; Parkes et al, 2011; Spikes et al, 2009), including transgender partners (Bockting et al, 2007). Our meta-analysis found that MSMW were significantly less likely to report engaging in URAI than MSMO, which could explain their reduced odds for HIV infection. There is additional evidence beyond the HIV prevalence literature that bisexually behaving men may be less likely to engage in URAI than their exclusively homosexual counterparts (Nakamura et al, 2011; Knight et al, 2007; Agronick et al, 2004; Wold et al, 1998; Hays et al, 1997). That MSMW have less HIV and report less URAI than MSMO may be a consequence of their less frequent engagement in receptive anal intercourse in general than men who have sex with men exclusively (Williams et al, 2009). On the other hand, we found no significant differences among MSMW and exclusively heterosexual men in

unprotected vaginal intercourse; or between MSMW and MSMO engaging in UIAI with men. Formative research analyzing differences in unprotected insertive intercourse rates among these three groups has been equivocal (Crepaz and Marks, 2003; Pathela and Schillinger, 2010; Zellner et al, 2009).

Our findings on prevalence of bisexual behavior within larger populations of MSM aligns closely with previous population-based research in the United States and Europe, in which relative proportions of MSMW and MSMO vary by the timeframe assessed in the recall measure for bisexual behavior: lifetime measures have tended to favor greater proportions of MSMW than MSMO, while past-year measures have tended to favor greater proportions of MSMO than MSMW (Rogers and Turner, 1991; Laumann et al, 1994; Smith, 2006; Jeffries and Dodge, 2007; Udry and Chantala, 2002; Billy et al, 1993; Eisenberg and Weschler, 2003; Pathela and Schillinger, 2010; Zellner et al, 2009; Sandfordt, 2008). Our finding that the past-year ratio of MSMW:MSMO was 0.235 (0.19/0.81) fits closely with population-based estimates, which have reported past-year MSMW:MSMO ratios of 0.27-0.42 depending on the year and the survey (Jeffries and Dodge, 2007; Rogers and Turner, 1991; Smith, 2006; Laumann et al, 1994). That our estimate is slightly below the low range of these population-based surveys may be an artifact of the methods used to recruit MSM into public health research, which have often concentrated on gay-affiliated venues at which MSMW who do not interact socially with larger gay communities may not be well represented (Miller et al, 2007).

Our results – that approximately 120,000 past-year MSMW in the U.S. are living with HIV – suggest two important conclusions. First, bisexually behaving men compose a small but significant proportion of the population of MSM infected with HIV. Little if any research has been conducted that tests how well MSMW have been linked to and retained in care. There is evidence that MSMW have not been effectively reached by existing HIV prevention interventions; may be less likely to disclose same-sex behaviors to health care providers and to have been tested for HIV than their MSMO peers; and may be more likely to be unaware of their HIV positivity and comparatively reluctant to disclose their HIV status to sexual partners, possibly due to greater dissociation from gay communities and higher homonegativity (Hays et al, 1997; Shoptaw et al, 2009; Munoz-Laboy, 2007; Udry and Chantala, 2002;

Flores et al, 2009; Wheeler et al, 2008; Bernstein et al, 2008). Given these challenges, HIV positive MSMW constitute a population that could greatly benefit from dedicated HIV prevention and care interventions. Second, there has been a dominant research trope that examines HIV risk among MSMW within their potential to serve as a bridge population from one community to another (read: the homosexual male community to the heterosexual female community). Our findings suggest that MSMW present potential to both acquire and transmit HIV. That said, heterosexual women may be just as likely to encounter a male sexual partner who acquired HIV through injection drug use (IDU) or heterosexual sex: only 120,000 MSMW are estimated to be HIV positive, compared with 110,900 heterosexual males and 131,600 heterosexual male IDU (CDC, 2011). Using the same logic, an MSMO would be almost 4 times as likely to encounter another MSMO who was HIV positive (460,000) than an HIV positive MSMW. These comparisons, while approximate, suggest three important conclusions. First, MSMW likely present no greater risk of HIV transmission to women than exclusively heterosexual partners. Second, MSMW likely present substantially less risk of HIV transmission to men than MSMO. Third, the HIV/AIDS risk that MSMW themselves face from each other, from MSMO, and from heterosexual women is currently under-researched and unmitigated by dedicated intervention development and delivery attuned to bisexually behaving men and their particular needs (also see Millett et al, 2005).

These findings have important implications for HIV prevention and care planning, priority-setting, and intervention development. Local and state HIV care and prevention planning groups rely on national data to constitute HIV prevention and care plans; to set priority populations; and to recommend intervention placement and training to service providers. Elision of MSMW as a specified risk category in HIV/AIDS surveillance reports creates an environment wherein bisexually behaving men are more easily ignored by organizations receiving funding to provide HIV prevention and care. There are currently no HIV prevention interventions that target or address bisexually behaving men in the CDC's Diffusion of Effective Behavioral Interventions portfolio, which has been the gold standard for intervention diffusion and deployment for the last several years (CDC, 2012). Two promising intervention designs for racial/ethnic minority MSMW are in evaluation stages, representing a long-

overdue development that may provide models for reaching other MSMW effectively (Martinez-Donate et al, 2010; Operario et al, 2010). Our results suggest a need to collect and report bisexual behavior in our local, state, and national HIV/AIDS and STI surveillance systems and within HIV intervention design, development, and delivery. Further formative research on HIV risk (such as synergistic epidemics, or syndemics) and protective factors (such as resiliencies) specific to MSMW is necessary to intervention development, as are meta-analyses specific to risky sexual behavior, mental health, and STI among MSMW and longitudinal research into bisexual men's physical and psychosocial health over time. At present, while research is emerging lately, data are insufficient to estimate HIV prevalence differences between MSMW of different races/ethnicities or assess HIV incidence among MSMW. A combination of MSMW-targeted research and improved data collection and reporting will allow national, state, and local HIV prevention and care planning groups to effectively address the acquisition and transmission risks of MSMW (Doll and Beeker, 2006; Rust, 2000; Mimiaga et al, 2009; Miller et al, 2007).

This systematic review and meta-analysis has several important limitations. First, our primary eligibility criterion of HIV prevalence assessment excluded several articles that solely presented secondary findings, such as STI and risky sexual behavior, of import to this analysis. Search strategies that target STI among MSMW, or risky sexual behavior among MSMW, may lead to different results in these domains. The paucity of existing research, as we have noted above, did not allow for subgroup analyses of HIV prevalence by race and ethnicity both within MSMW and compared to their peers. Our comparison of MSMW and MSWE may constitute a highly conservative (though still robust and highly significant) effect size, due to selection bias: the majority of studies that included MSWE in our review and meta-analysis did so using very high-risk samples, such as street-based illicit substance users and their sexual partners (Williams et al, 2009; Gorbach et al, 2009; Zule et al, 2009) or STI clinic attendees (Torian et al, 2002; Lehner and Chiasson, 1998). We did not code for sexual identity, because is an imperfect corollary of sexual behavior (Cochran and Mays, 2009; Wood et al, 1993; Pathela et al, 2006; Ross et al, 2003; Goodenow et al, 2002; Xia et al, 2006; Kral et al, 2005; Myers et al, 1997; Aggleton, 1996), but it may have proven an important moderator of HIV risk among MSMW. Most important, our

PubMed search screened for HIV infections/epidemiology; while intended to restrict findings to HIV prevalence rather than ancillary data, it may have excluded relevant studies from this meta-analysis. While we acknowledge these limitations, we suggest that the robustness of our results, their internal consistency, and their external congruence with other studies indicate their validity and generalizability.

2.5 TABLES AND FIGURES

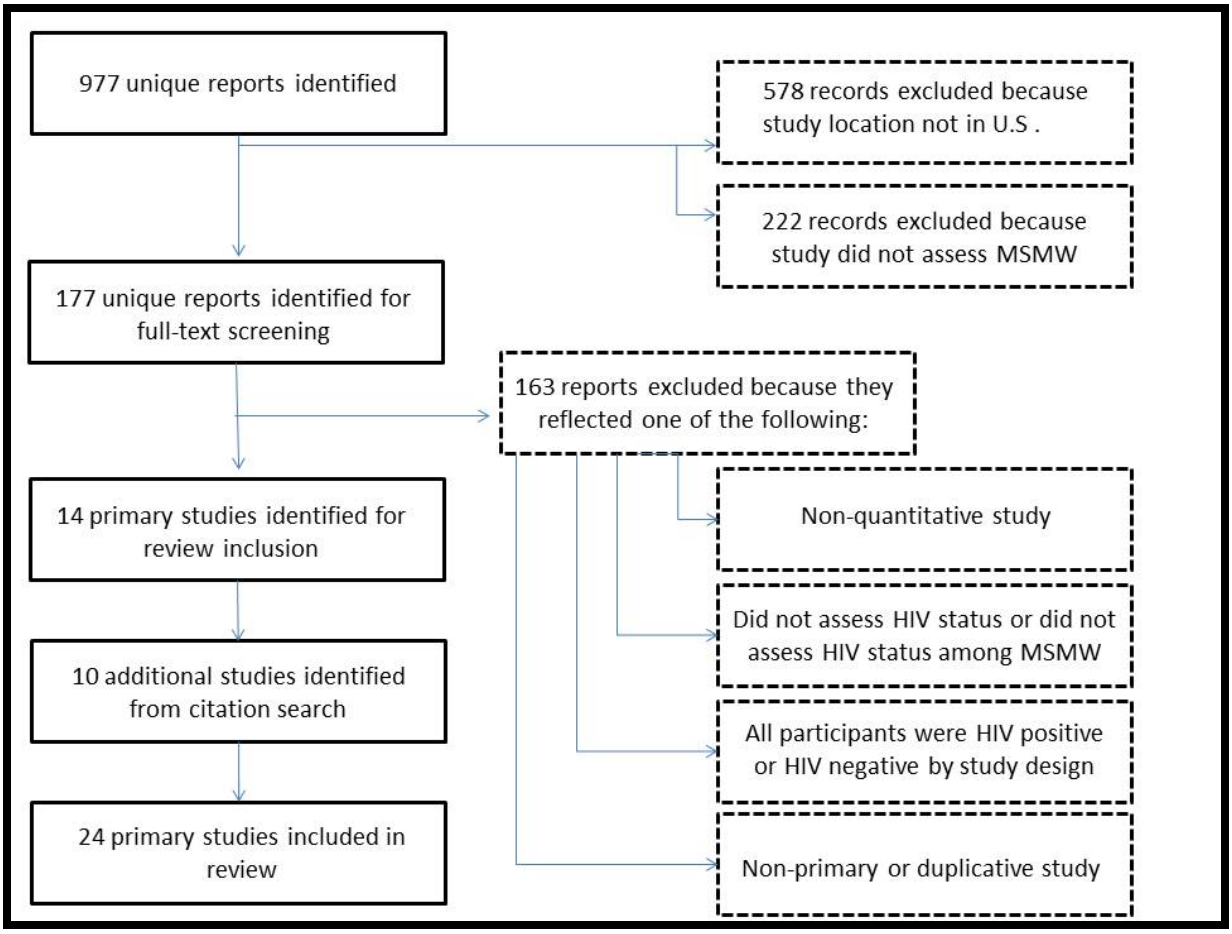

Figure 1. Flow diagram of included and excluded records

Table 7. Prevalence of MSMW in studies assessing HIV prevalence among MSM, U.S.

Authors(s)	Location(s)	Target population	Recall window	Sampling strategy	MSMW (n)	% MSMW
Bacon 2006	San Francisco, CA	YMSM-IDU	D	3	206	90.75
Catania 2001	SF, NY, LA, Chi.	MSM	D	5	385	14.73
Flores 2009	13 cities	YMSM	A	1	1494	14.51
Fuller 2005	New York, NY	Substance-using MSM	A	3	47	49.47
German 2011a	Baltimore, MD	MSM	B	1	216	33.49
German 2011b	Baltimore, MD	MSM	B	1	109	24.33
Gorbach 2009	Los Angeles, CA	Substance user or MSM	A	2	461	51.68
Kalichman 1998	*Not provided*	MSM	B	3	146	23.59
Kral 2005	San Francisco, CA	MSM-IDU	A	3	157	43.98
Latkin 2011	Baltimore, MD	Black MSM	A	3	79	33.76
Lehner 1998	NYC	Males in STD clinic	D	4	147	73.87
Levin 2009	Seattle, WA	General (18-39 year-olds)	D	5	43	59.72
McKirnan 1995	Chicago, IL	Young MSMW	C	3	536	*
Myers 1997	Los Angeles, CA	Black males	B	3	81	32.4
Operario 2011	Oakland, CA	Black MSMW	C	3	68	*

(Table 7 continued)

Salazar 2010	Atlanta, GA	Male IDU	B	2	38	--
Siegel 2008	NYC	MSMW	A	3	46	*
Torian 1996	NYC	MSM	*Not provided*	4	79	21.58
Torian 2000	NYC	Gh+ males in STD clinic	*Not provided*	4	25	36.23
Torian 2002a	NYC	MSM in STD clinic	*Not provided*	4	145	27.62
Torian 2002b	NYC	MSM in STD clinic	*Not provided*	4	133	30.5
Valleroy 2000	7 cities	YMSM	D	1	2117	61.38
Wheeler 2008	NYC; Philadelphia	Black MSM	A	2	226	27.49
Williams 2009	Chicago, IL	Substance user or MSM	A	2	343	71.31
Wood 1993	Seattle, WA	MSM in STD clinic	B	4	494	9.01
Zule 2009	Central North Carolina	Substance user or MSM	C	2	175	64.34

*Table 7 notes: Recall window refers to the recall window of bisexual behavior in each study (A=MSMW<6 months; B=MSMW<1 year; C=MSMW<3 years; D=MSMW greater than or equal to 3 years). Sampling strategy refers to recruitment technique (1=time/location sampling; 2=respondent-driven sampling; 3=convenience sampling; 4=HIV/STI clinic sampling; 5=population-based sampling. * Refers to studies that focused only on MSMW.*

Table 8. HIV prevalence among behaviorally bisexual, homosexual, and heterosexual men

Author, date	Age	Race	HIV measure	% HIV+, MSMW	% HIV+, MSMO	% HIV+, MSWE
Bacon 2006	Median age: 23 (16-29).	80% white, 20% nonwhite.	1	8.7	42.9	--
Catania 2001*		79% white, 4% AA, 10% Hispanic, 4% Asian, 3% Native American, <1% other.	1	10.1	19	0
Flores 2009	Mean age = 21.3 (SD=2.4, 15-25).	28% Black, 10% A/PI, 37% Latino, 22% White.	0	0.6	1.6	--
Fuller 2005	Median age=28 (18-40).	44% Hispanic, 46% Black, 10% white/other.	1	4.3	45.8	--
German 2011a	Median age 34 (range 18-69).	31% white, 62% African American, 6% other.	1	31.5	40.8	--
German 2011b	Median age 30 (range 18-72).	23%% white, 71% African American, 5% other.	1	30.3	39.8	--
Gorbach 2009	Mean age = 42.7 (SD=9.4).	19.1% white, 52.8% Black, 22% Hispanic.	1	11.9	64	4.3
Kalichman 1998	Mean age: 35.1 (18-70).	82% white, 7% Hispanic, 6% African American, 5% other.	0	3.6	19.5	--
Kral 2005	Median	62% white, 19% African	1	19.7	36.5	--

(Table 8 continued)

	age > 40.	American, 4% Latino, 14% other.				
Latkin 2011	Mean age: 38 (s.d. 10.6); 18+.	100% Black.	1	30.4	52.3	--
Lehner 1998	n/a	41% African American, 54% Hispanic, 4% white.	1	34.7	69.2	9.6
Levin 2009	Age 18-39.	6% Asian, 7% African American, 79% white, 4% Hispanic, 4% other.	0	7	20.7	0
McKirnan 1995	Mean age: 25 (range 18-30).	52% Black, 48% white.	0	6.9	--	--
Myers 1997	Mean age: 34.5.	100% Black.	1	58	74.6	6.8
Operario 2011	Median age: 44.6 (range 21-65).	100% Black.	0	21.4	--	--
Salazar 2010	Mean age: 45 (range 22-71).	95% African American, 3.6% white, 1.5% Hispanic.	0	26.3	--	7.1
Siegel 2008	Mean age 39.6 (s.d. 11, range 20-60).	41% African American, 35% Hispanic, 22% white, 2% Asian.	0	20.9	--	--
Torian 1996	Median age: 25-29.	32% white, 48% AA, 24% Hispanic, 3% other.	1	32.9	34.5	--
Torian	n/a	n/a	1	44	36.4	8

(Table 8 continued)

2000						
Torian 2002a	n/a	28% white, 43% African American, 19% Hispanic, 9% mixed/other.	1	43.4	47.6	--
Torian 2002b	n/a	37% white, 30% African American, 24% Hispanic, 9% other/mixed.	1	14.3	19.5	--
Valleroy 2000	Age range 15-22.	17% African American, 6% Asian, 30% Hispanic, 36% white, 11% mixed/other.	1	7.9	6.2	--
Wheeler 2008	Median age 40-49.	100% Black.	1	40.7	60.1	--
Williams 2009	Mean age=44 (range 17-70).	6% white, 80% Black, 13% Hispanic, 1% other.	1	11.4	53.6	4.7
Wood 1993	n/a	n/a	1	12.3	24.1	--
Zule 2009	n/a	77% African American, 20% white; 70% >age 35.	1	12	38.1	4.9

*Table notes: HIV assay refers to the form of assessment of HIV status (0=self-report; 1=serologic). *Catania et al inferred the validity of participants' self-reports by conducting a representative sample of serologic testing.*

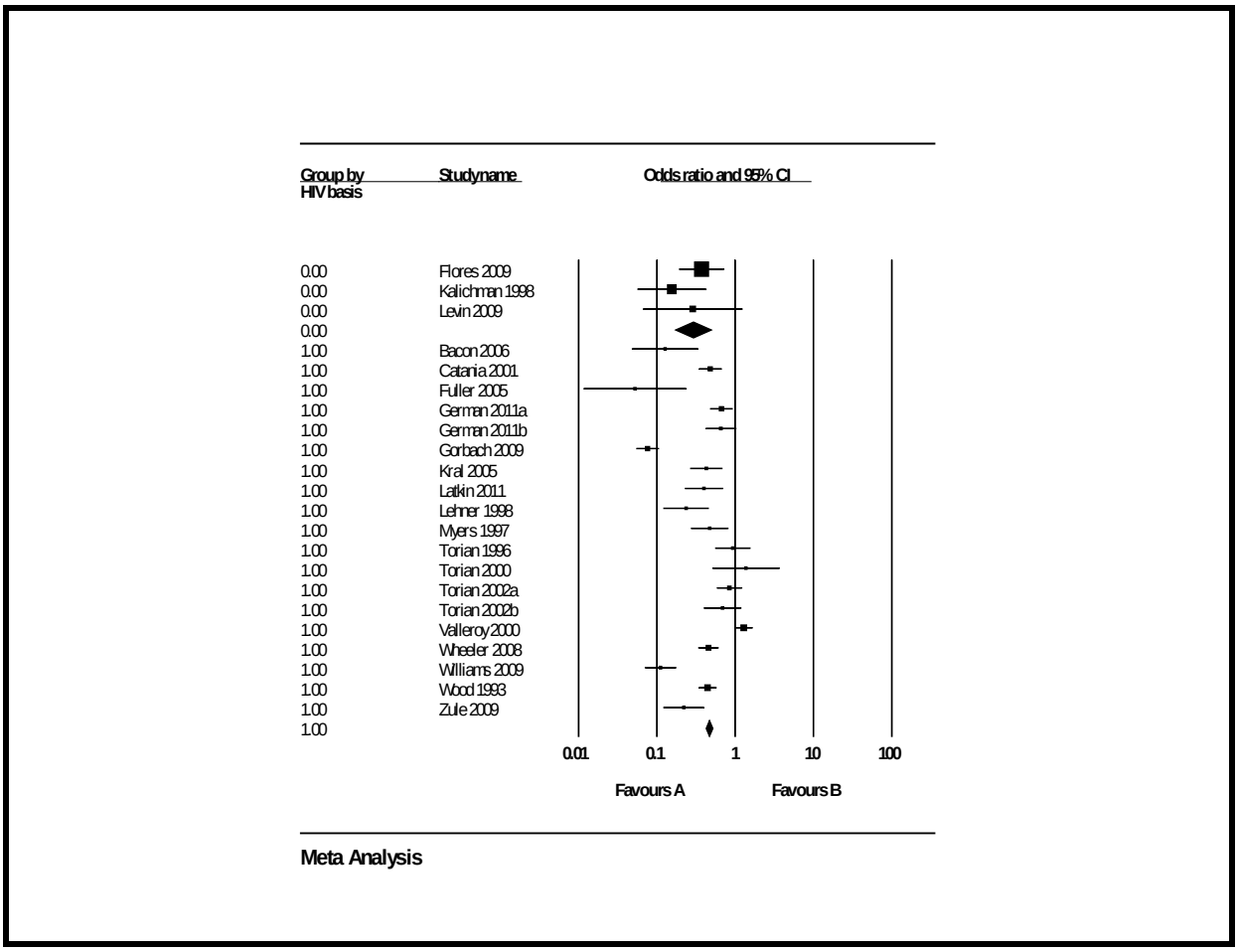

Figure 2. HIV prevalence among MSMW, compared to MSMO, U.S.

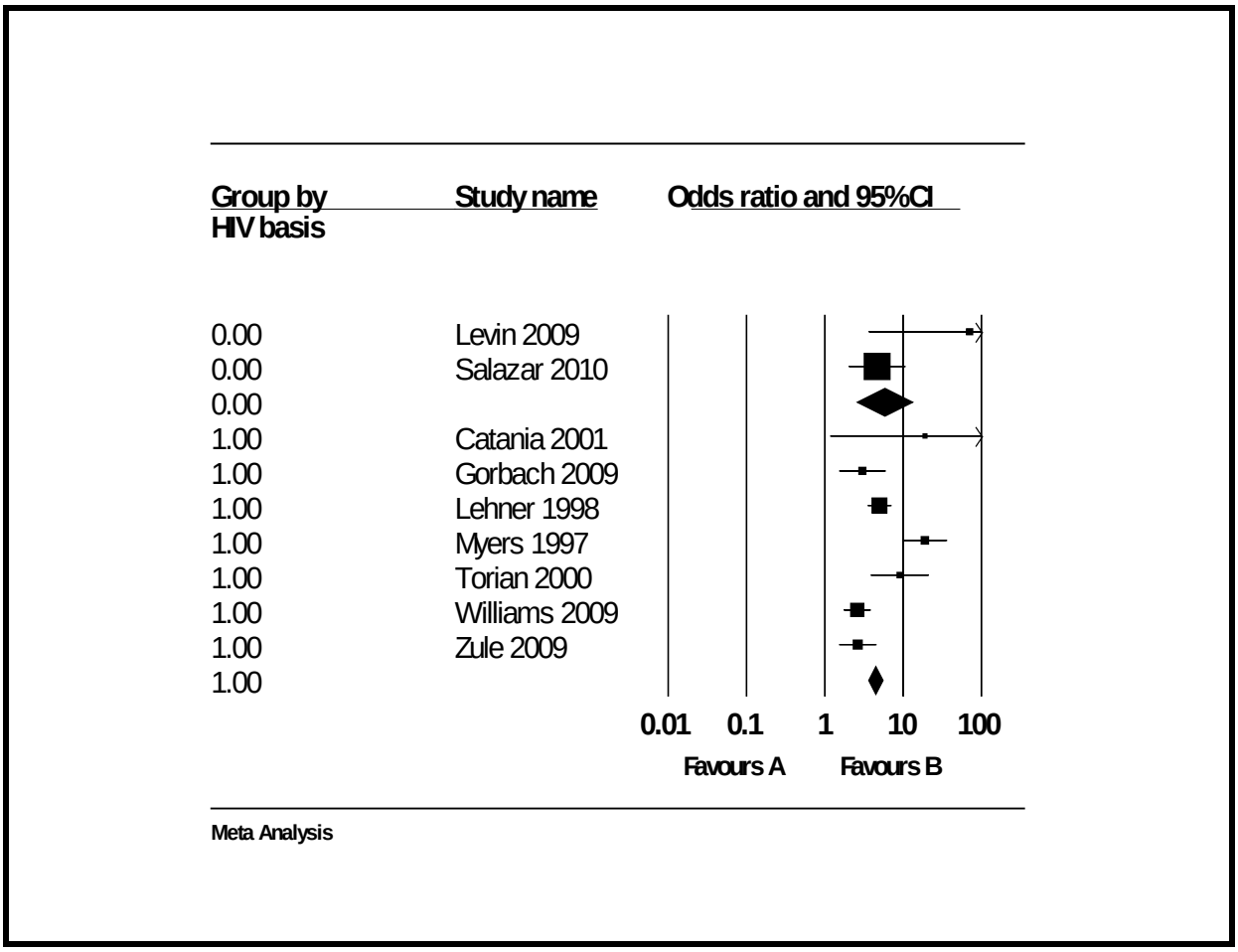

Figure 3. HIV prevalence among MSMW, compared to MSWE, U.S.

Table 9. Effect moderators of HIV status among MSMW compared to MSMO

Moderator varaibles	Subgroup categories	Number of studies	Mixed effect size (O.R.)	P-value	Q statistic (moderator class)
Date of data collection	Pre-2000	12	0.56 (0.40, 0.77)	<.001	0.02*
	2000 and after	10	0.24 (0.13, 0.44)	<.001	
Study locale	High HIV/AIDS prevalence zone	18	0.41 (0.28, 0.62)	<.001	0.32
	Other zone	4	0.37 (0.29, 0.47)	<.001	
Sampling strategy	Convenience	12	0.43 (0.31, 0.61)	<.001	0.56
	Probability	10	0.35 (0.19, 0.66)	<.001	
Minority-based	<90% minority	15	0.40 (0.25, 0.64)	<.001	0.30
	>90% minority	5	0.26 (0.13, 0.51)	<.001	
Recall window of bisexual behavior	12 months or less	13	0.29 (0.19, 0.45)	<.001	0.56
	>12 months	5	0.38 (0.17, 0.87)	0.02	
Assessment of HIV status	Self-report	3	0.29 (0.17, 0.49)	<.001	0.32
	Serologic	19	0.40 (0.27, 0.59)	<.001	

*Indicates moderation at p<.05.

Table 10. STI and risky sexual behavior among MSMW, MSMO, and MSWE

Outcome variables	Comparison group	Number of studies	Random effect size point estimate	Effect size p-value
STI diagnosis or symptoms	MSMO	2	0.88 (0.65, 1.2)	0.38
	MSWE	2	1.6 (0.4, 5.7)	0.51
UAI	MSMO	3	0.65 (0.58, 0.74)	<.001
URAI	MSMO	3	0.33 (0.25, 0.43)	<.001
UIAI with male	MSMO	3	1.0 (0.79, 1.3)	0.98
UIAI with female	MSWE	2	1.8 (1.4, 2.4)	<.001
UVI	MSWE	3	0.62 (0.20, 1.9)	0.40

3.0 TRAJECTORIES OF HIV ACQUISITION AND TRANSMISSION RISKS AMONG MEN WHO HAVE SEX WITH MEN AND WOMEN

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3.1 INTRODUCTION

Men who have sex with men (MSM) account for 61% of new HIV cases in the United States, with annual incidence rates estimated at 2.39%, leading to HIV prevalence rates approaching 40% by the time one reaches age 40 (CDC, 2012; Stall et al, 2009). HIV infection risk among MSM is thought to be catalyzed by a set of psychosocial health disparities, such as depression and internalized homophobia, which are in

turn influenced by the stress of enduring sexuality-related marginalization and violence, including peer bullying and abuse (Stall et al, 2008). Syndemics Theory posits that MSM suffer the effects of these factors as synergistic epidemics that work together to increase HIV risk behaviors (Herrick, 2011). To date, syndemics-based and other HIV risk research has generally pooled two potentially distinct groups of MSM: men who have sex with men only (MSMO), and men who have sex with both men and women (MSMW). When the HIV/AIDS literature has distinguished MSMW, it has historically been to judge their capacity to operate as viral bridges, introducing infection from MSM to the general population (Morse et al, 1991; O'Leary and Jones, 2006; Hightow et al, 2006). A newly emergent, largely cross-sectional, formative literature is beginning to indicate that men who identify and/or behave bisexually endure psychosocial health disparities and HIV risk behavior in ways distinct from other MSM: they may be more likely to be depressed and/or suicidal (Robin et al, 2002; Saewyc et al, 2007; Paul et al, 2002; Marshal et al, 2011; Nakamura et al, 2011); to use substances (Russell et al, 2002; Knight et al, 2007; Nakamura et al, 2011; Wheeler et al, 2008; Zule et al, 2009); to suffer violence victimization (Friedman et al, 2011; Goodenow et al, 2002; Udry and Chantala, 2002); and to report higher levels of internalized homophobia (O'Leary et al, 2007), which has been linked to relatively lower rates of HIV testing uptake (Shoptaw et al, 2009). These within-MSM differences have led some researchers to surmise that MSMW may in fact drive health disparities found between MSM and heterosexually-behaving males (Russell et al, 2002). Taken together, these findings suggest that MSMW may experience syndemics at a higher rate than MSMO; and that, if syndemics function as drivers of HIV acquisition and transmission risk among MSM, they may drive risk among MSMW as well.

Few studies have assessed bisexual behavior longitudinally. Diamond found that sexual minority women are more likely over time to adopt sexual behavior with both genders, evidencing heightened sexual fluidity over the lifespan, even as their relationships trend toward monogamy and therefore increasingly bimodal distributions of the gender of their sexual partners at ensuing cross-sectional time points (Diamond, 2008). Weinberg et al found that the great majority (85%) of bisexually-identified

adults reported changes in the ratio of the gender of their sexual partners over 5 years, with a little over half reporting increases in same-gender sexual partnering (Weinberg et al, 1994). Information related specifically to men is even more limited. Stokes et al found that, over a follow-up period of one year, almost twice as many bisexual men reported shifts in Kinsey ratings (which include dimensions of behavior, orientation, and fantasy) toward a more homosexual rating than a more heterosexual rating, and that these shifts were associated with increased anxiety (Stokes et al, 1993). Reporting on a nationally representative sample of adolescents and young adults, Savin-Williams and Ream found little stability in male bisexual behavior over a period of six years, with only 2.1% of MSMW in the first wave reporting sexual partners of both genders by the third wave, even as the weighted mean prevalence of MSMW increased over these years (Savin-Williams and Ream, 2007). While these studies provide an integral formative foundation, they have significant limitations related to their sampling frames (e.g., adolescents who may still be experimenting with sexual expression; small samples of adults recruited from cities with unusually cohesive bisexual communities) and/or brief follow-up periods. Additionally, none of these longitudinal studies report on HIV-related health risks over time. While several cross-sectional studies report on bisexually behaving men's unprotected intercourse rates with male and/or female partners few report on unprotected intercourse with partners of serodiscordant/unknown HIV status and none provide trajectory estimates of these risks over time (Nakamura et al, 2011; Knight et al, 2007; Wheeler et al, 2008; Agronick et al, 2004; Latkin et al, 2011; Flores et al, 2009; Wold et al, 1998; Williams et al, 2009; Zule et al, 2009; Munoz-Laboy and Dodge, 2007; Jeffries and Dodge, 2007; Kalichman et al, 1998; Hays et al, 1997; Spikes et al, 2009; Bockting et al, 2007; Crepaz and Marks, 2003; Wyatt et al, 1999; Goodenow et al, 2002; Pathela and Schillinger, 2010; Zellner et al, 2009; Solorio et al, 2003; Bacon et al, 2006). Although several studies report on psychosocial health risks among HIV positive MSMW, are not aware of any data providing biomedically relevant outcomes, such viral load levels (Nakamura et al, 2011; Knight et al, 2007; Ibanez et al, 2005; Pinkerton et al, 2000; Spikes et al, 2009; O'Leary et al, 2007; Poppen et al, 2004; Montgomery et al, 2003; Diaz et al, 1993; Chu et al, 1992; Crepaz and Marks, 2003; Solorio et al, 2003; Nawar et al, 2005). The HIV treatment cascade has lately garnered attention from

HIV prevention and care researchers, service providers, and community planners (CDC, 2011). The cascade demarcates gaps in the HIV testing and care continuum, estimating that only 28% of all HIV positive people in the United States achieve undetectable viral loads. It is essential to longitudinally characterize the HIV-related psychosocial, behavioral, and biomedical risks particular to MSMW in order to pinpoint appropriate intervention targets and timeframes within this under-studied population.

This study will explore factors related to HIV acquisition and transmission among MSMW by exploring longitudinal trajectories of bisexual behavior, risky sexual behavior with men and women among MSMW, viral load suppression among HIV positive MSMW, and psychosocial correlates that have been linked to HIV risk among MSM in general. We will also explore whether bisexually behaving men report elevated background levels of syndemics and internalized homophobia. We will address the following research questions. First, is bisexual behavior stable among MSMW; and does its prevalence and stability vary among racial/ethnic minorities? Second, do trends of HIV-related acquisition and transmission risks (including viral load and sexual risk behavior) vary between bisexually behaving men and men who have sex with men only (MSMO)? Third, to what extent do HIV positive MSMW present transmission risks to female sexual partners? Finally, are there psychosocial differences (such as IHP, depression, and overall syndemic burden) between MSMW and MSMO that might account for HIV risk differences between these groups?

3.2 METHODS

3.2.1 Sample.

To address these research questions, we conducted a secondary analysis of data collected by the Multicenter AIDS Cohort Study (MACS). The MACS, a prospective cohort study of MSM, is the

longest-running research study of the natural and treated history of HIV/AIDS among gay and bisexual men in the United States. Beginning in 1984, the MACS has purposively recruited successive cohorts in four cities: Baltimore, Pittsburgh, Chicago, and Los Angeles. Study design and targeted recruitment strategies have been described elsewhere (Kaslow et al, 1987; Dudley et al, 1995; Silvestre et al, 2006). Participants return to MACS sites every six months for a battery of medical and behavioral surveys, physical and neuropsychological examinations, and specimen collection. Sample questionnaires can be accessed on the website http://www.statepi.jhsph.edu/macs/forms.html. In 2009-2010 (waves 49 and 50), participants were retrospectively surveyed about psychosexual developmental characteristics theorized to be correlated with heightened HIV/AIDS acquisition and transmission risks over the life course. The present analysis was restricted to participants who completed at least one of these retrospective developmental surveys (n=1834). Methods of this supplemental survey have been described elsewhere (Herrick et al, 2012). This analysis considered biomedical (HIV status, viral load) and behavioral measures collected from a subsample of men who reported any sex with other men over a period of 6.5 years (waves 38 to 50).

3.2.2 Measures.

Sociodemographics: Sociodemographic information was obtained from the MACS study database. Age was computed by subtracting participants' dates of birth from date of completion of the supplementary study visit. Race/ethnicity was based on self-report data collected during baseline visits. Educational status and income were based self-report at the date of first visit of supplementary study completion. Dichotomous variables were created to distinguish white from racial/ethnic minority participants; participants with annual incomes below <$20,000; and participants under 40 years old.

HIV Serostatus: HIV serostatus was identified via ELISA and confirmatory Western blot analyses of whole blood.

Viral load: Assessed using standard laboratory procedures. Later dichotomized to denote potentially efficient transmissibility (viral load > or = 1500 copies/cubic milliliter vs. viral load <1500 copies/cubic milliliter) (Quinn et al, 2000). Viral load levels were further refined using log10 transformations to decrease variance within and between subjects.

MSMW/MSMO Categorization: Men were categorized as MSMW if they reported any sex with at least one male and at least one female between waves 38 and 50. Men were categorized as MSMO if they reported any sex with at least one male and no females between waves 38 and 50.

Percentage of opposite-gender sexual partners: The total number of each participant's male and female sexual intercourse partners was separately summed for each visit. A variable was computed that divided each subject's number of female partners by their total number of partners.

Developmental and psychosocial risk correlates: Dichotomous measures and their associated Cronbach's alpha scores for stimulant use; psychological distress; stress; sexual compulsivity; intimate partner violence; early internalized homophobia (IHP); current IHP; IHP resolution; and syndemic burden have been described elsewhere (Herrick et al, 2012). Depression was assessed per wave using a standardized CES-D scale, later dichotomized to measure depression (defined as CES-D scores above 16).

Unprotected anal intercourse (UAI) with male casual partners: Men were asked to distinguish insertive and receptive anal sex behaviors with casual male partners from those behaviors with main male partners. From their responses, dichotomous variables were created that assessed any unprotected receptive anal intercourse (URAI), and unprotected insertive anal intercourse (UIAI), and then summed to assess any UAI with casual male partners at each visit.

Unprotected vaginal or anal (UVI/UAI) intercourse with main female partners of unknown/serodiscordant status: Assessed only for main female partners, waves 46-50. Participants were asked whether they engaged in UVI or UAI with a main female partner and, if so, what that partner's HIV status was (negative, positive, or unknown).

By cross-referencing a participant's HIV serostatus with his partner's perceived serostatus for both UAI with women and UVI with women and summing these results, we created a variable that indicated any UVI/UAI with female partners of serodiscordant/unknown HIV status.

3.2.3 Statistical analysis.

Bivariate analyses were conducted by first grouping MSMW and MSMO into two mutually exclusive categories based on sexual behavior responses over waves 38-50 (MSMW categorization was operationalized as cross-sectional over a seven-year span). Sociodemographics of MSMO and MSMW were then compared using chi-square tests with SPSS v.20.0.0. We used Pearson's correlation to test for multicollinearity, identifying covariates significantly correlated at the $p<.05$ level. For dependent continuous variables, we used repeated measures mixed modeling (PROC MIXED in SAS 9.3) with unstructured covariance for trajectory and intercept testing, where MSMW/MSMO group was considered a fixed effect, along with time (wave). The interaction between MSMW/MSMO and visit number tested the difference in each group's trajectory for each dependent variable assessed. Multivariate models tested this effect and also added minority (non-white) race/ethnicity as a dichotomous covariate. We used an identical conceptual model to construct generalized estimating equations (GENLIN in SPSS 20.0.0) with Wald 95% confidence intervals for parameter estimates to test repeated measures of binary outcomes: models were generated with fixed effects and unstructured covariance parameters with binomial probability and logit function, with time (wave) as a within-subjects effect and minority race/ethnicity as a covariate. For analyses of viral load among MSM, seroconversion was also treated as a covariate (first visit with viral load data after seroconversion). Trajectory graphs were plotted using linear graphing options available in SAS Enterprise Guide 5.1 (PROC GPLOT). Finally, we conducted multiple logistic and linear regressions (using SPSS 20.0.0) to test cross-sectional psychosexual health disparities from

data collected in the methamphetamine substudy in waves 49 and 50, controlling for minority race/ethnicity.

Our analyses tested whether the percentage of female sexual partners declined over time among bisexually behaving men; and whether the slopes and intercepts of female partner percentage differed between MSMW of white and minority race/ethnicity. Comparing MSMW and MSMO intercepts and slopes over time, we tested for differences in log10 viral load and probability of viral load above 1500 copies/ml3 (among HIV positive MSM, adding seroconversion between waves 38 and 50 as a covariate); raw CES-D score and probability of CES-D above 16; and probability of UAI with casual partners. We conducted a formative trajectory analysis of counts of HIV positive MSMW who were potentially efficient HIV transmitters and who reported UAI/UVI with main female partners from waves 46-50. Finally, we tested to see whether MSMW and MSMO differed in their probabilities of experiencing IHP in childhood and adulthood; syndemic burden; sexual impulsivity; low masculinity attainment; and rates of IHP resolution from childhood to adulthood.

3.3 RESULTS

3.3.1 Sociodemographics.

A total of 1834 men visited a Multicenter AIDS Cohort Site at waves 49 and/or 50 and were offered a methamphetamine substudy survey. Over waves 38 to 50, 1 man did not complete any sexual behavior information; 2 men reported highly outlying numbers of sexual partners (999) at a given wave; 95 men reported having no sexual intercourse; and 111 men reported having sexual intercourse only with women. These men were removed from the analysis. Of the remaining 1625 men, 111 (6.8%) reported having sex with at least one man and at least one woman over the 6.5 year period; and 1514 reported having sex only with men. These men were included in trajectory analyses of HIV-related risk. A total of 1472 of these MSM completed the methamphetamine substudy survey. These included 1381 males who had sex only with men and 91 (6.2%) men who had behaved bisexually in waves 38 to 50. These men were included

in cross-sectional analyses of psychosexual development. In bivariate chi-square analyses, MSMW were significantly more likely than MSMO to be of minority race/ethnicity; to be recruited from Chicago; to be in the new cohort; to be under 40 years old; to earn less than $20,000 per year; and to have a HS degree or less (all p-values <0.001—see Table 11). Pearson's correlation tests of covariates indicated significant correlations between annual income under $20,000, age under 40, and racial/minority ethnicity (all p-values <0.001). To avoid multicollinearity within covariates in further analyses, we used racial/ethnic minority status, which had the highest chi-square value in bivariate analyses, as our key covariate.

3.3.2 Prevalence and stability of bisexuality.

Results demonstrate that an estimated 24.8% of MSMW partners were female at wave 38 (Figure 5). Racial/ethnic minority MSMW reported a significantly higher estimated percentage of female partners at wave 38 (42.7%; p<0.001) and across the overall model (p<0.001). While the percentage of female partners remained stable from waves 38-50 overall among MSMW (p=0.67), it also declined significantly among racial/ethnic minority MSMW (p=0.03) during this span (Table 12).

3.3.3 Differences in HIV-related risks between MSMW and MSMO.

HIV-positive MSMW in the MACS had a marginally significant higher viral load at wave 38 (p=.055; estimated mean of 2,011 copies/ml3 compared with 1,012 copies/ml3 for MSMO) and higher viral load across all waves (p<0.01). MSMW demonstrated significantly lower trajectories of viral load decline than MSMO between waves 38 to 50 (p<.05) in models controlling for racial/ethnic minority and seroconversion. HIV positive MSMW were more likely than HIV positive MSMO to be potentially efficient transmitters (viral load>1500 copies/ml3) than MSMO overall (p<.05), though the trajectory did not significantly differ (p=.32).

In both log10 viral load and potentially efficient transmission models, racial/ethnic minority status and recent seroconversion significantly predicted high viral load (Figures 9-10; Tables 15-16). Bisexually behaving men were no more or less likely than exclusively homosexually behaving men to have engaged in any UAI with casual male partners either at wave 38 or over time (Figure 6). Within

MSMW, racial/ethnic minority men were less likely than white men to report UAI with casual male partners between waves 38-50 ($p<.01$), though there was no overall difference in slope (Figure 7).

3.3.4 HIV transmission risk to female partners.

Only 6 total of 48 HIV positive MSMW (12.5%) were classified as being potentially efficient transmitters at any wave where they reported having UAI or UVI with a main female partner; this number dropped to one person by wave 50 (Figure 8). This decrease reflected viral load suppression over time concomitant with a reduction in UVI/UAI with main female partners over time.

3.3.5 Psychosocial differences between MSMW and MSMO.

Figure 11 shows that MSMW had significantly higher CES-D scores than MSMO at wave 38 (14.4; $p=0.05$). Table 17 shows that while their scores decreased significantly over time relative to MSMO ($p<.05$), the overall effect was significant ($p<0.01$). MSMW were more likely to have a probability of scoring higher than 16 on the CES-D score ($p=0.01$); trajectories of CES-D measures of depression were not significantly different between groups (Figure 12 and Table 18). Bisexually behaving men reported higher internalized homphobia retrospectively in childhood (95% CI: AOR=1.8; 1.1, 3.0) and currently (95% CI: AOR=3.0; 1.8, 5.0) than exclusively homosexually behaving men (Table 19). They also reported a lower rate of IHP resolution from childhood to adulthood (beta= -0.287; $p<.05$). While they did not differ from MSMO in low masculinity attainment (95% CI: AOR=0.8; 0.4, 1.3), MSMW reported higher sexual impulsivity (95% CI: AOR=1.8; 1.1, 2.9) and a higher probability of suffering two or more syndemic conditions (95% CI: AOR=1.7; 1.1, 2.6). In a logistic regression model controlling for racial/ethnic minority among all HIV positive MSM at wave 50 (n=606), syndemic burden was a significant predictor of potentially efficient transmission status (95% CI: AOR=1.6; 1.0, 2.5). We attempted this test among HIV positive MSMW only; results were not significant, likely due to the small number of HIV positive MSMW at who attended a wave 50 visit and received viral load testing (n=37).

3.4 DISCUSSION

Our report marks the first time that trajectory analyses of bisexual behavior and HIV acquisition and transmission risks have been conducted quantitatively over a wide timeframe with bisexually behaving adult men. This study is the first to indicate that bisexual behavior among adult MSM is, in fact, stable over time. Taken together with Diamond's reports on the fluidity of bisexual behavior among adult women, our results belie a dominant cultural assumption that bisexuality is a phase or experiment as a fallacy. Though this may be the case with adolescents – for whom much of sexuality exploration is experimental in different regards – it is incongruent with reports from populations of adult men and women. Our findings that MSMW of racial/minority ethnicity (predominately Black and Hispanic) have higher proportions of female partners than their white counterparts validates other research (Binson et al, 1995; Torian et al, 2002; Montgomery et al, 2003; Heckman et al, 1999; O'Leary et al, 2007; Millett et al, 2005). Different cultural constructions of masculinity and acceptability of same-gender sexual behavior appear, in this case, to influence sexual expression: minority MSM may be more likely to have sex with female partners in order to "pass" as straight or buffer individual feelings of internalized homophobia (Millett et al, 2005; Miller et al, 2005). It is also possible that within white gay communities, sexual behavior with women is more condemned that it is within racial/minority gay communities, which could explain the relatively lower percentage of female sexual partners among white MSMW. That this hypothesis has not been validated means only that it has not been empirically researched.

This study demonstrates that bisexually behaving men face worrisome disparities in several domains associated with HIV acquisition and transmission. Particularly concerning are the comparatively high and slowly declining levels of viral load, which have profound consequences both for individual health and for transmissibility. Since we can conceive of HIV positive MSMW within the MACS cohorts as a model sample – being motivated enough to keep coming to a research study every six months and

receive viral load tests, as well as direct linkages to HIV care clinics tied to each MACS site; being closely enough affiliated with the larger gay community to have been effectively recruited via convenience methods targeting MSM – what implications does this have for other MSMW who are less attached to gay communities and to biobehavioral research initiatives? HIV positive MSMW appear to deserve special attention in research and community planning focusing on the HIV cascade. But there is some good news. MSMW were no more likely than other MSM to engage in UAI with male casual partners, and a vanishingly small and steadily decreasing number of HIV positive MSMW reported having UAI or UVI with female partners of serodiscordant/unknown status while bearing viral loads above the threshold for potential infectivity (six men in total; only one man by wave 50). Thus, while greater attention must be paid to treatment and care among HIV positive MSMW for their own health, their HIV transmission risk threats (at least to their main female partners) may be overblown given the sensationalistic amplification of these threats in American media covering the so-called "down-low phenomenon" (Malebranche et al, 2008).

Our findings demonstrate that MSMW suffer major psychosocial health disparities relative to MSMO, including depression, internalized homophobia rates that have not resolved as quickly over time, and high syndemic burden. An emerging literature provides evidence that bisexuals encounter stigma from both straight and gay communities, and are regarded with greater negative feelings than people who partner exclusively with one gender, leading to higher levels of peer victimization (Rust et al, 2000; Saewyc et al, 2007; Herek et al, 2002; Friedman et al, 2012). Researchers have coined the term "biphobia" to distinguish the marginalization that bisexuals experience from the homophobia experienced by gays and lesbians, just as "transphobia" terms the specific stigma encountered by transgender individuals (Rust et al, 2000; Udis-Kessler, 1990). Syndemics Theory for MSM posits that the attachments that gay men form with each other help them to buffer the homonegativity they face from the dominant heternormative culture and may serve to explain migration of gay men to cities with large gay and lesbian communities with indigenous infrastructures such as gay-specific health care centers,

counseling organizations, and community centers (Stall et al, 2008). However, there are few cities in the United States with community resources and infrastructure specific to bisexuals; this may severely limit their ability to connect with like-minded individuals. When bisexual men reach out to either straight or gay/lesbian communities for support and camaraderie, it is possible that they do not receive messages of acceptance in return; or that they have a greater likelihood of experiencing acceptance from either community when they shelter their choices of sexual partners from others. A lack of ability to connect with other marginalized groups and gain acceptance may serve to increase feelings of depression and lead to unhealthy behaviors in order to escape, fit in, or subtly self-destruct: there is substantial evidence that bisexual males are likelier than both straight and gay males to use substances; use substances concurrently with sex; and engage in sex work. Unfortunately, all of these behaviors could further serve to leave bisexual men feeling even more alienated, as they confer further discrete stigmas of their own. Thus, the elevated rates of depression and other syndemic burdens may be linked to the uniquely debilitating effects of biphobia, which might not be resolved even as easily as homophobia among gay males due to a lack of available community resources. Disparities in viral load and syndemic burden among MSMW, coupled with the strong association between syndemic burden and unsuppressed HIV viral load at wave 50 among HIV positive MSM, suggests that interventions structured to alleviate syndemics such as depression, housing stability, sexual compulsivity, and substance use may have important distal effects on viral load suppression, and that MSMW stand to benefit greatly from such intervention delivery.

Our results are subject to several important limitations. First, the MACS sample, while a groundbreaking cohort study of the natural history of HIV infection among MSM, does not represent an ideal sampling frame for MSMW. The proportion of MSMW among MSM in the MACS over this 6.5-year span was less than 7%, much lower than both general population-based and MSM-centered probability samples that have used similar proximal windows to identify bisexual behavior retrospectively (Binson et al, 1995; Catania et al, 2001; Laumann et al, 1994; Smith, 2006). This indicates that the convenience sampling procedures used in MSM-targeted recruitment techniques did not serve to enroll

bisexual men with any great success; and the sociodemographic differences we found between MSMW and MSMO were substantial, if not unusual (Jeffries and Dodge, 2007; Maulsby et al, 2011; Wheeler et al, 2008). For these reasons, a study of bisexually behaving men in MACS may not furnish results that are generalizable to the larger population of bisexually behaving men in the United States. Second, as with many cohort studies of marginalized populations, the MACS dataset contains a significant amount of missing data, as men may skip some visits and return several years later. Our use of an end bookmark limited our study to only those men who had attended a MACS visit in waves 49 and/or 50; our results may not even be generalizable to MSM who did not attend either of those visits. Third, certain measures were not ideal for our analysis: perceived HIV status of heterosexual partners was only collected for main female partners, and only for a limited time period; internalized homophobia scales, while adapted to include "gay and bisexual" identities and behaviors, did not assess biphobia perceived or endured from gay communities and may not constitute valid measures for bisexual men; and viral load data listed undetectable viral loads differently depending on varying laboratory procedures, reporting the maximum value of the sensitivity threshold (e.g., 40 copies/ml3) for undetectable results. While we used HIV seroconversion as a covariate in trajectory models, we did not control for treatment regimens or medication adherence. Fourth, no qualitative data was collected to contextualize our formative epidemiology. Finally, both PROC MIXED and generalized estimating equations for repeated measures rely on assumptions of normality that may not have been met across all outcomes. Nonetheless, we believe that the significance and consistency of our findings over a variety of internally and externally validated measures and theoretically linked HIV-related acquisition and transmission domains provides strong evidence for their reliability.

There are many avenues of further research that may enlighten these results. Qualitative data collection with MSMW in the MACS would serve to better contextualize the disparities in viral load, internalized homophobia, syndemic burden, and depression among these men. Further quantitative research on this sample might further explore differences in behavioral, psychosocial, and biomedical

health outcomes and correlates (such as sexually transmitted infection, substance use, and antiretroviral treatment and adherence) both between MSMW and MSMO and within MSMW, by race and ethnicity, and thereby remediate a major gap in the literature, which has only rarely reported on subgroup differences within MSMW. More sophisticated examinations of factors that might mediate or moderate the pathways between bisexual behavior and HIV-related disparities could help pinpoint relevant intervention loci. Formative research into differences in early psychosexual development between MSMO and MSMW, and within MSMW, could provide important information for intervention design. Assessing attitudes that gay and lesbian people hold regarding bisexuals, as well as service providers' cultural competence toward bisexuals, is essential for informing social marketing campaigns and professional training curricula, respectively, that increase acceptance and ability to effectively serve men who have sex with men and women. Our results show that health disparities are real among bisexual men. Addressing these disparities will be of benefit to MSMW as well as the men and women whom they love.

3.5 TABLES AND FIGURES

Table 11. Sociodemographics at wave 50: MSMO and MSMW in the MACS

Sociodemographics	Subcategory	Total sample (n=1625)	MSMO (n=1514)	MSMW (n=111)	Chi-square
Race/ethnicity					103.3***
	White, non-Hispanic	1124	1090 (72.0%)	34 (30.6%)	
	White, Hispanic	94	84 (5.5%)	10 (9.0%)	
	Black, non-Hispanic	309	254 (16.8%)	55 (49.5%)	
	Black, Hispanic	11	7 (0.5%)	4 (3.6%)	
	American Indian or Alaskan	2	2 (0.1%)	0 (0%)	
	Asian or Pacific Islander	6	6 (0.4%)	0 (0%)	
	Other	13	12 (0.8%)	1 (0.9%)	
	Other Hispanic	66	59 (3.9%)	7 (6.3%)	
MACS site					42.4***
	Baltimore	391	376 (24.8%)	15 (13.5%)	
	Chicago	297	252 (16.6%)	45 (40.5%)	
	Pittsburgh	405	388 (25.6%)	17 (15.3%)	
	Los Angeles	532	498 (32.9%)	34 (30.6%)	
Cohort					68.6***
	1984	923	895 (59.1%)	28 (25.2%)	
	1987	109	107 (7.1%)	2 (1.8%)	
	2002	593	512 (33.8%)	81 (73.0%)	
HIV Status					0.8
	Negative	862	793 (52.4%)	63 (56.8%)	
	Positive	771	721 (47.6%)	48 (43.2%)	
Age					58.2***

(Table 11 continued)

	20-29	41	29 (1.9%)	12 (10.8%)	
	30-39	157	141 (9.3%)	16 (14.4%)	
	40-49	460	413 (27.3%)	47 (42.3%)	
	50-59	609	587 (38.8%)	22 (19.8%)	
	60+	358	344 (22.7%)	14 (12.6%)	
Income					84.5***
(n=1519)	<$10,000	214	171 (12.2%)	43 (42.2%)	
	$10,000-$19,999	192	174 (12.4%)	18 (17.6%)	
	$20,000-$29,999	158	147 (10.5%)	11 (10.8%)	
	$30,000-$39,999	158	149 (10.6%)	9 (8.8%)	
	$40,000-$49,999	131	129 (9.2%)	2 (2.0%)	
	$50,000 and higher	137	134 (9.6%)	3 (2.9%)	
	$60,000 or more	529	513 (36.6%)	16 (15.7%)	
Education					65.4***
(n=1471)	8th grade or less	11	9 (0.7%)	2 (1.9%)	
	9th, 10th, 11th grade	52	37 (2.7%)	15 (13.9%)	
	12th grade/HS degree	151	129 (9.5%)	22 (20.4%)	
	Some college, no degree	353	322 (23.6%)	31 (28.7%)	
	College degree	331	317 (23.3%)	14 (13.0%)	
	Some graduate work	160	149 (10.9%)	11 (10.2%)	
	Graduate degree	413	400 (29.3%)	13 (12.0%)	

*** *Denotes corresponding p-values <.001*

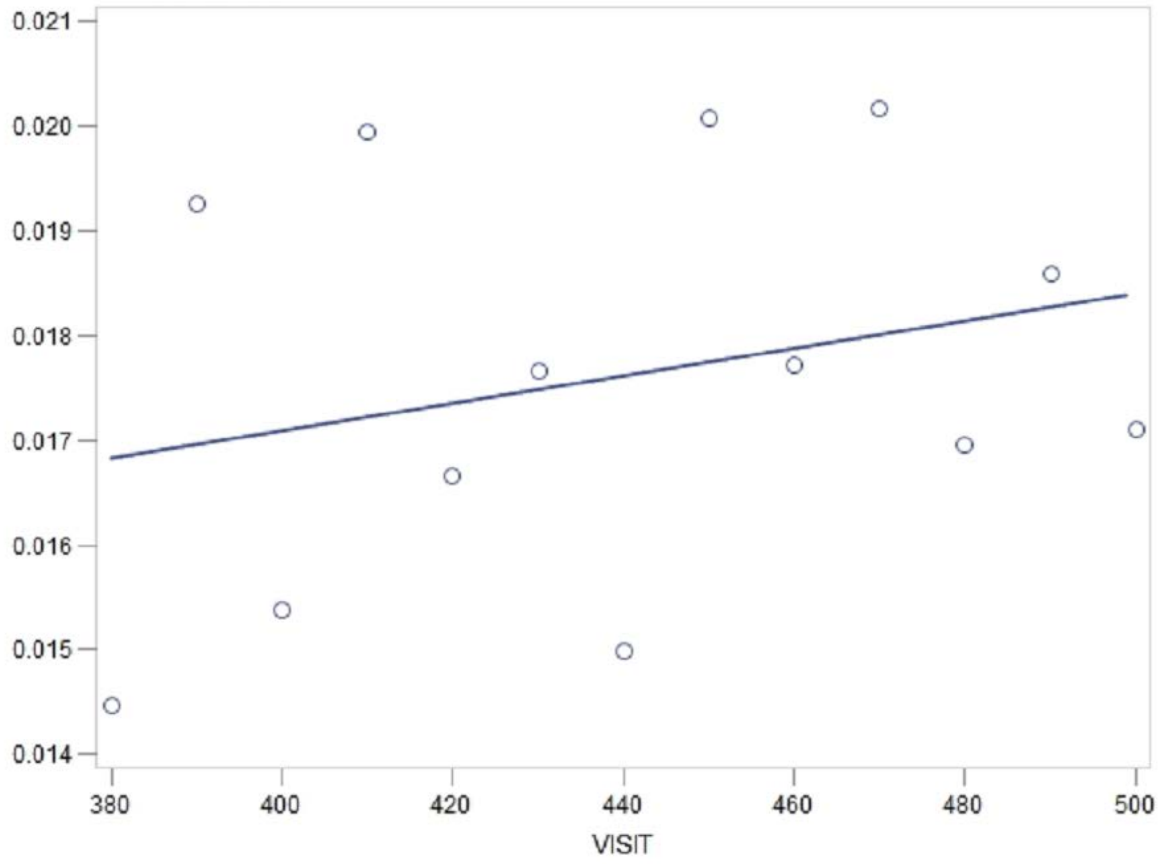

Figure 4. Average percentage of sexual intercourse partners who are female, waves 38-50*

**All figures present regression plots based on real values. Accompanying tables testing for group differences present results from means estimated via SAS PROC MIXED (for continuous outcomes) and SPSS generalized estimating equations with repeated measures (GENLIN) (for dichotomous outcomes).*

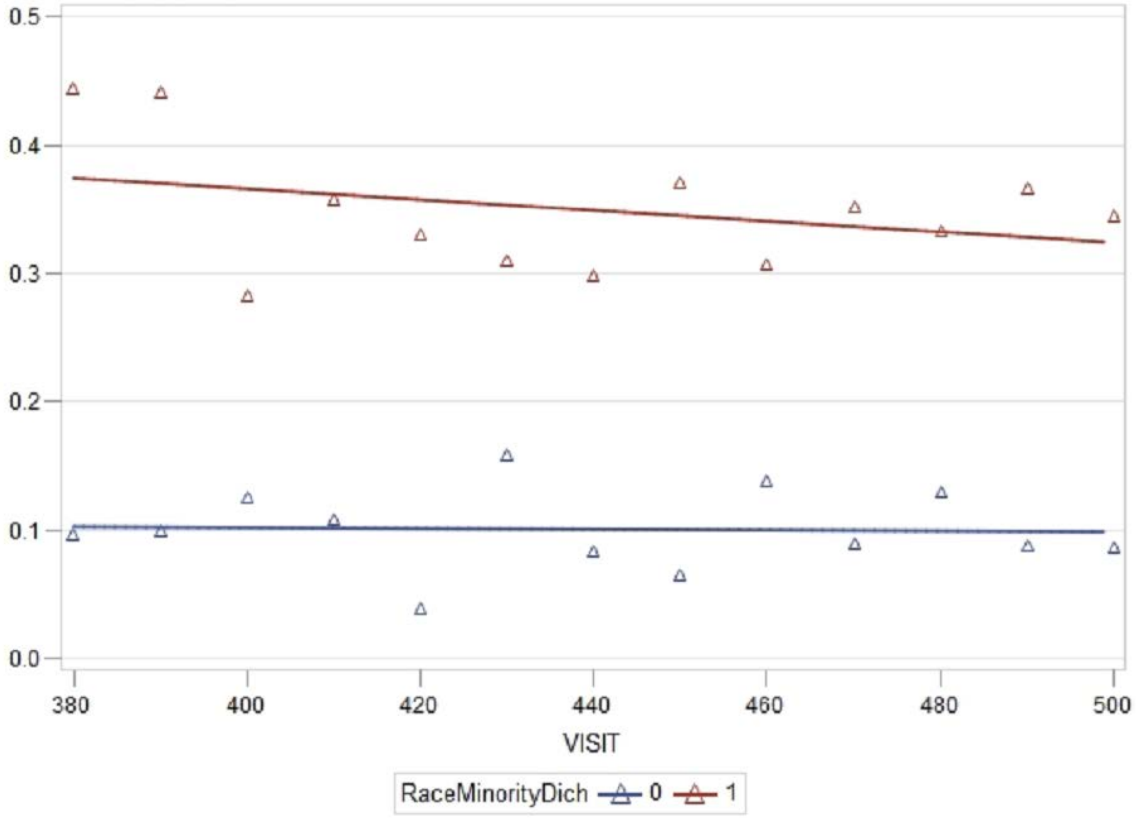

Figure 5. Percentage of female sexual partners among MSMW, by racial/ethnic minority

Table 12. Effects of racial/ethnic minority status on percentage of female partners: MSMW

Effect	Intercept estimate	Standard error	DF	t Value	Pr > |t|
Intercept	0.3919	0.04863	109	8.06	<.0001
Racial/ethnic minority	-0.3058	0.08660	109	-3.53	0.0006
Wave 38	0.03274	0.06506	109	0.50	0.6159

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
Racial/ethnic minority	1	109	14.85	<.001
Wave	12	109	0.77	0.678
Racial/ethnic minority by wave	12	109	1.99	<.05

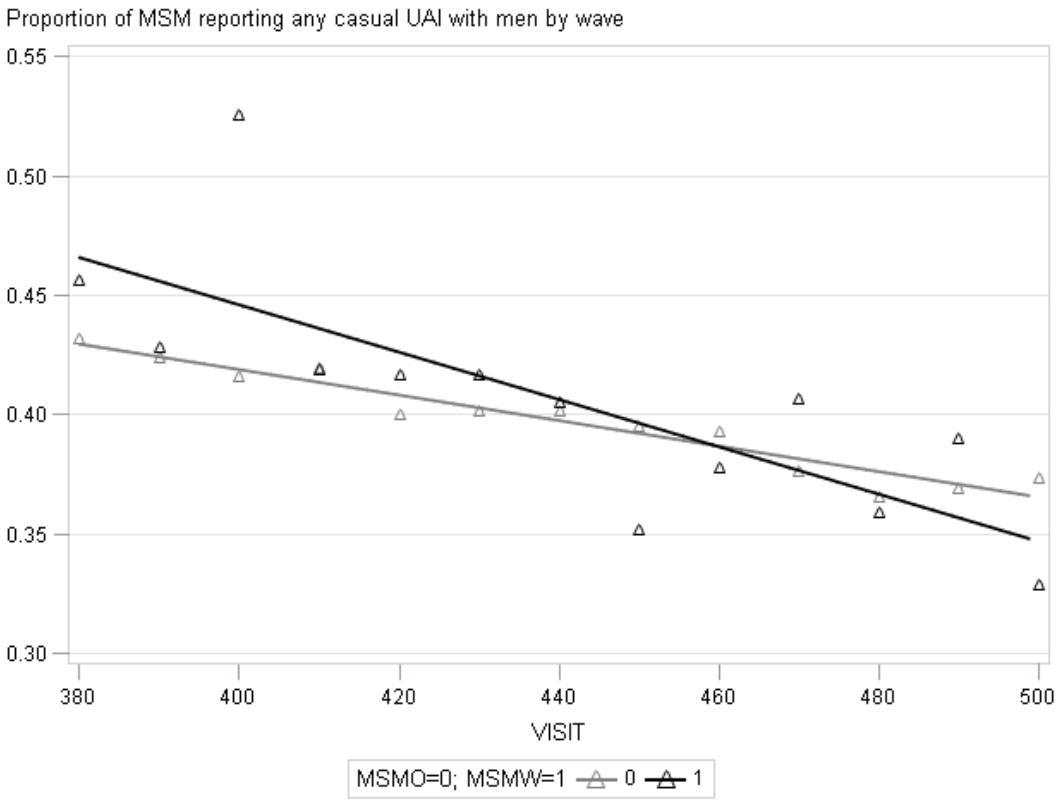

Figure 6. Proportion of MSM reporting any casual UAI with men (waves 38 to 50)

Table 13. Effects of MSMW status on casual UAI with men, waves 38-50

Tests of Model Effects			
Source	Type III		
	Wald chi-Square	df	sig.
(Intercept)	4.762	1	.029
Wave	15.740	12	.203
MSMW	.084	1	.772
MSMW by wave	9.919	12	.623
Racial/ethnic minority	4.901	1	.027

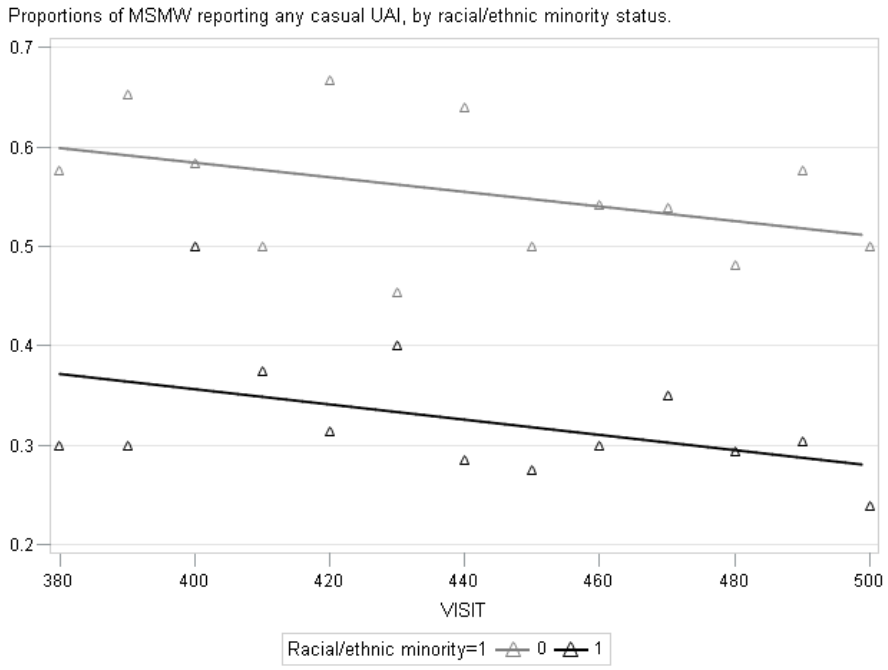

Figure 7. Proportions of MSMW reporting any casual UAI, by racial/ethnic minority status

Table 14. Effects of racial/minority status on casuaul UAI with men, within MSMW

Tests of model effects	Type III		
	Wald Chi-Square	df	Sig.
(Intercept)	2.174	1	.140
Minority by wave	19.728	12	.072
Racial/ethnic minority	7.634	1	.006
Wave	12.393	12	.415

Estimates	Mean	Std. Error	95% Wald Confidence Interval	
			Lower	Upper
White	.56	.075	.41	.69
Racial/ethnic minority	.32	.038	.25	.40

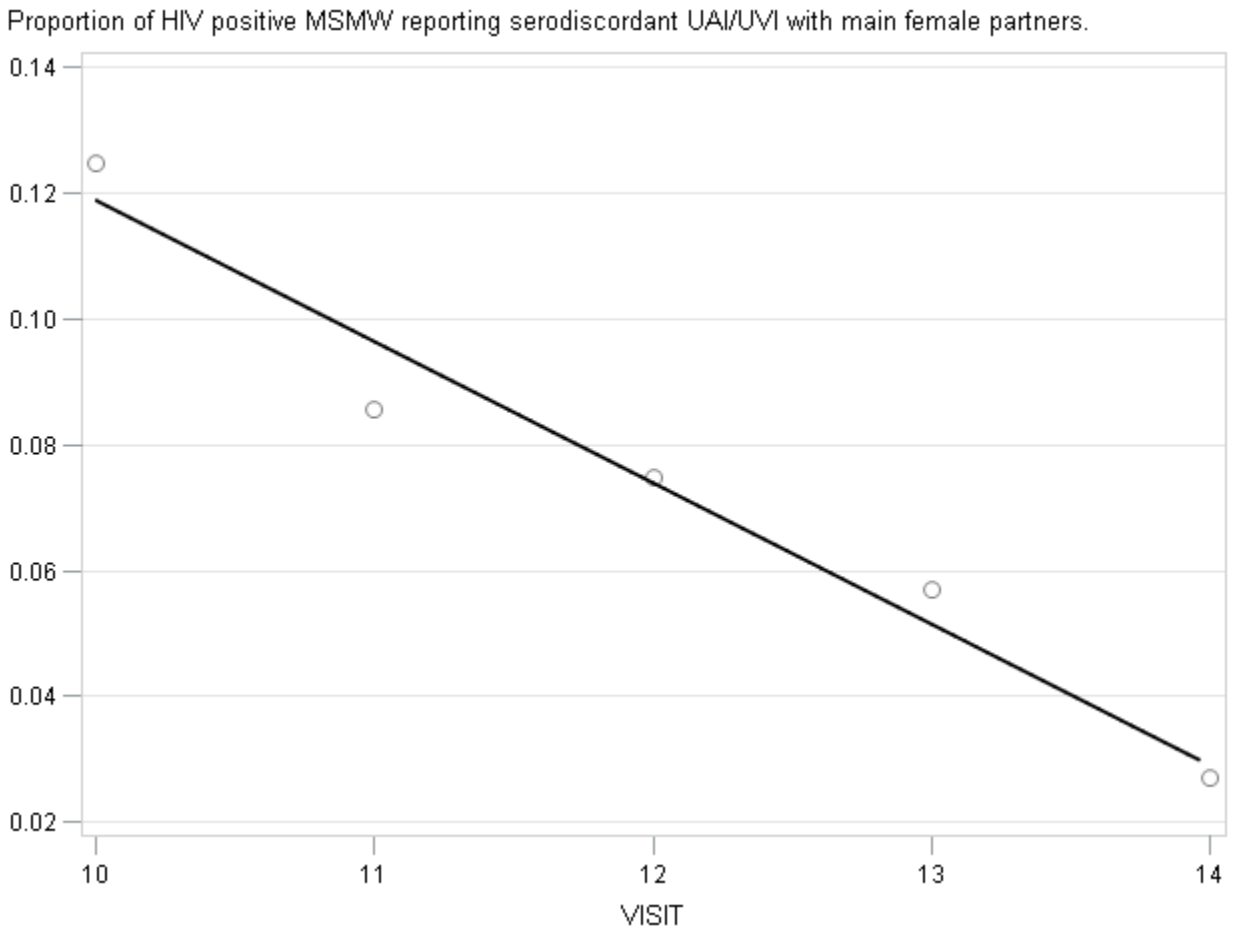

Figure 8. Proportions of HIV positive MSMW with heterosexual transmission risks

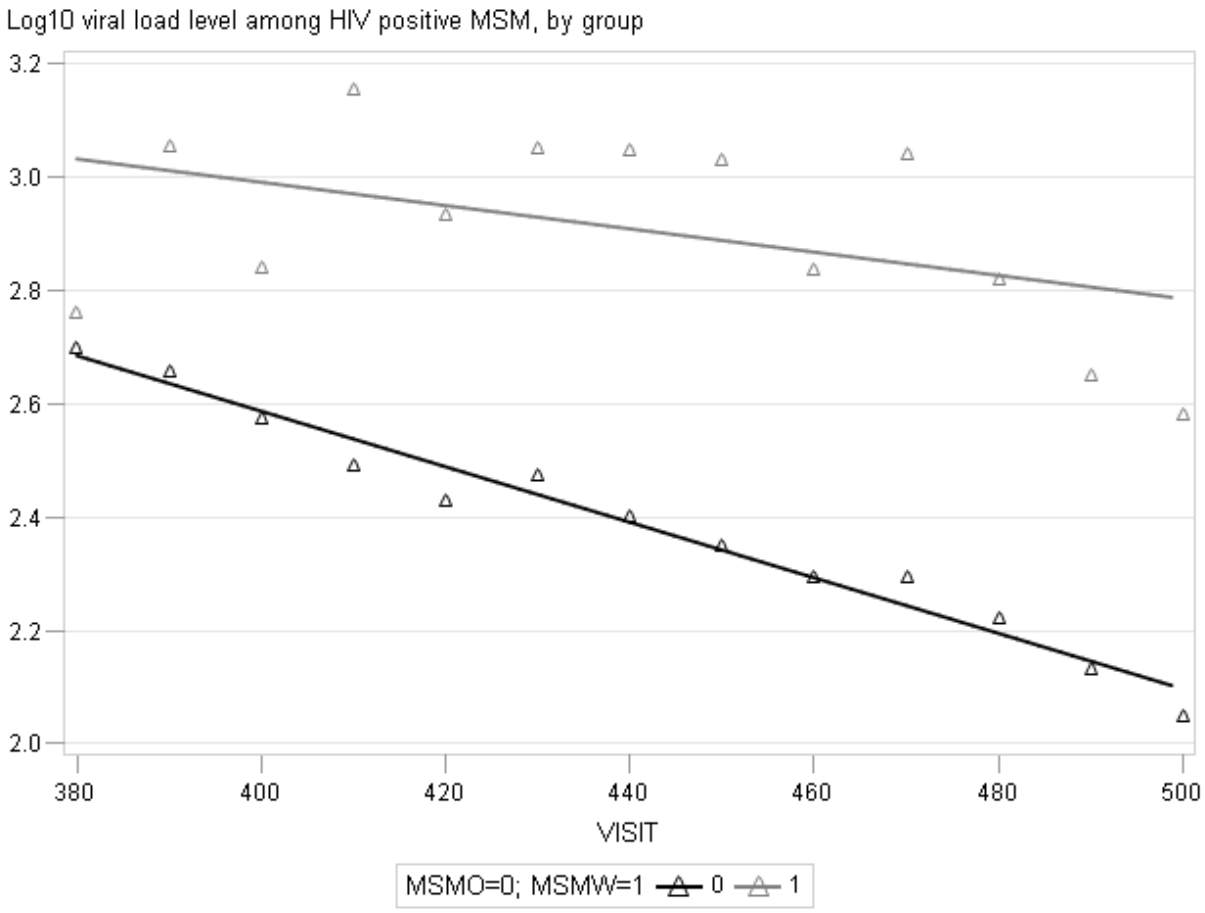

Figure 9. Log10 viral load level among HIV positive MSM, by group

Table 15. Effects of MSMW status on log viral load: HIV positive MSM, waves 38-50

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
MSMW	1	745	7.56	<.01
Racial/ethnic minority	1	745	44.14	<.001
Wave	12	745	4.79	<.001
Seroconverter at wave	1	745	48.53	<.001
MSMW by wave	12	745	1.83	<.05

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	2.3184	0.05457	745	42.48	<.001
MSMW	0.2983	0.1554	745	1.92	.055
Racial/ethnic minority	0.4232	0.06369	745	-6.64	<.001
Wave	0.6868	0.06420	745	10.70	<.001
Seroconverter at wave	0.9315	0.1337	745	6.97	<.001

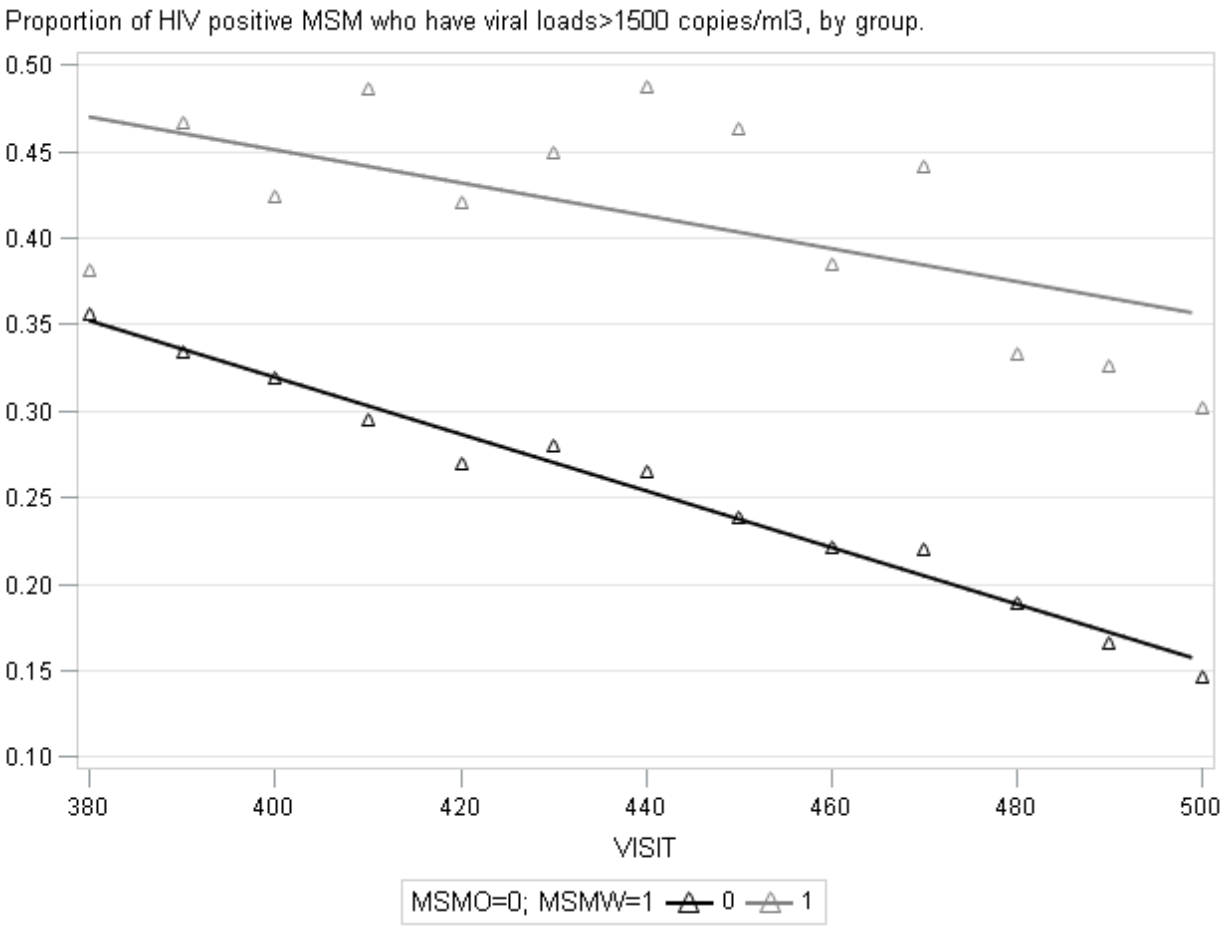

Figure 10. Proportion of HIV positive MSM who have viral loads>1500 copies/cubic milliliter

Table 16. Effects of MSMW status on viral load>1500 copies/ml3: HIV positive MSM

Source	Type III tests of model effects		
	Wald Chi-Square	df	Significance
(Intercept)	10.764	1	.001
MSMW	4.394	1	<.05
Wave	62.418	12	<.001
Racial/ethnic minority	35.254	1	<.001
MSMW by Wave	13.769	12	.316
Seroconverter at wave	5.057	1	<.05

Estimates				
	Mean	Std. Error	95% Wald Confidence Interval	
			Lower	Upper
MSMW	.45	.071	.32	.59
MSMO	.34	.043	.26	.43

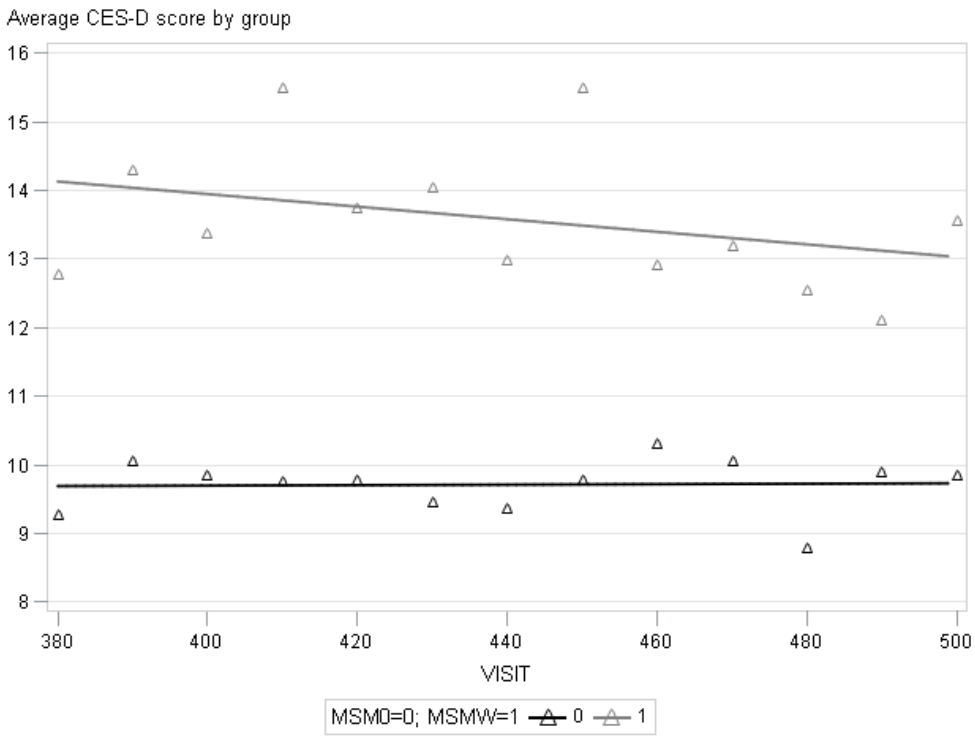

Figure 11. Average CES-D score, MSMW compared with MSMO (waves 38-50)

Table 17. Effects of MSMW status on CES-D score: MSM, waves 38-50

Type 3 tests of fixed effects				
Effect	Num DF	Den DF	F Value	Pr > F
MSMW	1	1603	9.14	<0.01
Wave	12	1603	2.06	<0.05
Racial/ethnic minority	1	1603	50.57	<.001
MSMW by wave	12	1603	1.82	<0.05

Solution for fixed effects					
Effect	Estimate	Standard error	DF	t Value	Pr > |t|
Intercept	12.2965	0.4276	1603	28.76	<.001
MSMW	2.0618	1.0539	1603	1.96	0.05
White	-3.2863	0.4621	1603	-7.11	<.001
Wave 38	0.08591	0.2900	1603	0.30	0.77

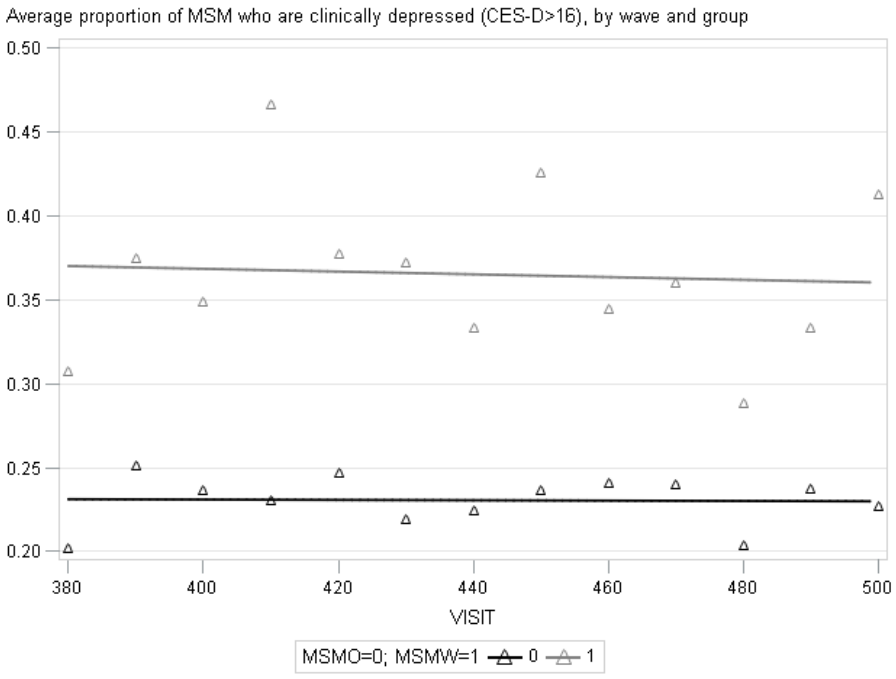

Figure 12. Proportions of MSMW and MSMO with CES-D score>16, waves 38-50

Table 18. Effects of MSMW status on CES-D score above 16: MSM, waves 38-50

Tests of Model Effects			
Source	Type III		
	Wald Chi-Square	df	Significance
(Intercept)	177.095	1	<.001
wave	22.842	12	<.05
MSMW by wave	14.815	12	0.25
MSMW	6.443	1	<.05
Racial/ethnic minority	43.863	1	<.001

Group	Estimated mean	Std. error	95% Wald confidence interval	
			Lower	Upper
MSMO	.23	.008	.21	.25
MSMW	.31	.031	.25	.37

Table 19. Psychosocial health conditions at waves 49/50 among MSMW and MSMO

	Total	MSMO	MSMW	AOR (95% CI)
High early IHP	380/1202 (31.6%)	348/1128 (30.9%)	32/74 (44.4%)	**1.7 (1.0, 2.8)**
High current IHP	400/1378 (29.0%)	351/1300 (27.0%)	29/78 (37.2%)	**3.0 (1.8, 5.0)**
Low masculinity attainment	499/1248 (40.0%)	474/1174 (40.4%)	25/74 (33.8%)	0.7 (0.5, 1.2)
High sexual compulsivity	541/1357 (39.9%)	495/1275 (38.8%)	46/82 (56.1%)	**1.8 (1.1, 2.9)**
2+ syndemic conditions	601/1472 (40.8%)	538/1381 (39.0%)	53/91 (58.2%)	**1.7 (1.1, 2.6)**

**All regressions controlling for racial/ethnic minority status.*

4.0 HIV RISK AMONG SUBSTANCE-USING MEN WHO HAVE SEX WITH MEN AND WOMEN (MSMW): FINDINGS FROM SOUTH FLORIDA

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Manuscript in preparation.

4.1 INTRODUCTION

An increasing literature on broad health disparities among men who have sex with men (MSM) has emerged over the past few decades (Stall et al, 2008). These disparities include physical health, such as HIV/AIDS and syphilis (CDC, 2010; Sullivan and Wolitski, 2008); mental and psychosocial health, such as suicidality, depression, and substance use (Mills et al, 2004; Cochran and Mays, 2009; Marshal et al,

2008; Ostrow and Stall, 2008); and behavioral health, such as unprotected anal intercourse (UAI) with partners of serodiscordant/unknown HIV status, being paid for sex (sex work), and using substances concurrently with sexual activity (Friedman et al, 2008; Ostrow et al, 2009). Health disparities among MSM have been theoretically and empirically linked to disparate rates of adversity in childhood and adulthood: peer bullying, sexual and physical violence victimization, and sexuality-related discrimination (Herek and Sims, 2008; Purcell et al, 2008; Friedman et al, 2011) work together to increase effects of minority stress (Meyer, 1995; Meyer, 2003) and contribute to the development of these co-occurring disparities (Herrick et al, 2012). Together, these findings lead to the conclusion that there are serious and closely linked health challenges among MSM that need to be addressed. The term "syndemics" has been recently used to describe the burden of synergistic epidemics that the MSM population suffers. As this literature has continued to develop, greater attention has been spent examining health disparities within MSM in a more fine-grained way, exploring differences among sub-populations such as young MSM, Black and Hispanic MSM, and non-gay-identified MSM. One emerging tradition in this work has been to describe health profile differences between men who have sex with men only (MSMO) and men who have sex with men and women (MSMW). When these two groups of MSM are compared in terms of health disparities, MSMW tend to present a more worrisome health profile. One of the most striking differences between the two groups has do to with the greater tendency of MSMW to engage in transactional sex, defined as buying or selling sex for money or drugs (Knight et al, 2007; Wheeler et al, 2008; Gorbach, et al 2009; Zule et al, 2009; Spikes et al, 2009; Jeffries & Dodge, 2007; Diaz et al, 1993; Hightow et al, 2006; Latkin et al, 2011; Wyatt et al, 1999; Udry and Chantala, 2002; Levin et al, 2009; Bobashev et al, 2009). MSMW have also reported using substances (Shoptaw et al, 2009; Wheeler et al, 2008; Zule et al, 2009; Russell et al, 2002) and engaging in concurrent substance use and sex at greater rates than MSMO (Jeffries and Dodge, 2007; Pathela and Schillinger, 2010; Goodenow et al, 2002; Levin et al, 2009; Spikes et al, 2009; Agronick et al, 2004; Zellner et al, 2009). This raises an interesting epidemiological puzzle: why would MSMW be more likely to engage in these behaviors than MSMO?

Qualitative research has suggested that for many MSMW, transactional sex serves an introduction to same-gender sex: the transactional sex demimonde may be viewed as a multi-gendered scene wherein both substance use and sexual needs can be met, and wherein the transactional component enables and motivates concurrent substance use and sex with other men by helping participants psychologically buffer the stigma of same-sex behaviors (Harawa et al, 2008; Wheeler, 2006; Rhodes et al, 1999; Lichtenstein, 2000; Boyer, 1989, Friedman, 2003). A similar psychological mechanism has been offered as an explanation for elevated rates of concurrent substance use and sex among MSMW: getting drunk or high before sex can also serve important dissociative purposes, facilitating sexual contact between men while allowing participants to smooth over their own internalized stigma regarding same-gender sexual activities (Zea et al, 2003; Wheeler, 2006). Our concern here exceeds basic academic curiosity: the intersection of transactional sex involvement and using substances concurrently with sex may constitute a particularly risky milieu for bisexually behaving men. Concurrent sexual and substance use behavior, especially stimulant drug use, has been shown to be an important predictor of HIV seroconversion among MSM generally (Ostrow et al, 2009). Male sex work involvement has also been demonstrated to significantly predict both current and future HIV risk behavior and depression (Friedman et al, 2011). Within populations of Black MSMW, concurrent substance use and sex is associated with higher rates of unprotected sex with male and transgender sexual partners (Operario et al, 2011); and sex work involvement has been significantly correlated with unprotected insertive anal intercourse (UIAI) (Wheeler et al, 2008), with Black MSMW more likely than their white counterparts to buy sex and to sell sex (McKirnan et al, 1995). Within MSMW, selling sex has been associated with inconsistent condom use with casual female partners and injection drug use (Reitmiejer et al, 1998).

Given the robust findings related to health behavior disparities in concurrent substance use and sex and transactional sex involvement among MSMW, further research must be undertaken that identifies correlates of these behaviors in order to better inform intervention development: what are the background forces driving these disparities? Guided by Syndemics Theory for MSM (Stall et al, 2008), we elected to test whether higher levels of psychosocial conditions within MSMW are associated with greater HIV risk,

as has already been shown within MSM (Herrick et al, 2011). It is not known whether syndemic properties among MSMW (such as homelessness, depression, sexual compulsivity, and adverse childhood experiences) are associated with concurrent substance use and sex and transactional sex involvement; and whether, within high-risk MSMW, concurrent substance use and sex and transactional sex involvement are linked to unprotected anal intercourse with partners of serodiscordant or unknown HIV status. This paper will compare MSMO and MSMW, and test within MSMW, to determine the psychosocial correlates of risk behaviors most associated with UAI with partners of serodiscordant/unknown HIV status among an exceptionally high-risk sample of MSM: substance users in Miami and Fort Lauderdale. Specifically, we will test whether MSMW conjointly engage in concurrent substance use and sex and transactional sex at significantly higher rates than MSMO; whether conjointly engaging in concurrent substance use and sex and transactional sex significantly predicts UAI with partners of serodiscordant/unknown HIV status within MSMW; and whether, within MSMW, syndemic burden significantly predicts conjoint engagement in transactional sex and concurrent substance use and sex. Conducting these analyses within a sample of substance users in a high-prevalence HIV/AIDS catchment area will maximize our ability to pinpoint the psychosocial and behavioral intervention-related needs of MSMW at highest risk for HIV acquisition and transmission.

4.2 METHODS

4.2.1 Sample.

We used a sample of sexually active, substance-using MSM in a CDC-defined high HIV/AIDS prevalence area, which allowed us to conduct a highly conservative comparative analysis, as substance-using MSM have been demonstrated to suffer exceptionally high background rates of psychosocial health issues and HIV risk behavior (Stall et al, 2008). Although several studies have characterized the sexual risks of MSMW in the United States, few have done so within a sample of high-risk MSM residing in an HIV epicenter. This reports data on the sexual risks of MSMW in a sample of substance-using MSM in

South Florida, which has among the highest HIV prevalence and incidence rates in the nation, and the 6th-highest number of cumulative AIDS cases (Centers for Disease Control and Prevention, 2011).

We analyzed baseline data from a study of sexually active, substance-using MSM in Miami and Fort Lauderdale, who were recruited into an HIV prevention intervention via targeted sampling (n=515). Men were eligible for the study if they were 18 to 55 years of age; reported unprotected anal intercourse (UAI) with at least one non-monogamous male partner in the past 90 days; and reported either binge drinking (5 or more drinks) or drug use (excluding marijuana) at least three times in the past 90 days, or marijuana use on at least 20 days during the past month. Recruitment methods have been described elsewhere (Kurtz et al, 2012). Computer-assisted face-to-face interviews were administered by trained staff in private locations and took between 30 and 60 minutes to complete. Research protocols were approved by Institutional Review Boards for the University of Delaware (predecessor institution), Nova Southeastern University, and the University of Pittsburgh (secondary data analysis).

4.2.2 Measures.

Men were classified as MSMW if they reported having sex with a female in the past year. Based on self-reported HIV status (negative, positive, or unknown), perceived HIV status of sexual partners within the past 90 days, and sexual behaviors within the past 90 days, dichotomous variables were created that measured UAI with a partner of serodiscordant or unknown HIV status. We collected basic sociodemographic information about participants' self-reported age, race, ethnicity, annual income, HIV status, and sexual orientation. We collected data on sexual behaviors with both primary and non-primary male sexual partners. Participants reported the partner type and HIV status (negative, positive, or unknown) of each partner, and frequency of unprotected insertive and receptive anal intercourse with X number of male partners in the prior three months. Frequencies of substance use in the past three months, including binge drinking (5 or more drinks per night), methamphetamine, crack, cocaine, ecstasy, and marijuana, were assessed. Participants also reported frequencies of using each of these substances if they used before sex with a man (concurrent substance use and sex). Responses were later converted to dichotomous variables. Additionally, participants were asked "How often in the last 3 months were you

'high' on alcohol or drugs when you were having anal sex with a man?" Interval-level responses (almost all the time/more than half the time/about half the time/less than half the time/never) were later dichotomized (almost all the time vs. other).

Selling sex: Participants were asked, "During the past 12 months, did you trade sex to get drugs, gifts, or money?"

Buying sex: Participants were asked, "During the past 12 months, did you use drugs, gifts, or money to purchase or get sex?"

Transactional sex: Reflected any buying or selling sex within the past 12 months.

Involvement in transactional sex and almost always high while having anal sex with a man: Dichotomous interaction term created by multiplying the transactional sex variable by the variable assessing being almost always high while having sex with a man.

Severe depression: Assessed using the 9-item Depression Symptom Scale (DSS-9) developed by Chestnut Health Systems (Dennis et al). Continuous variables were developed into categorical variables for non-clinical, moderate, and severe depressive symptoms, and then dichotomized into binary (yes/no) variables for severe depressive symptoms.

Sexual compulsivity: Dichotomized from standard scale by estimating mean scores and establishing a cut-off for high sexual compulsivity at two standard deviations or more above the mean.

Child abuse history: Assessed by asking participants separately whether anyone had ever sexually abused them (pressured or forced to participate in sexual acts against their will); physically abused them; or emotionally abused them. Participants who reported experiencing any of these violent victimizations before the age of 18 were considered to have child abuse histories.

Syndemic burden: A count measure (0-4) of positive scores for severe depression (DSS-9), sexual compulsivity, homelessness, and child abuse history was used as the syndemic variable. This was later recoded to dichotomously assess 2 or more syndemic conditions (syndemic burden).

4.2.3 Statistical analysis.

We first used bivariate analyses (Pearson's chi-square tests for categorical variable and t-tests for continuous variables) to compare sociodemographics (age, race, income, ethnicity, and sexual orientation) between MSMW and MSMO. We calculated descriptive statistics to determine the mean and standard deviation of the number of female sexual partners in the past 90 days among MSMW. We conducted one-way analyses of variance (ANOVA) to compare the mean numbers of male sexual partners in the past 90 days between MSMW and MSMO. We then conducted multiple logistic regressions to test associations between concurrent substance use and sex and MSMW status; transactional sex and MSMW status; and high-risk UAI and MSMW status. Each regression controlled for Black race, young adult status, annual income under $20,000, and Hispanic ethnicity (sexual identity was not included as a covariate due to multicollinearity with sexual behavior.) We then conducted multiple logistic regressions to test associations between syndemic conditions, concurrent substance use and sex, and transactional sex on high-risk UAI among MSMW only, controlling for the covariates above. Finally, we conducted hierarchical logistic regressions within the MSMW subgroup to determine the amount of variance in a) high-risk UAI contributed by sociodemographic covariates, being HIV positive aware, and transactional sex involvement and always being high for anal sex with men; and b) conjoint transactional sex involvement and always being high for anal sex with men contributed by sociodemographic covariates and individual syndemic properties (severe depression, adverse childhood experiences, homelessness, and high sexual compulsivity). All statistical tests were performed using SPSS 18.0.0.

4.3 RESULTS

MSMW comprised 16.7% (n=86) of the sample (Table 20). MSMW were significantly more likely than other MSM to identify as bisexual and as Black, and to report past-year incomes of less than $20,000. No significant differences were noted in mean age or in the rate of those who identified as Hispanic/Latino.

Compared with men who had sex with men exclusively in the past year, MSMW were more likely to report having 5+ drinks before sex (AOR=1.8; 1.0, 3.4, 95% CI), using Ecstasy before sex (AOR=2.8; 1.5, 5.4, 95% CI), using powder cocaine before sex (AOR=2.1; 1.3, 3.4, 95% CI), and selling sex (AOR=1.6; 1.0, 2.8, 95% CI). They were also significantly more likely to have engaged in any transactional sex (AOR=1.7; 1.0, 2.8, 95% CI). MSMW were significantly more likely than MSMO to conjointly report both engagement in transactional sex *and* almost always being high when having anal sex with a man (AOR=1.7; 1.0, 3.0, 95% CI). MSMW were marginally ($p \leq .10$) more likely than MSMO to report concurrent stimulant use and sex; almost always being high while having anal sex with a man; and purchasing sex. High proportions of MSMW (53.5%) reported having UAI with male partners of serodiscordant or unknown HIV status within the past 90 days. MSMW reported a past-year mean of 6.5 female partners, and a past-90 day mean of 12.8 male anal sex partners (not significantly different from the 13.3 mean for MSMO). MSMW were significantly less likely than MSMO to report having URAI with non-primary partners of serodiscordant or unknown HIV status (AOR=0.4; 0.2, 0.8, 95% CI) and to self-report being HIV positive (AOR=0.4; 0.2, 0.7, 95% CI) – see Table 21.

Within MSMW, concurrent substance use and sex variables were not associated with high-risk UAI, though MSMW who reported almost always being high before anal sex with a man were more likely than other MSMW to also report high-risk UAI (Table 22). MSMW who engaged in forms of transactional sex were significantly more likely to report any high-risk UAI. MSMW who reported any transactional sex involvement *and* who reported almost always being high before anal sex with a man were also significantly more likely than other MSMW to engage in high-risk UAI (AOR=3.3; 1.2, 9.6, 95% CI).

Being HIV positive did not significantly contribute to the variance in high-risk UAI given sociodemographic factors. Transactional sex involvement concurrent with almost always being high before having anal sex with a man significantly predicted high-risk UAI, accounting for 4.8% of the variance in UAI with partners of serodiscordant or unknown HIV status, given other sociodemographic variables and being HIV positive aware (Table 23).

In a hierarchical logistic regression, psychosocial syndemic factors significantly predicted transactional sex involvement concurrent with almost always being high before having anal sex with a man, adjusting for young age, Black race, low-income status, and Hispanic or Latino ethnicity (Table 23). These models demonstrate that transactional sex involvement and almost always being high before male anal sex is significantly predicted by severe depression, which accounted for 13.5% of the variance in these conjoint behaviors among MSMW. All told, syndemic properties contributed 20.3% of the variance in conjoint transactional sex involvement and being almost always high when having anal sex with a man (Table 24).

4.4 DISCUSSION

MSMW are highly prevalent among substance-using MSM in South Florida and may account for a substantial proportion of at-risk MSM in other HIV epicenters. We have demonstrated that, within this population of substance-using MSM in South Florida, MSMW are significantly more likely than MSMO to engage in transactional sex; to report using several substances concurrently with sex; and to conjointly report engaging in transactional sex and almost always being high for anal sex with men. These behavioral factors, in turn, significantly predict UAI with partners of serodiscordant or unknown HIV status among MSMW; and they are significantly predicted by severe depression and overall syndemic burden suffered by MSMW. Our findings indicate that interventions that can address transactional sex and concurrent substance use and sex – for instance, by addressing safer exchange sex – may maximize the relevance of health promotion efforts targeting MSMW. Interventions that attempt to decrease the syndemic threshold faced by bisexually behaving men, such as those that provide mental health support for depression and sexual compulsivity, as well as transitional housing services, may also bolster these men's ability to reduce their rates of transactional sex and concurrent substance use and sex. While this study did not allow us to measure rates of unprotected vaginal intercourse (UVI) or UAI with female partners, these risks should be considered essential during intervention design with bisexually behaving

men; previous research has indicated that MSMW may be more likely than MSWE to engage in UVI (Myers et al, 2003; Spikes et al, 2009; Zellner et al, 2009). The bisexually behaving men in this sample reported a considerable number of recent female sexual partners. However, they were less likely to report being HIV-infected than MSMO. Moreover, because they were less likely than MSMO to engage in unprotected receptive anal intercourse with partners of serodiscordant or unknown HIV status, they may be less likely to seroconvert.

High levels of substance use, especially stimulants, among sexually active MSM have been consistently associated with higher risk of HIV infection and a sequelae of other physical and mental health morbidities, including other sexually transmitted infections, depression, and suicidality (Ostrow et al, 2009; Homer et al, 2008; Stall et al, 2003). Syndemics Theory for MSM adapts Meyer's theories on accessing minority strengths and coping with minority stressors (Meyer, 1995; Meyer, 2003) into a life-course model informed by the constructs of masculinity failure and resultant sexual silence that can characterize the profound alienation experienced by MSM youth, as theorized by Diaz (Diaz, 1998). Essentially, Syndemics Theory for MSM posits that the early emotional and social development of MSM youth is often marred by profound feelings of inadequacy related to not being able to meet social expectations of masculinity and heterosexuality. This can lead to internalized homophobia and consequent feelings of self-loathing even as MSM make contact with the gay community and develop individual sexual identities. These background negative feelings related to self-concept can lead to self-destructive behavior, including substance use and HIV risk behavior, especially when adolescent and young adult MSM make contact with a larger gay community with high background rates of substance use, STI, and HIV (Stall et al, 2003; Friedman et al, 2008; Stall et al, 2008).

We can conceive the experiences of MSMW to be similar to those of MSM, but with important distinctions. First, MSMW may have less access to minority strengths than men who have sex exclusively with men. Second, MSMW may have less success resolving sexual identities because of the liminal status of bisexuality in a culture that emphasizes binary categories over continua. As a result, they may be more susceptible to using substances during same-gender sex – for reasons of escape, belonging,

sexual disinhibition, or even self-destruction. On the other hand, sexual partnerships with women offer MSMW the opportunity to "pass" as heterosexual, potentially mitigating some minority stress effects. MSMW in North America have reported frustration with "invisible" identities and biphobic harassment from both gay/lesbian and straight communities and partners, which can substantially inflect mental health (Ross et al, 2010; Weinberg, 2005; Nakamura 2011). An important tenet of Syndemics Theory for MSM is that gay men are able to harness the organic support offered by gay and lesbian communities, which can provide necessary emotional connections while also imparting positive (i.e., safer sex) and negative (i.e., frequent substance use) community norms (Friedman et al, 2008; Stall et al, 2008). There is limited but compelling evidence in the scientific literature that bisexually behaving men are less likely than MSMO to be closely attached to gay and lesbian communities (Rust, 2000; Hightow et al, 2006). Without a strong, vibrant bisexual community in most American cities, MSMW may feel forced to secret their behaviors and fail to fully attach themselves to minority support mechanisms.

For these reasons, interventions designed to increase health levels among MSMW must also focus on reducing stigma particular to bisexual behavior within larger gay and lesbian networks and communities. Recent network-based research has demonstrated that MSMW increase social networks' interconnectivity (density) and range (breadth). These findings indicate that interventions for MSMW may also need to contain network-level components (Mimiaga et al, 2009; Hightow, 2006; O'Leary and Jones, 2006). Networks based on transacting money and drugs for sex and that are centered on MSMW are particularly well-suited to network-based approaches for four key reasons. First, their members are at high risk for HIV acquisition and transmission across their networks (MSMW are at risk for acquiring and transmitting HIV across sexual networks (Hightow, 2006). Second, they are unlikely to congregate together in public spaces due to stigma related to both sex exchange and same-gender sexual behavior, and the possibility of law enforcement action against both prostitution and drug possession. Third, their members have means and ability to contact each other, like other hard-to-reach populations who have been successfully recruited via respondent-driven sampling procedures such as injection drug users and transgender sex workers (Heckathorn, 1997). Finally, members of these networks may be likely to uptake

HIV prevention interventions that are incentive-based, such as Social Network Strategy for HIV Counseling, Testing, and Referral Services (Kimbrough et al, 2009). Interventions in which MSMW have participated are have not typically assessed in outcome data specific to bisexual risk (i.e., see Jones et al, 2008). Informed intervention design can remediate historical gaps in HIV prevention activities targeting MSMW (Operario et al, 2010; Martinez-Donate et al, 2011). Based on this study's results, we can envision an intervention design built on transactional sex network-based recruitment that provides individual-level harm reduction counseling in conjunction with ancillary services such as mental health treatment and housing services, augmented by a social marketing component focused on decreasing biphobia emitted by the gay and lesbian community.

This study has several important limitations. First and foremost, the non-random sampling frame of very high-risk substance-using MSM in South Florida is unlikely to be generalizable to the larger MSMW population. Certain variables created, such as those that reflect reciprocal sex exchangers (men who both buy and sell sex), or men engaged in transactional sex who also report being high almost all the time during anal sex with men, may not serve as useful measures in less targeted samples. Though the proportion of bisexually behaving men in this sample was substantial, their total number (86) may have been too small to effectively distinguish significant correlates for outcomes of interest, which is reflected by the number of findings that were only marginally significant as well as those that were significant but had wide confidence intervals; the subgroup sample size also made it unfeasible to conduct additional subgroup analyses (for instance, by race) within MSMW. Lastly, the alarmingly elevated rates of psychosocial health conditions faced by the sample as a whole reduced the possibility that significant differences between MSMW and MSMO would be detected during statistical testing.

The scientific literature has portrayed MSMW as a small proportion of MSM who are strategically important targets for HIV prevention because of their danger to female partners. Our results show that MSMW are not a small population, especially among high-risk MSM, and that their health risks are important in their own right. Prevailing depictions of bisexually behaving men as an HIV transmission risk to female sexual partners ignores their own risk of acquiring HIV (from males or

females) as well as their risk of transmitting HIV to male partners. This conceit is an unusual example of one population's risk behavior being framed entirely as another population's health risks; even smokers, who are at risk of causing respiratory illness in non-smokers exposed to secondhand smoke, are offered interventions designed to lower their own health risks from smoking. Intervention frameworks that consider bisexually behaving men solely as agents of infection are unlikely to effectively raise health levels among MSMW or, consequently, the women and men with whom they partner. Developing holistic interventions for substance-using MSMW that address involvement in transactional sex and concurrent substance use and sex has relevance for not only public health, but also human rights.

4.5 TABLES AND FIGURES

Table 20. Sociodemographics of substance-using MSMW and MSMO (n=515)

Sociodemographics	Category	MSMO (n=429)	MSMW (n=86)	Chi-square value	P-value
Age	Mean (+- s.e.)	39.2 (+- 0.5)	37.5 (+- 1.1)	--	n/s
Ethnicity	Hispanic	114 (26.6%)	19 (22.1%)	0.75	n/s
Race				54.3	.000
	Black or African-American	72 (16.8%)	44 (51.2%)		
	Asian	5 (1.2%)	0 (0%)		
	Native American	2 (0.5%)	0 (0%)		
	Caucasian	285 (66.4%)	28 (32.6%)		
	Other race	67 (15.6%)	14 (16.3%)		
Sexual identity				266.77	.000
	Gay	403 (93.9%)	18 (20.9%)		
	Bisexual	22 (5.1%)	66 (78.6%)		
	Homothug or other	4 (0.9%)	2 (2.3%)		
Income/poverty	Annual income <$20,000	203 (47.3%)	51 (59.3%)	4.04	.044

Table 21. HIV risk context among substance-using MSMW and MSMO (n=515)

Category	Measure	MSMO (n=429)	MSMW (n=86)	AOR (95% CI)*
HIV positive	Self-report	207 (48.3%)	32 (37.2%)	0.4 (0.2, 0.7)
Concurrent substance use and sex, last 90 days	5+ drinks before sex	285 (66.4%)	68 (79.1%)	1.8 (1.0, 3.4)
	Marijuana before sex	184 (42.9%)	50 (58.1%)	1.5 (0.9, 2.5)
	Ecstasy before sex	38 (8.9%)	22 (25.6%)	2.8 (1.5, 5.4)
	Crystal meth before sex	110 (25.6%)	12 (14.0%)	0.6 (0.3, 1.2)
	Powder cocaine before sex	131 (30.5%)	44 (51.2%)	2.1 (1.3, 3.4)
	Crack before sex	62 (14.5%)	24 (27.9%)	1.4 (0.8, 2.7)
	Any stimulant use before sex	237 (55.2%)	60 (70%)	1.6 (0.9, 2.7)*t*
	Almost always high when having anal sex with a man	186 (43.4%)	49 (57%)	1.5 (0.9, 2.5)*t*
Transactional sex, last 90 days	Traded sex for money, drugs, or gifts	89 (20.7%)	30 (34.9%)	1.6 (1.0, 2.8)
	Used money, drugs or gifts to purchase sex	90 (21%)	34 (39.5%)	1.6 (0.9, 2.8)
	Reciprocal sex exchangers (both bought and sold)	46 (10.7%)	21 (24.4%)	1.6 (0.9, 3.1)
	Any transactional sex	133 (31%)	43 (50%)	1.7 (1.0, 2.8)
Transactional sex *and* high during anal sex with a man, last 90 days	Any transactional sex involvement *and* almost always high when having anal sex with a man	78 (18.2%)	29 (33.7%)	1.7 (1.0, 3.0)
Sexual risk behavior, last 90	Mean number of male sexual partners	13.3 +- 0.9	12.8 +- 2.4	*n/s* (p=0.75)

(Table 21 continued)

days				
	Any UAI with a primary partner of serodiscordant/unknown status	23 (5.4%)	5 (5.8%)	1.0 (0.4, 3.0)
	Any UIAI with a non-primary partner of serodiscordant/unknown status	176 (41%)	34 (39.5%)	0.8 (0.5, 1.4)
	Any URAI with a non-primary partner of serodiscordant/unknown status	169 (39.4%)	19 (22.1%)	0.4 (0.2, 0.8)
	Any UAI with any partner of serodiscordant/unknown status	255 (59.4%)	46 (53.5%)	0.7 (0.4, 1.1)

**controlling for youth (age<30), annual income <$20,000, Black race, and Hispanic ethnicity.*

Table 22. Correlates of high-risk UAI among substance-using MSMW (n=86)

Category	Measure	No high-risk UAI (n=40)	High-risk UAI (n=48)	AOR (95% CI)*
HIV-positive	Self-report	9 (22.5%)	23 (50%)	2.1 (0.7, 6.0)
Concurrent substance use and sex, last 90 days	5+ drinks before sex	32 (80%)	36 (78.3%)	0.6 (0.2, 2.1)
	Marijuana before sex	22 (55%)	28 (60.9%)	1.1 (0.4, 2.8)
	Ecstasy before sex	13 (32.5%)	9 (20%)	0.4 (0.1, 1.1)
	Crystal meth before sex	6 (15%)	6 (13.0%)	1.1 (0.3, 4.3)
	Powder cocaine before sex	18 (45%)	26 (56.5%)	1.3 (0.5, 3.4)
	Crack before sex	7 (17.5%)	17 (37%)	2.2 (0.8, 6.4)
	Stimulant use before sex	30 (75%)	30 (65.2%)	0.4 (0.1, 1.2)
	Almost always high when having anal sex with man	18 (45%)	31 (67.4%)	1.9 (0.7, 4.8)
Transactional sex, last 90 days	Traded sex for money, drugs, or gifts	10 (25%)	20 (43.5%)	2.8 (1.0, 8.1)
	Used money, drugs or gifts to purchase sex	9 (22.5%)	25 (54.3%)	2.8 (1.0, 7.8)
	Reciprocal sex exchangers (both bought and sold)	5 (12.5%)	16 (34.8%)	3.3 (1.0, 11.1)
	Any transactional sex	14 (35%)	29 (63%)	2.7 (1.0, 7.0)
Transactional sex/concurrent substance use and sex	(Any transactional sex involvement)*(Almost always high when having anal sex with a man)	7 (17.5%)	22 (47.8%)	3.3 (1.2, 9.6)
Syndemic burden	2 or more syndemic conditions	16 (40%)	26 (56.5%)	1.7 (0.7, 4.3)

**controlling for youth (age<30), annual income <$20,000, Black race, and Hispanic ethnicity*

Table 23. Hierarchical logistic regression of risk factors on high-risk UAI: MSMW (n=86)

	B	s.e. (B)	Standardized Beta coefficient	R-square	R-square change
Step 1				0.125*	0.125*
Income <$20,000	0.05	0.11	0.05		
Black/African-American	0.16	0.12	0.16		
Hispanic or Latino	-0.12	0.14	-0.10		
Age <30	-0.25	0.13	-0.21		
Step 2				0.145*	0.021
Income <$20,000	0.03	0.11	0.02		
Black/African-American	0.13	0.12	0.13		
Hispanic or Latino	-0.11	0.14	-0.09		
Age <30	-0.20	0.14	-0.16		
HIV positive aware	0.17	0.12	0.16		
Step 3				0.193**	0.048*
Income <$20,000	0.03	0.11	0.03		
Black/African-American	0.08	0.12	0.08		
Hispanic or Latino	-0.11	0.14	-0.09		
Age <30	-0.17	0.14	-0.14		
HIV positive aware	0.14	0.12	0.14		
Transactional sex *and* always high during anal sex with a man	0.24	0.11	0.23		

*$p<.05$. **$p<.01$.

Table 24. Syndemic correlates of transactional sex and high during male UAI among MSMW

	B	s.e. (B)	Standardized Beta coefficient	R-square	R-square change
Step 1				0.085	0.085
Income <$20,000	0.01	0.11	0.01		
Black/African-American	0.21	0.12	0.22		
Hispanic or Latino	-0.01	0.14	-0.00		
Age <30	-0.17	0.13	-0.14		
Step 2				0.220***	0.135***
Income <$20,000	-0.03	0.10	-0.03		
Black/African-American	0.23	0.11	0.24		
Hispanic or Latino	0.02	0.13	0.02		
Age <30	-0.18	0.12	-0.16		
Severe depression (DSS-9)	0.38	0.10	0.37		
Step 3				0.249***	0.029
Income <$20,000	-0.08	0.10	-0.08		
Black/African-American	0.21	0.11	0.22		
Hispanic or Latino	-0.02	0.13	-0.02		
Age <30	-0.19	0.12	-0.16		
Severe depression (DSS-9)	0.34	0.10	0.33		
High sexual compulsivity	0.21	0.12	0.19		
Step 4				0.274***	0.025
Income <$20,000	-0.06	0.10	-0.07		
Black/African-American	0.23	0.11	0.24		
Hispanic or Latino	0.01	0.13	0.01		
Age <30	-0.21	0.12	-0.18		
Severe depression (DSS-9)	0.31	0.10	0.30		
High sexual compulsivity	0.21	0.12	0.19		
History of child abuse	0.16	0.10	0.17		
Step 5				0.288***	0.014
Income <$20,000	-0.09	0.11	-0.10		
Black/African-American	0.21	0.11	0.22		
Hispanic or Latino	0.02	0.13	0.02		

(Table 24 continued)

Age <30	-0.21	0.12	-0.18		
Severe depression (DSS-9)	0.25	0.11	0.25		
High sexual compulsivity	0.21	0.12	0.19		
History of child abuse	0.15	0.10	0.15		
Homelessness in past year	0.13	0.11	0.14		

**p<.05. **p<.01. ***p<.001*

5.0 CONCLUSION

Why should HIV/AIDS researchers and practitioners pay attention to bisexually behaving men? They compose, after all, roughly only 2% of the U.S. male population. Don't they benefit already from existing interventions targeted to men who have sex with men only (MSMO)? Perhaps: but there is little data to support this. In fact, all available evidence indicates that MSMW are less likely than other MSM to disclose same-sex behaviors to health care providers; less likely to be tested for HIV; less likely to be recruited into HIV/AIDS research or interventions; and less likely, when HIV positive, to be aware of their serostatus. Though their relative numbers are small, MSMW are disproportionately at risk for HIV infection, comprising roughly 10% of the entire U.S. population estimated to be living with HIV: though they are less than half as likely to have HIV than other MSM, they are many times more likely to have HIV as MSWE. And, when they are infected with HIV, MSMW have higher viral loads than other MSM and achieve viral suppression at a slower pace. Meanwhile, they are all but invisible in federal reporting mechanisms on HIV surveillance and in the federally promoted compendium of evidence-based interventions. Despite all of this, MSMW, if truly a hidden population, are hiding in plain view: the literature has demonstrated that MSMW have been recruited successfully when they are thoughtfully targeted.

This dissertation sets forth a rationale for greater public health attention to MSMW, but not because we have discovered compelling evidence of a significant amount of HIV transmission to female partners that is attributable to MSMW. Instead, it is the opposite: HIV positive MSMW with viral levels sufficient for heterosexual transmission are extraordinarily and decreasingly unlikely over time to report unprotected sex with main female partners of serodiscordant or unknown HIV status. This is not to say that MSMW do not assume the role of viral bridges from homosexual to heterosexual populations: though this of course happens, it is now clear that sexually active women are twice as likely to meet male partners who have acquired HIV through heterosexual intercourse or injection drug use than male partners who have acquired HIV through homosexual sex. The data we have presented impels us to consider

bisexually behaving men as whole people with stable sexual expression and unexceptional unprotected sex rates, who are nonetheless subject to profound psychosocial, behavioral, and biomedical disparities. These disparities may be theoretically – if not yet entirely empirically – linked to perceived and endured stigma and discrimination by a culture that disdains MSMW more than any other group. The esteem that MSMW are held in by U.S. society is exemplified within the microcosm of the scientific literature and general American media, which without adequate formative epidemiology to support their arguments have repeatedly laid the blame of heterosexual HIV/AIDS in the United States at the feet of bisexual men. We can view these volleys of the press and research establishments as a kind of biphobia index: in the way that the "men on the down-low" meme is panicked by and demonizes Black male sexuality (with all genders), viewing all bisexual men as potential HIV infectors (i.e., causes of danger and death) to the women with whom they partner is likely reflective of more than just a lack of information or an ignorance of facts. Our data show that while the bisexual bridge has its passengers, it is not a crowded causeway: it is, for the most part, pedestrian.

If the bisexual bridge rests on shaky foundations, the same can be said for the support of bisexuality itself in the United States. In a society that prizes binary categories over continua, bisexuals and transgender people report feeling detached from both the minority support of the gay and lesbian community and the majority support of the larger straight community. Among MSMW, this may manifest as (and/or be amplified by) such background adversities as high childhood internalized homophobia that does not resolve over time; elevated rates of violence victimization and peer bullying; and lower conceptions of family and school connectedness than their male peers. If they operate in similar fashion among MSMW as they do among MSM as a whole, these early adversities help explain the profound psychosocial health disparities, particularly substance use and depression, that bisexually behaving men present when compared to their peers. We have demonstrated in two separate studies that compared with other MSM, bisexually behaving men report almost twice the rate of experiencing syndemic burden. We have shown that syndemic burden is strongly associated with the intertwining of two chief HIV risk behavior disparities noted continually within MSMW: transactional sex involvement

and concurrent substance use and sex; and we have found that, among HIV positive MSM as a whole, syndemic burden is associated with unsuppressed viral load. Given what we know about syndemic production among MSM generally, we theorize that the roots of the HIV-related biomedical, psychosocial, and behavioral health disparities we have reported among MSMW have been fertilized in the toxic soil of social marginalization and nourished by overlapping sediments of stigma, discrimination, and secrecy.

The three analyses we report herein contain essential information about the HIV acquisition and transmission risks attributable to bisexually behaving men in the United States by attending to three key gaps in the literature. We have first looked at the HIV infection burden facing American MSMW, by estimating the HIV prevalence rate in this community via a meta-analysis; this was buttressed by a sub-analysis of the percentage of MSM who behave bisexually, allowing us to estimate both the population size of MSMW and the percentage of MSMW who were infected with HIV. Next, we have looked at the longitudinal stability of bisexual behavior and the trajectories of biomedical, behavioral, and psychosocial risks in a prospective cohort of MSM with substantial HIV infection. This allowed us to hone in on groups of MSMW who are at particular risk of HIV acquisition and transmission, and develop a better understanding of background risk factors most associated with HIV-related risk behavior in this population. Finally, we explored the relationship between distal psychosocial factors, key HIV-related health behavior disparities consistently found among MSMW, and high-risk UAI in this population, using a cross-sectional study of extremely high-risk, substance-using MSM in an HIV/AIDS epicenter. Taken together, these findings help us better understand those MSMW at highest risk for HIV acquisition and transmission, and provide needed background data that can inform intervention design for a population of men who face substantial HIV-related health risks but for whom interventions have not yet been successfully developed.

What implications do our findings have for intervention design and delivery? It is clear that the uniqueness of bisexual men's social standing requires tailored interventions. We might start by considering ways to address background adversities: working to make our schools safe for young MSMW

by reducing violence victimization and peer bullying. There are indications that young MSMW have not benefitted from bullying prevention programs as well as other young MSM. Social marginalization related to gays and lesbians continues to abate, but effects may not be trickling down commensurately to bisexuals. Social marketing campaigns, for example such programs as it "It Gets Better" and "Acceptance Journeys," are positioned to help destigmatize MSMW if an effort is made to reflect these men's experiences. The scientific literature has recommended network-level interventions to address HIV-related health risks among MSMW. This is a sensible solution: community-level interventions are unlikely to work with this population, given the available evidence indicating a relatively feeble bisexual community and infrastructure in most U.S. cities. New strengths-based efforts to focus on building resilience among MSM in general are very promising. We can envision an intervention design approach that diffuses resiliencies through the social and sexual networks of MSMW, perhaps focusing on helping these men reduce their levels of psychosocial health disparities (depression and substance use) most strongly associated with behaviors that facilitate high-risk UAI in this population (transactional sex involvement and concurrent substance use and sex). Given the data we have presented about IHP among MSMW, we respectfully suggest that interventions tailored to this population must contain components that empower men to celebrate bisexual desire and increase self-acceptance. Using resiliencies to moderate syndemic burden is a new field of research among MSM, and we submit that formative research must be conducted with MSMW concomitantly in order to develop and deliver interventions that are salient to the unique experiences of this population.

Much research needs to be conducted to fully understand the subtle differences both between MSMW and other sexual minority groups and within groups of MSMW. Qualitative research is necessary to contextualize our findings on higher viral loads, higher syndemic burden, higher levels of internalized homophobia, and lower levels of unprotected receptive anal intercourse found among MSMW compared to other MSM. Formative epidemiology cannot fully explain the pathways to these multiple and potentially synergistic conditions. Research that develops and standardizes consistent measures for various modes of transactional sex involvement, experienced and perceived sexual stigma

beyond simply homophobia, and appropriate proximal windows to assess bisexual behavior would add considerably to the canon. Longitudinal research that examines other variables such as substance use and sexually transmitted infections among MSMW is also important. Very little research has so far compared HIV-related acquisition and transmission risks within MSMW, for instance between MSMW by different races, ethnicities, and ages. Only larger samples than have traditionally been achieved (perhaps through recruitment that targets bisexually behaving men) will offer researchers the power to conduct such subgroup analyses across biomedical, psychosocial, and behavioral domains. This dissertation presents data that can ultimately serve as a framework for theorizing experiences particular to bisexually behaving men. Lastly, then, we recommend the design and empirical testing of behavioral theory attuned specifically to MSMW. The success of Syndemics Theory for MSM in predicting health effects of minority stress may well serve as a guide in such theoretical development. We can thus foresee an offshoot theory, Syndemics Theory for MSMW, which incorporates the unique adversities and disparities we have reported and pinpoints the most fruitful interstices for intervention delivery.

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