THE APPLICATION OF A SYNDEMIC FRAMEWORK IN EXPLORING RACE RELATED HIV DISPARITIES AND VULNERABILITIES AMONG MEN WHO HAVE SEX WITH MEN IN ATLANTA, GEORGIA

by

THOMAS L. STEVENS JR.

(Under the Direction of Amara Ezeamama)

ABSTRACT

INTRODUCTION: Since the beginning of the epidemic in the United States, HIV/AIDS has severely affected men who have sex with men (MSM). Black MSM continue to be disproportionately affected by the epidemic. The syndemic framework offers an innovative approach to understanding the relationship between HIV risk factors and the trajectory of HIV infection in MSM. **PURPOSE:** The dissertation examined the relationship between biopsychosocial risk factors, the association between HIV risk factors and respective HIV outcomes, and the relationship between the syndemic risk scores and HIV outcomes, in respect to race for MSM in Atlanta, Georgia. **METHODS:** Secondary data analysis was conducted on data derived from the NHBS-MSM 4th cycle (2014). The Chi-square (X^2) and one-way analysis of variance (ANOVA) tests determined the differences in the proportion of select variables. Multivariate analyses tested the association between syndemic risk scores and race and the association between syndemic risks scores and defined HIV outcomes by race. **RESULTS:** There were no significant differences in syndemic risk scores by race ($p < 0.05$). The mean syndemic

risk scores were .68 to 2.96 units higher for Black MSM and 1.93 to 6.84 units higher for Other MSM compared to White MSM ($p < 0.05$). The PCA ($p = 0.004$) and Literature Informed ($p = 0.012$) Weighted Syndemic Risk Scores were associated with HIV positive status. There were no differences by race in the association between syndemic risks scores and HIV outcomes. **CONCLUSION:** There was a co-occurrence of multiple biopsychosocial risk factors for HIV infection across races. The odds of HIV infection and unprotected insertive anal intercourse (UIAI) increased by as much as 2.4 and 1.7 times per unit increment in syndemic risk score, respectively. Black MSM were associated with elevated odds of HIV positive status but lower odds of unprotected receptive anal intercourse (URAI). There was no significant difference by race and the association between syndemic risks scores and HIV outcomes. The convergence of biopsychosocial risk factors increases HIV outcomes beyond the individual risk of these factors. Researchers, practitioners, and policy makers must develop new approaches (e.g., syndemic) to addressing health disparities in the MSM population.

INDEX WORDS: HIV/AIDS, Men who have sex with men, Racial disparities, Ethnic groups, HIV risk factors, Syndemic, Black MSM, Biopsychosocial, Sexual behavior

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by

THOMAS L. STEVENS JR.

BS, The University Of Georgia, 1994

MBA, Kennesaw State University, 2004

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by

THOMAS L. STEVENS JR.

Major Professor: Amara Ezeamama

Committee: Timothy Heckman
George Khalil
Andrea Kim
Joel Lee

Electronic Version Approved:

Suzanne Barbour
Dean of the Graduate School
The University of Georgia
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DEDICATION

I dedicate this dissertation to the men and women who are working diligently to support people living with HIV/AIDS and to end the HIV/AIDS epidemic.

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CHAPTER 1

INTRODUCTION

Public Health Significance

In 2016, it was estimated that 78 million people globally were infected with the human immunodeficiency virus (HIV), 35 million people died of HIV/acquired immune deficiency syndrome (AIDS), and 36.7 million people were living with HIV since the beginning of the HIV pandemic (UNAIDS, 2016). There were 2.1 million new infections and 1.1 million AIDS-related deaths at the end of 2015 (UNAIDS, 2016). In the United States, more than 1.2 million people were living with HIV with an estimated 161,200 (13%) cases undiagnosed (CDC, 2015d). In 2015, there were 18,303 new AIDS diagnoses, with 1,216,917 people diagnosed since the beginning of the epidemic (CDC, 2015d). There were also 39,513 newly diagnosed cases of HIV infection (CDC, 2015d).

Although between 2005 and 2014 the number of new HIV diagnoses declined by 19% (CDC, 2015d), the HIV/AIDS epidemic continued to severely affect men who have sex with men (MSM) (CDC, 2012b). In 2010, 4% of the U.S. male population and 2% of the general U.S. population were MSM (Purcell et al., 2012). However, in 2015, MSM accounted for 82% (26,375) of newly diagnosed infections among men and 67% (26,474) among the general population (CDC, 2015d). In 2012, approximately 311,087 MSM diagnosed with AIDS had died since the start of the epidemic compared to 658,507 people in the general population (CDC, 2015d).

In 2007, among the 7.1 million MSM living in the United States, 5.1 million (71%) were White, 1.1 million (16%) were Hispanic, and 635,000 (9%) were Black (CDC, 2015d). The Centers for Disease Control and Prevention (CDC) estimated that approximately 1 in 2 Black MSM and 1 in 4 Latino MSM would be diagnosed with HIV in their lifetime, compared to 1 in 11 for White MSM (CDC, 2016b). In 2015, Black MSM accounted for 39% (10,315) of the estimated new HIV infections, compared to 29% (7,570) for White MSM and 27% (7,013) for Hispanics (CDC, 2015h). Black MSM also accounted for 39% (3,928) of the newly diagnosed AIDS cases, followed by 31% (3,096) of White MSM and 24% (2,430) of Hispanic MSM (CDC, 2015h). Models have also predicted that 39% of Black MSM would become HIV-positive by age 30 and 61% by age 40 (Matthews et al., 2015).

Many researchers have sought to determine the racial disparities and the factors implicated in the higher prevalence of HIV in Black MSM. They found that the adoption of higher risk behaviors, such as having multiple sexual partners or engaging in UAI, does not explain the disparate disease burden among Black MSM (Kerr et al., 2015; Magnus et al., 2010; Millett, Ding, et al., 2007; Millett, Flores, Peterson, & Bakeman, 2007; Millett, Peterson, Wolitski, & Stall, 2006). In fact, studies showed that Black MSM had equal or even lower rates of unprotected anal intercourse and sexual partners compared to other racial and ethnic groups (Magnus et al., 2010; Millett, Ding, et al., 2007; Millett, Flores, et al., 2007; Millett et al., 2006).

Despite continuous efforts to reduce racial disparities in HIV infection among MSM, Black MSM continue to be disproportionately affected by HIV/AIDS. There is an urgent need for more novel approaches to provide insight into the contributors of these health disparities among MSM.

One such approach is the identification of a theoretical framework, which incorporates biological, behavioral, psychosocial and structural determinants in understanding and addressing disparate HIV infection rates in MSM (Engel, 1977; Perry N Halkitis, Richard J Wolitski, & Gregorio A Millett, 2013). This framework encourages a more holistic approach to the interconnections between the HIV epidemic and related health conditions. The framework describes the interplay of interrelated syndemic conditions (i.e., mental health, HIV, STIs, substance abuse, violence and sexual abuse) in explaining the disproportionate rates of HIV in Black MSM (Perry N Halkitis et al., 2013). Syndemic is defined as two or more synergistically interacting epidemics (i.e., diseases or health problems), resulting in an increased disease burden in a population (Singer & Clair, 2003).

The utility of this syndemic framework can assist researchers and public health practitioners in understanding the factors and conditions that amplify HIV infection among Black MSM by exploring not only the individual effects, but also the syndemic interaction between these risk factors (e.g., STI, substance abuse, violence, PrEP usage, high-risk behaviors and exposures, access to healthcare, stress, homophobia, stigma, and discrimination, legal protection, and other risk factors).

Gaps in the Literature/Research

Several epidemiologic studies have investigated the association between individual risk factors for HIV infection in MSM (Magnus et al., 2010; Mayer et al., 2014; Millett, Flores, et al., 2007; Millett et al., 2006; Siddiqi, Hu, & Hall, 2015). Many studies have focused on the inter-relationship between a risk factor (e.g., substance abuse) and HIV infection. However, most of these studies have failed to explore the syndemic effect between risk factors and the trajectory

of the HIV epidemic in MSM (Stall et al., 2003). As previously mentioned, syndemic is described as the co-occurrence of two or more epidemics that increases the disease burden in a population (Singer & Clair, 2003).

Researchers of syndemic studies on MSM populations in the United States typically focused on the co-occurrence of psychosocial conditions. These conditions included depression, substance abuse, childhood sexual abuse, partner violence in a relationship, sexual risk behaviors, and the prevalence of HIV (Dyer et al., 2012; Mimiaga et al., 2015; Mustanski, Garofalo, Herrick, & Donenberg, 2007; O'Leary, Jemmott, Stevens, Rutledge, & Icard, 2014; Parsons, Grov, & Golub, 2012; Stall et al., 2003). However, there have been limited applications of the syndemic framework to assess the inter-relationship of biopsychosocial risk factors in explaining HIV infection and racial disparities in MSM. This inter-relationship requires a holistic approach when examining the interconnections between HIV epidemics and associated risk factors (Wolitski, Stall, & Valdiserri, 2008).

Although Black MSM are disproportionately affected by the HIV epidemic, many of the sample populations in the studies were comprised primarily of White MSM. Consequently, there are very limited studies that focus primarily Black MSM so that inferences can be made to this population of men. HIV/AIDS studies, specifically tailored to Black MSM in Atlanta, Georgia, were also very non-existent in the literature. The absence of adequate data on Black MSM in relation to HIV/AIDS have somewhat hindered the public health efforts to reduce HIV infections in this population of men.

Purpose of the Dissertation

First, in a racially and ethnically diverse sample of MSM in Atlanta, Georgia the dissertation will examine the relationship between syndemic biopsychosocial risk factors. Second, it will assess the association between HIV and the number of biopsychosocial risk factors and the prevalence of HIV high-risk sexual behaviors. Last, the dissertation will measure the uniformity of syndemic risks and defined HIV outcomes across a diverse group of MSM in Atlanta, Georgia.

Research Questions

The dissertation will focus on the following research questions. First, in a diverse sample of MSM in Atlanta, GA are men with a given biopsychosocial risk factor for HIV infection more likely to have other risk factors as well? Second, how do we adequately combine individual biopsychosocial risk factors for HIV acquisition to derive syndemic biopsychosocial risk scores? Third, does the convergence of multiple syndemic biopsychosocial risk factors for HIV acquisition differ materially based on race/ethnicity? When this is established, is there an association between the number of syndemic biopsychosocial risk factors and the prevalence of HIV infection (e.g., HIV seropositive status) and high-risk sexual behaviors? Next, does race and ethnicity remain an independent risk factor for HIV infection after adjustment for a defined syndemic risk profile? Last, is there an interaction between the number of syndemic biopsychosocial risk factors and race and ethnicity, in relation to the prevalence of HIV infection and HIV high-risk sexual behaviors?

Specific Research Aims

The aim of the first study is to systematically examine the relationship between individual biopsychosocial risk factors for HIV by deriving integrated measures of convergent biopsychosocial risk factors among MSM in Atlanta GA and assess whether the average number of syndemic risk scores differ among racial and ethnic groups of MSM in Atlanta, Georgia. To accomplish this aim, the study will conduct a descriptive analysis to determine the prevalence and range of individual risk factors in the study participants. The descriptive analysis will include socio-demographic characteristics, biopsychosocial risk factors, and HIV high-risk sexual behaviors. The study will determine how biopsychosocial risk factors are related to one another (if they cluster together) by conducting correlation analyses to examine the extent in which the existence of one risk factor is positively related in the presence of the other. It will then derive integrated measures of syndemic risk factors that combine individual risk factors for HIV infection. Lastly, the study will determine if the aggregation of the syndemic risk differs based on race and ethnicity by conducting a multivariable analysis to assess if higher syndemic risk scores are significantly associated with race and ethnicity.

The aim of the second study is to assess if the number of syndemic risk scores is associated with HIV high-risk sexual behaviors and HIV infection among racial and ethnic groups of MSM in Atlanta, Georgia. To accomplish this aim, the study will determine the extent in which the co-occurrence of multiple biopsychosocial risk factors increases the odds of HIV seropositive status and HIV high-risk sexual behaviors. It will also analyze if there is an independent association between the syndemic risk scores and the respective outcomes of HIV seropositive status and HIV high-risk sexual behaviors. Finally, the study will explore the

existence of an interaction between syndemic risk scores and race and ethnicity in relationship to the prevalence of the stated outcomes of HIV seropositive status and HIV high sexual risk behaviors.

Hypothesis

The dissertation offers the following hypotheses on assessing whether aggregation of biopsychosocial risk factors is exacerbating HIV risk and infection among MSM in Atlanta, GA resulting in the racial and ethnic disparities between Black MSM and other groups of MSM. The first hypothesis predicts that the co-aggregation of biopsychosocial risk factors drives the disproportionate rates of HIV-infection beyond the sum of individual risks. Second, there are measurable differences by race and ethnicity in the aggregation of multiple risk factors for HIV infection. Third, the syndemic risk factors will be positively associated with HIV seropositive status and sexual risk behaviors. Lastly, the direction and strength of the relationship between syndemic risk factors and the outcomes (i.e., HIV infection and sexual risk behaviors) may differ by race and ethnicity such that for any syndemic risk score, the risk of HIV infection is magnified for Black MSM compared to White MSM.

CHAPTER 2

REVIEW OF LITERATURE

Blacks and HIV in the United States

Blacks continue to experience the most severe burden of HIV and account for the highest proportion of new HIV diagnoses, people living with HIV (PLHIV), and people diagnosed with AIDS of all racial and ethnic groups in the United States (CDC, 2015c). Although Blacks made up approximately 12% of the total U.S. population, they accounted for 44% of all new HIV infections compared to 31% for Whites and 21% for Hispanics (CDC, 2012a). Forty-four percent of people living with HIV among adults and adolescents (age 13 years or older) were Black (CDC, 2012a, 2015c). Among new HIV infection cases among Blacks, MSM accounted for 51% of these cases, while heterosexual contact attributed 38%. Furthermore, the rate of 68.9 new HIV infections per 100,000 of the population among Blacks was approximately eight times higher than that of Whites (8.7 per 100,000) (CDC, 2012a).

According to data from the National HIV Surveillance System, Blacks living with HIV experienced higher rates of deaths during 2008–2012 when compared to other racial and ethnic groups (Siddiqi et al., 2015). In 2012, it was estimated that 8,165 (48%) deaths occurred among Blacks living with HIV. This rate was 3.2 times the number of deaths among Hispanics (2,586) and 1.5 times the number of deaths among Whites (5,426) (Siddiqi et al., 2015).

In 2013, an estimated 516,401 persons in the United States were living with AIDS (CDC, 2012d). Most importantly, Blacks accounted for the largest percentage (42%) of people living

with AIDS (CDC, 2012d). Also in 2013, 79% of Blacks living with HIV were linked to medical care within three months (CDC, 2015c). However, after this period, only 51% were retained in care. At the end 2012, 37% of Blacks were on antiretroviral therapy (ART), with a viral suppression rate of 29% (CDC, 2015c). In 2013, Blacks accounted for 54% of total deaths caused by HIV/AIDS (CDC, 2015c).

Black MSM and HIV in the United States

The HIV epidemic has disproportionately affected MSM (CDC, 2015f, 2015g). In 2012, the CDC estimated that the proportion of MSM in the United States was approximately 3% of the general population (Purcell et al., 2012), but male-to-male sexual contact accounted for most of the newly diagnosed HIV infections (CDC, 2015b). In 2013, an estimated 933,941 people in the United States were living with a diagnosed HIV infection (CDC, 2015b). Out of this estimated total, 705,165 (76%) were males, aged 13 years and older (CDC, 2015b). More specifically, 70% of the total male infections were attributed to male-to-male sexual contact, 11% to injection drug use, 10% to heterosexual contact, 7% to male-to-male sexual contact and injection drug use, and 1% to perinatal transmission (CDC, 2015b).

By the end of 2013, the CDC estimated that 493,543 MSM were living with HIV. Of these HIV diagnosed cases 31% were Black, 43% were White, and 21% were Hispanic (CDC, 2014b). From 2005-2014, there was a 6% increase in HIV diagnoses, which according to the CDC was driven mainly by new cases of HIV among Black and Hispanic MSM. There was a 22% increase in HIV diagnoses among Black MSM, compared to a decrease of 18% (9,966 to 8,207) for White MSM. More disturbingly, the largest increase (87%) was among young Black and Hispanic MSM (CDC, 2015g).

Using data from the 2008 National HIV Behavioral Surveillance (NHBS), the survey found that HIV prevalence was 28% among Black MSM compared to 16% for White MSM (CDC, 2010b). In 2010, young Black MSM (aged 13-24) accounted for more than half (55%) of new HIV infections among all young MSM, which is twice as many infections when compared to young White or Hispanic MSM (CDC, 2014b). Almost one-third of the newly diagnosed HIV infections were found in young Black MSM, who were 30 years of age or younger (Mayer et al., 2014).

In addition to having a higher prevalence of HIV, more Black MSM were unaware of their HIV status. Forty percent of all HIV-infected MSM were unaware of their status (CDC, 2010b). The proportion of those unaware of their HIV status was highest among Black MSM (59%) and lowest among White MSM (26%)(CDC, 2010b). Approximately 70% of young Black MSM were unaware of their HIV infection. Among age groups, HIV prevalence was highest in Black MSM who were less than 30 years old [18-19 years (9%), 20-24 years (20%), and 25-29 years (30%)] (CDC, 2010b).

Black MSM and HIV in the Southern United States and the State of Georgia

Researchers have also found regional differences in HIV prevalence. According to the CDC, the Southern region of the United States experiences the most severe burden of HIV compared to other U.S. regions (CDC, 2015a). This region, which includes the States of Alabama, Arkansas, Delaware, the District of Columbia (DC), Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia, comprised of 44 percent of all people living with a HIV diagnosis in the United States, despite making up only 37% of the general U.S. population (CDC, 2015a, 2015b). In one study, researchers examined the rates of MSM living with HIV in 17 states in the

southern region (including DC) found that Black MSM had considerably higher HIV infection rates than other groups of MSM. In DC, an estimated 1 in 2 Black MSM were living with HIV compared to a 1 in 5 in Georgia (Lieb et al., 2011).

The South includes eight of the ten states with the highest rates of new HIV diagnoses by area of residence (DC=57.8, Louisiana=30.4, Florida=26.9, Maryland=23.3, Georgia 22.3, Texas=17.9, South Carolina=17.5, and Mississippi=17.3). It also contains 10 Metropolitan Statistical Area (MSAs), including Atlanta–Sandy Springs–Roswell, GA= 25.9 that was ranked 7th out of a 107 MSAs, with the highest rates of HIV diagnoses (CDC, 2015a, 2015b). Blacks and Black MSM accounted for 54 percent and 59 percent of new HIV diagnoses respectively (CDC, 2015a). According to the CDC, people living in the South are more likely to be diagnosed with HIV in their lifetime, with the highest risks found in states and district such as Washington, DC (1 in 13), Maryland (1 in 49), Georgia (1 in 51), and Louisiana (1 in 56) (CDC, 2016b).

Researchers have also found that in the "Deep South", there were higher rates of HIV diagnosis, deaths, and PLHIV when compared to other regions (Reif et al., 2015). Blacks accounted for 52% of the diagnosed HIV cases and 54% of PLHIV (Reif et al., 2015). The Deep South is defined as a region of states that actively promoted slavery and produced agricultural products such as cotton and tobacco (Reif et al., 2015). These states include Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Texas (Reif et al., 2015).

According to the GDPH, HIV infection continues to be a major public health concern for the state of Georgia (GDPH, 2012a). In 2012, Georgia was ranked the sixth highest state in the country for the total number of adults and adolescents living with HIV infection. Georgia was

also the fourth highest state in the country for the total number of new diagnoses (3,023) (an incidence rate of 29 cases per 100,000 population) of HIV infection in 2011 (GDPH, 2012a). In 2012, the number of PLHIV in the state of Georgia was 50,436, with a prevalence rate of 508 per 100,000 (GDPH, 2012a). Of these PLHIV, 23, 218 (45%) had HIV and 27, 218 (55%) had AIDS (GDPH, 2012a). This rate represents a 53% increase in HIV prevalence in the state of Georgia since 2005 (GDPH, 2012a). Sixty-four percent of PLHIV in the state of Georgia resided in the MSA of Atlanta, Georgia (GDPH, 2012a). Among the 18 Public Health Districts of Georgia, Fulton (14,561 or 29%) and DeKalb (7,731 or 15%) counties had the highest number of HIV infection diagnoses and AIDS cases in Georgia through December 2012 (GDPH, 2012a).

In addition, Blacks accounted for 55% of HIV cases and 70% of AIDS cases, while only making up 30% of Georgia's population (GDPH, 2012b). MSM was the only risk group in the state of Georgia with increasing HIV incidence in recent years. MSM accounted for 63% (1,423) of all male adults and adolescents with HIV infections and 76 % (784) with stage 3 (AIDS) (GDPH, 2012a). Among MSM, Georgia was the only state with ≥15, 000 cases/100,000 MSM (number of people living with an HIV diagnosis) and ≥15% diagnosed prevalence rate (E.S. Rosenberg, Grey, Sanchez, & Sullivan, 2016).

Disproportionate Rates of HIV among Black MSM in the United States

The explanation for the racial disparity in HIV infection between Black MSM and other racial and ethnic groups of MSM has been elusive. Although unprotected anal intercourse (UAI) and the multiple sex partners are high-risk factors for increased HIV infection among MSM, several studies have found that Black MSM have comparable or lower rates relative to MSM of other races or ethnicities (Koblin, Husnik, et al., 2006).

Many studies have examined different factors to explain the racial disparity in HIV infection rates among Black MSM and other MSM (Beer, Oster, Mattson, Skarbinski, & Medical Monitoring, 2014; Harawa et al., 2004; Millett, Flores, et al., 2007; Millett et al., 2006; Oster et al., 2011; E. S. Rosenberg, Millett, Sullivan, Del Rio, & Curran, 2014; Sullivan et al., 2015). These studies identified factors such as low frequency of HIV testing, barriers to linkage and retention to healthcare, a history of STI, adherence to antiretroviral drugs and therapies, and racially assortative mixing in social-sexual networks (Beer et al., 2014; Harawa et al., 2004; Millett, Flores, et al., 2007; Millett et al., 2006; Oster et al., 2011; E. S. Rosenberg et al., 2014; Sullivan et al., 2015). To better understand HIV epidemic among MSM, the following sections will provide an overview of the most salient biological, behavioral, psychosocial, and structural factors that effect an MSM's risk for HIV transmission.

Biological Factors

Biological factors are known to increase or decrease the risk of HIV transmission during sexual intercourse or contact. Factors such as circumcision and sexually transmitted infections (STI) play a major role in the racial disparities in HIV infection. This is true for Black MSM as well as other racial and ethnic MSM.

Circumcision

Empirical evidence has shown that circumcision reduces HIV transmission in heterosexual men (Auvert et al., 2005; Bailey et al., 2007; Gray et al., 2007; Weidner, 2007). Randomized controlled trials (RCTs) conducted in Africa found that male circumcision reduces the risk of HIV acquisition in heterosexual men (Auvert et al., 2005; Bailey et al., 2007; Gray et

al., 2007; Weidner, 2007). The studies showed that circumcision provided a 50%-60% protective effect against HIV infection when compared to the control group of uncircumcised men (Auvert et al., 2005; Bailey et al., 2007; Gray et al., 2007; Weidner, 2007).

Studies have found that Black men (65% to 73%) are less likely to be circumcised than White men (81% to 88%). Moreover, Hispanic men (42% to 54%) are less likely to be circumcised than Black and White men (Laumann, Masi, & Zuckerman, 1997; Xu, Markowitz, Sternberg, & Aral, 2007). Since male circumcision rates in Black MSM are usually lower than White MSM, there is an assumption in many studies that these lower rates contribute to the increase in HIV infection in Black MSM (Goodreau et al., 2014; Millett, Ding, et al., 2007; Millett, Flores, Marks, Reed, & Herbst, 2008; Sanchez et al., 2011).

However, Millet et al. questioned the applicability of these studies to the MSM population in the United States (Millett, Ding, et al., 2007). First, the authors argued that the studies focused on heterosexual males, and not specifically on the MSM population (Millett, Ding, et al., 2007). Second, MSM take on both insertive and receptive roles during anal sex. As a result, circumcision may not reduce a receptive partner's risk. (Millett, Ding, et al., 2007). Finally, HIV viral load is found to be higher in rectal secretion when compared to viral vaginal secretion, which increases the effect of transmission of HIV in MSM when compared to women (Millett, Ding, et al., 2007).

The study also found that circumcision prevalence was higher in Black MSM (74%) when compared to Hispanic MSM (33%)(Millett, Ding, et al., 2007). However, Hispanic MSM usually have lower HIV infection rates than Black MSM (Millett, Ding, et al., 2007). The study concluded that circumcision was not associated with HIV infection and did not confer risk or protection in

Black MSM (Millett, Ding, et al., 2007). There was no association found between circumcision and newly diagnosed HIV infection in Black MSM (Millett, Ding, et al., 2007).

Furthermore, one meta-analysis study found insufficient evidence that male circumcision protects against HIV and STI (Millett et al., 2008). However, the HIV Network for Prevention Trials Vaccine Preparedness Study found that uncircumcised MSM were twice as likely as circumcised men to HIV seroconvert (Buchbinder et al., 2005). Similarly, the Kreiss et al. study concluded that HIV infection was significantly associated with uncircumcision (Kreiss & Hopkins, 1993). Based on these study results, it is still unclear whether circumcision reduces the risk of HIV transmission in MSM.

Sexually Transmitted Infections

According to the CDC, MSM are at an increased risk for sexually transmitted infections (STIs) (CDC, 2015k). The higher incidence of STIs among MSM can serve as an indicator for increased risk of HIV infections (CDC, 2015j).Studies have evaluated the association between STIs and the increased risk for HIV infection to better understand the disparity of HIV infections among Black MSM (Millett et al., 2006; Pathela et al., 2011; Scott, Bernstein, Raymond, Kohn, & Klausner, 2010).

It has been hypothesized that Black MSM who engage in high HIV risk sexual behaviors such as unprotected anal intercourse, coupled with the high prevalence of STIs increase their risk of HIV transmission and infection (Millett et al., 2006). Some studies have shown that HIV transmission is enhanced by the presence of STIs, which include ulcerative (e.g., syphilis, herpes) and non-ulcerative (e.g., chlamydia, `gonorrhea) diseases. STIs have been shown to facilitate HIV transmission, infectiousness and susceptibility (Anzala et al., 2000; Heffelfinger,

Swint, Berman, & Weinstock, 2007) by disrupting the mucosal membranes of the genital tract and recruiting HIV-infected inflammatory cells to infected areas (Fleming & Wasserheit, 1999).

Studies have demonstrated that increased syphilis rates can facilitate both HIV infection and transmission among high-risk groups (Fleming & Wasserheit, 1999; Su, Beltrami, Zaidi, & Weinstock, 2011). Black MSM continue to experience the biggest increase in HIV and syphilis diagnoses (Torrone et al., 2011). According to the CDC, men accounted for 90 % of primary and secondary syphilis cases in 2014, while MSM accounted for 83% of these cases (CDC, 2015e). Most surprisingly, 51% of the cases among MSM were HIV-positive (CDC, 2015j).

Surveillance data also showed that approximately half of MSM infected with syphilis was also infected with HIV (CDC, 2015e). Su et al. conducted a study to determine whether primary and secondary syphilis disproportionately affected MSM based on age and race or ethnicity (Su et al., 2011). The results revealed that from 2005 to 2008, rates of primary and secondary syphilis increased each year among MSM (Su et al., 2011). More specifically, Black MSM syphilis rates were eight times the rate of White MSM (Su et al., 2011).

Behavioral Factors

According to the CDC, the most effective way to prevent an individual from transmitting or becoming infected with HIV is through behavioral controls such as antiretroviral medication adherence, the proper usage of condoms, and the testing and treatment of STIs (CDC, 2014b). This section outlines the salient behavioral risk factors associated with increased HIV infection and HIV seropositivity status in MSM**.**

ART Use and Adherence

HIV continues to profoundly affect MSM in the United States (CDC, 2015b, 2015f, 2015g). Antiretroviral therapy (ART) has been shown to be effective in reducing the sexual transmission of HIV and the HIV viral load in bodily fluids (Oster et al., 2011). The use and adherence of ART may explain the disparities in HIV infection rates among racial and ethnic groups of MSM (Oster et al., 2011).

Studies have shown that the suppression of HIV concentrations with ART reduces the risk of HIV transmission, resulting in the reduction of HIV incidence (Attia, Egger, Muller, Zwahlen, & Low, 2009; Donnell et al., 2010; Porco et al., 2004). HIV-infected patients who are treated with ART usually experience a decrease in HIV viremia, which increases the levels of CD4 lymphocytes (Ho et al., 1995). ART regimens suppress HIV viral load, prevent transmission of the virus, improve one's health, and increase the patient's survivability rate (Bangsberg et al., 2001; Paterson et al., 2000).

Researchers have investigated the rates of ART adherence among MSM. One study assessed the proportion of MSM, who were not on ART, and the factors associated with non-adherence. They found that 42% of diagnosed, HIV-infected MSM were not taking ART, and 48% of these men reported having discordant UAI (Dombrowski, Kerani, Stekler, Menza, & Golden, 2010). Authors of another study found that White MSM (44%) had the highest percentage of self-reported adherence visits, followed by Hispanic MSM (32 %) and Black MSM (28 %) (Oh et al., 2009). Beer et al.'s study found that Black MSM had significantly lower levels of ART usage and viral suppression when compared to White MSM (Beer et al., 2014). Halkitis

et al. found that Black MSM in New York were less likely to be on ART compared to the other racial and ethnic groups (Halkitis, Parsons, Wolitski, & Remien, 2003).

Gay Identification and Sexual Identity Disclosure

There is a school of thought that acculturation in the gay community, gay identification, and sexual identity disclosure are usually associated with lower HIV-risk behaviors and lower HIV infection rates in MSM. Although, Black MSM are less likely than other MSM to identify as gay or to disclose their sexual identity, there is no supporting evidence that the lack of disclosure or gay identification leads to increased HIV high-risk behaviors among Black MSM (Bernstein et al., 2008; C. V. Johnson et al., 2009; Magnus et al., 2010; Millett, Flores, et al., 2007; Millett et al., 2006; Mimiaga, Reisner, et al., 2009; O'Leary, Fisher, Purcell, Spikes, & Gomez, 2007).

Studies have shown that Black MSM were less likely to identify as gay or homosexual and disclose their sexual identity to others (e.g., healthcare providers, non-gay identified friends, and family) when compared to MSM of other ethnic and racial groups (Bernstein et al., 2008; C. V. Johnson et al., 2009; Magnus et al., 2010; Millett, Flores, et al., 2007; Millett et al., 2006; Mimiaga, Reisner, et al., 2009; O'Leary et al., 2007). HIV-positive Black MSM were less likely than White MSM to identify as gay and were less comfortable discussing their MSM behavior with close friends and acquaintances (O'Leary et al., 2007). Black MSM exhibited higher levels of internalized homophobia and had a lower self-efficacy for disclosing their HIV status to sex partners (O'Leary et al., 2007).

Authors of another study used data from an NHBS-NYC to examine disclosure rates of same-sex attraction to a health care provider and found that more than one-third of MSM

(39%) failed to disclose their sexual identity to their health care providers (Bernstein et al., 2008). Among the MSM participants who identified as gay, 78% had disclosed to their health care providers compared to 68% for Black MSM (Bernstein et al., 2008). Moreover, of the 86 self-identified bisexual MSM, none reported disclosing their same sex attraction to their health care providers (Bernstein et al., 2008). Whites were significantly more likely than Blacks, Hispanics, and Asian and Pacific Islanders to have disclosed to their health care providers (Bernstein et al., 2008). Also, MSM who reported testing for HIV were more than two times likely to have disclosed to their health care providers (Bernstein et al., 2008).

In Magnus et al. study, Black (86%) and Hispanic/Asian/other (93%) men were less likely than White (98%) men to disclose their MSM status to non-gay–identified friends (Magnus et al., 2010). Black men (72%) were less likely to tell health care providers about engaging in MSM behavior when compared to Hispanic/Asian/other (76%) and White (86%) men (Magnus et al., 2010). Despite less disclosure, the use of condoms remained high among these men, suggesting HIV testing was associated with disclosure, instead of condom use.

The Johnston et al. study found that 21% of the MSM participants did not disclose (hereinafter referred to as non-disclosers) their sexual identity to their healthcare providers (C. V. Johnson et al., 2009). The non-disclosures were more likely to have been tested for STIs and HIV (C. V. Johnson et al., 2009). They were more likely to engage in risky sexual behaviors, which include unprotected anal intercourse without a condom (C. V. Johnson et al., 2009). Non-Whites (i.e., Blacks, Hispanics, Asian/Native Hawaiian/ Pacific Islander, and American Indian/Alaska Native) were more likely to identify as bisexual and not “out” to others (C. V.

Johnson et al., 2009). These men did not reveal to their health care provider that they engaged in male-to-male sexual contact (C. V. Johnson et al., 2009).

Contrary to these findings, a cross-sectional study of young MSM, where researchers assessed the association between disclosure and the rates of STI, HIV testing, and sexual behaviors, found that the prevalence of HIV was lower among non-disclosures (14%) when compared to disclosers (24%) (CDC, 2003). Non-disclosures reported less sexual activity with men compared to the disclosures (CDC, 2003). Researchers also found that Black MSM had the highest HIV prevalence burden when compared to all racial and ethnic groups combined (CDC, 2003).

HIV Testing and Status Knowledge

To further understand the HIV burden among Black MSM, it has been hypothesized that Black MSM are less likely to test for HIV and more likely to unknowingly infect their sexual partners with the HIV (Millett, Ding, et al., 2007). Researchers have found that HIV testing and knowledge of one's HIV status can prevent the transmission of the virus and increase the opportunity to be linked to treatment and care services (CDC, 2016a; Seth et al., 2015; Washington, Robles, & Malotte, 2013). It has been shown that the awareness of one's HIV status reduces the likelihood of engaging in risky behaviors (Marks, Crepaz, Senterfitt, & Janssen, 2005).

As a result, the CDC recommends an annual HIV test for sexually active MSM, including those who are HIV seropositive (CDC, 2015l). According to the 2011 NHBS-MSM survey, 67% of MSM who reported a negative or unknown HIV status in the United States tested for HIV in the

past 12 months (CDC, 2012c). Surprisingly, only 5% of HIV-seropositive MSM, who were also unaware of their status, had been tested within 12 months (CDC, 2012c).

A cross-sectional study assessed HIV testing history and healthcare utilization among young Black MSM and found that 52% of these men reported HIV testing during the past 12 months (Petroll et al., 2009). Results also showed that 70% of these young MSM engaged in unprotected intercourse, 52% had multiple sex partners, and 27% reported unprotected sex with multiple partners. However, 72% of these men had seen a healthcare provider during the prior 12 months (Petroll et al., 2009).

Study results were even more striking in the Phillips et al. study that measured the behavioral differences among MSM HIV testers in Washington, DC (Phillips et al., 2013). Researchers found that 30% of Black MSM had 1 to 3 HIV tests in the past two years when compared to 52% of White MSM (Phillips et al., 2013). Fewer than 10% of MSM who had not tested in the prior two years were offered HIV testing by a health-care provider (Phillips et al., 2013). Mimiaga et al. found that 33% of HIV-negative men had not been tested for HIV in the two years and 6.9% had never been tested for HIV in their lifetime (Mimiaga, Helms, et al., 2009). The reasons for not being tested were the perception of low risk for HIV, afraid to learn their status, and privacy issues (Mimiaga, Helms, et al., 2009).

A cross-sectional study conducted in Atlanta, Georgia found that Black MSM who were HIV-negative were more likely to report having unprotected anal intercourse with a partner of unknown HIV status (Grey, Rothenberg, Sullivan, & Rosenberg, 2015). According to the study, perceived knowledge of partner HIV status did not differ between the races of MSM (Grey et al., 2015). This consequently led to the conclusion that the number of UAI with partners of

unknown status is associated with the disproportionate rates of HIV infection among Black MSM (Grey et al., 2015).

Sexual Networks

Studies have shown that there is a tendency for Black MSM to engage in sex with partners of the same race and ethnicity (intra-racial) and older age (intergenerational), which may explain the higher rates of HIV infection in these men (Bingham et al., 2003). Older men and those of specific race groups (i.e., Black MSM) tend to have higher prevalence rates of HIV (Bohl, Raymond, Arnold, & McFarland, 2009). These intra-racial and intergenerational sexual networks may contribute to the increase of HIV infection created by the interconnectedness of partnerships among different age groups and the same race and ethnicity (Bingham et al., 2003).

In a cross-sectional study conducted in Los Angeles among young MSM, 27% of Blacks reported higher numbers of Black male partners in the previous 12 months compared to Hispanics (12%), Whites (3%), and Asian and Pacific Islanders (2%) (Bingham et al., 2003). Fifty-seven percent of Blacks reported a higher proportion of male anal sex partners with men who were 5 years older or younger compared to Hispanics (38%) and Whites (39%) (Bingham et al., 2003). The researchers suggested that the differences in partner types (i.e., Black and older) are associated with higher HIV infection rates among Black MSM when compared to White MSM (Bingham et al., 2003).

Another study also found more assortative mating (i.e., mating within one's race and ethnicity) among Black MSM, which was shown to lead to more sexual contacts and higher risk for STIs (Laumann & Youm, 1999). Black MSM had a tendency of selecting partners of their race

and ethnicity and older (i.e., 10 or more years older) when compared to other racial and ethnicity groups (Berry, Raymond, & McFarland, 2007). To further explain this assortative mating, when the participants were asked their preference of race for a partner, Black race was the least preferred among all racial and ethnic groups, except among Black MSM (Raymond & McFarland, 2009). White MSM were more likely to practice serosorting (i.e., selecting a partner based on HIV status) to protect against HIV infection (Eaton, Kalichman, & Cherry, 2010).

Substance Abuse

Increased risk for HIV infection is associated with injecting, drinking, smoking, ingesting, or inhaling drugs, such as alcohol, crack cocaine, methamphetamine (e.g. speed or "crystal"), and amyl nitrite (CDC, 2013a). These drug and alcohol related activities can reduce one's inhibition by affecting judgment and reasoning when engaging in risky sexual behaviors (CDC, 2013a). According to the CDC, gay and bisexual men are more likely to use drugs and alcohol, become heavy drinkers later in life, and have higher rates of substance abuse (CDC, 2013a).

Published studies based on the hypothesis that Black MSM are more likely than other MSM to abuse substances, paint a very complex picture in understanding the disparate rates of HIV infection in Black MSM (Millett et al., 2006). For example, one study that compared patterns of drug use and drug dependence between homosexuals and heterosexuals found that homosexual men had patterns of elevated lifetime drug use and were more likely to report usage of drugs such as cocaine, heroin, and marijuana (Cochran, Ackerman, Mays, & Ross, 2004). Another study found no association between lifetime drug use and the prevalence HIV in young Black and White MSM (Celentano et al., 2005). However, in young White MSM drug use was common across all drug categories. Sixty-one percent of White MSM reported recreational

drugs use, 23% had a history of “hard” drug use, and 8% reported injection drugs use. Nevertheless, there was no association between drug use and HIV prevalence among young Black or White MSM (Celentano et al., 2005).

In HIV-infected gay/bisexual and heterosexual men over the age of 50, Black gay/ bisexual men were more likely than White gay/bisexual men to report a history of intravenous drugs and unprotected vaginal and anal intercourse (Siegel, Schrimshaw, & Karus, 2004). Older non-Hispanic Black MSM were less likely to be high on methamphetamine during sex compared to older White and Hispanic MSM (Ober, Shoptaw, Wang, Gorbach, & Weiss, 2009). These men were also more likely to be high on crack (Ober et al., 2009).

In one study, which was designed to explore rates of problematic alcohol use and its role in HIV risk among Black MSM, researchers found that men who reported unprotected anal intercourse with a serodiscordant casual partner during their last sexual encounter in the last 12 months were twice as likely to have a drinking problem (Reisner et al., 2010). Researchers also found that binge drinkers (individuals who had 5 or more alcoholic drinks during the past 30) were more likely to report discordant receptive unprotected intercourse, discordant insertive unprotected intercourse, sex in exchange for drugs or money during their last sexual encounter, concurrent sexual partners, and unprotected sex with a sexual partner in the past 12 months (Hess et al., 2015).

The use of drugs has been shown to affect judgment and reduce inhibitions, resulting in increased risk of HIV infection (CDC, 2013a). Heavy alcohol use by MSM has shown to increase the likelihood of engaging in risky sexual behaviors such as unprotected sex, multiple sex

partners, and sexual partners with high-risk for STIs (CDC, 2014a). However, there was no association between lifetime drug use and the prevalence HIV in MSM (Celentano et al., 2005).

Unprotected Anal Intercourse and Number of Sexual Partners

Unprotected anal intercourse and multiple sexual partners are high-risk sexual behaviors associated with HIV infection (Goedert et al., 1985). According to the CDC, unprotected anal sex (receptive or insertive anal intercourse) is considered the riskiest sexual act for transmitting HIV (CDC, 2015i). More specifically, per 10,000 sexual exposures, the estimated HIV transmission risk per sexual act for insertive penile/vaginal intercourse was 4, receptive penile/vaginal intercourse was 8, insertive anal intercourse was 11, and receptive anal intercourse was 138 (Patel et al., 2014).

In recent studies, the results have found comparable or lower rates of UAI between Black MSM and other ethnic and racial MSM groups (Magnus et al., 2010; Millett et al., 2006). One meta-analysis found no significant difference by race for UAI among MSM (Millett, Flores, et al., 2007). Furthermore, the analysis found that UAI rates were higher in Black MSM for studies that were published during the first decade of the epidemic (1981 – 1990)(Millett, Flores, et al., 2007). However, between 1991-2006, Black and White MSM reported comparable rates of UAI after the introduction of ART (HAART) (Millett, Flores, et al., 2007).

Studies have consistently shown that Black MSM have the same or fewer number of male sexual partners, casual male sex partners, and lifetime male sexual partners when compared to other MSM (Millett, Flores, et al., 2007). The Magnus et al. study showed that Black MSM reported fewer male sex partners and fewer bare-backing practices when compared

to other MSM (Magnus et al., 2010). Also, Black MSM more often used condoms during their last receptive or insertive anal sexual intercourse (Magnus et al., 2010).

In another study, participants at gay pride festivals in Atlanta, Georgia were asked to report the number of partners based on HIV status (i.e. HIV negative, HIV positive, and HIV unknown) with whom they had unprotected receptive and insertive anal intercourse within the past six months (Eaton et al., 2010). The researchers found Black MSM were more likely than White MSM to report UAI with a partner of an unknown HIV status and more unlikely to know the HIV status of their last sexual partner (Eaton et al., 2010). However, Black MSM were more likely to have used a condom during these unprotected anal intercourse episodes (Eaton et al., 2010).

Psychosocial Factors

Knowledge, attitudes, beliefs, and perceptions can be associated with HIV infection risk and seropositive status and negatively impact standard HIV prevention approaches in Black MSM. It is important to understand how psychosocial factors such as violence, homophobia, stigma, and discrimination can increase the risk of HIV transmission and infection in MSM. It is also helpful to understand how stigma, discrimination, and violence events can lead to less disclosure of one's HIV status to current sexual partners and family members.

Homophobia, Stigma, and Discrimination

Homophobia, stigma, and discrimination against MSM can negatively affect physical and mental health, rates of substance abuse, sexual risk behaviors, suicide attempts, ability to have long-term relationships, and social support (CDC, 2011). In a multisite study of Hispanic gay

men, the results showed that men who reported more instances of social discrimination (i.e., homophobia and racism) experienced more symptoms of anxiety, depression, and suicidal tendencies (Diaz, Ayala, & Bein, 2004). The researchers also found that these gay men participated in risky sexual situations such as public sex, sex with partners who refuse to use condoms, and sex under the influence of drugs or alcohol (Diaz et al., 2004).

Researchers investigated HIV stigma (social avoidance, rejection, and shame) and sexual minority stigma (perceptions of social avoidance, rejection, and shame related to being ‘‘not straight”) among young HIV-positive Black MSM (Radcliffe et al., 2010). Eighty-eight percent of these men reported sexual minority stigma, 90% experienced HIV stigma, while 78% reported both stigmas (Radcliffe et al., 2010). High HIV stigma was associated with unprotected sex while high or intoxicated on drugs and alcohol (Radcliffe et al., 2010). Young MSM who experienced higher levels of HIV stigma also tend to engage in more unprotected receptive anal intercourse (Radcliffe et al., 2010).

In a cross-sectional study, Black MSM reported being hit or beaten up (9–13 %), treated rudely or unfairly (34–39 %), made fun of or called names (36–41%), forced to act more manly to be accepted by others (35–45 %), and felt uncomfortable in a crowd of heterosexual Black people (39–41 %)(Jeffries, Marks, Lauby, Murrill, & Millett, 2013). In another study, researchers suggested that homophobic events could potentially be associated with the acquisition and transmission of HIV among Black MSM (Jeffries et al., 2013). The researchers found that HIV-negative MSM who were treated rudely or unfairly or made fun of or called names, but were not hit or beaten up, had higher odds of engaging in UAI when compared to MSM who had not experienced any homophobia (Jeffries et al., 2013). The MSM who reported that they were hit

or beaten up, showed higher odds of engaging in UAI compared to those that were not hit or beaten. MSM who acted more manly or felt uncomfortable in a crowd of heterosexual had higher odds of engaging in UAI (Jeffries et al., 2013).

In HIV-positive Black MSM, investigators found that participants who reported greater internalized HIV stigma were less likely to disclose their HIV status to their current sexual partners and family members (Overstreet, Earnshaw, Kalichman, & Quinn, 2013). Consequently, the disclosure of one's HIV seropositive status to family, friends, the church, and even gay community can sometimes have negative effects (Bird & Voisin, 2013). In cases where disclosure of status received a supportive responsive, many HIV-positive MSM still perceived themselves as "damaged" and also had feelings of "imminent mortality"(Bird & Voisin, 2013). In the gay community, discrimination against HIV-positive MSM has led to "sexual and social desirability", increased perception of being "diseased and contagious", and higher levels of internalized homophobia among these men (Bird & Voisin, 2013).

Violence

Researchers have examined relationship violence (physical, psychological or emotional, verbal, or sexual abuse) and its association with sexual risk behaviors among MSM (Buller, Devries, Howard, & Bacchus, 2014; Houston & McKirnan, 2007; Koblin, Torian, et al., 2006; Welles, Corbin, Rich, Reed, & Raj, 2011). The CDC Sexual Orientation Report showed that lesbians, gays, and bisexuals have an equal or higher prevalence of experiencing intimate partner violence (IPV), sexual violence (SV), and stalking compared to heterosexuals (CDC, 2010a). Twenty-six percent of gay men, 37% of bisexual men, and 29% of heterosexual men experienced rape, physical violence, and stalking by an intimate partner in their lifetime (CDC,

2010a). Furthermore, 40% of gay men, 47% of bisexual men, and 21% of heterosexual men have experienced SV (non-rape) in their lifetime (CDC, 2010a).

In a cross-sectional HIV seroprevalence and risk behavior study, researchers examined young MSM in New York and found an association between IPV, older age, a history of forced sex, and running away from home (Koblin, Torian, et al., 2006). In fact, during the study, 68% of young MSM reported experiencing threats or violence from either their partners or family and 25% reported from both partners and family (Koblin, Torian, et al., 2006). Club drug use and recent unprotected sex were also associated with threats or violence from family members and partners (Koblin, Torian, et al., 2006).

In another study, MSM who experienced intimate partner abuse in a current or past relationship, 32% reported intimate partner abuse, 21% verbal abuse, 19% physical abuse and 19% sexual abuse (Houston & McKirnan, 2007). Thirty-three percent of Black MSM, 33% of White MSM, and 35% of Hispanics reported intimidate partner abuse (Houston & McKirnan, 2007). Abused men reported higher use of substance before or during unprotected anal sex (Houston & McKirnan, 2007).

Black MSM who had early-life experiences of physical and sexual abuse tend to be either a victim or a perpetrator of physical or sexual violence in adulthood (Welles et al., 2011). Men who disclosed having male sex partners were three times more likely to report being victims of physical abuse in young adulthood. These men were also two times more likely in their lifetime to report being victims of physical abuse in their youth when compared to non-MSM (Welles et al., 2011).

Structural Factors

Structural factors can present major challenges for reducing the HIV burden and implementing public health intervention strategies in MSM. Structural factors as the limited access to healthcare and incarceration may help to explain the disproportionate rates of HIV infection among MSM. More specifically, these factors can be associated with HIV infection and high-risk sexual behaviors among men, resulting in the increased burden of the disease.

Access to Healthcare

Limited access to health care can explain the higher rates of HIV infection among MSM. More specifically, the effect of these higher rates of early diagnosis and also the treatment and transmission of HIV (Gonzalez, Hendriksen, Collins, Duran, & Safren, 2009; Millett et al., 2006). In a study where researchers investigated the association of healthcare-specific racial discrimination on access to care (i.e., healthcare utilization) and HIV testing found that 19% of Black HIV-negative MSM reported healthcare-specific racial discrimination (Irvin et al., 2014). Approximately 12% of Black MSM reported a need for healthcare in the last six months (Irvin et al., 2014). However, these men did not receive care because 1) care was too expensive and not covered by insurance (73%), 2) other reasons (25%), 3) have no place to go (11%), and 4) could not get an appointment (4%) (Irvin et al., 2014). The researchers also found a positive association between healthcare utilization and perceived healthcare-specific racial discrimination (Irvin et al., 2014). However, the authors of the study suggested that there are potentially other contributing factors that could explain the lower frequency of HIV testing and healthcare visits among Black MSM (Irvin et al., 2014).

Researchers in one study utilized spatial analysis to measure the availability of health services for Black MSM in the Chicago area (Pierce, Miller, Morales, & Forney, 2007). They found that although higher prevalence rates of HIV were observed in predominantly Black areas of the city, most of the HIV services were located in historically epidemic areas (Pierce et al., 2007). The location of these services resulted in lower service densities in areas where Black MSM reside (Pierce et al., 2007). In another study, researchers found that race did not dictate if an HIV-infected MSM sought emergency room services, had health insurance, had the ability to access ART, and used inpatient services (Kass, Flynn, Jacobson, Chmiel, & Bing, 1999). In fact, Black MSM were less likely to seek medical services when their CD4 cell counts were high (Kass et al., 1999).

Incarceration

The CDC theorized that the disproportionate rate of HIV in Black men is due in part to higher rates of incarceration (CDC, 2006). Is it believed that incarceration increases Black men exposure to unprotected sex with other men in institutions where HIV seroprevalence is usually higher (CDC, 2006). In 2014, the U.S. Department of Justice (DOJ) estimated that 1,561,500 prisoners were held in state and federal correctional facilities (Justice, 2015). Black men accounted for 37% (516,900) of the male prison population in the United States compared to 32% (453,500) for White males and 22% (308,700) for Hispanic males (Justice, 2015). Furthermore, 2.7% of Black men (2,724 per 100,000 of incarcerated Black residents) and 1.1% of Hispanic males (1,090 per 100,000 Hispanic male residents) were serving prison sentences of at least one year, compared to 0.5% of White males (465 per 100,000 White male residents) (Justice, 2015).

In October 2005, Georgia Department of Corrections (GDC) housed 44,990 male inmates (CDC, 2006). Black men accounted for 63% (28,350) of the inmates compared to 36% (16,364) for White males (CDC, 2006). Of the total male inmate population, 1.9% (856) was infected with HIV, and 91% (780) of these men were infected before entry into the prison system. Black men accounted for 86% (732) of the HIV-infected males that entered into the system (CDC, 2006). Another study found that 88 GDC inmates seroconverted between 1998 and 2005 while incarcerated (CDC, 2006). Among them, 59 (67%) were Black, and 29 (33%) were White. The study also found that Black race and male to male sex in prison were significantly associated with HIV seroconversion during incarceration (CDC, 2006).

Some studies have shown that a history of incarceration is not associated with higher rates of HIV infections among MSM (Oster et al., 2011; Wohl et al., 2000). For example, a case-control study of HIV-infected Black men in Los Angeles, California, found no association between anal sex, oral sex, or IDU and HIV infection during incarceration (Wohl et al., 2000). However, the investigators did find an association between increased jail or prison time and lower HIV infection (Wohl et al., 2000).

Lastly, Lim et al. showed that 6.8% of MSM reported an arrest in the past 12 months (Lim, Sullivan, Salazar, Spaulding, & Dinenno, 2011). Black MSM were more likely than White MSM to report an arrest history (Lim et al., 2011). Men who reported using non-injection or injection drugs and also exchanged things for sex were more likely to report an arrest history. Recent arrest (i.e., within 12 months of the interview) was found to be associated with insertive unprotected anal intercourse, while a history of arrest was associated with high-risk sexual behaviors (Lim et al., 2011).

Summary

There are many factors that influence HIV infection and racial disparities between Black MSM and other racial and ethnic MSM. As outlined above, these factors include biological, behavioral, psychosocial, and structural factors. Biological factors are known to influence HIV risk, transmission, and infection during sexual intercourse or contact. Behavioral factors could prevent HIV infection and transmission among MSM. Psychosocial factors, such as knowledge, attitudes, beliefs, and perceptions are associated with HIV infection, status, and prevention. Structural factors, such as access to healthcare and incarceration, sometimes present major challenges for reducing the HIV burden and also implementing public health intervention strategies. A summary of HIV risk factors for MSM is summarized in Table 2.1.

Table 2.1. Summary of Risk Factors for HIV Infection in MSM

Risk Factors	Description
Biological Factors	
Circumcision	Circumcision potentially provides a protective effect and confers a decreased risk for HIV infection.
STI	STI facilitates the transmission, infectiousness, and susceptibility to HIV infection.
Behavioral Factors	
ART Use and Adherence	ART suppresses HIV viremia concentrations and prevents HIV transmission. Adherence to drug regimens suppresses HIV infection, prevents transmission of the virus, improves health, and increases survivability.
Gay Identification and Sexual Identity Disclosure	Gay identification and disclosure decrease engagement in risky sexual behavior and HIV prevalence, but increase HIV testing.

HIV Testing and Status Knowledge	HIV testing and knowledge of status prevent the transmission of the HIV and increase the opportunity to link infected individuals to treatment and care services.
Sexual Networks	Sexual networks (intra-racial and intergenerational) contribute to the spread of HIV and the higher prevalence of HIV.
Substance Abuse	Substance abuse (drug and alcohol related activities) reduces inhibition by affecting judgment and reasoning when engaging in HIV risky sexual behaviors.
Unprotected Anal Intercourse and Number of Sexual Partners	Unprotected anal sex (receptive and insertive intercourse) and the number of male sexual partners, casual male sex partners, and lifetime male sexual partners can increase the transmission of HIV.
Psychosocial Factors	
Homophobia, Stigma, and Discrimination	Homophobia, stigma, and discrimination affect physical and mental health, access to health services, rates of substance abuse, risk behaviors, and suicide attempts, the ability to have long-term relationships, and social supports.
Violence	Violence (physical, psychological or emotional, verbal, or sexual abuse) increases sexual risk behaviors and drug use.
Structural Factors	
Access to Healthcare	Limited access to health care affects early HIV diagnosis, treatment, and transmission of HIV.
Incarceration	Incarceration history increases exposure to unprotected sex with men in institutions where HIV seroprevalence is usually higher

Overview of the Syndemic Framework

To better understand the HIV epidemic crisis, the syndemic theory could be used as a framework to explain the HIV infection disparities among Black MSM. Syndemic has been described as two or more epidemics (i.e., diseases or health problems) interacting synergistically or additively that results in the increased burden of a disease (e.g., HIV) in a given population (Singer & Clair, 2003). This theory holistically takes into account the multitude of factors and conditions that can affect a marginalized population (P. N. Halkitis, R. J. Wolitski, & G. A. Millett, 2013).

Merrill Singer, a medical anthropologist, introduced the term syndemic to characterize a set of intertwining health and social factors or conditions (e.g., poverty, substance abuse, unemployment, healthcare inequality, and support networks) that affect the United States urban poor (Singer, 1994). The author coined the term SAVA (substance abuse, violence, and AIDS) to illustrate the interrelatedness of these health conditions among the poor (Singer, 1994).

Few studies have expanded the SAVA model to assess the influence of syndemic conditions on HIV risk (Dyer et al., 2012; Mustanski et al., 2007; O'Leary et al., 2014; Santos et al., 2014; Stall et al., 2003). These conditions included sexual risk behaviors and the risk of HIV infection among MSM (Dyer et al., 2012; Mustanski et al., 2007; O'Leary et al., 2014; Santos et al., 2014; Stall et al., 2003). Stall et al. examined the additive effect of four psychosocial health problems (i.e., drug use, depression, childhood sex abuse, and partner violence) among MSM in the cities of Chicago, Los Angeles, and New York (Stall et al., 2003). The authors concluded that these health problems are inter-correlated and positively associated with high-risk sexual

behaviors and HIV infection, which could explain the disparate HIV rates among MSM (Stall et al., 2003).

Another study found an interrelationship between psychosocial health problems and HIV infection and also high-risk sexual behaviors among an ethnically diversified sample of young MSM in the Chicago area (Mustanski et al., 2007). Furthermore, Dyer et al. assessed the syndemic relationship of psychosocial health conditions (i.e., depression, sexual compulsiveness, substance use, intimate partner violence, and stress) among Black MSM (Dyer et al., 2012). The study found that these conditions were independently associated and there was a linear relationship between the reported number of health conditions and the odds of engaging in unprotected anal intercourse with men (Dyer et al., 2012).

A global cross-sectional study evaluated the syndemic relationship among conditions, including depression, substance use, violence, sexual stigma, homelessness unprotected anal intercourse and HIV infection among MSM (Santos et al., 2014). Similar to the Dyer study, it found relationships between the number of syndemic conditions and HIV infection and also unprotected anal intercourse, suggesting that multiple conditions must be addressed concurrently to reduce the HIV burden (Santos et al., 2014).

Finally, a study conducted in the Philadelphia area examined if resilience factors, such as social support, connection to the gay community, religiosity, Black pride, optimism, education, and income, buffer the effects of syndemic factors, which contribute to high risk sexual behaviors and HIV seropositive status. (O'Leary et al., 2014). Similar to the Stall et al. study, the researchers found that syndemic factors are associated with HIV sexual risk behavior and HIV infection in Black MSM (O'Leary et al., 2014).

Biopsychosocial Factors Driving the Syndemic Among Black MSM

The identification of a theoretical framework, which incorporates biological, behavioral, psychosocial and structural determinants, is a key element in addressing disparate HIV infection rates (Engel, 1977; Perry N Halkitis et al., 2013). This framework encourages a more holistic approach to the interconnections between the HIV epidemic and related health conditions. Halkitis et al. established a syndemic framework (Figure 1) that introduced a biological component in association with behavioral, psychosocial, and structural factors (Perry N Halkitis et al., 2013). The framework describes the interplay of interrelated syndemic conditions (i.e., mental health, HIV, STIs, substance abuse, violence and sexual abuse) in explaining the disproportionate rates of HIV in MSM (Perry N Halkitis et al., 2013).

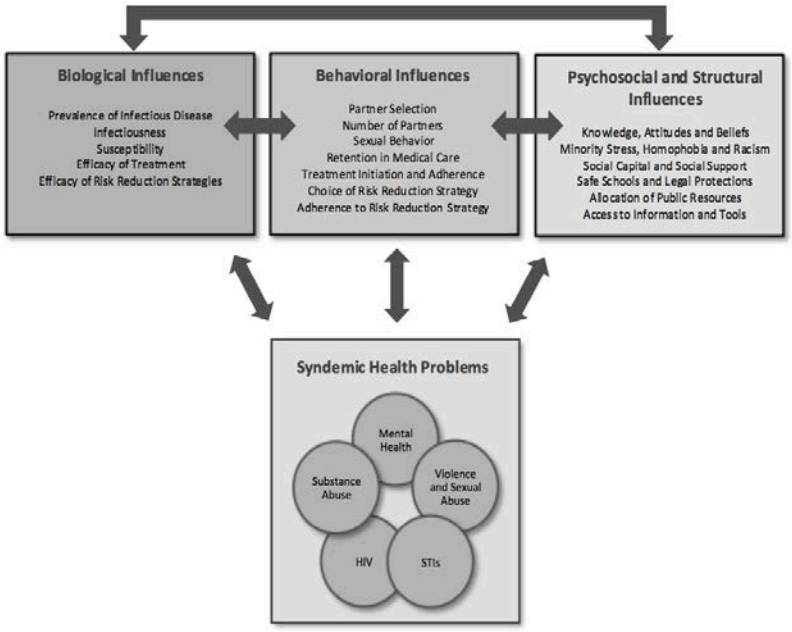

Figure 2.1. **Biopsychosocial drivers of the syndemic in gay, bisexual, and other men who have sex with men.** Adapted from "A Holistic Approach to Addressing HIV Infection Disparities in Gay, Bisexual, and Other Men Who Have Sex with Men" by P.N. Halkitis, R.J. Wolitski, G.A. Millett, 2013, Am Psychol, 68(4), 261-273, 263.

Outlined below are the potential influences that drive the syndemic in MSM according to the theoretical framework proposed by the authors.

Biological Influences

Halkitis et al. listed five biologically influences that can potentially increase one's risk to HIV infection and transmission. These influences include the 1) prevalence of infectious disease, 2) infectiousness, 3) susceptibility, 4) efficacy of treatment and 5) the effectiveness of risk reduction strategies (Perry N Halkitis et al., 2013).

As previously discussed, MSM have a higher incidence of STIs, which serves as an indicator for increased risk or susceptibility to HIV infection (CDC, 2015j). STIs have been shown to facilitate the transmission, infectiousness, and susceptibility of HIV (Anzala et al., 2000; Fleming & Wasserheit, 1999; Heffelfinger et al., 2007). Also, MSM are more likely than heterosexuals in the United States to be infected with a drug-resistant virus because of failure to maintain treatment regimens for viral suppression. Lack of adherence to these ART regimens reduces the efficacy of treatment and also the effectiveness of risk reduction strategies that prevent transmission (Banez Ocfemia MC, 2014).

Behavioral Influences

The authors outlined the role of behavioral influences associated increased HIV infection among MSM. The influences include 1) partner selection, 2) sexual behavior, 3) retention in medical care, 4) treatment initiation and adherence, 5) choice of risk reduction strategy, and 6) adherence to risk reduction strategy (Perry N Halkitis et al., 2013).

Unprotected anal intercourse and multiple sexual partners are high-risk sexual

behaviors that are associated with HIV infection (Goedert et al., 1985). According to the CDC, unprotected anal sex is considered the riskiest sexual act for transmitting HIV (CDC, 2017a). Studies have shown that Black MSM tend to engage in sex with partners of the same race and ethnicity (intra-racial) and older age (intergenerational), which may explain the higher rates of HIV infection among this group of men (Bingham et al., 2003). Prevention strategies such as adhering to an ART regimen, using HIV prophylaxis, engaging in low-risk sexual behaviors, using condoms effectively, limiting the number of sexual partners, and adopting abstinence behaviors can reduce the risk of acquiring and transmitting HIV (CDC, 2017a).

The treatment of HIV-infected patients with ART has been shown to decrease HIV viremia. It can also increase the levels of CD4 lymphocytes (Ho et al., 1995). Sustained adherence to treatment regimens can suppress the virus, prevent transmission of HIV, improve health, and increase survivability rates among MSM (Bangsberg et al., 2001; Paterson et al., 2000).

Psychosocial and Structural Influences

Psychosocial and structural influences can also affect the health and wellness of MSM (Diaz, Ayala, Bein, Henne, & Marin, 2001; Meyer, 1995; Russell, Ryan, Toomey, Diaz, & Sanchez, 2011). According to Halkitis et al. these psychosocial and structural influences include minority stress, homophobia and racism, social capital and social support, safe schools and legal protections, allocation of public resources, access to information and tools, and one's knowledge, attitudes, and beliefs (Perry N Halkitis et al., 2013).

Homophobia, stigma, and discrimination against MSM have been shown to affect physical and mental health, access to health services, quality of the service, rates of substance

abuse, risk behaviors, and suicide attempts, ability to have long-term relationships, and social support (CDC, 2011). Studies have examined the relationship between violence (e.g., physical, psychological or emotional, verbal, or sexual abuse) and sexual risk behaviors among MSM (Buller et al., 2014; Houston & McKirnan, 2007; Koblin, Torian, et al., 2006; Welles et al., 2011).

Structural factors, such as limited access to health care, may explain the disparate HIV infection rates among MSM. These factors can affect early HIV diagnosis and the transmission and treatment of HIV (Gonzalez et al., 2009; Millett et al., 2006). Also, the relationship between social support and HIV-related risk behaviors among MSM can be shaped by HIV-status, the disclosure of sexual orientation, and the individual providing social support (e.g., friends, family, peers, and partners) (Qiao, Li, & Stanton, 2014). Sometimes in the MSM population, family members can be the perpetrators of discrimination and the abusers (Perry N Halkitis et al., 2013).

Also, legal protection for lesbian, gay, bisexual, and transgender (LGBT) rights still vary by state. Five states, including the State of Georgia, do not have hate crime laws. Furthermore, there are fifteen states that do not hate crime laws that cover sexual orientation (MAP, 2017). In addition to legal protection and rights, safe schools, allocation of public resources, and access to HIV information and tools are recognized as other important factors for reducing the HIV burden among MSM (Perry N Halkitis et al., 2013).

In summary, interconnections of these related health conditions and factors have undermined the health and well-being of MSM and also fuel the disproportionate rates of HIV in Black MSM (Perry N Halkitis et al., 2013). The syndemic framework, which incorporates biological, behavioral, psychosocial and structural factors, encourages a more holistic approach

to explaining the interconnections between the HIV epidemic and related health conditions (Perry N Halkitis et al., 2013). Rather than just focusing on one factor that increases HIV infection, this holistic framework takes into account the multitude of factors and conditions that affect a marginalized population (Perry N Halkitis et al., 2013).

Syndemic Health Problems

This biopsychosocial syndemic framework posits that overlapping health epidemics, such as HIV, STIs, mental health, substance abuse, and violence and sexual abuse, fuel each other and influence the HIV health disparity in MSM as well as other health conditions. The epidemics are driven or influenced by biopsychosocial factors. Consequently, these mutually reinforcing health epidemics are exacerbating the disproportionate rates of HIV infection among MSM. Social, cultural, and environmental factors can serve as stressors and must be considered as in the overall syndemic framework.

As previously discussed, homophobia, stigma, and discrimination against MSM negatively affect their physical and mental health (CDC, 2011). Men who reported more instances of social discrimination (i.e., homophobia and racism) experienced more symptoms of anxiety, depression, and suicidal tendencies (Diaz et al., 2004). When it comes to violence and sexual abuse, lesbians gays, and bisexuals have an equal or higher prevalence of experiencing IPV, SV, and stalking when compared to heterosexuals (CDC, 2010a). Six-three percent of MSM have experienced rape, physical violence, and stalking by an intimate partner in their lifetime (CDC, 2010a). Furthermore, 87% of these men have experienced SV (non-rape) in their lifetime (CDC, 2010a). These men who experience discrimination and abuse tend to participate in more risky sexual situations such as public sex, sex with partners who refuse to use condoms, and sex

under the influence of drugs or alcohol, and higher use of substance before or during unprotected anal sex, which fuel the HIV epidemic (Diaz et al., 2004; Diaz et al., 2001; Houston & McKirnan, 2007).

Men who have sex with men are also at an increased risk for STI (CDC, 2015k). The higher incidence of STI serves as an indicator for increased risk of HIV infections (CDC, 2015j). HIV transmission is enhanced by the presence of STI by facilitating viral transmission, infectiousness, and susceptibility (Anzala et al., 2000; Heffelfinger et al., 2007). Studies have also investigated the effect of circumcision on increased risk for STI and HIV (Gray et al., 2007; Millett et al., 2008). HIV infection is also associated with injecting, drinking, smoking, ingesting, or inhaling drugs (CDC, 2013a). These drug and alcohol related activities reduce inhibition by affecting judgment and reasoning, resulting in a chance of engaging in risky sexual behaviors (CDC, 2013a). Researchers have shown that binge drinkers reported instances of discordant receptive and insertive unprotected intercourse, sex in exchange for drugs or money, concurrent sexual partners, and unprotected sex (Hess et al., 2015).

These mutually reinforcing health epidemics, such HIV, STIs, mental health, substance use, and violence and sexual abuse do not occur in a vacuum (Perry N Halkitis et al., 2013). In effect, these epidemics require a more holistic approach to address health disparities and the disproportionate burden of HIV in the MSM at both the individual and population level. Other factors, such as socioeconomic, cultural, and environmental factors, must be nested in the syndemic framework to better understand the cause of the HIV epidemic among MSM. Syndemics can change the way researchers, practitioners, and policy makers approach the HIV epidemic among MSM.

CHAPTER 3

USING DEFINED SYNDEMIC RISK APPROACHES TO MEASURE HIV INFECTION IN A RACIALLY AND ETHNICALLY DIVERSE SAMPLE OF MEN WHO HAVE SEX WITH MEN IN ATLANTA, GEORGIA[1]

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[1] Stevens, T.L., Lee, J., Kim, A., Khalil, G., Heckman, T., Whalen, C., and Ezeamama, A. To be submitted to *Journal of AIDS and Behavior*.

Abstract

Introduction: In the United States, HIV/AIDS has disproportionately affected MSM. Despite the continued efforts to address racial disparities in HIV infection rates among MSM, Black MSM continue to be heavily affected by the HIV/AIDS epidemic. **Objectives:** The purpose of the study is to examine the relationship between individual HIV biopsychosocial risk factors, by deriving integrated measures of convergent biopsychosocial risk factors, to assess whether the average number of each defined integrated measure differ by race among MSM. **Methods:** Secondary data analysis was conducted on data derived from the NHBS-MSM 4th cycle (2014) in Atlanta, Georgia. Principal Component Analysis (PCA) and literature review methods were used to develop PCA and literature informed syndemic risk scores. Chi-square (X^2) and one-way analysis of variance (ANOVA) tests were used to examine the differences in the groups and means. A p value less than 0.05 was considered significant. Multivariate analyses were conducted to determine whether syndemic risk scores were associated with race and ethnicity among MSM, adjusting for age and county of residence. **Results:** When compared to White MSM, the mean syndemic risk scores in the adjusted models were .18 to 3.08 points higher for Black MSM and 1.68 to 7.49 points higher for Other MSM, ($p < .05$). Other MSM were significantly different in both models for all syndemic risk scores ($p< 0.05$). Black MSM syndemic risk scores were also significantly different from White MSM scores in the both models, except in the case of the PCA Weighted Syndemic Risk Score ($p = .71$). **Conclusion:** The study provides evidence that syndemic risk scores among MSM differ by race. When compared to White MSM, both Black MSM and Other MSM scores were elevated across the defined syndemic risk scores, with Other MSM having the highest unit increases across the scores. A syndemic framework is a useful tool

for researchers, practitioners, and policy makers to understand the interrelation of biopsychosocial factors that lead to higher HIV infection rates and racial health disparities among MSM.

INDEX WORDS: HIV, MSM, risk behavior, risk score, syndemic, Blacks, African American, National HIV Behavioral Surveillance

Introduction

Since the beginning of the HIV epidemic in the United States, HIV/AIDS has continued to severely affect gay, bisexual, and other men who have sex with men (MSM) (CDC, 2012b). In 2015, MSM accounted for 67% of the new HIV infections and 82% of newly diagnosed infections among men (CDC, 2015d), but comprised of 2% of the U.S. population (Purcell et al., 2012). In 2012, the CDC estimated that 311,087 (26%) MSM diagnosed with AIDS had died of AIDS-related causes compared to 658,507 (55%) of the general population in the United States (CDC, 2015d).

Black MSM, particularly young Black MSM (aged 13-24 years), continue to face the greatest burden of the HIV infection in the United States (CDC, 2015d). In 2015, Black MSM accounted for 39% (10,315) of the estimated new HIV infections, compared to 29% (7,570) for White MSM and 27% (7,013) for Hispanics (CDC, 2015h). According to the CDC, young Black MSM accounted for 3,888 new HIV diagnoses, which was more than any other subpopulation of MSM (i.e., race and ethnicity, age, and sex)(CDC, 2016a). Black MSM also accounted for 39% (3,928) of the newly diagnosed AIDS cases, followed by 31% (3,096) of White MSM and 24% (2,430) of Hispanic MSM (CDC, 2015h).

Despite efforts to reduce racial disparities in HIV infection rates among MSM, Black MSM continue to be disproportionately affected by HIV/AIDS (CDC, 2015d, 2015h, 2016a). Researchers have shown that the risk of HIV infection is not uniform across racial and ethnic groups in the MSM population (Crosby, Holtgrave, Stall, Peterson, & Shouse, 2007; Koblin, Husnik, et al., 2006; MacKellar et al., 2005; Millett, Flores, et al., 2007; Millett et al., 2012). In fact, the synergistic interaction of risk factors can have an increased effect on risk of HIV

infection among MSM (Dyer et al., 2012; Mustanski et al., 2007; O'Leary et al., 2014; Santos et al., 2014; Stall et al., 2003). The greater the number of risk factors experienced by an MSM can be significantly associated with high-risk sexual behaviors and HIV infection.(Millett et al., 2012).

It has been theorized that a syndemic theoretical framework, which incorporates biological, behavioral, psychosocial and structural determinants, can be a fundamental element in addressing the disproportionate HIV infection rates (Engel, 1977; Perry N Halkitis et al., 2013). Syndemic has been described as two or more epidemics (i.e., diseases or health problems) interacting synergistically, resulting in an increased burden of a disease in a given population (Singer & Clair, 2003). This framework encourages a more holistic approach in addressing the interconnections between epidemics and health conditions when related to HIV infections among MSM (Engel, 1977; Perry N Halkitis et al., 2013).

Limited studies have made effective use of the syndemic framework to predict the probability of HIV infection (Hoenigl, Green, Mehta, & Little, 2015; Menza, Hughes, Celum, & Golden, 2009; Smith, Pals, Herbst, Shinde, & Carey, 2012). In fact, at the time of this paper, no previous studies have used the biopsychosocial syndemic framework to create an integrated measure that can examine the aggregation of risk factors in predicting HIV infection.

To address the current gaps in the literature, the aim of the study is to systematically examine the relationship between individual biopsychosocial risk factors for HIV by deriving defined integrated measures of convergent biopsychosocial risk factors and assess whether the average number of syndemic risk scores differ among racial and ethnic groups of MSM in Atlanta, Georgia.

To accomplish this aim, the study will conduct a descriptive analysis to determine the prevalence of individual risk factors in the study participants. The descriptive analysis will include socio-demographic characteristics, biopsychosocial risk factors, and HIV high-risk sexual behaviors. The study will determine how biopsychosocial risk factors are related to one another (if they cluster together) by conducting correlation analyses to examine the extent in which the existence of one risk factor is positively related in the presence of another. We will then derive integrated measures of syndemic risk factors that combine individual risk factors for HIV infection. Furthermore, the study will determine if the aggregation of the syndemic risk differs based on race by conducting multivariable analysis to assess if higher syndemic risk scores are significantly associated with race and ethnicity.

Finally, we hypothesized that the co-aggregation of biopsychosocial risk factors drives the disproportionate rates of HIV-infection beyond the sum of individual risks. Also, there are measurable differences by race and ethnicity in the aggregation of multiple risk factors for HIV infection. The hypotheses focus on the aggregation of biopsychosocial risk factors in exacerbating HIV risk and infection among MSM in Atlanta, GA resulting in the racial and ethnic disparities between Black MSM and other groups of MSM**.**

Methods

The secondary data analysis uses data derived from the National HIV Behavioral Surveillance (NHBS)-MSM 4th (2014) cycle in Atlanta, Georgia. The CDC developed the NHBS to help state and local health departments establish a surveillance system that monitors HIV prevalence, risk behaviors for HIV, and testing behaviors and to assess access to HIV prevention programs and services (CDC, 2010b, 2013b). This national health survey collects information on

populations at high risk of exposure to HIV infection, to include MSM, injection drug users (IDU), and heterosexuals at greater risk for HIV infection (HET)(CDC, 2013b).

The survey consists of three cycles that are repeated in rounds. Data from each high-risk population is collected every three years to monitor HIV trends (CDC, 2013b). State and local health departments, whose jurisdictions included MSAs with high levels of HIV prevalence, participate in this national survey (CDC, 2013b). The NHBS-MSM 4th cycle (2014-2015) collected data from adult MSM in approximately 22 MSAs to include Atlanta, Georgia (CDC, 2013b). A map of the cities that made up the project areas for National HIV Behavioral Surveillance System can be found in Figure 3.1.

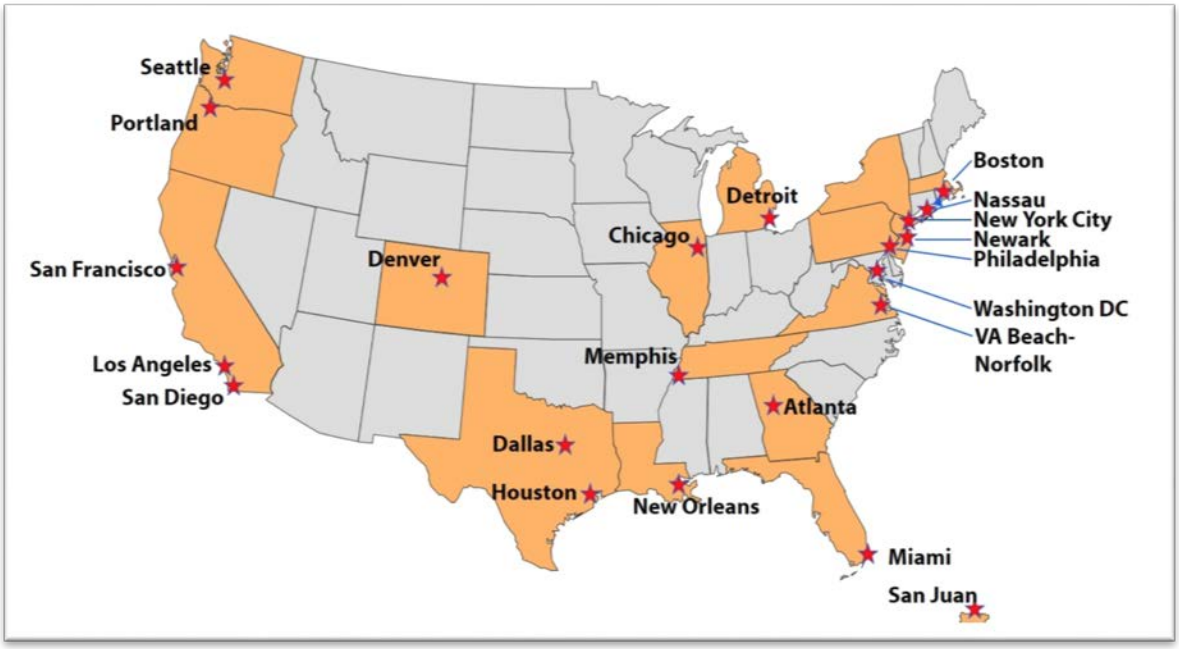

Figure 3.1 **Metropolitan statistical areas — Project Areas for National HIV Behavioral Surveillance System - 22 U.S. cities.** Reprinted Centers for Disease Control and Prevention HIV/AIDS, Retrieved from https://www.cdc.gov/hiv/statistics/systems/nhbs/projectareas.html.

Design

The NHBS-MSM cycles are repeated cross-sectional surveys for high-risk populations at increased risk of HIV infection using venue-based sampling, time-space sampling (VBS) to recruit participants. The method was used to target attendees of venues within local communities, which had the ability to attract large and diverse samples of MSM (CDC, 2013b). The venues included bars, dance clubs, retail businesses, cafes and restaurants, health clubs, social or religious organizations, adult bookstores, street locations, parks, beaches, and special events such as gay pride festivals, raves, and circuit parties (CDC, 2013b). The VBS methods helped to research, identify, and assess venues most frequented by MSM in Atlanta, Georgia (CDC, 2013b).

Sampling

In 2014, the Georgia Department of Public Health (GADPH) implemented the NHBS-MSM survey in the Atlanta metropolitan area. Between the months of September and November, the GADPH implemented VBS methods to randomly select the survey sites, recruit the participants, and collect the data (CDC, 2013b). Recruitment events continued until a minimum of 500 eligible MSM were enrolled in the survey or at the end date of the NHBS-MSM cycle (CDC, 2013b). In Atlanta, Georgia, the collection of data process was completed by November 2014.

Inclusion criteria

The survey inclusion criteria were men who had oral or anal sex with another man in the past 12 months, not previously participated in the NHBS-MSM4 cycle, resided in the Atlanta

MSA, were 18 years of age or older, were born male and self-identifies as male, and were able to complete the interview in English or Spanish (CDC, 2013b). Participants meeting these criteria were eligible to complete the survey interview.

Data collection procedures

As part of the survey process, MSM were recruited and interviewed (face-to-face) by trained staff using handheld tablets (CDC, 2013b). A standardized NHBS core questionnaire, which included additional questions on topics of local interest, was used to collect information about behavioral risks for HIV infection, HIV testing, and the utilization of HIV prevention and treatment services (CDC, 2013b). The questionnaires were developed in collaboration with CDC and local project sites (CDC, 2013b).

Also, informed consent was mandatory for the participants to take part in the interview process (CDC, 2013b). The participants who consented to the interview were offered an anonymous HIV test on site using the INSTI^{TM} HIV Antibody Test (CDC, 2013b). The INSTI^{TM} HIV-1 Antibody Test is a rapid HIV test used to detect antibodies to HIV. Reactive (preliminary positive) test results were confirmed with a supplemental or confirmatory test (i.e., Western Blot) based on approved laboratory algorithms (CDC, 2013b). Participants who consented to HIV testing also received HIV counseling. Referral information for medical and psychosocial support services was provided to the participants when appropriate. All HIV test counselors completed the required training before meeting with participants (CDC, 2013b). The participants were given monetary incentives for completing the survey and taking the HIV test (CDC, 2013b).

Principal Component Analysis

A Principal Component Analysis (PCA) was conducted to reduce the number variables into components that accounted for the maximum variance among the observed variables. The analysis was also used to develop principal component scores. Twenty-three variables from the NHBS core and local questionnaires underwent PCA. A correlation matrix using polychoric correlation assessed the adequacy of the variables for inclusion in the PCA process. Correlation among the variables indicates redundancy in the data, which helps the PCA to reduce the number of variables into smaller components. Variables with correlations greater than 0.30, were included in the analysis. A correlation coefficient of .30 is usually considered a moderate correlation (Cohen, 1988). Also, variables with low or too high correlations were also identified and assessed for removal from the analysis. The Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's Test of Sphericity were used as minimum standards that should be passed before PCA is conducted.

Once factorability was determined, the first step in the PCA process was to extract the components using the principal component method. The extraction output identified the total number of components to be retained. In general, it is expected that first few extracted components would account for larger or more "meaningful" amounts of variance compared to the latter components, which tend to be smaller with relatively small amounts of variance (Hatcher & O'Rourke, 2013).

When determining which components to retain, the following options were considered: 1) retaining any components with an eigenvalue greater than 1.00 (i.e., Kaiser-Guttman criterion) (Kaiser, 1960), 2) using the scree test to identify the plotted eigenvalue and

associated components that appear above the breakpoint, that is where the line levels off (Cattell, 1966), 3) retaining a component if it accounts for a certain proportion of variance in the dataset (Hatcher & O'Rourke, 2013), and 4) applying the interpretability criteria to the components. The interpretability criteria state that at least three variables should have significant loadings on each retained components. The variables that load on a given component should share some commonality or conceptual meaning. Also, the variables that load on different components should appear to be different. Lastly, most of the components loadings should be relatively high only one component and fairly low on the others (Hatcher & O'Rourke, 2013)

After the extraction step, a varimax rotation was conducted using the retained components. The orthogonal or uncorrelated rotation produced a rotated component pattern, which facilitated interpretation of the variables (Abdi, 2003). In interpreting the pattern, a variable was said to load on a given component if the loading was equal to or greater than the absolute value of 0.30 and it also met the interpretability criteria (Hair, 2010; Stevens, 2012; Yong & Pearce, 2013). For situations where a variable may cross-load (i.e., having a loading of equal to or greater than the absolute value of 0.30 on multiple components), the loading with the highest absolute value was chosen from among the different components.

Syndemic Risk Scores

PCA methods were used to develop the PCA Weighted and Unweighted Syndemic Risk Scores. First, loadings greater than the absolute value of 0.30 were selected for each principal component. These loadings would have the greatest effect on the overall component score. Second, z-scores were created for each variable by subtracting the mean was subtracted from

the score and dividing by the standard deviation. The z-scores standardized the process by setting the mean equal to zero and standard deviation equal to one. Third, for each component, the loadings were multiplied by the z-scores and then summed together. Fourth, each component score was added together to create the syndemic risk score, which was used to determine each participant's risk for HIV. Last, unweighted risk scores were developed as described above. However, the individual variable z-scores associated with each component were just summed to create the syndemic risk score.

Literature informed risk scores were developed and compared to the PCA syndemic risk scores. In developing these literature informed risk scores, a literature review was conducted for racial and ethnic comparative studies with quantitative outcomes (odds ratios) associated with HIV risk or HIV infection. Studies were used to estimate the odds ratios for the individual variables that made up the risk scores. When the estimates were unattainable (could not be found in the literature), the odd ratios were based on the variable's potential for increased HIV infection or assumed a uniform weight equivalent to one. Multiplying the odds ratio by the variables' z-scores and summing the products together created the weighted syndemic risk score. For the unweighted scores, the variables' z-scores were added together to create the final score.

Measures

Demographics

The study's predictor variables included the following demographic variables: 1) age categories (18-24, 25-29, 30-39, 40-49, and > 50), 2) race and ethnicity (White, Black and Other- included Hispanics-non-Black, American Indian or Alaska Native, Asian, and Native Hawaiian

and Other Pacific Islander), 3) educational level (a high school diploma/equivalent or less, some college or technical degree, college degree, or post graduate studies), 4) annual household income ($0 -$19,999, $20,000 - $49,999, $50,000 - $74,999, and > $75,000), 5) county of residence (Clayton, Cobb, DeKalb, Fulton, Gwinnett, and Other), 6) sexual identity (Gay or Non-Gay - Straight or Bisexual), and 7) HIV status.

Biopsychosocial Risk Factors

Binge drinking: **For men,** binge drinking is defined as the consumption of five or more drinks in one sitting in the last 30 days. To assess binge drinking the participants were asked: During the past 30 days, how many times did you have 5 or more alcoholic drinks in one sitting?

Circumcision*:* Circumcision was defined as being circumcised or uncircumcised. Participants were asked during the survey: Have you been circumcised?

Employment Status: Employment status was defined as employed (full and part time), unemployed (unemployed and unable to work for health reasons) and neither employed or unemployed/outside the labor force (retired, homemaker, full-time student, and other). Participants of the survey were asked: What best describes your employment status?

Exchanged or Received Things for Sex*:* Exchanged or received things for sex was defined as giving or receiving things like money or drugs in exchange for sex with a main or casual partner in the 12 months before interview. Participants of the survey were asked questions such as: In the past 12 months, did you give things like money or drugs in exchange for sex? In the past 12 months, did you get things like money or drugs, in exchange for sex?

Gay Discrimination Score*:* Gay discrimination score was defined as 1) experienced insults and name-calling, 2) received poorer services than other people in restaurants, stores, other

businesses or agencies, 3) treated unfairly at work or school, 4) denied or given lower quality healthcare, 5) or physically attacked or injured in the past 12 months because of their sexual orientation. Summing each discrimination experience the participant reported during the survey created a gay discrimination score variable.

Health Insurance Coverage: Health insurance was defined as currently having health insurance or health care coverage. Survey participants were asked the following question: Do you currently have health insurance or health care coverage?

HIV Status: HIV status was measured by laboratory-confirmed test results through a defined testing algorithm. HIV status was reported as positive, negative, or indeterminate tests. There were two indeterminate HIV test results, which were combined with HIV negative test results. Since the two indeterminate HIV tests were negligible, combining them with the HIV negative test results did not have an impact on overall study results.

Homelessness: Homelessness was defined as living on the street, in a shelter, in a single room occupancy hotel, or in a car in the past 12 months.

Incarceration: Incarceration was defined as being held in a detention center, jail, or prison, for more than 24 hours during the past 12 months.

Injection Drug Use Score: Injection Drug Use Score was defined as the use of injection drugs in the past 12 months since the interview (i.e., speedball – the combination of heroin and cocaine, heroin, powdered cocaine, crack cocaine, crystal meth – tina, crank, or ice, oxycodone, or other injection drugs in the past 12months). An injection drug use score variable was developed by summing each injection drug use the participant reported during the survey.

Non-Injection Drug Use Score: Non-injection Drug Use Score was defined as the use of non-

injection of drugs in the past 12 months since the interview (i.e., marijuana. crystal meth, crack cocaine, powdered cocaine, downers “Benzes” such as Valium, Ativan, or Xanax, painkillers such as oxycodone, Violin, or Percocet, hallucinogens such as LSD or mushrooms, ecstasy, heroin, poppers- amyl nitrite, GHB - “club drug” or “date rape drug”, and Special K (ketamine), or other non-injection drugs in the past 12months). A non-injection drug use score variable was developed by summing each non-injection drug use the participant reported during the survey.

Number of Sexual Partners: The Number of Sexual Partners was defined as the number of different men a participant engaged in oral or anal sex in the past 12 months. Participants were asked: In the past 12 months with how many different men have you had oral or anal sex?

Outness*:* Outness was defined as having told someone that you are attracted to or have sex with men. Participants were asked the question: Have you ever told anyone that you are attracted to or have sex with men?

PEP or PrEP: PEP or PrEP was defined as reporting the usage of anti-HIV medicines after or before sex in the past 12 months. Specific survey questions were “In the past 12 months, have you taken anti-HIV medicines after sex because you thought it would keep you from getting HIV”? “In the past 12 months, have you taken anti-HIV medicines before sex because you thought it would keep you from getting HIV”?

Sexual Debut: Sexual Debut was defined as the age when one experienced oral or anal sex with a man for the first time? The participants were asked: How old were you the first time you had oral or anal sex with a man?

Sexual Identity: Sexual Identity was defined as identifying as heterosexual or straight, homosexual or gay, or bisexual.

Sexually Transmitted Infection (STI) Score: STI Score was defined as being diagnosed by a doctor or health care provider with a sexually transmitted infection. The participant was asked: 1) Has a doctor or health care provider ever told you that you had any of the following STI: genital herpes, genital warts, or human papillomavirus or HPV? 2) In the past 12 months, has a doctor or other health care provider told you that you had gonorrhea, chlamydia, or syphilis or other STD? Summing each STI diagnosis, the participant reported during the survey developed the STI score variable.

Unable to Pay Medical Bills: Unable to Pay Medical Bills was defined as having problems paying or unable to pay any medical bills for care. To assess this variable, participants were asked: During the past 12 months did you have problems paying or were you unable to pay any medical bills for your care?

Unprotected Anal Sex: Unprotected Anal Sex was defined as having receptive or insertive anal sex with a man without a condom in the past 12 months.

Violence Scores: Violence was assessed by 1) ***Perpetrator of Violence Score:*** Physical, sexual, or psychological harm perpetrated by the participant or 2) ***Victim of Violence Score****:* Physical, sexual, or psychological harm perpetrated by someone on the participant (i.e., partner, family member, friend/acquaintance, stranger, or other) in the past 12 months. Examples of violent acts or situations include 1) arguments that escalated into any of the following: destruction of property, grabbing, restraining, pushing, kicking, slapping, punching, threatening with violence, or other acts of physical intimidation 2) pressured or forced to do something sexual after saying no 3) pressured to have sex without a condom after requesting to use a condom 4) lied about HIV status, and intentionally tried to transmit the virus 5) insulted, criticized, threatened, or

yelled at in any way 6) prevented from communicating with or seeing friends/family/coworkers 7) monitored or demanded access to a cell phone, email, social networking sites, finances or spending, and 8) felt afraid, threatened, isolated, trapped or walked on eggshells in any relationship or friends or family raised concerns about your safety in this relationship.

Visited a Healthcare Provider: Visited a healthcare provider was assessed by asking the participants: In the past 12 months, have you seen a doctor, nurse, or other health care provider?

Syndemic Risk Scores

PCA Weighted Syndemic Risk Score: The PCA Weighted Syndemic Risk Score was developed using PCA. During this process biopsychosocial risk factors were reduced to account for the maximum amount of shared variance. For each identified principal component, the component loadings were multiplied by the standardized z-scores of each variable and then the individual products were summed together. The sum of the products was totaled, which resulted in a weighted syndemic score that estimated HIV risk for each participant.

PCA Unweighted Syndemic Risk Score: The PCA Unweighted Syndemic Risk Score was developed similarly to the PCA Weighted Syndemic Risk Score. Biopsychosocial risk factors were reduced to account for the maximum amount of shared variance. However, instead of multiplying the loadings by the standardized z-scores of the variables for each identified component, the z-scores were just summed together, which resulted in an unweighted score that estimated HIV risk for each participant.

Literature Informed Weighted Syndemic Risk Score: The Literature Informed (LI) Weighted Syndemic Risk Score was developed through a literature review process. The review process

identified MSM comparative studies with quantitative outcomes (odd ratios) that are associated with HIV risk or HIV infection. Each biopsychosocial variable's z score was multiplied by its respective odds ratio and then added together to create a weighted score used to estimate HIV risk.

Literature Informed Unweighted Syndemic Risk Score: The Literature Informed Unweighted Syndemic Risk Score was developed very similar to the Literature Informed Weighted Syndemic Risk Score, as described above. However, the variables' z-scores were summed together, which resulted in an unweighted score used to estimate HIV risk.

Analysis

First, a descriptive analysis was conducted to determine the frequency and proportion of selected variables, including the number of sexual partners, HIV status, and unprotected anal intercourse, which were stratified by race and ethnicity among the 507 study participants. Chi-square (X^2) and one-way ANOVA tests were conducted to test for differences in categorical variables and means, respectively, of select demographic and biopsychosocial indicators by race and ethnicity. A *p* value less than .05 was considered to be a significant difference. Second, a correlation analysis was conducted to examine the extent in which the existence of one HIV risk factor is positively or negatively related in the presence of another. We also assessed the adequacy of the factors for inclusion in the PCA, and test for multicollinearity. Third, a PCA was performed to reduce the number variables into components that accounted for the most variance among these observed variables. Tests for factorability were also conducted to determine if the data was appropriate for PCA. Fourth, integrated measures (syndemic risk score) were developed by PCA and informed literature review processes. Lastly, multivariate

analyses were conducted to determine whether a syndemic risk score was significantly associated with race and ethnicity among MSM, while adjusting for covariates such as age and county of residence. Again, a *p* less than 0.05 was considered to be a significant difference. The selected variables in the model were based on the outcome of the PCA process and literature review. All analyses were conducted using SAS® Studio 3.5 (Basic Edition) software.

Results

A total of 507 men met the criteria for eligibility, consented to participate in the survey, and completed the survey. Table 3.1 and Table 3.2 show the characteristics of the sample by race and ethnicity.

In Table 3.1, Black MSM made up 55% of the participants. Nearly half of the participants fell within the age range of 30-49-years ($p < .001$) and 48% of the participants reported having a college degree or completed post-graduate studies (61% for Whites compared to 43% for Blacks) ($p < .001$). Most participants reported annual incomes in either the $20,000-$49,999 range (38%) or the $>50,000 range (also 38%), with 30% of Blacks and Others reported making less than $20,000 a year compared to 13% for Whites ($p < .001$). Ten percent of Blacks reported being unemployed compared to 5% for Whites and 8% for Others. Over half of participants (57%) in the survey resided in Fulton County.

Of the eligible participants, 79% identified themselves as gay or homosexual, and 21% identified themselves as non-gay (identifying as either straight or bisexual), specifically 31% of "Others" identified as non-gay compared to 26% of Blacks and 10% for Whites ($p < .001$). Thirty-four percent of the participants were HIV positive. Laboratory confirmed HIV test showed that 42% of Blacks were HIV positive when compared to 22% for Whites and 28% for Others ($p <$

.001). Also, in the 12 months before the survey, 40% of the participants had 5 or more male sexual partners (p = 0.01). Broken down by race, 48% of Whites reported 5 or more partners, when compared to Blacks (34%), and Others (42%).

Fifty-seven percent of the participants reported being sexually active by the age of 17 years (Whites 60%, Blacks 53%, and Others 57%) (p = 0.004). UAI in the past 12 months was reported by 64% overall, Whites 62%, Blacks 62%, and 77% of Others. Eight percent of respondents reported exchanging and receiving things for sex (p = 0.02). Seventy-two percent of respondents reported having health insurance or coverage. However, Whites (82%) reported having more health insurance or coverage than Blacks (68%) and Others (67%) (p = 0.004). The incarceration rate was 28%. A lower proportion of Whites (16%) reported being held in a detention center, jail, or prison, for more than 24 hours during the past 12 months, compared to Blacks (34%) and Others (32%) (p < .001). Also, 90% of the participants reported never being homeless. Forty-one percent of the participants reported having 5 or more drinks in one sitting in the last 30 days. A higher proportion of Whites (95%) were circumcised compared to Blacks (81%) and Others (54%) (p < .001). Finally, the overall reported PEP or PrEP usage was 4% (p = 0.03).

Table 3.1. Selected Characteristics among Men Who Have Sex With Men by Race/Ethnicity: NHBS MSM4 Survey, Atlanta, Georgia (2014).

Characteristics	Total *N*=507 *N*%	White *n*=166 *n*%	Black *n*=280 *n*%	Other [a] *n*=61 *n*%	X^2 *p*-value
Age Groups					< .001
18-24	96 (18.93)	14 (8.43)	69 (24.64)	13 (21.31)	
25-29	88 (17.36)	23 (13.86)	55 (19.64)	10 (16.39)	
30-39	139 (27.42)	45 (27.11)	72 (25.71)	22 (36.07)	

40-49	114 (22.49)	42 (25.30)	62 (22.14)	10 (16.39)	
50 and over	70 (13.81)	42 (25.30)	22 (7.86)	6 (9.84)	
Educational Attainment					< .001
High school diploma/ equivalent or less	103 (17.75)	18 (10.84)	68 (24.29)	17 (27.87)	
Some college or technical degree	162 (31.95)	47 (28.31)	93 (33.21)	22 (36.07)	
College degree or post graduate studies	242 (47.73)	101 (60.84)	119 (42.50)	22 (36.07)	
Annual Household Income					< .001
$0-$19,999	124 (24.46)	22 (13.25)	84 (30.00)	18 (29.51)	
$20,000-$49,999	192 (37.87)	53 (31.93)	113 (40.36)	26 (42.62)	
$50,000-$74,999	94 (18.54)	37 (22.29)	46 (16.43)	11 (18.03)	
$75,000 and over	97 (19.13)	54 (32.53)	37 (13.21)	6 (9.84)	
Employment Status					0.20
Employed	392 (77.32)	137 (82.53)	212 (75.71)	43 (70.49)	
Unemployed	41 (8.09)	9 (5.42)	27 (9.64)	5 (8.20)	
Neither Employed or Unemployed	74 (14.60)	20 (12.05)	41 (14.64)	13 (21.31)	
County of Residence					0.17
Clayton	20 (3.94)	2 (1.20)	14 (5.00)	4 (6.56)	
Cobb	44 (8.68)	14 (8.43)	24 (8.57)	6 (9.84)	
DeKalb	99 (19.53)	36 (21.69)	54 (19.29)	9 (14.75)	
Fulton	287 (56.61)	94 (56.63)	160 (57.14)	33 (54.10)	
Gwinnett	31 (6.11)	9 (5.42)	14 (5.00)	8 (13.11)	
Other Counties	26 (5.13)	11 (6.63)	14 (5.00)	1 (1.64)	
Sexual Identity					< .001
Gay	398 (78.50)	150 (90.36)	206 (73.57)	42 (68.85)	
Non Gay (Straight or Bisexual)	109 (21.50)	16 (9.64)	74 (26.43)	19 (31.15)	
HIV Status (Lab Confirmed) [b]					< .001
Positive	164 (34.24)	35 (22.44)	113 (42.48)	16 (28.07)	
Negative (includes 2 indeterminate)	315 (65.76)	121 (77.56)	153 (57.52)	41 (71.93)	
Recent HIV Test					0.09
Less than 12 months	327 (64.50)	99 (59.64)	182 (65.00)	46 (75.41)	

Greater than or equal to 12 months	180 (35.50)	67 (40.36)	98 (35.00	15 (24.59)	
Number of sexual partners					0.01
0 partners	28 (5.52)	8 (4.82)	18 (6.43)	2 (3.28)	
1-2 partners	156 (30.77)	43 (25.90)	95 (33.93)	18 (29.51)	
3-4 partners	120 (23.67)	34 (20.48)	71 (25.36)	15 (24.59)	
5-10 partners	121 (23.87)	40 (24.10)	68 (24.29)	13 (21.31)	
More than 10 partners	82 (16.17)	41 (24.70)	28 (10.00)	13 (21.31)	
Sexual Debut					0.004
4 to 17 years of age	284 (56.02)	100 (60.24)	149 (53.21)	35 (57.38)	
18 to 24 years of age	187 (36.88)	46 (27.71)	117 (41.49)	24 (39.34)	
25 to 45 years of age	36 (7.10)	20 (12.05)	14 (5.00)	2 (3.28)	
Outness					0.16
Yes	486 (95.86)	163 (98.19)	266 (95.00)	57 (93.44)	
No	21 (4.14)	3 (1.81)	14 (5.00)	4 (6.56)	
Unprotected Anal Intercourse (UAI)					0.07
Yes	323 (63.71)	103 (62.05)	173 (61.79)	47 (77.05)	
No	184 (36.29)	63 (37.95)	107 (38.21)	14 (22.95)	
Homelessness					0.05
Homeless in past 12 months	19 (3.75)	2 (1.20)	12 (4.29)	5 (8.20)	
Not homeless in past 12 months	27 (5.33)	6 (3.61)	19 (6.79)	2 (3.28)	
Never	461 (90.33)	158 (95.18)	249 (88.93)	54 (88.52)	
Health Insurance Coverage					0.004
Yes	367 (72.39)	136 (81.93)	190 (67.88)	41 (67.21)	
No	140 (27.61)	30 (18.07)	90 (32.14)	20 (32.79)	
Unable to Pay Medical Bills					0.39
Yes	52 (10.26)	15 (9.04)	33 (11.79)	4 (6.56)	
No	455 (89.74)	151 (90.96)	247 (88.21)	57 (93.44)	
Visited Healthcare Provider					0.68
Yes	421 (83.04)	136 (81.93)	236 (84.29)	49 (80.33)	
No	86 (16.96)	30 (18.07)	44 (15.71)	12 (19.67))	

Incarceration					< .001
Less than 12 months (since interview)	45 (8.88)	6 (3.61)	34 (12.14)	5 (8.20)	
Greater than 12 months (since interview)	99 (19.53)	22 (13.25)	62 (22.14)	15 (24.59)	
Never	363 (71.60)	138 (83.13)	184 (65.71)	41 (67.21)	
Binge Drinking					0.07
Yes	210 (41.42)	70 (42.17)	107 (38.21)	33 (54.10)	
No	297 (58.58)	96 (57.83)	173 (61.49)	28 (45.90)	
Circumcision					< .001
Yes	418 (82.45)	157 (94.58)	228 (81.43)	33 (54.10)	
No	89 (17.55)	9 (5.42)	52 (18.57)	28 (45.90)	
PEP or PrEP					0.03
Yes	18 (3.55)	11 (6.63)	5 (1.79)	2 (3.28)	
No	489 (96.45)	155 (93.37)	275 (98.21)	59 (96.72)	
Exchanged/Received Things for Sex					0.02
Yes	40 (7.89)	5 (3.01)	29 (10.36)	6 (9.84)	
No	467 (92.11)	161 (96.99)	251 (89.64)	55 (90.16)	

Note. X^2 *p* value=Chi Square Test; [a] Other=Hispanics-non-Black, American Indian or Alaska Native, Asian, and Native Hawaiian and Other Pacific Islander [b] 28 participants missing (no laboratory confirmed test results)

In Table 3.2, we tested for differences in means for selected biopsychosocial indicators by race and ethnicity. The Non Injection Drug Use Score for Whites was .46 units higher than the score for Blacks and .23 units lower than the score for Others (*p* = .004). STI Score for Whites was .10 units higher than the score for Blacks and .16 units lower than the score for Others (*p* = .05). The Perpetrator of Violence and Victim of Violence Scores for Blacks and Others were not significantly different from the Perpetrator of Violence and Victim of Violence Scores for Whites. Furthermore, the Gay Discrimination/Stigma and Injection Drug Use Scores

for Blacks and Others were also not significantly different from the comparable scores of Whites. In general, Black MSM had the lowest mean scores across the races. The mean scores for Black MSM were also lower than the mean scores of the sample population.

Table 3.2. Bivariate Analysis of Characteristics by Race/Ethnicity for Men Who Have Sex With Men: NHBS MSM4 Survey, Atlanta, Georgia (2014) (Continuous Variables)

Characteristics	Total *N*=507	White *n*=166	Black *n*=280	Other *n*=61	[a] *p*-value
Gay Discrimination/Stigma Score					0.43
Mean (SD) [b]	0.63 (1.05)	0.69 (1.17)	0.62 (1.02)	0.42 (0.81)	
Min [c]**/Max** [d]	0/5.00	0/5.00	0/4.00	0/4.00	
Injection Drug Use Score					0.27
Mean (SD)	0.03 (0.27)	0.06 (0.32)	0.02 (0.25)	0.03 (0.18)	
Min/Max	0/4.00	0/3.00	0/4.00	0/1.00	
Non Injection Drug Use Score					0.004
Mean (SD)	1.28 (1.80)	1.51 (1.86)	1.05 (1.61)	1.74 (2.31)	
Min/Max	0/12.00	0/7.00	0/12.00	0/11.00	
Sexually Transmitted Infections (STI) Score					0.05
Mean (SD)	0.41 (0.79)	0.45 (0.84)	0.35 (0.72)	0.61 (0.94)	
Min/Max	0/4.00	0/4.00	0/4.00	0.3.00	
Perpetrator of Violence Score					0.69
Mean (SD)	0.33 (0.66)	0.36 (0.71)	0.31 (0.63)	0.34 (0.68)	
Min/Max	0/3.00	0/3.00	0/3.00	0/3.00	
Victim of Violence Score					0.54
Mean (SD)	0.92 (1.30)	0.97(1.36)	0.86 (1.27)	1.04 (1.26)	
Min/Max	0/7.00	0/7.00	0/7.00	0/5.00	

Note. [a] *p*-value = one-way ANOVA test [b] SD=Standard Deviation [c] Min= Smallest (Minimum) Value
[d] Max=Largest (Maximum) Value

Principal Component Analysis

Principal component analysis was used to reduce the number variables into components that accounted for the maximum variance among the observed variables. From the polychoric correlation matrix, 22 out of the 23 variables correlated with at least one other variable at a coefficient of 0.3 or greater (Table 3.3) Circumcision was the one variable that did not correlate with any other variable based on the defined coefficient cut off point of 0.3. Also, the matrix results showed very high correlation (i.e., an absolute value of 0.90 or greater) between PEP or PrEP Use and Outness (1.00), Visited Healthcare Provider and Injection Drug Use (-0.92), and Visited Healthcare Provider and PEP or PrEP Use (0.92). This high correlation may indicate the effects of multicollinearity. Because highly correlated variables are known predictors for increased risk of HIV infection, we decided to keep these variables from the analysis.

Standard testing requirement analyses showed that the Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0.71 (0.70356218), which was above the recommended value of 0.6 (Cerny & Kaiser, 1977), and Bartlett's Test of Sphericity was found to be significant (df =253, $\chi 2 = 1600.74$, $p < .001$), indicating that there were statistically significant interrelationships among the variables.

We determined that eight components were considered sufficiently important to be retained for interpretation. Also, the interpretability criteria were met for identifying significant loadings on each retained components.

Table 3.3. Polychoric Correlation Coefficients for Biopsychosocial Risk Factors

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Employment Status	1.00																						
2. Education	0.32	1.00																					
3. Income	0.41	0.51	1.00																				
4. Circumcision	0.05	0.22	0.14	1.00																			
5. STI	0.20	-0.02	0.06	-0.03	1.00																		
6. Sexual Identity	0.23	0.19	0.14	0.15	-0.15	1.00																	
7. Outness	0.17	0.31	0.20	0.03	-0.44	0.34	1.00																
8. HIV Test	0.09	0.04	0.02	-0.16	0.02	-0.03	-0.09	1.00															
9. Sexual Debut	0.04	0.18	0.09	-0.05	0.15	-0.18	-0.33	0.10	1.00														
10. Sexual Partners	0.03	-0.13	0.10	-0.01	0.35	-0.04	-0.44	-0.16	0.20	1.00													
11. Injection Drug Use	0.42	-0.17	0.05	-0.18	0.39	-0.23	-0.87	0.32	0.04	0.47	1.00												
12. Non-Injection Drug Use	0.22	0.03	0.06	-0.03	0.26	0.01	-0.18	0.05	0.22	0.27	0.57	1.00											
13. Binge Drinking	0.19	0.10	0.03	0.04	-0.01	0.12	0.13	-0.13	-0.01	-0.01	-0.14	0.34	1.00										
14. Things for Sex	0.31	0.16	0.37	-0.11	0.10	0.22	0.05	0.13	0.17	0.34	0.28	0.35	0.01	1.00									
15. PEP or PrEP Use	0.14	0.35	0.19	0.02	-0.10	0.19	1.00	0.35	-0.06	-0.29	-0.19	-0.24	-0.16	-0.09	1.00								
16. Health Insurance	0.35	0.44	0.58	0.10	-0.09	0.17	0.25	0.02	0.10	0.04	-0.12	0.09	0.15	0.29	0.40	1.00							
17. Pay Medical Bills	0.30	0.14	0.30	-0.05	0.33	-0.17	-0.02	0.35	0.03	0.02	0.16	0.25	-0.02	0.13	0.14	0.23	1.00						
18. Visited Healthcare Provider	-0.13	0.20	0.09	0.17	-0.42	0.21	0.37	0.23	-0.03	-0.05	-0.92	-0.08	-0.03	-0.17	0.92	0.34	-0.40	1.00					
19. Incarceration	0.43	0.30	0.33	0.01	0.03	0.32	0.37	0.11	0.19	0.00	0.29	0.27	0.24	0.41	0.30	0.38	0.27	0.01	1.00				
20. Homelessness	0.50	0.53	0.59	0.12	0.00	0.37	0.20	0.09	0.13	-0.02	0.08	0.18	0.32	0.46	-0.06	0.61	0.20	-0.24	0.55	1.00			
21. Discrimination	0.13	0.25	0.20	-0.04	0.06	0.00	0.16	-0.05	0.18	0.16	0.01	0.11	-0.06	0.29	-0.10	0.22	0.03	0.03	0.25	0.30	1.00		
22. Victim of Violence	0.12	0.14	0.13	0.03	0.20	0.12	0.02	0.05	0.11	0.30	0.20	0.26	0.07	0.32	-0.11	0.24	0.19	-0.07	0.30	0.33	0.56	1.00	
23. Perpetrator of Violence	0.26	0.20	0.14	0.00	0.11	0.07	0.03	0.01	0.12	0.19	0.28	0.31	0.22	0.41	-0.05	0.10	0.16	-0.17	0.29	0.32	0.35	0.70	1.00

After applying the loading and interpretability criteria, 6 variables were found to load on the first component, which was subsequently labeled as Socioeconomic and Structural. Three variables were loaded on the second component, which was labeled Discrimination and Violence. Three variables were loaded on the third component, which was labeled IDU, Selling Sex, and Sexual Partners. Three variables loaded on the fourth component and labeled Gay Identity and Sexual Debut. Two variables were loaded on the fifth component and labeled STI and Unable to Pay Bills. Two variables were loaded on the sixth component and labeled Alcohol and Non-Injection Drug Use. Two variables were loaded on the seventh component and labeled Prophylaxis Use and HIV Testing. Lastly, two variables were loaded on the eighth component and labeled Access to Care and Circumcision.

The variables, corresponding component loadings, communalities, and the variance explained for each component are outlined in Table 3.4.

Table 3.4. Rotated (Varimax) Components Patterns and Variance Explained from Principal Component Analysis of Biopsychosocial Risk Factors.

	Principal Components								
Variable	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC7**	**PC8**	**h^2**
Employment Status	0.53	.	.	.	0.29	.	.	.	0.47
Education	0.67	.	.	.	.	.	.	.	0.53
Income	0.72	.	.	.	.	.	.	.	0.60
Circumcision	.	.	.	.	.	.	.	0.64	0.50
STI	.	.	0.26	.	0.62	.	.	.	0.52
Sexual Identity	.	.	.	-0.52	.	.	.	.	0.42
Outness	.	.	.	-0.56	.	.	.	.	0.38
HIV Test	.	.	.	.	.	.	0.78	.	0.65
Sexual Debut	.	.	.	0.73	.	.	.	.	0.64
Sexual Partners	.	0.26	0.53	0.30	.	.	-.031	0.30	0.64

Injection Drug Use	.	.	0.67	.	.	.	.	.	0.51
Non-Injection Drug Use	.	.	0.52	.	.	0.55	.	.	0.64
Binge Drinking	.	.	.	.	.	0.82	.	.	0.72
Exchanged or Received Things for Sex	0.27	.	0.53	.	.	.	.	-0.25	0.4
PEP or PrEP Use	.	.	.	.	.	.	0.41	.	0.29
Health Insurance	0.65	.	.	.	.	.	.	.	0.49
Unable to Pay Medical Bills	.	.	.	.	0.66	.	0.34	.	0.58
Visited Provider	.	.	.	.	-0.52	.	0.44	0.53	0.75
Incarceration	0.49	.	.	.	.	0.26	.	.	0.45
Homelessness	0.62	.	.	.	.	.	.	-0.27	0.54
Discrimination	.	0.68	.	.	.	.	.	.	0.57
Victim of Violence	.	0.87	.	.	.	.	.	.	0.78
Perpetrator of Violence	.	0.75	.	.	.	.	.	.	0.65
Variance Explained	2.61	1.98	1.59	1.40	1.38	1.33	1.31	1.15	

Note. PC=Principal Component; . = Loadings on the PCs were below the threshold of the absolute value of .25; h^2 = communality

Table 3.5 outlines which variables were loaded on each component with the assignment of the final component name.

Table 3.5. Component Loadings and Final Names from the Principal Component Analysis of Biopsychosocial Risk Factors.

Component	Variables	Final Name
PC1	Employment Status, Education, Income, Health Insurance, Incarceration, and Homelessness	Socioeconomic and Structural
PC2	Discrimination, Victim of Violence, and Perpetrator of Violence	Discrimination and Violence

PC3	Injection Drug Use, Exchanged or Received Things for Sex, and Sexual Partners	IDU, Selling Sex, and Sexual Partners
PC4	Sexual Identity, Outness, and Sexual Debut	Gay Identity and Sexual Debut
PC5	STI and Unable to Pay Medical Bills	STI and Unable to Pay Bills
PC6	Binge Drinking and Non-Injection Drug Use	Alcohol and Non injection Drug Use
PC7	PEP or PrEP Use and HIV Test	Prophylaxis Use and HIV Testing
PC8	Visited Provider and Circumcision	Access to Care and Circumcision

Note. PC=Principal Component

Syndemic Risk Scores

Table 3.6 displays the estimated and aggregated odds ratios for each biopsychosocial risk factors used to develop the Literature Informed Weighted Syndemic Risk Score. An odds ratio (OR) greater than one indicates an increased likelihood of HIV infection in MSM, while an OR less than one indicates a decreased likelihood of HIV infection in MSM.

Table 3.6. Estimated Odds Ratios for Predictors Associated with the Increased Odds of HIV Infection Used to Develop the Literature Informed Weighted Syndemic Risk Score

Variable Names	Estimated Odds Ratio	Variables Defined
Employment Status	1.50	Unemployed
Education	2.00	Less than a high school education
Income	2.00	Lower Income (<$20,000 per year)
Circumcision	1.00	Circumcision status
STI	3.00	STI (current diagnosis)
Sexual Identity	0.50	Gay Identity
Outness	0.50	Disclosure of homosexuality to others

HIV Test	1.00	HIV test in the past year
Sexual Debut	2.00	Age of first oral or anal sex with a man (< 18 years old)
Sexual Partners	1.50	High number of male sex partners (> 4 partners in the past year)
Injection Drug Use	1.50	Injection drug use
Non-Injection Drug Use	2.00	Any lifetime drug use
Binge Drinking	2.00	Alcohol Use
Exchanged or Received Things for Sex	2.00	Sex work (lifetime)
PEP or PrEP Use	2.00	Use of PEP and PrEP
Health Insurance	0.50	Have health insurance or coverage
Unable to Pay Medical Bills	1.00*	Problems paying medical bills
Visited Provider	1.00*	Have seen a health care provider
Incarceration	2.00	Ever incarcerated
Homelessness	1.50	Homelessness
Discrimination	2.00*	Discrimination based on sexual orientation
Victim of Violence	2.00	Experienced Emotional Violence
Perpetrator of Violence	1.00	Perpetrator of Emotional Violence

Notes. * The variable's odds ratio was not found in the literature – estimates for these odds ratios were based on the variable's increased risk for HIV infection or an assumed uniform weight equivalent to 1.00.

Table 3.7 describes the results of race and ethnicity as a determinant for syndemic risk score using the PCA and Literature Informed approaches. The means of the summed syndemic risk scores were stratified by race and ethnicity. No matter how the syndemic risk score is defined, mean score was consistently lower for white MSM and elevated for Black and Other MSM. When compared to Whites, there was a .68 and 1.94 mean unit increase in the PCA Weighted Syndemic Risk Score for Blacks and Others, respectively (p = 0.03). There were also mean unit increases for PCA Unweighted Syndemic Risk Score: Blacks (2.29) and Others (4.57)

($p < .001$), Literature Informed Weighted Syndemic Risk Score: Blacks (2.96) and Others (6.83) ($p < .001$), and Literature Informed Unweighted Syndemic Risk Score: Blacks (2.27) and Others (4.57) when compared to White MSM ($p < .001$).

Table 3.7. Descriptive Statistics for Syndemic Risk Scores Stratified by Race Based on the Respective Defined Approach Among MSM in Atlanta, Georgia

	Total		White		Black		Other		
Risk Scores	***N***	**Mean (SD [a])**	***n***	**mean (SD)**	***n***	**mean (SD)**	***n***	**mean (SD)**	***p*-value [b]**
PCA Weighted Syndemic Risk Score	507	0.001 (4.86)	166	-0.61 (4.66)	280	0.07 (4.98)	61	1.33 (4.63)	0.03
Min/Max		-10.57/ 22.13		-9.64/ 22.13		-10.57/ 19.68		-7.79/ 12.70	
PCA Unweighted Syndemic Risk Score	507	0.34 (7.72)	166	-1.48 (7.31)	280	0.81 (7.83)	61	3.09 (7.19)	< .001
Min/Max		-15.33/ 34.76		-15.36/ 34.96		-12.59/ 28.08		-13.52/ 19.92	
Literature Informed Weighted Syndemic Risk Score	507	0.007 (12.89)	166	-2.45 (12.31)	280	0.51 (13.03)	61	4.38 (12.52)	< .001
Min/Max		-25.88/ 54.31		-25.88 /54.31		-21.31 /49.73		-23.54 /35.68	
Literature Informed Unweighted Syndemic Risk Score	507	0.007 (7.86)	166	-1.80 (7.46)	280	0.47 (7.99)	61	2.77 (7.29)	< .001
Min/Max		-15.82/ 34.46		-15.82 /34.46		-13.08 /28.60		-14.02 /19.93	

Note. [a] SD=Standard Deviation [b] *p*-value= one-way ANOVA

In Table 3.8, the multivariable linear regression analyses results showed that in the unadjusted models of the respective syndemic risk scores, Black MSM risk scores were higher, with a range of .68 to 2.96 units per respective syndemic risk scores when compared to the scores of White MSM. Also, the scores for Other MSM were higher, with a range of 1.93 to 6.84 units per respective syndemic risk score, again when compared to White MSM risk scores.

The PCA Unweighted Syndemic Risk Score (p = 0.002), LI Weighted Syndemic Risk Score (p = .02), LI Weighted Syndemic Risk Score (p = 0.003), but not PCA Weighted Syndemic Risk Score (p = .15) were significantly elevated for Black MSM compared to White MSM. Other MSM were also significantly elevated when compared to White MSM in relation to all syndemic risk scores (i.e., PCA Weighted Syndemic Score (p = 0.007), PCA Unweighted Risk Score (p < .001), LI Weighted Syndemic Risk Score (p < .001) and LI Unweighted Syndemic Risk Score (p < .001). However, the findings showed that there was no significant difference between Blacks and Whites for the PCA Weighted Syndemic Risk Score (p = 0.15).

When the models were adjusted for age and county of residence, Black MSM scores were .23 to 2.00 units higher when compared White MSM, while Other MSM scores were also higher with a range of 1.54 and 5.95 units. The scores for Blacks were significantly elevated when compared to Whites for the PCA Unweighted Syndemic Risk Score (p = 0.02), and LI Unweighted Syndemic Risk Score (p = 0.02). Other MSM scores were significantly elevated when compared to White MSM in relation to PCA Weighted Syndemic Score (p = 0.03), PCA Unweighted Risk Score (p = < .001), LI Weighted Syndemic Risk Score (p = 0.002), and LI Unweighted Syndemic Risk Score (p = < .001). There was no significant difference between

Black and White MSM for the PCA Weighted Syndemic Risk Score and LI Weighted Syndemic Risk Score.

Table 3.8. The Unadjusted and Adjusted Differences Between Defined Syndemic Risk Scores and Race/Ethnicity Among MSM in Atlanta, Georgia

	PCA (Weighted)		PCA (Unweighted)		LI (Weighted)		LI (Unweighted)	
	B 95% CI *p*-value [a]		B 95% CI *p*-value		B 95% CI *p*-value		B 95% CI *p*-value	
	Unadj.	Adj.	Unadj.	Adj.	Unadj.	Adj.	Unadj.	Adj.
Race								
White	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Black	0.68 0.25, 1.60 .15	0.23 -0.71, 1.19 .62	2.30 0.85, 3.75 .002	1.86 0.36, 3.36 .02	2.96 0.52, 5.40 .02	2.00 -0.51, 4.51 .12	2.27 0.79, 3.75 .002	1.81 0.28, 3.34 .02
Other	1.93 0.52, 3.35 .01	1.54 0.12, 2.96 .03	4.57 2.35, 6.79 < .001	4.17 1.93, 6.41 < .001	6.84 3.10, 10.56 < .001	5.95 2.19, 9.70 0.002	4.56 2.30, 6.83 < .001	4.14 1.86, 6.43 < .001

Notes. PCA=Principal Component Analysis; LI=Literature Informed; Adjusted for Age and County of Residence; [a] *p*-value= Wald Chi Square Test

Discussion

The aim of the study was to systematically examine the relationship between individual biopsychosocial risk factors for HIV, derive integrated measures of convergent biopsychosocial risk factors (i.e., syndemic risk scores), and assess whether the average number of syndemic risk scores differ among racial and ethnic groups of MSM in Atlanta, Georgia. The study found that the mean syndemic risk scores for Black and Other MSM were approximately two to three folds higher when compared to the mean scores of White MSM. When controlling for the effects of

age and county of residence, the study found elevated syndemic risk scores among Black and Other MSM, with the highest unit increases in syndemic scores found among Other MSM. The PCA and Literature Informed syndemic risk scores for Black and Other MSM were higher when compared to the scores of White MSM. Other MSM had the highest significant unit increase per risk score when compared to White and Black MSM. Finally, the PCA Unweighted Syndemic Risk Score and LI Weighted Syndemic Risk Score were highest among the four defined risk scores by race.

Our results have public health implications for researchers, practitioners, public health programs, and policy makers seeking to address the disproportionate rates of HIV infection among MSM. The study highlighted the need for a more integrated and holistic approach to understanding the intertwining health problems and factors that are negatively affecting the health of MSM. Additional research is needed to examine the role of these factors and conditions (e.g., substance abuse, STIs, violence, mental health) and amplification of HIV infection among Black MSM. More specifically, the scientific research should not only explore the individual effects of these factors, but also their syndemic interaction. In addition, this research should also examine the association between syndemic biopsychosocial risk factors and the prevalence of HIV infection in MSM and other related populations.

Limitations

Some potential limitations should be considered when drawing conclusions from this study. The survey results are derived from unweighted data that may under- or over-represent some of the subgroups of the respondent group. As a result, the study findings cannot be generalized to the survey population (i.e., all MSM in Atlanta, Georgia), but only to this sample.

The survey data was self-reported, which can be subject to social desirability and recall biases. Many of the study participants may have provided answers that are perceived as desirable responses or experienced problems recalling events or experiences from their past.

Also, no temporal or causal inferences can be derived from the results because the study used a cross-sectional design. Furthermore, PCA methods limited the use of the covariates in the multivariate models. Specifically, many of the variables were used as part of the PCA process and could not also be used in the multivariate analyses. Also for the PCA, the criteria for the selection of loaded variables were not well defined in the literature, which sometimes made the process of naming the final components a more difficult task. Finally, because we combined races that had small sample sizes into one race group "Other," we could not generalize the study findings to one specific race (i.e. Hispanics) from within this group.

Conclusion

MSM continue to be disproportionately affected by HIV/AIDS in the United States. This study provides evidence that coaggregation of multiple risk factors can influence HIV infection in MSM. The results of the study show that syndemic risk scores differ by race and ethnicity among MSM in Atlanta, Georgia, which may explain the disproportionate and the increasing HIV infection in Black MSM. To our knowledge, this is the first study to derive syndemic risk scores of convergent biopsychosocial risk factors to assess whether defined risk scores differ across racial and ethnic groups of MSM in Atlanta, Georgia. The application of a syndemic framework can serve as a useful tool for assisting researchers, practitioners, and policy makers in understanding the interrelation of biopsychosocial factors that negatively affect the health of MSM.

CHAPTER 4

THE SYNDEMIC RISK ASSOCIATED WITH THE TRAJECTORY OF HIV INFECTION AND SEXUAL RISK BEHAVIORS AMONG MEN WHO HAVE SEX WITH MEN IN ATLANTA, GEORGIA [2]

[2] Stevens, T.L., Lee, J., Kim, A., Khalil, G., Heckman, T., Whalen, C., and Ezeamama, A. To be submitted to *Journal of AIDS and Behavior*.

Abstract

Introduction: Men who have sex with men (MSM) have been disproportionately impacted by HIV/AIDS since the beginning of the epidemic in the United States. Studies have sought to determine the cause of racial and ethnic disparities in HIV infection and the associated factors implicated in the high burden of the disease among MSM. However, many of these studies have not completely explored the syndemic of multiple biopsychosocial risk factors and the trajectory of the HIV infection in explaining the racial health disparities among racial and ethnic groups of MSM. **Purpose:** The purpose of the study was to assess the association between the syndemic risk scores and outcomes such as HIV seropositive status, unprotected insertive anal intercourse (UIAI), and unprotected receptive anal intercourse (URAI). The study will also analyze the independent association between the syndemic risk scores and the respective outcomes. Also, it will explore the existence of an interaction between syndemic risk scores and race/ethnicity in relation to the respective outcomes. **Methods:** Secondary data analyses were conducted on data derived from the NHBS-MSM 4th cycle (2014) in Atlanta, Georgia. Chi-square (X^2) and one-way analysis of variance (ANOVA) tests were used to examine the differences in the proportions and means ($p < 0.05$). Multivariate analyses were conducted to determine whether the syndemic risk scores were significantly associated with race among MSM when adjusting for age and county of residence. **Results:** The study found significant associations between Black MSM and HIV positive status (OR = 3.3) and URAI (OR =.44) compared to White MSM. There were significant associations between syndemic risk scores and HIV positive status (OR = 1.04 to 2.4) and also UIAI (OR = 1.02 to 1.7), with higher odds for the PCA approaches. There was no

association between syndemic risk score and URAI, no matter how defined. Finally, the study found no significant difference by race between the association of syndemic risks scores and HIV outcomes. **Conclusion:** The study highlighted the need for a more integrated and holistic approach to understanding the intertwining health problems and factors that are negatively affecting the health of MSM. Additional syndemic research is needed to examine the role of these factors and conditions.

INDEX WORDS**:** HIV, MSM, risk behavior, risk score, syndemics, Blacks, African American, National HIV Behavioral Surveillance.

Introduction

In 2016 it was estimated that 78 million people globally were infected with the human immunodeficiency virus (HIV), 35 million people died of HIV/acquired immune deficiency syndrome (AIDS), and 36.7 million people were living with HIV since the beginning of the HIV pandemic (UNAIDS, 2016). In the United States, more than 1.2 million are living with HIV with an estimated 161, 200 (13%) cases undiagnosed (CDC, 2015d).

Although the number of new HIV diagnoses has declined (19% from 2005 to 2014) (CDC, 2015d), the HIV/AIDS epidemic has continued to severely affect MSM (CDC, 2012b). In 2015, MSM accounted for 82% (26,375) of newly diagnosed infections among men and 67% (26,474) of the new HIV infections (CDC, 2015d). Black MSM continue to bear the burden of the disease and are disproportionately affected by the HIV epidemic (CDC, 2010b; Centers for Disease & Prevention, 2005). It is estimated that approximately 1 in 2 Black MSM and 1 in 4 Latino MSM will be diagnosed with HIV in their lifetime, compared to 1 in 11 lifetime risk for White MSM (CDC, 2016b). According to the CDC, from 2005-2014 the increase in HIV diagnoses was mainly driven by new HIV diagnoses among Black and Hispanic MSM (CDC, 2015g). There was a 22% increase in HIV infections among Black MSM compared to a decrease of 18% for White MSM (CDC, 2015g). More disturbingly, the largest increase was among young Black and Hispanic MSM (87%) (CDC, 2015g).

Many studies have sought to determine the factors implicated in the disproportionate rates of HIV among MSM by investigating the association between individual HIV risk factors and HIV infection (Millett, Flores, et al., 2007; Millett et al., 2006; Siddiqi et al., 2015). There is a growing need for more holistic approaches to understanding the interconnectedness between

the risk factors and HIV infection in MSM (Halkitis, 2010; P. N. Halkitis et al., 2013).

Syndemic is described as two or more factors or epidemics interacting synergistically, resulting in the increased burden of a disease within a given population (Singer & Clair, 2003). This framework takes into account the plethora of factors, which can affect a marginalized population (Perry N Halkitis et al., 2013). However, very limited studies have attempted to expand this framework to assess the potential interaction of individual risk factors on HIV infection (Dyer et al., 2012; Mustanski et al., 2007; O'Leary et al., 2014; Santos et al., 2014; Stall et al., 2003). Moreover, at the time of this writing, no studies have attempted to assess the association between the syndemic of biopsychosocial risk factors and HIV infection in the MSM population.

The aim of the study is to assess the association between the number of biopsychosocial risk factors and the prevalence of HIV high-risk sexual behaviors and HIV infection. The study will also measure the uniformity of syndemic risks across a diverse group of MSM in Atlanta, Georgia. To accomplish these aims, the study will determine the extent in which the co-occurrence of multiple biopsychosocial risk factors increases the odds of HIV seropositive status and HIV high-risk sexual behaviors. It will analyze if there is an independent association between the syndemic risk scores and the defined outcomes (i.e., HIV seropositive status and HIV high-risk sexual behaviors). The study will also explore the existence of an interaction between syndemic risk scores and race in relationship to the prevalence of the HIV outcomes.

Methods

This secondary data analysis uses data derived from the National HIV Behavioral Surveillance System (NHBS)-MSM 4th (2014) cycle in Atlanta, Georgia. The CDC developed the

NHBS to help state and local health departments establish a surveillance system that monitors HIV prevalence, risk behaviors for HIV, and testing behaviors and to assess access to HIV prevention programs and services (CDC, 2010b, 2013b). This national health survey collects information on populations at high risk for exposure to HIV infection, to include MSM, injection drug users (IDU), and heterosexuals at greater risk for HIV infection (HET) (CDC, 2013b).

The survey consists of three cycles (repeated in rounds), where data from each high-risk population is collected every three years to monitor trends (CDC, 2013b). State and local health departments, whose jurisdictions included MSAs with the highest prevalence of HIV, participate in this national survey (CDC, 2013b). The NHBS-MSM 4th cycle (2014-2015) collected data from adult MSM in approximately 22 MSAs to include Atlanta, Georgia (CDC, 2013b).

Design

The NHBS-MSM cycles are repeated cross-sectional surveys for high-risk populations at increased risk of HIV infection using venue-based sampling, time-space sampling (VBS) to recruit participants. This method was used to target attendees of venues within local communities with the ability to attract large and diverse samples of MSM (CDC, 2013b). The venues included bars, dance clubs, retail businesses, cafes and restaurants, health clubs, social or religious organizations, adult bookstores, street locations, parks, beaches, and special events such as gay pride festivals, raves, and circuit parties (CDC, 2013b). The VBS methods helped the survey staff to research, identify, and assess the venues most frequented by MSM in Atlanta, Georgia (CDC, 2013b).

Sampling

In 2014, the Georgia Department of Public Health (GADPH) implemented the NHBS-MSM survey in the Atlanta metropolitan area. Between the months of September and November, the GADPH implemented VBS methods to randomly select the survey sites, recruit the participants, and collect the data (CDC, 2013b). Recruitment events continued until a minimum of 500 eligible MSM were enrolled in the survey or at the end date of the NHBS-MSM cycle (CDC, 2013b). In Atlanta, Georgia, the collection of data process was completed in November 2014.

Inclusion criteria

The survey inclusion criteria included men who had oral or anal sex with another man in the past 12 months, not previously participated in the NHBS-MSM4 cycle, resided in the Atlanta MSA, were 18 years of age or older, were born male and self-identifies as male, and were able to complete the interview in English or Spanish (CDC, 2013b). Participants meeting these criteria were eligible to complete the survey interview.

Data collection procedures

As part of the survey process, MSM were recruited and interviewed (face-to-face) by trained staff using handheld tablets (CDC, 2013b). A standardized NHBS core questionnaire, which also included additional questions on topics of local interest, was used to collect information about behavioral risks for HIV infection, HIV testing, and the utilization of HIV prevention and treatment services (CDC, 2013b). The questionnaires were developed in collaboration with CDC and local project sites (CDC, 2013b).

Informed consent was mandatory for participants to take part in the interview process (CDC, 2013b). The participants who consented to the interview were offered an anonymous HIV test on site using the INSTI ^{TM} HIV Antibody Test (CDC, 2013b). The INSTI^{TM} HIV-1 Antibody Test is a rapid HIV test used to detect antibodies for HIV. Reactive (preliminary positive) test results were confirmed with a supplemental or confirmatory test (i.e., Western Blot) based on approved laboratory algorithms (CDC, 2013b). Participants who consented to HIV testing received HIV counseling. Referral information for medical and psychosocial support services was provided to the participants when appropriate. All HIV test counselors completed the required training before meeting with participants (CDC, 2013b). The participants were given monetary incentives (i.e., gift cards) for completing the survey and taking the HIV test (CDC, 2013b).

Measures

Outcome Variables

HIV Status: The HIV status was measured by laboratory-confirmed test results through a defined testing algorithm. HIV status was reported as positive, negative, or indeterminate tests. The HIV laboratory-confirmed test results included two indeterminate tests, which were added to the negative test results. Since the two indeterminate tests were negligible, combining them with the HIV negative test results did not have an impact on overall results.

Unprotected Insertive Anal Intercourse: I order to assess unprotected insertive anal intercourse (UIAI), the participants were asked about their HIV high-risk behaviors with their last male sexual partner in the past 12 months. More specifically, they were asked the question, “during insertive anal sex that last time, did you use a condom?”

Unprotected Receptive Anal Intercourse: The study assessed unprotected receptive anal intercourse (URAI) with last male partner in the past 12 months. Participants were asked at the time of the survey, "during receptive anal sex that last time, did you use a condom?"

Predictor Variables

Predictor variables included the following demographic characteristics: age categories (18-24, 25-29, 30-39, 40-49, and greater than 50) race and ethnicity [White, Black and Other (race group includes Hispanics-non-Black, American Indian or Alaska Native, Asian, and Native Hawaiian and other Pacific Islander)], and county of residence (Clayton, Cobb, DeKalb, Fulton, Gwinnett, and Other).

Syndemic Risk Scores

PCA Weighted Syndemic Risk Score: The PCA Weighted Syndemic Risk Score was developed using Principal Component Analysis (PCA). During this process, biopsychosocial risk factors were reduced to account for the maximum amount of shared variance. For each identified principal component, the component loadings were multiplied by the standardized z-scores of each variable and then the individual products were summed together. The sum of the products was totaled, which resulted in a weighted syndemic score that estimated HIV risk for each participant.

PCA Unweighted Syndemic Risk Score: The PCA Unweighted Syndemic Risk Score was developed similarly to the PCA Weighted Syndemic Risk Score. However, instead of multiplying the loadings by the standardized z-scores of the variables for each identified component, the z-scores were just summed together, which resulted in an unweighted score that estimated HIV risk for each participant.

Literature Informed Weighted Syndemic Risk Score: The Literature Informed (LI) Weighted Syndemic Risk Score was developed through a literature review process. The review process identified MSM comparative studies with quantitative outcomes (odd ratios) that are associated with HIV risk or HIV infection. Each biopsychosocial variable's z score was multiplied by its respective odds ratio and then added together to create a weighted score used to estimate HIV risk.

Literature Informed Unweighted Syndemic Risk Score: The Literature Informed Unweighted Syndemic Risk Score was developed very similar to the Literature Informed Weighted Syndemic Risk Score, as described above. However, the variables' z-scores were summed together, which resulted in an unweighted score used to estimate HIV risk.

Biopsychosocial Risk Factors

Biopsychosocial factors used in the development of these syndemic risk scores were: employment status, educational attainment level, household income, circumcision, STI, sexual identity, outness, recent HIV test, sexual debut, number of sexual partners, unprotected anal sex, injection drug use, non-injection drug use, binge drinking, exchanged or received things for sex, PEP or PrEP use, health insurance coverage, unable to pay medical bills, visited a healthcare provider, incarceration, homelessness, discrimination, victim of violence, and perpetrator of violence.

Analyses

First, descriptive analyses were conducted to determine the frequency and proportion of select variables, individual risk factors, and syndemic risk scores stratified by HIV status among the study participants. Chi-square (X^2) and one-way analysis of variance (ANOVA) tests

were used to examine the differences in the groups and means. A *p* value less than 0.05 was considered to be a significant difference. Second, bivariate analyses were conducted to test the association between the outcome variable (HIV positive status) and predictors (UIAI, URAI, race and ethnicity, and syndemic risk score), also adjusting for age and county of residence. Third, syndemic risk scores were divided into three risk levels (low, moderate, and high) using tertile groupings to create cut-off points for risk (Q1=<25%, Q2= ≥25% and < 75%, Q3 = ≥75). Lastly, multivariate analyses were conducted to test the interaction of the outcome variables (i.e., HIV positive status, UIAI, and URAI) with syndemic risk scores with respect to race and ethnicity groups of MSM in Atlanta Georgia. The selected variables in the model were based on the outcome of the PCA process and literature review. All analyses were conducted using SAS® Studio 3.5 (Basic Edition) software.

Results

A total of 507 men met the criteria for eligibility, consented to participate in the survey, and completed the survey. Table 4.1 and Table 4.2 show descriptive analyses of characteristics and syndemic risk scores stratified by HIV status. For HIV status, twenty-eight participants had no HIV confirmed test results and were excluded from the analysis, resulting in a final analytic sample size of 479.

In Table 4.1 analysis, Black MSM made up 69% of the HIV positive cases when compared to Whites (21%) and Other (10%). Sixty-three percent of MSM between 30 and 49 years old were HIV positive. Fifty-seven percent of the participants lived in Fulton County, and 65% of the HIV positive men lived in this county. Twenty-one percent of HIV positive participants reported having UIAI or URAI with their last male sexual partner in the past 12 months were HIV positive,

compared to 21% and 23% for HIV negative participants, respectively. Also, 21% of the participants, who reported UIAI and URAI, were HIV positive. Lastly, in the bivariate analysis HIV status was significantly associated with age, race and ethnicity, and county of residence.

Table 4.1. Bivariate Analysis of Characteristics by HIV Status for Men Who Have Sex With Men: NHBS MSM4 Survey, Atlanta, Georgia

Characteristics	Total N = 479 [a] N %	HIV+ [b] n= 164 n %	HIV- [c] n=315 n %	*p*-value[d]
Age Groups				<.001
18-24	94 (19.62)	20 (12.20)	74 (23.49)	
25-29	84 (17.54)	22 (13.41)	62 (19.68)	
30-39	133 (27.77)	56 (34.15)	77 (24.44)	
40-49	106 (22.13)	47 (28.66)	59 (18.73)	
50 and over	62 (12.94)	19 (11.59)	43 (13.65)	
Race				<. 001
White	156 (32.57)	35 (21.34)	121 (38.41)	
Black	266 (55.53)	113 (68.90)	153 (48.57)	
Other	57 (11.90)	16 (9.76)	41 (13.02)	
County of Residence				0.05
Clayton	20 (4.18)	9 (5.49)	11 (3.49)	
Cobb	42 (8.77)	10 (6.10)	32 (10.16)	
DeKalb	93 (19.42)	26 (15.85)	67 (21.27)	
Fulton	273 (56.99)	106 (64.63)	167 (53.02)	
Gwinnett	25 (5.22)	4 (2.44)	21 (6.67)	
Other Counties	26 (5.43)	9 (5.49)	17 (5.40)	

Unprotected Receptive Anal Intercourse in Past 12 Months (Last male Partner)				0.86
Yes	100 (20.88)	35 (21.34)	65 (20.63)	
No	379 (79.12)	129 (78.66)	250 (79.37)	
Unprotected Insertive Anal Intercourse in the Past 12 months (Last Male Partner)				0.71
Yes	107 (22.34)	35 (21.34)	72 (22.86)	
No	372 (77.66)	129 (78.66)	243 (77.14)	

Notes. [a] 28 participants missing (no laboratory confirmed test results); [b] HIV+= Laboratory confirmed positive for HIV; [c] HIV- = Laboratory confirmed negative for HIV (includes 2 indeterminate) [d] X^2= Chi Square Test

Table 4.2 presents descriptive data (average, minimum, maximum) on syndemic risk scores derived through four approaches for the overall sample and by HIV status. In Table 4.2, HIV positive MSM had elevated unit increases in the mean score of PCA Weighted Syndemic Risk Score (2.29 units; $p < .001$), PCA Unweighted Syndemic Risk Score (3.46 units; $p < .001$), Literature Informed Weighted Syndemic Risk Score (5.94 units; $p < .001$), and Literature Informed Unweighted Syndemic Risk Score (3.48 units; $p < .001$), when compared to the mean scores of HIV negative MSM.

Average syndemic risk scores regardless of how defined varied systematically by HIV status (All $p <.001$). Specifically, mean syndemic scores for HIV positive participants were consistently higher than corresponding averages for the total and HIV negative samples regardless of how syndemic risk score was defined. On the other hand, mean syndemic risk

scores for HIV negative participants were consistently lower than corresponding scores for HIV positive participants and the entire sample.

Table 4.2. Bivariate Analysis of Characteristics by HIV Status for Men Who Have Sex With Men: NHBS MSM4 Survey, Atlanta, Georgia (Continuous Variables Only)

Characteristics	Total *N* = 479[a]	HIV+ [b] *n*= 164	HIV- [c] *n* =315	*p*-value
PCA Weighted Syndemic Risk Score				
• Mean (SD) [d]	0.15 (4.89)	1.65 (5.29)	-0.64 (4.47)	< .001
• Min [e]/Max [f]	-10.57/22.13	-7.79/22.13	-10.57/13.23	
PCA Unweighted Syndemic Risk Score				
• Mean (SD)	0.54 (7.77)	2.82 (8.42)	-0.64 (7.14)	< .001
• Min/Max	-15.32/34.95	-10.56/34.96	-15.33/23.49	
Literature Informed Weighted Syndemic				
• Mean (SD)	0.35 (12.98)	4.25 (14.09)	-1.69 (11.90)	< .001
• Min/Max	-25.87/54.30	-20.41/54.31	-25.88/38.68	
Literature Informed Unweighted Syndemic				
• Mean (SD)	0.22 (7.91)	2.51 (8.57)	-0.97 (7.28)	< .001
• Min/Max	-15.82/34.46	-11.05/34.46	-15.82/24.01	

Notes. [a] 28 participants missing (no HIV test results) [b] HIV+= Human Immunodeficiency Virus laboratory confirmed positive for HIV [c] HIV- = Human Immunodeficiency Virus laboratory confirmed negative for HIV (includes 2 indeterminate) [d] SD=Standard Deviation [e] Min= Smallest (Minimum) Value [f] Max=Largest (Maximum) Value

Independent associations between race groups and syndemic risk scores as determinants of HIV positive serostatus are presented in Table 4.3. Adjusted for age and county of residence, the odds of HIV positive sero-status was 3.3 times higher for Black MSM and 1.74

times higher for Other MSM compared to White MSM from Atlanta, Georgia. Minority race associated with elevated risk of HIV-positive serostatus compared to White MSM was statistically significant for Black (p = < .001), but not for Other MSM. Regardless of how syndemic risk score is defined, there was a statistically robust elevation of the odds for HIV infection per unit increase in syndemic risk score. Specifically, for the per unit increment in syndemic risk score, there was a statistically robust increase in the odds of HIV-infection regardless of how the syndemic risk score was defined (all p-value <.001). Of note, the magnitude of elevation in HIV-infection odds per unit increment in syndemic risk score was higher for PCA risk score approaches (OR range: 1.7 to 2.4, p <.001) compared to Literature Informed risk score derived approaches (OR range: 1.04 to 1.06, p <.001).

Table 4.3. The Unadjusted and Adjusted Associations of Race and Syndemic Risk Scores with HIV Positive Status Among Men Who Have Sex With Men in Atlanta, Georgia

Variables	Unadj. OR (95% CI)	*p*-value	Adj. OR (95% CI) [b]	*p*-value
White	Ref.	Ref.	Ref.	Ref.
Black	2.55 (1.63, 4.00)	< .001	3.29 (2.03, 5.31)	< .001
Other	1.35 (0.68, 2.69)	0.39	1.74 (0.85, 3.55)	0.13
Syndemic Risk Score Approaches				
PCA[a] Weighted Syndemic Risk Score	2.18 (1.57, 3.01)	< .001	2.40 (1.70, 3.37)	< .001
PCA Unweighted Syndemic Risk Score	1.58 (1.30, 1.94)	< .001	1.66 (1.35, 2.04)	< .001
Literature Informed Weighted Syndemic Risk Score	1.04 (1.02, 1.05)	< .001	1.04 (1.02, 1.06)	< .001
Literature Informed Unweighted Syndemic Risk Score	1.06 (1.03, 1.08)	< .001	1.06 (1.04, 1.09)	< .001

Note. [a] PCA Principal Component Analysis; [b] Adjusted for Age and County of Residence; *p*=Wald Chi Square

Next, independent associations between race and syndemic risk scores as determinants of UIAI – an HIV relevant behavioral risk factor, are presented in Table 4.4. Among MSM in Atlanta, Georgia, the odds of UIAI was 38% lower for Other MSM (p = 0.23) and 11% lower for Black (p = 0.61) compared to White MSM. Overall, race was not an important predictor of the odds of UIAI as the prevalence of this behavior was statistically similar for MSM across all racial groups (all p-values > 0.23). However, there was a significant and positive associations between UIAI and each unit increment in syndemic risk scores no matter how defined. Adjustment for age and county of residence in multivariable models resulted in minor attenuation of estimated associations without loss of statistical significance.

Table 4.4. The Unadjusted and Adjusted Associations of Race and Syndemic Risk Scores with Unprotected Insertive Anal Intercourse (UIAI) with Last Male Partner in the Last 12 months Among Men Who Have Sex With Men in Atlanta, Georgia

Variables	Unadj. OR (95% CI)	*p*-value	Adj. OR (95% CI) [b]	*p*-value
White	Ref.	Ref.	Ref.	Ref.
Black	0.99 (0.63, 1.57)	0.97	0.89 (0.55, 1.44)	0.64
Other	0.68 (0.32,1.48)	0.33	0.62 (0.28, 1.35)	0.23
Syndemic Risk Score Approaches				
PCA[a] Weighted Syndemic Risk Score	1.69 (1.21, 2.37)	0.002	1.66 (1.18, 2.33)	0.004
PCA Unweighted Syndemic Risk Score	1.26 (1.02, 1.56)	0.03	1.24 (1.00, 1.54)	0.05
Literature Informed Weighted Syndemic Risk Score	1.02 (1.01, 1.04)	0.01	1.02 (1.00, 1.04)	0.02
Literature Informed Unweighted Syndemic Risk Score	1.03 (1.00, 1.06)	0.03	1.03 (1.00, 1.06)	0.04

Note. [a] PCA Principal Component Analysis; [b] Adjusted for Age and County of Residence

In Table 4.5, where independent associations between race and syndemic risk scores as determinants of UIAI were tested, there were lower odds of URAI for Black and Other MSM compared to White MSM in Atlanta, Georgia. Specifically, significantly lower odds were noted for the association between Black race and engagement in URAI (p = 0.001) compared to White MSM. Similarly, the odds of engaging in URAI was 66% lower, but not statistically robust for Other MSM compared to White MSM (p = 0.27). However, syndemic risk scores, no matter how defined, were not associated with URAI.

Table 4.5. The Unadjusted and Adjusted Associations of Race and Syndemic Risk Scores with Unprotected Receptive Anal Sex (URAI) with Last Male Partner in the Last 12 months Among Men Who Have Sex With Men in Atlanta, Georgia

Variables	Unadj. OR (95% CI)	*p*-value	Adj. OR (95% CI) [b]	*p*-value
White	Ref.	Ref.	Ref.	Ref.
Black	0.58 (0.36, 0.92)	0.02	0.44 (0.27, 0.72)	0.001
Other	0.85 (0.43, 1.70)	0.65	0.67 (0.33, 1.37)	0.27
Syndemic Risk Score Approaches				
PCA[a] Weighted Syndemic Risk Score	1.21 (0.854, 1.71)	0.29	1.09 (0.76, 1.56)	0.63
PCA Unweighted Syndemic Risk Score	0.95 (0.76, 1.20)	0.68	0.90 (0.71, 1.14)	0.37
Literature Informed Weighted Syndemic Risk Score	1.01 (0.99, 1.02)	0.56	1.00 (0.98, 1.02)	0.95
Literature Informed Unweighted Syndemic Risk Score	1.00 (0.97, 1.02)	0.73	1.00 (0.96, 1.02)	0.40

Note. [a] PCA Principal Component Analysis; [b] Adjusted for Age and County of Residence

Results of analyses evaluating the extent to which independent associations between syndemic risk scores and respective outcomes varied across race and ethnicity groups are

presented in Tables 4.6 through 4.11 with emphasis on PCA weighted and Literature informed syndemic risk scores derived in Study 1. The extent to which the relationship between PCA weighted syndemic risk score and HIV positive status varied across racial categories is presented in Table 4.6. There was no evidence of heterogeneity (i.e., no significant variation or difference) by race in the association between syndemic risk score and HIV-positive status (p = 0.80).

Across all racial groups, the odds of HIV infection rose between 7% and 16 % per unit increment in syndemic risk scores ($p < 0.001$). Specifically, per unit increase in the number of syndemic risk factors, the risk of HIV-infection increased significantly for White (OR=1.16; 95% CI: 1.06, 1.26) and Black (OR = 1.12; 95% CI: 1.06, 1.18) MSM. Similarly, a 7% increase in odds of HIV-infection was evident for MSM of Other races but the association was not statistically robust (OR=1.07; 95% CI: 0.94, 1.21).

In analyses with syndemic risk scores defined as levels – high, moderate vs. low, there was still no evidence of variation across racial in the association of syndemic risk levels with HIV-infection (p = 0.80). However, the magnitude of association varied across racial categories with consistent evidence of dose-response for in the association of syndemic risk levels with HIV-infection within all racial groups. Specifically, among White MSM, the odds of HIV-infection was respectively 8.7 times and 3.8 times elevated for high and moderate syndemic risk scores compared to White MSM with low levels of syndemic risk factors. Among Black MSM, the odds of HIV infection increased dose dependently for MSM exposed to moderate (OR=2.22; 95% CI: 1.14, 4.33) and high (OR =3.43; 95% CI: 1.62, 7.28) compared to MSM exposed to low syndemic risk levels. Among Other MSM, there was a positive, dose dependent but non-significant

increase in the risk of HIV-infection for MSM exposed to high and moderate syndemic risk scores.

Table 4.6. The Relation of PCA Weighted Syndemic Risk Score to HIV-positive Status Among MSM in Respective Race Groups in Atlanta, Georgia

		White OR (95 % CI)	Black OR (95 % CI)	Other OR (95 % CI)	*p*-value Syndemic Score[a]	*p*-value Race*Syndemic Score[a]
PCA Weighted Syndemic Risk Score	**Unadjusted Associations**					
	Per unit increment	1.11 (1.03, 1.21)	1.11 (1.05, 1.17)	1.05 (.93, 1.20)	0.01	0.74
	Levels of Syndemic Risk Score				0.04	0.97
	High	5.09 (1.47, 17.64)	3.23 (1.55, 6.72)	3.00 (0.30, 30.12)		
	Moderate	3.14 (0.99, 9.93)	2.10 (1.10, 4.03)	2.29 (0.24, 22.09)		
	Low	Ref	Ref	Ref		
	Adjusted [b] Associations					
	Per unit increment	1.16 (1.06, 1.26)	1.12 (1.06, 1.18)	1.07 (0.94, 1.21)	< .001	0.58
	Categories of Syndemic Risk Score				0.004	0.80
	High	8.68 (2.40, 31.38)	3.43 (1.62, 7.28)	3.83 (0.38, 38.84)		
	Moderate	3.80 (1.18, 12.23)	2.22 (1.14, 4.33)	2.83 (0.29, 27.78)		
	Low	Ref	Ref	Ref		

Note. [a] PCA Principal Component Analysis; [b] Adjusted for Age and County of Residence

Potential heterogeneity by racial categories in the relation of PCA Weighted Syndemic Risk Score to UIAI, a high-risk sexual behavior, is shown in Table 4.7. There was no evidence of heterogeneity (i.e., no significant variation or difference by race) in the association between syndemic risk score and UIAI (p = 0.22). Across all racial groups, the odds of engaging in UIAI range from a 2% decrease to a 10% per unit increment in syndemic risk scores (p = 0.41). Specifically, per unit increase in the number of syndemic risk factors, the risk of UIAI increased significantly for Black MSM (OR= 1.10; 95% CI: 1.04, 1.16). There was also odds increase in UIAI among White (OR = 1.03; 95% CI: 1.04, 1.16) and an odds decrease among Other MSM (OR = .98; 95% CI: 1.04, 1.16). However, the associations were not statistically robust.

In analyses with syndemic risk scores defined as categories, there was still no evidence of variation across racial in the association of syndemic risk levels with UIAI (p = 0.54). The magnitude of association varied across racial categories, but there was consistent evidence of dose-response in association with syndemic risk levels for UIAI. Specifically, among White MSM, the odds of UIAI were lower for high (OR = 0.96; (95% CI: 0.34, 2.74) and moderate (OR = 0.80, 95% CI: 0.34, 1.90) syndemic risk scores compared to White MSM with low levels of syndemic risk factors. For Black MSM, the odds of UIAI increased dose dependently for MSM exposed to moderate (OR = 1.59; 95% CI: 0.73, 3.49-not statistically significant) and high (OR = 3.05, 95% CI: 1.32, 7.05) compared to MSM exposed to low syndemic risk levels. Among MSM of Other racial groups, there was a positive, dose dependent but non-significant increase in the risk of UAI for MSM exposed to high and moderate levels of syndemic risk scores. However, the magnitude of association across the racial categories in relation to the syndemic risk levels for UIAI, was statistically non–significant (p= 0.85).

Table 4.7: The Relation of PCA Weighted Syndemic Risk Score to Unprotected Insertive Anal Intercourse (UIAI) Among MSM in Respective Race Groups in Atlanta, Georgia

		White OR (95 % CI)	Black OR (95 % CI)	Other OR (95 % CI)	*p*-value Syndemic Score[a]	*p*-value Race*Syndemic Score[a]
PCA Weighted Syndemic Risk Score	**Unadjusted Associations**					
	Per unit increment	1.04 (0.97, 1.13)	1.10 (1.04, 1.16)	0.96 (0.85, 1.14)	0.27	0.28
	Levels of Syndemic Risk Score				0.82	0.67
	High	1.16 (0.42, 3.21)	3.05 (1.32, 7.03)	1.56 (0.15, 16.45)		
	Moderate	0.86 (0.37, 2.04)	1.59 (0.73, 3.49)	1.35 (0.13, 13.47)		
	Low	Ref	Ref	Ref		
	Adjusted [b] Association					
	Per unit increment	1.03 (0.96, 1.12)	1.10 (1.04, 1.16)	0.98 (0.84, 1.14)	0.41	0.22
	Levels of Syndemic Risk Score				0.85	0.54
	High	0.96 (0.34, 2.74)	3.05 (1.32, 7.05)	1.42 (0.13, 15.11)		
	Moderate	0.80 (0.34, 1.90)	1.59 (0.73, 3.49)	1.24 (0.12, 12.50)		
	Low	Ref	Ref	Ref		

Notes: [a] PCA Weighted Syndemic Risk Score [b] Adjusted for Age and County of Residence

In Table 4.8, we assessed the potential heterogeneity by racial categories in the relation of PCA Weighted Syndemic Risk Score to URAI. There was no evidence of heterogeneity (i.e., no significant variation or difference) by race in the association between syndemic risk score and URAI (p = 0.54). Across all racial groups, the odds of engaging in URAI range from an increase of 1% decrease to 9% per unit increment in syndemic risk scores (p=0. 92). Specifically, per unit increase in number of syndemic risk factors, the risk of URAI increased, but not statistically significant, for White MSM (OR = 1.00; 95% CI: 0.92, 1.08), Black MSM (OR = 1.01; 95% CI: 0.94, 1.07), and Other MSM (OR = 1.09; 95% CI: 0.95, 1.25),

In analyses with syndemic risk scores defined by levels, there was also no evidence of variation across racial groups in association with syndemic risk levels for UIAI (p = .61). Again, the magnitude of association varied across racial categories (p = 0.95) and there was some evidence of inverse dose-response relationship in association with syndemic risk levels for URAI. Specifically, for White MSM, the odds of URAI were higher for high (OR= 1.13; 95% CI: 0.40, 3.20) and moderate (OR = 1.15, 95% CI: 0.48, 2.75) syndemic risk scores compared to White MSM with low levels of syndemic risk factors. For Black MSM, the odds of URAI decreased dose dependently for MSM exposed to moderate (OR = 1.59; 95% CI: 0.69, 3.63) and high (OR = 1.38, 95% CI: 0.54, 3.55) compared to MSM exposed to low syndemic risk levels. Among Other MSM, there was a positive, dose dependent increase in the risk of URAI for MSM exposed to high OR = 3.04 (95% CI: 0.31, 29.89) and moderate (OR = 1.09; 95% CI: .11, 11.10) levels of syndemic risk scores. However, the magnitude of association across the racial categories in relation to the syndemic risk levels for URAI was statistically non–significant (p = 0.95).

Table 4.8. The Relation of PCA Weighted Syndemic Risk Score to Unprotected Receptive Anal Intercourse (URAI) Among MSM in Respective Race Groups in Atlanta, Georgia

		White OR (95 % CI)	Black OR (95 % CI)	Other OR (95 % CI)	P-value Syndemic Score[a]	P-value Race*Syndemic Score[a]
PCA Weighted Syndemic Risk Score	**Unadjusted Association**					
	Per unit increment	1.03 (0.95, 1.10)	1.01 (0.95, 1.08)	1.10 (0.96, 1.26)	0.51	0.52
	Levels of Syndemic Risk Score				0.55	0.65
	High	1.74 (0.64, 4.72)	1.45 (0.57, 3.70)	4.00 (0.41, 38.65)		
	Moderate	1.37 (0.59, 3.21)	1.57 (0.69, 3.56)	1.35 (0.13, 13.47)		
	Low	Ref	Ref	Ref		
	Adjusted [b] Association					
	Per unit increment	1.00 (0.92, 1.08)	1.01 (0.94, 1.07)	1.09 (0.95, 1.25)	0.92	0.54
	Levels of Syndemic Risk Score				0.95	0.61
	High	1.13 (0.40, 3.20)	1.38 (0.54, 3.55)	3.04 (0.31, 29.89)		
	Moderate	1.15 (0.48, 2.75)	1.59 (0.69, 3.63)	1.09 (.11, 11.10)		
	Low	Ref	Ref	Ref		

Notes: [a] PCA Weighted Syndemic Risk Score [b] Adjusted for Age and County of Residence

In Table 4.9, we assessed the potential heterogeneity by racial categories in relation of Literature Weighted Syndemic Risk Score to HIV infection. There was no evidence of significant difference by race in the association between syndemic risk score and HIV-positive status (p = 0.40). Across all racial groups, the odds of HIV infection rose between 3% and 6 % per unit increment in syndemic risk scores (p <. 001). Specifically, per unit increase in the number of syndemic risk factors, the risk of HIV-infection increased for White MSM (OR = 1.06; 95% CI: 1.03, 1.10) and also among Black MSM (OR = 1.03; 95% CI: 1.01, 1.06). Although there was an increase among Other MSM (OR = 1.03; 95% CI: 0.99, 1.09), the association was not statistically robust.

In analyses of syndemic risk scores defined by levels, there was no evidence of variation across racial groups in association of syndemic risk levels for HIV-infection (p = 0.79). However, the magnitude of association varied across racial categories with consistent evidence of dose-response for in the association of syndemic risk levels with HIV-infection within all racial groups (p = 0.01). Specifically, among White MSM, the odds of HIV-infection was respectively (OR= 7.23; 95% CI: 1.95, 26.74) and (OR = 4.14; 95% CI: 1.30, 13.17)) elevated for high and moderate syndemic risk scores compared to White MSM with low levels of syndemic risk factors. Among Black MSM, the odds of HIV infection increased dose dependently for MSM exposed to moderate (OR = 1.95; 95% CI: 1.01, 3.75) and high (OR = 2.81; 95% CI: 1.36, 5.83) compared to Blacks MSM exposed to low syndemic risk levels. Among Other MSM, there was a positive dose-response dependent relationship. However, there was a non-significant increase in the risk of HIV-infection for MSM exposed to high (OR = 4.60; 95% CI: 0.45, 47.09) and moderate (OR = 3.03; 95% CI: 0.31, 29.71) syndemic risk scores.

Table 4.9. The Relation of Literature Informed Weighted Syndemic Risk Score to HIV-positive Status Among MSM in Respective Race Groups in Atlanta, Georgia

		White OR (95 % CI)	Black OR (95 % CI)	Other OR (95 % CI)	*p*-value Syndemic Score[a]	*p*-value Race*Syndemic Score
Literature Informed Weighted Syndemic Risk Score	**Unadjusted Association**					
	Per unit increment	1.05 (1.02, 1.08)	1.03 (1.01, 1.05)	1.03 (0.98, 1.08)	0.004	0.77
	Levels of Syndemic Risk Score				0.05	0.88
	High	4.54 (1.28, 16.20)	2.59 (1.27, 5.26)	3.23 (0.32, 32.48)		
	Moderate	3.56 (1.14, 11.15)	1.73 (0.91, 3.29)	2.18 (0.23, 21.04)		
	Low	Ref	Ref	Ref		
	Adjusted [b] Association					
	Per unit increment	1.06 (1.03, 1.10)	1.03 (1.01, 1.06)	1.03 (0.99, 1.09)	<. 001	0.40
	Levels of Syndemic Risk Score				0.01	0.79
	High	7.23 (1.95, 26.74)	2.81 (1.36, 5.83)	4.60 (0.45, 47.09)		
	Moderate	4.14 (1.30,13.17)	1.95 (1.01, 3.75)	3.03 (0.31, 29.71)		
	Low	Ref	Ref	Ref		

Notes: [a] Literature Informed Weighted Syndemic Risk Score [b] Adjusted for Age and County of Residence

Potential heterogeneity by racial categories in the relation of Literature Informed Weighted Syndemic Risk Score to UIAI is shown in Table 4.10. There was no evidence of heterogeneity (i.e., no significant variation or difference) by race in the association between syndemic risk score and UIAI (p = .08). Across all racial groups, the odds of engaging in UIAI range from a 3% decrease to a 4% increase per unit increment in syndemic risk scores (p = 0.47). Specifically, per unit increase in the number of syndemic risk factors, the risk of UIAI increased significantly for Black MSM (OR = 1.04; 95% CI: 1.01, 1.06). There was also odds increase in UIAI among White MSM (OR = 1.01; 95% CI: 0.98, 1.04) and odds decrease among Other MSM (OR = 0.97; 95% CI: 0.91, 1.03). However, the associations were not statistically robust.

In analyses with syndemic risk scores defined by categories, there was still no evidence of variation across racial groups in the association of syndemic risk levels with UIAI (p = 0.29). The magnitude of association varied across racial categories, but had some consistent evidence of dose-response in association with syndemic risk levels for UIAI. Specifically, among White MSM, the odds of UIAI were higher for high (OR = 1.07; 95% CI: 0.36, 3.17) and moderate (OR = 1.02, 95% CI: 0.43, 2.43) syndemic risk scores compared to White MSM with low levels of syndemic risk factors. For Black MSM, the odds of UIAI increased dose dependently for MSM exposed to moderate (OR = 1.71 95% CI: 0.75, 3.86) and high (OR = 3.41, 95% CI: 1.46, 7.99) compared to MSM exposed to low syndemic risk levels. Among Other MSM, there was a decrease in odds, and an inverse dose dependent relationship in the risk of UIAI for MSM exposed to high (OR = 0.44 95% CI: 0.06, 3.32) and moderate (OR = 0.49 95% CI: 0.08, 3.21) levels of syndemic risk scores. Statistical significance was found only among Black MSM at the

high level of syndetic risk. However, the magnitude of association across the racial categories in relation to the syndemic risk levels for UIAI, was statistically non–significant (p = 0.99).

Table 4.10. The Relation of Literature Informed Weighted Syndemic Risk Score to Unprotected Insertive Anal Intercourse (UIAI) Among MSM in Respective Race Groups in Atlanta, Georgia

		White OR (95 % CI)	Black OR (95 % CI)	Other OR (95 % CI)	*p*-value Syndemic Score[a]	p-value Race*Syndemic Score
Literature Informed Weighted Syndemic Risk Score	**Unadjusted Association**					
	Per unit increment	1.02 (0.99, 1.05)	1.03 (1.01, 1.06)	0.97 (0.92, 1.03)	0.30	0.11
	Levels of Syndemic Risk Score				0.91	0.38
	High	1.27 (0.44, 3.66)	3.46 (1.48,8.09)	0.50 (0.07, 3.74)		
	Moderate	1.08 (0.45, 2.55)	1.76 (0.78, 3.97)	.56 (0.09, 3.58)		
	Low	Ref	Ref	Ref		
	Adjusted [b] Association					
	Per unit increment	1.01 (0.98, 1.04)	1.04 (1.01, 1.06)	0.97 (0.91, 1.03)	0.47	0.08
	Levels of Syndemic Risk Score				0.99	0.29
	High	1.07 (0.36, 3.17)	3.41 (1.46, 7.99)	0.44 (0.06, 3.32)		
	Moderate	1.02 (0.43, 2.43)	1.71 (0.75, 3.86)	0.49 (0.08, 3.21)		
	Low	Ref	Ref	Ref		

Notes: [a] Literature Informed Weighted Syndemic Risk Score [b] Adjusted for Age and County of Residence

In Table 4.11, we assessed the potential heterogeneity by racial categories in the relation of Literature Informed Weighted Syndemic Risk Score to URAI. There was no evidence of heterogeneity (i.e., no significant variation or difference) by race in the association between syndemic risk score and URAI (p = 0.61). Across all racial groups, the odds of engaging in URAI range from a decrease of 1% to a 2% increase per unit increment in syndemic risk scores (p = .67). Specifically, per unit increase in number of syndemic risk factors, the risk of URAI increased, but not statistically significant, for White (OR = 0.99; 95% CI: 0.97, 1.02), Black MSM (OR = 1.00; 95% CI: 0.98, 1.03), and Other MSM (OR = 1.02; 95% CI: 0.97, 1.08).

In analyses with syndemic risk scores defined by levels, there was also no evidence of variation across racial groups in association with syndemic risk levels for URAI (p = .20). The magnitude of association varied across racial categories, with some evidence of inverse dose-response in association with syndemic risk levels for URAI. Specifically, for White MSM, the odds of URAI were lower with an inverse dose relationship between high (OR = 0.68; 95% CI: 0.24, 1.93) and moderate (OR = 0.76, 95% CI: 0.33, 1.74) syndemic risk scores compared to White MSM with low levels of syndemic risk factors. For Black MSM, the odds of URAI decreased dose dependently for MSM exposed to moderate (OR = 1.96; 95% CI: 0.84, 4.60) and high (OR = 1.13; 95% CI: 0.41, 3.07) compared to MSM exposed to low syndemic risk levels. Among Other MSM, there was a positive, dose dependent increase in the risk of URAI for MSM exposed to high (OR = 1.02; 95% CI: 0.16, 6.58) and moderate (OR = 0.38; 95% CI: 0.06, 2.55) levels of syndemic risk scores. However, the magnitude of association across the racial categories in relation to the syndemic risk levels for URAI, was statistically non–significant (p = 0.73).

Table 4.11. The Relation of Literature Informed Weighted Syndemic Risk Score to Unprotected Receptive Anal Intercourse (URAI) Among MSM in Respective Race Groups in Atlanta, Georgia

		White OR (95 % CI)	Black OR (95 % CI)	Other OR (95 % CI)	*p*-value Syndemic Score[a]	*p*-value Race*Syndemic Score
Literature Informed Weighted Syndemic Risk Score	**Unadjusted Association**					
	Per unit increment	1.01 (0.98, 1.03)	1.00 (0.98, 1.03)	1.03 (0.98, 1.08)	0.73	0.69
	Levels of Syndemic Risk Score				0.90	0.22
	High	1.05 (0.39, 2.86)	1.21 (0.45, 3.27)	1.50 (0.24, 9.44)		
	Medium	0.87 (0.39, 1.95)	2.10 (0.90, 4.88)	0.56 (0.09, 3.58)		
	Low	Ref	Ref	Ref		
	Adjusted [b] Association					
	Per unit increment	0.99 (0.97, 1.02)	1.00 (0.98, 1.03)	1.02 (0.97, 1.08)	0.67	0.61
	Levels of Syndemic Risk Score				0.73	0.20
	High	0.68 (0.24, 1.93)	1.13 (0.41, 3.07)	1.02 (0.16, 6.58)		
	Medium	0.76 (0.33, 1.74)	1.96 (0.84, 4.60)	0.38 (0.06, 2.55)		
	Low	Ref	Ref	Ref		

Notes: [a] Literature Informed Weighted Syndemic Risk Score [b] Adjusted for Age and County of Residence

Discussion

Contrary to our hypothesis that syndemic risk scores were positively associated with sexual risk behaviors and HIV positive status and the direction and strength of these relationships may differ by race and ethnicity, the study found that race and ethnicity did not effect on these relationships. The study found statistically significant associations between Black MSM and HIV positive status (OR= 3.3) and URAI (OR = 0.44) compared to White MSM. There were also significant associations between syndemic risk scores and HIV positive status (OR = 1.04 to 2.4) and also UIAI (OR = 1.02 to 1.7), with higher odds for the PCA approaches. The magnitude of association varied across races for HIV positive status, UIAI, and URAI when compared to low levels of syndemic risk scores, although not significant. There was evidence of dose-response relationships between the syndemic risk score levels and HIV positive status, UIAI, and URAI across racial groups. The highest odds by race for syndemic risk score levels are as follow: HIV positive status (White MSM); UIAI (Black MSM); URAI (Other and Black MSM). Lastly, the study found no significant differences by race and the association between syndemic risks scores and HIV positive status, UIAI, and URAI.

The results of the study underscore some of the challenges faced by researchers, practitioners, and policy makers in reducing health disparities and HIV infection among MSM. The emergent of syndemic frameworks is changing the way we address diseases in a population. Rather than narrowly focusing on one disease, a more integrated approach that looks at the “bigger picture” of how diseases and associated factors, such as psychosocial, behavioral, structural, socio-economical, and biological, cluster together to negatively impact health and increase the disease burden in a given population, like MSM. This approach provides

additional opportunities for novel public health and clinical research. Research designed to be more evidence-based and interventions that focus on the intertwining of health conditions and factors in understanding the severe burden of the HIV epidemic in MSM. This study found no significant differences by race and the association between syndemic risks scores and HIV positive status, UIAI, and URAI.

Our results have public health implications when addressing the disproportionate rates of HIV infection among MSM. The study highlighted the need for a more integrated and holistic approach to understanding the health conditions and factors that are negatively affecting the health of MSM. Prevention and intervention public health programs will be more successful when multiple epidemics and influencing factors are holistically studied, tested, and evaluated. Researchers and practitioners must recognize the role of other factors, such as the co-infection of HIV and STI (facilitates the transmission, infectiousness, and susceptibility of HIV), structural barriers (such as access to care), and the use of PEP and PrEP as an intervention tool in the fight against HIV transmission.

Limitations

Some potential limitations should be considered when drawing conclusions from this study. The survey results are derived from unweighted data that may under- or over-represent some of the subgroups of the respondent group. As a result, the study findings cannot be generalized to the survey population (i.e., all MSM in Atlanta, Georgia), but only to this sample. The survey data was self-reported, which can be subject to social desirability and recall biases. Many of the study participants may have provided answers that are perceived as desirable responses or experienced problems recalling events or experiences from their past.

Also, no temporal or causal inferences can be derived from the results because the study used a cross-sectional design. Furthermore, PCA methods limited the use of the covariates in the multivariate models. Specifically, many of the variables were used as part of the PCA process and could not also be used in the multivariate analyses. Also for the PCA, the criteria for the selection of loaded variables were not well defined in the literature, which sometimes made the process of naming the final components a more difficult task. Finally, because we combined races that had small sample sizes into one race group "Other," we could not generalize the study findings to one specific race (i.e. Hispanics) from within this group.

However, notwithstanding these limitations, the study provides preliminary insights into the interplay of synergistic interaction between risk factors and the trajectory of HIV epidemic in MSM. This interplay can potentially explain the disproportionate rates of HIV infection in racial and ethnic groups of MSM.

Conclusion

The study explored the relationship between biopsychosocial syndemic risk scores and HIV infection and examined if the interaction of a syndemic risk score and HIV infection is dependent on race and ethnicity. The study findings reinforce the notion that studies, which primarily focus on individual risk factors (e.g., behavioral factors), should examine the effects of syndemic on HIV risk factors and the trajectory of HIV epidemic in MSM that can explain the disproportionate rates of HIV infection in racial and ethnic groups of MSM. Public health programs should continue to strengthen policies, implement robust intervention strategies, and coordinate efforts to reduce the disparities associated with HIV infection among MSM in Atlanta, Georgia.

CHAPTER 5

DISSERTATION CONCLUSION

In this chapter of the dissertation, we will revisit the purpose of the dissertation, review the research questions and proposed hypotheses, discuss the empirical findings and limitations, talk about public health implications, and provide a few recommendations.

Background

Since the beginning of the HIV pandemic, it was estimated that 78 million people globally were infected with HIV, 35 million people died of AIDS, and 36.7 million people were living (UNAIDS, 2016). There were 2.1 million new infections and 1.1 million AIDS-related deaths at the end of 2015 (UNAIDS, 2016). In the United States, more than 1.2 million are living with HIV with an estimated 161, 200 (13%) cases undiagnosed (CDC, 2015d). In 2015, there were 18,303 new AIDS diagnoses, with 1,216,917 people diagnosed since the beginning of the epidemic (CDC, 2015d). There were also 39,513 newly diagnosed cases of HIV infection (CDC, 2015d).

Although the number of new HIV diagnoses has declined (19% from 2005 to 2014) (CDC, 2015d), the HIV epidemic has continued to severely affect gay, bisexual, and other MSM (CDC, 2012b). In 2014, MSM accounted for 83% of the new HIV infections and 67% of newly diagnosed infections among men (UNAIDS, 2016). In 2012, approximately 311,087 MSM diagnosed with AIDS had died since the start of the epidemic in comparison to 658,507 people in general population (CDC, 2015d). In 2015, Black MSM accounted for 39% (10,315) of the

estimated new HIV infections, compared to 29% (7,570) for White MSM and 27% (7,013) for Hispanics (CDC, 2015h). Black MSM also accounted for 39% (3,928) of the newly diagnosed AIDS cases, followed by 31% (3,096) of White MSM and 24% (2,430) of Hispanic MSM (CDC, 2015h). The CDC estimated that approximately 1 in 2 Black MSM and 1 in 4 Latino MSM would be diagnosed with HIV in their lifetime, compared to 1 in 11 for White MSM (CDC, 2016b).

Studies have sought to determine the cause of these disparities in HIV infection and the associated factors implicated in the higher disease burden among Black MSM (Millett, Flores, et al., 2007; Millett et al., 2006; Siddiqi et al., 2015). The explanation for these racial health disparities in HIV infection between Black MSM and other racial/ethnic groups of MSM has been elusive. Many studies have examined individual risk factors to help understand racial disparity of HIV infection rates among MSM (Beer et al., 2014; Harawa et al., 2004; Millett, Flores, et al., 2007; Millett et al., 2006; Oster et al., 2011; E. S. Rosenberg et al., 2014; Sullivan et al., 2015). Some of these factors include the low testing frequency for HIV, barriers that prevent linkage and retention to health care, substance abuse, UAI, number of sexual partners, a history of STI, homophobia, stigma, and discrimination, violence, adherence to antiretroviral drugs and therapies, higher incarceration rates, and social-sexual networks (Beer et al., 2014; CDC, 2015i; Harawa et al., 2004; Millett, Flores, et al., 2007; Millett et al., 2006; Oster et al., 2011; E. S. Rosenberg et al., 2014; Seth et al., 2015; Sullivan et al., 2015).

However, most of these studies have focused primarily on the inter-relationship between a particular risk factor (e.g., substance abuse) and HIV infection, which failed to explore potential syndemic interactions between individual risk factors and the trajectory of HIV epidemic in MSM (Stall et al., 2003). As previously discussed, syndemic is two or more factors or epidemics

interacting synergistically, resulting in the increased burden of a disease in a given population (Singer & Clair, 2003). The framework takes into account the plethora of factors that can affect marginalized populations (Perry N Halkitis et al., 2013).

Purpose

The purpose of the dissertation was to examine the relationship between biopsychosocial risk factors. Assess the association between the syndemic risk scores and the prevalence of HIV high-risk sexual behaviors and HIV infection. Finally, measure the relationship between the syndemic risk scores and the prevalence of the respective outcomes across a racially and ethnically diverse sample of MSM in Atlanta, Georgia.

Research Questions

The dissertation focused on the following research questions. First, in a diverse sample of MSM in Atlanta, GA are men with a given biopsychosocial risk factor for HIV infection more likely to have other risk factors as well? Second, how do we adequately combine individual biopsychosocial risk factors for HIV acquisition to derive syndemic biopsychosocial risk scores? Third, does the convergence of multiple syndemic biopsychosocial risk factors for HIV acquisition differ materially based on race/ethnicity? Once established, is there an association between the number of syndemic biopsychosocial risk factors and the prevalence of HIV infection (e.g., HIV seropositive status) and high-risk sexual behaviors? Next, does race and ethnicity remain an independent risk factor for HIV infection after adjustment for a defined syndemic risk profile? Last, is there an interaction between the number of syndemic biopsychosocial risk factors and race, in relation to the defined HIV outcomes?

Hypotheses

The dissertation offered the following hypotheses on assessing whether the aggregation of biopsychosocial risk factors is exacerbating HIV risk and infection among MSM in Atlanta, GA, resulting in the racial and ethnic disparities between Black MSM and other groups of MSM. The first hypothesis predicts that the co-aggregation of biopsychosocial risk factors drives the disproportionate rates of HIV-infection beyond the sum of individual risks. Second, there are measurable differences by race/ethnicity in the aggregation of multiple risk factors for HIV infection. Third, the syndemic risk factors will be positively associated with HIV seropositive status and sexual risk behaviors. Lastly, the direction and strength of the relationship between syndemic risk factors and the outcomes (i.e., HIV infection and sexual risk behaviors) may differ by race and ethnicity such that for any syndemic risk score, the risk of HIV infection, is magnified for Black MSM compared to White MSM.

Research Design

The NHBS-MSM cycles are repeated cross-sectional surveys for high-risk populations at increased risk of HIV infection using venue-based sampling, time-space sampling (VBS) to recruit participants. This method was used to target attendees of venues within local communities with the ability to attract large and diverse samples of MSM (CDC, 2013b). The venues included bars, dance clubs, retail businesses, cafes and restaurants, health clubs, social or religious organizations, adult bookstores, street locations, parks, beaches, and special events such as gay pride festivals, raves, and circuit parties (CDC, 2013b). The VBS methods helped research, identify, and assess venues most frequented by MSM in Atlanta, Georgia (CDC, 2013b)

Sampling

In 2014, the Georgia Department of Public Health (GADPH) implemented the NHBS-MSM survey in the Atlanta metropolitan area. Between the months of September and December, the GADPH implemented VBS methods to randomly select the survey sites, recruit the participants, and collect the data (CDC, 2013b). Recruitment events continued until a minimum of 500 eligible MSM were enrolled in the survey or at the end date of the NHBS-MSM cycle (CDC, 2013b). In Atlanta, Georgia, all of the data was collected by the end of November 2014.

Inclusion criteria

The survey inclusion criteria were men who had oral or anal sex with another man in the past 12 months, not previously participated in the NHBS-MSM4 cycle, resided in the Atlanta MSA, were 18 years of age or older, were born male and self-identifies as male, and were able to complete the interview in English or Spanish (CDC, 2013b).

Findings

The aim of the first study was to systematically examine the relationship between individual biopsychosocial risk factors for HIV by deriving integrated measures of convergent biopsychosocial risk factors (i.e., syndemic risk scores) among MSM in Atlanta GA. Furthermore, it assessed whether the average number of syndemic risk scores differ among racial and ethnic groups of MSM in Atlanta, Georgia. No matter how the syndetic risk score is defined, it was consistently lower for White MSM and elevated for Black and Other MSM. Furthermore, the study found that the mean syndemic risk scores for Black and Other MSM were approximately two to three folds higher when compared to the mean scores of White MSM. In adjusted

models (controlling for age and county of residence), the study found high syndemic risk scores among Black (.23 to 2.00 units) and Other MSM (1.54 to 5.95 units), with the highest unit increases in syndemic scores found among Other MSM. The PCA and Literature Informed syndemic risk scores for Black and Other MSM were higher when compared to the scores of White MSM. Other MSM had the highest significant unit increase per risk score when compared to White and Black MSM. Finally, the PCA Unweighted Syndemic Risk Score (1.86 to 4.17 units) and LI Weighted Syndemic Risk Score (2.00 to 5.95 units) were highest among the four defined risk scores by race.

The second study assessed the association between the syndemic of biopsychosocial risk factors and HIV infection among MSM in Atlanta, Georgia. The study analyzed if there is an association between syndemic risk scores and the respective outcomes. Lastly, it explored the existence of an interaction between syndemic risk scores and race/ethnicity in relation to the outcomes (i.e., HIV positive status, URAI, and UIAI). The study found that the average syndemic risk scores regardless of how defined varied systematically by HIV status. Specifically, the mean scores for HIV positive participants were consistently higher than the corresponding averages for the total and HIV negative samples. The mean syndemic risk scores for HIV negative participants were also consistently lower than the scores for HIV positive participants.

The study also found statistically significant associations between Black MSM and HIV positive status (OR = 3.3) and URAI (OR =0.44) when compared to White MSM. There were also significant associations between syndemic risk scores and HIV positive status (OR = 1.04 to 2.4) and also UIAI (OR = 1.02 to 1.7), with higher odds for the PCA approaches. The magnitude of association varied across races for HIV positive status, UIAI, and URAI when compared to low

levels of syndemic risk scores, although not significant. There was evidence of dose-response relationships between the syndemic risk score levels and HIV positive status, UIAI, and URAI across racial groups. White MSM had higher odds for HIV positive status. Black MSM had higher odds for UIAI and URAI, while Other MSM had higher odds for URAI. Most importantly, the study found no significant differences by race and association between syndemic risks scores and HIV positive status, UIAI, and URAI.

Limitations

Some potential limitations should be considered when drawing conclusions from this study. The survey results are derived from unweighted data that may under- or over-represent some of the subgroups of the respondent group. As a result, the study findings cannot be generalized to the survey population (i.e., all MSM in Atlanta, Georgia), but only to this sample. The survey data was self-reported, which can be subject to social desirability and recall biases. Many of the study participants may have provided answers that are perceived as desirable responses or experienced problems recalling events or experiences from their past.

Also, no temporal or causal inferences can be derived from the results because the study used a cross-sectional design. Furthermore, PCA methods limited the use of the covariates in the multivariate models. Specifically, many of the variables were used as part of the PCA process and could not also be used in the multivariate analyses. Also for the PCA, the criteria for the selection of loaded variables were not well defined in the literature, which sometimes made the process of naming the final components a more difficult task. Finally, because we combined races that had small sample sizes into one race group “Other,” we could not generalize the study findings to one specific race (i.e. Hispanics) from within this group.

However, notwithstanding these limitations, the study provides preliminary insights into the interplay of synergistic interaction between risk factors and the trajectory of HIV epidemic in MSM. This interplay can potentially explain the disproportionate rates of HIV infection in racial and ethnic groups of MSM.

Public Health Implications and Recommendations

The dissertation holds important public health implications while providing insight on efforts to enhance public health programs and policies in communities where MSM are at increased risk for HIV/AIDS. The findings of this dissertation contribute to the body of knowledge for the syndemic theory by providing empirical evidence that confirms that the convergence of biopsychosocial risk factors increases HIV outcomes in MSM. Specifically, the co-occurrence of multiple biopsychosocial risk factors for HIV infection results in higher frequencies and increased odds for HIV outcomes in MSM of minority racial/ethnic groups when compared to White MSM in Atlanta, Georgia. Biopsychosocial factors, which include biological, behavioral, psychosocial and structural determinants, work in concert to negatively impact health conditions. There is a critical need for more holistic approaches, rather than individual approaches that focus on a particular disease, condition, factor, intervention, or method, in addressing the interplay of HIV risk factors and health epidemics in the MSM population.

The findings of this dissertation hold significant public implications for policy makers, public health practitioners and researchers. There is a need for more evidence-based research that focuses on the interplay of salient HIV risk factors and their role in the disproportionate rates of HIV among Black MSM. From a behavioral perspective, Black MSM engage in less

unprotected sex, have fewer sexual partners, and use drugs less frequently than White MSM. Based on these findings, more interventions should focus on structural and socioeconomic factors and associated barriers to include STI transmission and treatment, HIV prophylaxis and usage, and higher incarceration rates in explaining the HIV disparities in Black MSM.

According to the CDC, the incidence of STI serves as an indicator for increased risk of HIV infections (CDC, 2015). Black MSM have higher STI diagnoses when compared to other MSM (Millett et al., 2012). Our results showed that prevalence of STI was higher among non-white MSM compared to White MSM. Studies have demonstrated that co-infection of HIV and STI facilitates the transmission, infectiousness, and susceptibility of HIV (Anzala et al., 2000; Heffelfinger, Swint, Berman, & Weinstock, 2007). Based on these findings, public health programs should implement focused interventions to reduce the prevalence of STIs among Black MSM. These interventions should focus on increasing knowledge about transmission and prevention of STIs and linking newly diagnosed infections to treatment. Also, more emphasis is needed on the prevention and transmission of syphilis. Surveillance data have shown that approximately 50% of MSM infected with syphilis was HIV positive (CDC, 2015e). Furthermore, Black MSM syphilis rates were eight times the rate of White MSM (Su et al., 2011).

The use of PrEP has been shown to be a promising intervention in the fight against HIV. It lowers the risk of HIV transmission in MSM. Our findings showed that 2% of Black MSM reported usage rates for PEP or PrEP compared to 6% for White MSM and 4% for Other MSM. When researchers initiated PrEP among MSM, they found fewer new infections cases or sometimes new no cases at the end of the intervention period (McCormack et al., 2016; Volk et

al., 2015). According to the CDC, daily PrEP usage reduces sexual contact of HIV transmission by approximately 90% (CDC, 2017c).

However, structural barriers associated with uptake and adherence of these drugs can sometimes prevent access and usage. Some of the barriers include 1) the lack of knowledge on PrEP use and effectiveness, 2) the high costs associated with these drugs and the lack of healthcare coverage, 3), implicit biases can exist among healthcare providers and lead to inappropriate care and treatment for MSM of color 4) African American distrust towards medical providers, 5) the potential for drug resistance, which can may the drugs non-effective against new, drug-resistant HIV, and 6) the long term side effects caused by the prolonged usage of these drugs (Broder, 2017). Furthermore, increased stigma and discrimination may intertwine with other risk factors such as substance use, mental health, sexual identity, and higher risk sexual behaviors. However, with all of these potential barriers, PrEP has shown to an important intervention tool in the fight against HIV infection.

Higher incarceration rates also play a role in the disproportionate rates of HIV are among Black MSM (CDC, 2006). Incarceration has been shown to increase Black men's exposure to unprotected sex with other men in institutions where HIV seroprevalence is usually higher (CDC, 2006). For instance, in 2014, Black men accounted for 37% of the male prison population in the United States compared to 32% for White males and 22% for Hispanic males (Justice, 2015). In Georgia, Black men accounted for 86% of the HIV-infected males that entered into the system (CDC, 2006). Another study found that 88 GDC intimates seroconverted between 1998 and 2005 while incarcerated (CDC, 2006). Among these intimates, 59 (67%) were Black, and 29 (33%) were White. The study also found that Black race and male-to-male sex in prison were

significantly associated with HIV seroconversion during incarceration (CDC, 2006). National efforts are necessary to reduce the number of Black men being incarcerated, which will decrease HIV risk and transmission among Black MSM.

Also, public health agencies and implementing partners should ensure that the allocation of HIV funding is reaching the most at risk populations (such as MSM) and areas with the highest burden of HIV infection in the US population. The allocation of funding should be supported by evidence-based data that continuously monitor and evaluate specific geographic areas to measure the impact of HIV programs, prevention, treatment, and access to care measures. The strengthening of data usage to ensure that the policy makers and public agencies, implementing partners, and community leaders have the necessary information to target the appropriated funding, programs, and interventions in MSM communities. Such data can be an important tool for evaluating the HIV epidemic and reducing the disparities by race and ethnicity among MSM. By frequently collecting and analyzing local and state level HIV data and leveraging this information to prevent new HIV infections among MSM. Having a better understanding of what is driving increasing HIV infections MSM will improve efforts to target the risk factors associated with increased HIV infection and ultimately save more lives. The data should also be used to the compelling stories of the HIV/AIDS epidemic in Black MSM to get the attention of policy makers, stakeholders, and the public. Also, finding champions or advocates for the cause will also bring more attention to the growing concerns of this epidemic in Black MSM in the US, while leading and supporting effective HIV response and outcomes.

Sometimes the needs of racial and ethnic marginalized populations (e.g., MSM) can be better met with an ethnically diverse research workforce. It is also important for the scientific

and public health communities to diversify its workforce (Wilson et al., 2014). This workforce can include ethnic/racial minorities that have the knowledge and skills to target these marginalized populations. Studies have shown that racial minorities are more likely to receive care and service from service providers who are also minorities (Commission, 2004; Mitchell & Lassiter, 2006). Workforce diversity is associated with greater patient-provider relationships, higher satisfaction with overall care and service while reducing cultural barriers (Mitchell & Lassiter, 2006). This diversity among researchers and practitioners can enhance the field of public health through the developing and strengthening of diversity policies, the recruitment of qualified minority public health or health-care professionals, and the improvement of patient-provider communication, which can lead to HIV epidemic control.

The dissertation has also highlighted the need for more HIV multidisciplinary and interdisciplinary approaches among public health agencies, providers, support groups, and healthcare organizations to strengthen syndemic frameworks in addressing HIV/AIDS disparities in MSM or other marginalized populations such as IDUs and Black women. These approaches should focus on public health activities associated with the formulation of effective policies, examination of risk reduction strategies, the study of individual and syndemic factors that increase HIV infection, and resiliency among MSM to reduce the HIV burden in this population.

In summary, biopsychosocial factors work in concert with each other to negatively impact health conditions while increasing HIV infections beyond the individual risk among MSM. The emergent of syndemic frameworks is reconfiguring current practices in addressing health conditions in a population, which includes moving away from conventional approaches and historical understanding of disease prevention and epidemic control. There will be more

opportunities for developing novel interventions and programs and strengthening cross collaborations between public health agencies, researchers, community-based organizations, providers, and support groups in addressing the HIV epidemic. There is a critical need for more holistic approaches that focus on addressing the interplay of HIV risk factors (e.g., STIs, incarceration, and PrEP usage) and other health epidemics in the MSM population.

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APPENDIX

Phone 706-542-3199

The University of Georgia

Office of the Vice President for Research
Human Subjects Office

NOT HUMAN RESEARCH DETERMINATION

July 17, 2017

Dear Thomas Stevens:

The University of Georgia Human Subjects Office reviewed the following protocol on 7/17/17:

Type of Review:	Initial Study
Title of Study:	Biopsychosocial Risk Factors and the Disproportionate Rates of HIV Among MSM in the United States: The Application of a Syndemic Risk Framework in Exploring Race Related HIV Disparities and Vulnerabilities Among Men Who Have Sex With Men in Atlanta, Georgia
Investigator:	Thomas Stevens
IRB ID:	STUDY00005083
Funding:	None
Grant ID:	None

We have determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations. The project activities are limited to analysis of existing, de-identified data.

University of Georgia (UGA) IRB review and approval is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities are research involving human subjects, please submit a new request to the IRB for a determination.

Sincerely,

Kimberly Fowler, Director
Human Subjects Office, University of Georgia