GAYS IN THE NEIGHBORHOOD: HOW NEIGHBORHOOD AND CONTEXT IMPACT HIV AND SUBSTANCE USE RISKS AND RESILIENCIES OF GAY, BISEXUAL AND OTHER MEN WHO HAVE SEX WITH MEN IN NEW YORK CITY

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ABSTRACT

Thirty years into the HIV pandemic gay, bisexual, and other men who have sex with men (MSM) are still disproportionately impacted by HIV/AIDS, accounting for two-thirds of the U.S epidemic. There is increasing evidence that context is an important driver of HIV risk. This dissertation was designed to summarize the literature on the influences of neighborhoods on MSM health and to explore three contextual moments of heightened HIV risk using data from the NYCM2M study (N=1493). Migration: There is a well-established history of gay migration to NYC. These data support that migration is an important moment of heightened HIV risk for MSM. More recent migrants to NYC had increased risk for condomless sex and heavy drinking compared to men in NYC for longer. Compared to White MSM, Black and Latino MSM had a greater proportional hazard of seroconverting within the first ten years of migration. Community Viral Load (CVL): Where MSM live and have sex is not random, but constructed by socio-historical factors. These findings suggest that differences may be an important determinant in the social epidemiology of HIV. Compared to White MSM, Black MSM had greater odds of living in and having sex in higher CVL neighborhoods, Latino MSM had greater odds of a higher CVL sex neighborhood. Both Black MSM and bisexuals had greater odds of migrating to higher CVL spaces (than White gay men). White MSM who migrated had greater odds for condomless sex than those who did not. Substance Use: Elevated substance use has been documented among

MSM, particularly those in cities. These findings show significant between neighborhood differences in any drug use and hazardous drinking (home and social) and heavy drinking (social) suggesting that neighborhood factors uniquely influence substance use behaviors among MSM. Without substantial changes to the implementation of HIV treatment/prevention, we will continue to fall short of our potential impact. Although context/place has considerable promise as a location for HIV prevention efforts, it has been underemphasized. This dissertation is a step towards addressing this gap, suggesting contextual opportunities for multi-level public health HIV interventions to reduce HIV among MSM.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

Thank you to the gay bisexual and other men who have sex with men who gave their time to make this study possible. I'm indebted to my committee Drs. Silvestre, Sharma, and Herrick, without whom this would not have happened. To my secondary committee, the NYC team: Drs. Koblin and Frye and Ms. Nandi, your guidance has been invaluable. Thank you to Dr. Jessie Daniels for your reading and critique of this document. And finally, thank you to Dr. Ron Stall, my committee chair and mentor, for all you have done for me. The only way to pay you back is to pay it forward.

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1.0 INTRODUCTION

HIV prevention is changing in a profound way, altering the foundation upon which it has been built over the past 30 years. Biomedical advances and the use of combination prevention approaches are becoming the most important tool to combat the continued spread of this virus both in the United States (U.S.) and around the world. Likely to occur at nexus of biology, individual behavior and context to impact community viral load (CVL), understanding of how neighborhoods impact the risks and resiliencies of Gay, Bisexual and Other Men Who Have Sex with Men (MSM) will be essential to building and implementing novel and effective interventions.

There is evidence suggesting that few MSM report consistent high-risk sex over time (Stall et al., 2009). Risk is more often episodic, contextual and predictable (G. N. Colfax et al., 2001; Grant, 2013). As such, sexual risk reductions are unlikely to be permanent, but rather characterized by episodic lapses (Stall et al., 2009). Previous research has shown increased risk associated with certain spaces or venues such as bathhouses or public sex environments (Somlai, Kalichman, & Bagnall, 2001; Van Beneden et al., 2002; Woods, Binson, Mayne, Gore, & Rebchook, 2000) and the impact of having socio-sexual networks within high CVL contexts (Millett, Flores, Peterson, & Bakeman, 2007; Millett et al., 2012). There is also evidence suggesting that some MSM may be self-identifying periods of risk and initiating context-specific risk reduction strategies such as Post-Exposure Prophylaxis (PrEP) (Anderson et al., 2011; Golub, Kowalczyk, Weinberger, & Parsons,

2010; Kellerman et al., 2006; Liu et al., 2008; Mansergh, Koblin, Colfax, Flores, & Hudson, 2011; Mimiaga, Case, Johnson, Safren, & Mayer, 2009). A better understanding of the specific contexts associated with elevated risk and/or episodic lapses is essential to the design and implementation of bio-behavioral structural interventions.

The goal of this dissertation is to understand more about how neighborhoods impact the behaviors and risks of MSM in New York City (NYC). I consider how neighborhood and context impacts behavior risk and resilience through three different lenses including: migration to gay urban center, living and having sex in neighborhoods with heightened CVL and the impact of home and social neighborhood on substance use. This dissertation is composed of four chapters.

Chapter 1: *The Where Makes a Difference: Impact of Neighborhoods on the Health of Gay, Bisexual and Other Men Who Have Sex with Men.* This chapter is a summary of research related to the impact of neighborhoods on behavior, with a specific focus on MSM health. Included is a brief discussion of HIV/AIDS in the U.S. and the overwhelming impact the virus continues to have on MSM; other health disparities faced by MSM and the role of syndemic production; the move to combination prevention and structural intervention approaches to HIV prevention; and the importance of better understanding neighborhood/geographical impacts on MSM risk and resilience. This chapter also includes a discussion of the history of MSM migration to urban centers and a brief summary of how the environment impacts health in general. It concludes with a summary of the current literature related to the impact of social and physical environments on the health of MSM including two primary theories suggesting different pathways inclusive of environmental and contextual factors that may influence MSM behavior.

Chapter 2. *Migration and Risk among Gay, Bisexual and Other Men Who Have Sex with Men in New York City*. Using data from the NYCM2M study, this chapter hopes adds to the understanding of geo-temporal risk associated with migration to a gay-centric urban center. Informed by Kurtz's model of health risks associated with MSM urban migration, we hypothesized that recent migrants would experience a heightened period of HIV risk and substance use compared to those who had migrated less recently. Furthermore, we hypothesized that this increased risk would translate into HIV seroconversion within the first few years of migration.

Chapter 3. *The Where of Risk: Composition and community viral load of the home and sexual neighborhoods of HIV-negative gay, bisexual, and other men who have sex with men in New York City.* In this chapter, we are attempting to describe the composition of neighborhoods with higher and lower CVL, and to characterize the men who move in between these spaces. In doing this we hope to identify spaces (e.g. higher CVL neighborhoods) and moments (e.g. individuals who travel to/from higher CVL risk neighborhoods) for targeted HIV combination interventions including both prevention (e.g. risk assessment skills, access to PrEP and PEP) and treatment (e.g. access to treatment, adherence skills). We first describe the Sociodemographics characteristics of HIV-negative MSM who live in and have sex in NYC neighborhoods with different levels of CVL. We then describe the Sociodemographics characteristics of sexual migration to and from neighborhoods with different levels of CVL. Finally, we characterize the sexual risk associated with living in or migrating to higher CVL neighborhoods.

Chapter 4. *The influence of Home and Social Neighborhoods on Drug and Alcohol Use among MSM in the NYCM2M Study*. This chapter was designed to consider how both individual and neighborhood-level factors contribute to substance use among MSM in NYC. We hypothesized that the home and social neighborhoods will have a significant and unique influence on substance use behaviors among MSM in NYC. We first describe the variance across the home and social neighborhoods for drug and alcohol use. We then investigate individual level factors including: connection to the NYC gay community, internalized homophobia, sexual minority based discrimination, and substance use norms. Finally, we include neighborhood-level variables, including: gay male presence, the proportions of young people and of people living in poverty, and neighborhood substance use norms, explain any of the variance.

Chapter 5. *Final Discussion and Future Directions*. This final chapter includes a summary of the findings and public health impacts from each of the previous chapters. There is also a discussion of future directions to consider for ongoing neighborhood related research with MSM. Finally, a brief research agenda is proposed.

Thirty years into the HIV epidemic, MSM continue to be disproportionately impacted and account for nearly two-thirds of U.S. epidemic. Without substantial changes to the way treatment and prevention of HIV are implemented, we will continue to fall short of our potential to create meaningful change. Although context/place has considerable promise as a location for HIV prevention efforts, it has been underemphasized in the literature. This dissertation is a step towards addressing this gap.

2.0 THE WHERE MAKES A DIFFERENCE: THE IMPACT OF NEIGHBORHOOD ON THE HEALTH OF GAY, BISEXUAL, AND OTHER MEN WHO HAVE SEX WITH MEN

2.1 INTRODUCTION

Thirty years into the HIV pandemic gay, bisexual, and other men who have sex with men are still disproportionately impacted by HIV, accounting for nearly two-thirds of the U.S. epidemic.

In June of 1981 the CDC published a MMWR documenting five cases of Pneumocystis carinii pneumonia (PCP) among previously healthy homosexual men in Los Angeles (CDC, 1981b). A month later the CDC published another MMWR documenting cases of Kjaposi's Sarcoma (KS) in 26 homosexual men in NYC (20) and in LA and San Francisco (6) and another ten cases of PCP in LA and San Francisco (CDC, 1981a). This marks the first documentation of HIV in the U.S. (the initial documented case was in 1978). In 1995 death rates in the US peaked at 50,877 (UCSF, 2014).

Now after thirty years of waging war on this virus, the epidemic among gay, bisexual, and other men who have sex with men (MSM hereafter) continues to spin out of control. Over this time MSM have consistently been disproportionately impacted by HIV (CDC, 2011b). While it is estimated that only 3-5% of the adult population of the US are MSM (Purcell et al., 2012), MSM currently account for half of the total people living with HIV in the US and two-thirds of all new infections each year (Prejean et al., 2011). New diagnoses among MSM, particularly among young

Black MSM, continue to increase (CDC, 2012). Estimates suggest that this disparity is likely to continue to grow (Stall et al., 2009). HIV in New York City (NYC) follows similar trends. In the first six months of 2013, MSM made up 53.6% of all newly diagnosed HIV infections and 46.1% of late diagnosis (concurrent HIV and AIDS diagnosis) (New York City Deparment of, 2012). The AIDS epidemic in the United States cannot be resolved unless the epidemic among MSM is brought under control.

While HIV may be the most publicized, many MSM face other health disparities. The theory of syndemics production suggests that early life experiences may put MSM at increased risk for these disparities.

Sexual minority stress has been shown to significant impact the physical and mental health of adults (Meyer, 2003a). Such adversity has also resulted in disproportionate rates of mental health issues, psychological distress, and substance use among sexual minority youth (M. P. Marshal et al., 2011; M. P. Marshal et al., 2008). Several studies have shown increased rates of depression among MSM with prevalence rates ranging from 15-26 percent (Cochran & Mays, 2000a, 2000b; King et al., 2008; Meyer, 2003a; Meyer, Dietrich, & Schwartz, 2008; Mills et al., 2004; Reisner, Mimiaga, Safren, & Mayer, 2009; Reisner, Mimiaga, Skeer, et al., 2009). In a recent meta analysis, compared to MSM, MSM had a 2.58 increased odds of life time depression and 2.41 increased odds of depression in the previous 12 months (King et al., 2008). There is also evidence that experiencing adversity and depression may increase an individuals HIV risk (Koblin et al., 2006; Mustanski, Garofalo, Herrick, & Donenberg, 2007; Reisner, Mimiaga, Safren, et al., 2009; Reisner, Mimiaga, Skeer, et al., 2009; Stall et al., 2003).

Elevated substance use and substance use disorders among MSM has been well documented in the literature. Studies, beginning with Fifield's study investigating alcohol use among gay men in Los

Angeles in the 1970's, have demonstrated, to varying degrees, the increased prevalence of drug, tobacco, and alcohol use (Cochran, Ackerman, Mays, & Ross, 2004; Greenwood et al., 2005; Stall et al., 2001). Estimates of use among LGB populations range as high as 2-3 times that of heterosexual populations (Jordan, 2000). In a 2003 national household survey, MSM were more likely to report substance use (ever) compared to heterosexual men including the use of cocaine (OR=2.5), hallucinogens (OR=2.3), inhalants (OR=3.8), analgesics (OR=2.2) and tranquilizers (OR=2.9) (Cochran et al., 2004). Use of sedatives, stimulants, and heroin was also elevated but not significantly. MSM were also more likely to report recent use of cocaine (OR = 3.4), heroin (OR = 9.5) and daily use of marijuana (OR = 3.5) and/or cocaine (OR = 10). In his meta-analysis, Marshal reported the odds for young LGB substance use to be 190% higher than for heterosexual youth (M. P. Marshal et al., 2008). In a recent meta-analysis, MSM had a 2.41 relative risk of experiencing drug dependence in the previous 12-months compared to MSW (King et al., 2008). While not all substance using MSM develop issues of dependence and addiction, substance use has also been associated with HIV/STI risk and infection (Stall et al., 2001).

Syndemics theory provides a model to explain these disparities. Syndemics (Singer, 1994, 1996, 2009; R. Stall, M. Friedman, & J. Catania, 2008a; Stall et al., 2003) is predicated on the proposition that early social and emotional development of MSM occurs within systems of social and structural homophobic violence. These experiences predispose men to vulnerability for specific psychosocial health issues as adult men that can snowball into multiple, co-occurring and interacting health problems over time creating pathways to increased sexual risk, HIV infection and poor biomedical outcomes. New research is now attempting to determine how resiliencies, the dynamic process over the life course when individuals are able to overcome, adapt and cope with risk

exposure/experience (Garmezy, Masten, & Tellegen, 1984; Herrick, Egan, Coulter, Friedman, & Stall, in press; Herrick et al., 2011; Herrick, Stall, Goldhammer, Egan, & Mayer, 2013 ; Luthar, Cicchetti, & Becker, 2000; Masten & Powell, 2003; Rutter, 1985; Werner, 1992), are able to interrupt syndemic production. A better understanding of how people thrive despite adversity will hopefully provide important insight in how to intervene with those doing less well.

Focusing on individual level behavior change, while still often the corner stone of public health theory and intervention design, provides an incomplete picture of health and risk of MSM. In the area of combination prevention structural level bio-behavioral research and intervention is a major focus.

Focus on the individual was fairly effective in initial HIV-related research and intervention (Herbst et al., 2007); however, prioritizing individual-level factors have not been sufficiently able to explain variance and intervene with infection over the long run (Stall et al., 2009). In this new era of combination prevention, the HIV field is focusing more attention on how to create structural level changes, rather than continued focus on individual behavioral change [9].

Biomedical advances have created the opportunity to increase the effectiveness of biobehavioral HIV interventions (Sullivan et al., 2012). Combination prevention (Coates, Richter, & Caceres, 2008; Rotheram-Borus, Swendeman, & Chovnick, 2009) approaches focus on reducing HIV transmission through multiple methods including ARV treatment to decrease individual and community viral load, structural change, and behavioral. ARV treatment has proven effective in decreasing individual plasma HIV RNA (also known as “viral load”) thereby reducing the risk of sexual transmission of HIV (M. S. Cohen et al., 2011). Furthermore, reductions in plasma HIV RNA at the individual level have resulted in reducing levels of viral load at the community level

(CVL) (M. S. Cohen & Baden, 2012; Ray et al., 2010; Vernazza, Hirschel, Bernasconi, & Flepp, 2008). For example, providing access to testing and treatment (including PrEP and PEP) to communities with high viral load and dense sexual networks is a promising new prevention strategy. These methods are cutting edge but are, as of yet, not well defined. What seems certain is it will be at the nexus of biology, individual behavior and context that we will be able to impact CVL on the physical and social landscape.

Structural-level combination prevention approaches to HIV prevention intervention cannot be done without a focus on neighborhoods. A focus on the individual is insufficient to capture the entire variation of risk or sufficiently slow viral transmission. Medical advances have provided opportunities to intervene at multiple levels. Considering the landscape of MSM lives will be essential to new bio-behavioral interventions focused on combination prevention. Neighborhoods of influence will likely play a key role in understanding the biological and behavioral distribution of risk and in the design and implementation of interventions.

2.2 THE ENVIRONMENT AND HEALTH

The relationship between where we live, how we live, and our health is complex and has long been seen as an important to understanding disease and well-being.

While it is beyond the scope of this dissertation, it is important to acknowledge the long historical tradition of thinking about how the environment impacts individuals and communities. In the early 19th century, mapping was being used to understand and demonstrate the clustering of disease and death documenting relationships the socio-eco-political spheres and health. Villermé and Virchow explored the connections of the urban environment, poverty, and work (Ackernecht, 1953; Coleman, 1982; McMichael, 1999). Chadwick and Engles documented the relationship of structural systems (e.g. environment), poverty and health suggesting ecological causation and the need for structural or "across society" intervention (Engels, 1987 (First edition, 1845). ; McMichael, 1999; Susser & Susser, 1996). Guerry described the geographical distribution of crime demonstrating disparities in where different social behaviors happen (Sampson, 2012). Snow famously mapped cholera cases in London and implemented a structural intervention to protect the community (Johnson, 2006). Durkheim argued that society itself impacts health (Durkheim, 1997; McMichael, 1999).

Taking into consideration geography, socio-political context, the built environment and other structural factors, neighborhood-based research has demonstrated the significant impact of the home neighborhood on individual and community health.

Beginning in the 1980's public health researchers began to take greater interest in how neighborhood characteristics impact individual health and wellbeing (Diez-Roux & Mair, 2010).

First relying on individual-level secondary data analyses linked with available census data this field has fairly quickly moved to more sophisticated methods and collecting specific data on physical and social environments (Diez-Roux & Mair, 2010). In this time many studies have described the influence of neighborhood (conditions of the social and physical environments) on the health and wellbeing of individuals and communities (Galea, Freudenberg, & Vlahov, 2005; Pappas, Queen, Hadden, & Fisher, 1993; D. R. Williams & Collins, 2001; Yen & Kaplan, 1999). For example, characteristics of social and physical environment have been found to have a significant impact on: self-rated health (Browning & Olinger-Wilbon, 2003; Inagami, Cohen, & Finch, 2007; Ross & Mirowsky, 2001; Wen & Christakis, 2006), premature mortality (D. A. Cohen, Farley, & Mason, 2003), overall mortality (Kawachi & Kennedy, 1997; Wen & Christakis, 2005), coronary heart disease (Diez-Roux et al., 1997; Sundquist et al., 2006; Yen & Kaplan, 1999), depression (Aneshensel & Sucoff, 1996; Latkin & Curry, 2003; Yen & Kaplan, 1999), violence (Frye & Wilt, 2001; Galea, Karpati, & Kennedy, 2002; Sampson, Raudenbush, & Earls, 1997), drug use (Galea, Nandi, & Vlahov, 2004; C. T. Williams & Latkin, 2007) and some health behaviors (Pickett & Pearl, 2001).

To this point, neighborhood-based research has been largely guided by two theoretical models: *physical disorder* and *social disorganization*. Physical disorder, or the "broken windows" theory considers how the physical appearance of the physical environment may be an indicator for community norms and expectations, which in turn can influence behavior (D. Cohen et al., 2000; Sampson, 2012; Wilson & Kelling, 1989). For example, Cohen and colleagues found higher rates of STIs in neighborhoods with greater poverty and disorder (D. Cohen et al., 2000). Social disorganization theory posits that neighborhood structural disadvantage impact health and

wellbeing through social norms, by limiting exposure/access to resources and weakening social ties and collective efficacy (Browning & Cagney, 2002; Browning, Leventhal, & Brooks-Gunn, 2004; Browning & Olinger-Wilbon, 2003; Sampson, 2012). Browning and colleagues have found social disorganization to be associated with increased sexual risk among adolescents in urban environments (Browning, Burrington, Leventhal, & Brooks-Gunn, 2008; Browning et al., 2004; Browning & Olinger-Wilbon, 2003). As important as these findings have been to understanding disease and health and influencing urban policy, only a very few researchers have applied these insights to the study of LGBT health.

2.3 GAY BISEXUAL AND OTHER MSM AND THE URBAN ENVIRONMENT

There is an established historical record of the migration of LGBT peoples to urban cities of the U.S. (Chauncey, 1994; Kaiser, 1997). Over time MSM became concentrated in pockets of the urban landscape (Gates & Ost, 2004; Kenney, 1995; Weston, 1995). Cities have historically offered MSM more tolerant social policies allowing for less fear in enacting stigmatized behaviors and identities (D'Emilio, 2005; Gates & Ost, 2004) and others like them to find sex and life partners (Ellingson & Schroeder, 2004). The city played an essential role in providing the space for LGBT peoples to build identity (Fischer, 1975). It was inside the city walls that individuals had the opportunity to form community and even build neighborhoods (Levine, 1978). It was here that community transformed in to activism as LGBT peoples began and continue to fight for visibility and human rights.

As time moves so do we evolve. The role of the historically gay enclaves, our ghettos, may be growing less important or are perhaps transitioning into something different (Simon Rosser, West, & Weinmeyer, 2008). As with many other city-dwellers, LGBT peoples have chosen or been forced into other areas of the city. There is also evidence that migration patterns are also changing with partnered GB men preferring moderate-sized cities with amenities but without regard for tolerance and partnered LB women gravitating toward less-populous regions with an already established partnered lesbian community (Cooke & Rapino, 2007). As MSM neighborhood research must continue to evolve as well looking beyond the historical city and neighborhood enclaves.

While NYC continues to be a major epicenter of lesbian, gay and bisexual life and culture, the landscape of queer life in NYC continues to evolve. According to 2000 US Census data and a report by the Williams Institute (Romero & Gates, August 2008), 26,000 same-sex couples were living in all five boroughs of NYC including: Manhattan (38%), Brooklyn (27%), Queens (20%), Bronx (11%) and Staten Island (4%). Male couples outnumber female couples 3-to-1 in Manhattan; female couples outnumber male couples in Brooklyn and the Bronx; in Queens and Staten Island numbers are similar. Aproximately15% of same sex couples are also raising children (~8,400 under 18 living in the home). Most (92%) of these families live in outer boroughs.

Research demonstrating that MSM's health and risk are influenced by environmental and systems-level factors provides an important foundation on which to build future neighborhood research.

Recent research considering how the larger socio-eco-political environment impacts disease and health has pushed the field of public health to move beyond individual-level risk causation/intervention and to consider how multiple levels exist simultaneously resulting in "the intermingling of ecosystems, economics, politics, and history" (Krieger, 1994, 2012). This new work has provided a foundation on which to build future neighborhood and other spatial/temporal context-specific research and intervention.

For example, Meyer's *Sexual Minority Stress Theory* provides a model to better understand how MSM and other sexual minorities may develop physical and emotional health issues related to the chronic stress develop over time living in non-affirming social environment (Lazarus & Folkman, 1984; Meyer, 2003b). Similarly, Krieger suggests that the sociopolitical condition is manifest in the body; that embodiment of inequality (e.g. homophobia, racism) is a structural cause of behavior and disease (Ali, 2004; Krieger & Davey Smith, 2004). Hatzenbuehler has been able to quantify the impact of these environmental risks. His recent work has shown that LGB people living in states with anti-gay policies have increased mental health issues over time; that living in states with higher concentrations of other LGB people is protective for other LGB people; and that more supportive environments for LGB youth was associated with less tobacco use (Hatzenbuehler, Keyes, & McLaughlin, 2011; Hatzenbuehler, McLaughlin, Keyes, & Hasin, 2010; Hatzenbuehler, Wieringa, & Keyes, 2011).

Millett's groundbreaking work on the impact of socio-sexual context has made an enormous impact on how HIV risk is now conceived. He has found that African-American MSM experience disproportionate burden of HIV not due to individual risk behaviors but because of the epidemiological context within which they find sexual partners (Millett et al., 2007; Millett et al., 2012). The influence of context is also evidenced by the increased behavioral risk sometimes associated with certain spaces or venues such as bathhouses or public sex environments (Somlai et al., 2001; Van Beneden et al., 2002; Woods et al., 2000) or the combination of spatial and temporal risk as can be the case with travel/vacation. For example, circuit party-goers reported increased substance use, unprotected anal sex with more partners and more serodiscordant unprotected anal sex during party weekends away from home compared to MSM attending parties at home and MSM during typical home weekends (G. N. Colfax et al., 2001; Mansergh et al., 2001). Other recent studies (described in more detail below) also suggest complex interactions between neighborhood environments and individual-level identity expression and behavior (Carpiano, Kelly, Easterbrook, & Parsons, 2011; Egan et al., 2011; Frye et al., 2014; Frye et al., 2010; Frye et al., 2006; Jones, 2012; Mills et al., 2001; K. E. Tobin, Cutchin, Latkin, & Takahashi, 2013; K. E. Tobin, Latkin, & Curriero, 2014) that function to raise levels of risk.

To explain potential relationships between neighborhoods and the health of MSM Frye and Kurtz have developed theoretical models suggesting pathways that may influence MSM behavior.

Building off of previous theoretical models of neighborhood studies (predominately among heterosexuals) and integrating the theories of sexual minority stress (Meyer, 2003a) and social identity (Tajfel & Turner, 1979; Tarrant et al., 2001) Frye and colleagues (Frye et al., 2006) developed a theoretical model to help explain potential relationships between identity,

neighborhood (social and built environment) and risk and resiliencies of MSM. In this paper Frye discusses the importance of considering the urban environment when considering sexual risk behavior as individual level variables are unable to describe the entire picture. This multilevel framework theorizes multiple pathways that may influence MSM behavior in the urban context. It includes the urban environment (i.e. social norms and physical and social characteristics), intervening mechanisms (i.e. stress, collective efficacy, social influence), situational factors (i.e. partner substance use, high risk venue, partner type), individual-level factors (i.e. demographics, psychosocial, health, and identity) and behavioral outcomes (i.e. substance use and sexual risk behavior).

Kurtz posits a theoretical model of health risks associated with MSM urban migration (Egan et al., 2011). Incorporating elements from Frye (identity, neighborhood, and risk) (Frye et al., 2006) and Stall (syndemics) (R. Stall, M. Friedman, & J. A. Catania, 2008b) this model theorizes that men looking to leave their natal environment have likely experienced homophobic environments starting in early life that may have manifested in lasting mental and physical health issues and that while migration intention is often to find liberty, there are many associated drawbacks (e.g. loss of support network and social capital). He further posits that men living in gay-enclave spaces are likely caught up in syndemics and therefore unable to provide the necessary support to new residents. This combined with social norms accepting of risky behavior (e.g. substance use, hypersexuality, competition) results in adverse mental and physical health.

2.4 THE GAY NEIGHBORHOOD AND HEALTH: REVIEW OF THE LITERATURE

Despite the substantial body of literature describing the significant impact of the built environment and neighborhood characteristics on individual and community health, little is known about the specific ways MSM experience neighborhood spaces and the impact on behavior and health.

It is important to acknowledge that much influential work has come from other disciplines (e.g. Gender studies, Geography, Sociology) discussing the role of LGBT people in public space and social movements. In their paper, *Geographies of Sexuality – A Review of Progress* (Binnie & Valentine, 1999) Binnie and Valentine discuss the trajectory of this field prior to 1999. Of particular importance is the work of Levine who in 1979 offered the first data driven evidence of the existence of gay ghettos (of gay men in the US) (Levine, 1978). It is upon the shoulders of those who have come before that the papers included in this review are built. It is, however, beyond the scope of this paper to include the wider literature on gay space.

Articles included in this review were first identified using the NCBI PubMed search engine using search terms including: homosexual, gay, LGBT, neighborhood, geography. After an initial set of articles were identified and reviewed, the citations of papers were explored for any additional relevant articles that were not identified in the initial searches. Considering the available evidence, the social and physical environments of the gay neighborhood seems to be a double edged sword both promoting and preventing sexual risk and substance use. Papers from Mills (Mills et al., 2001), Pierce (Pierce, Miller, Morales, & Forney, 2007), Green (Green, 2008), Scribner (Scribner et al., 2008), Frye (Frye et al., 2010), Das, (Das et al., 2010), Laraque (Laraque, Mavronicolas, Robertson, Gortakowski, & Terzian, 2011; Laraque, Mavronicolas, Robertson, Gortakowski, &

Terzian, 2013), Egan (Egan et al., 2011), Tobin (Egan et al., 2011; K. E. Tobin et al., 2014), Carpiano (Carpiano et al., 2011), Kelly (Kelly, Carpiano, Easterbrook, & Parsons, 2012), Jones (Jones, 2012), Kurtz and Buttram (Buttram & Kurtz, 2013; Egan et al., 2011), and Koblin (Koblin et al., 2013) are summarized in Table 1 and by major themes below.

The Gayborhood: According to the UMHS, MSM living in a gay enclave (compared to non-residents) were more involved with the gay community, less involved with non-gay communities, more access to gay media, having more community cohesion, more likely to be out to family (Mills et al., 2001). More involvement with organized groups was associated with lower odds of living in a gay enclave (Buttram & Kurtz, 2013). And those not living in an enclave were more likely to report female sex partner in previous year.

Table 1. Papers Addressing the Neighborhood Impact on the Health of MSM

Author (yr)	Geography	Neighborhood	Define Gay Neighborhood	Methods (N)	Major Findings
Mills (2001)	SF, LA, Chicago, NYC	Home zip	data on commerce, institutions and census	RDD cross sectional survey (N=2881)	Differences in community involvement, friend and sex partner selection, and HIV testing of men living within or outside of gay enclave
Pierce (2007)	Chicago	Home zip	(service areas)	GIS (N=908)	Poor correlation between where YBMSM live and location of services
Green (2008)	Toronto	(time in gay enclave)	Anecdotal	Qual. (N=70)	Socio-sexual stressors associated with gay enclave impact health and behavior
Scribner (2008)	New Orleans	Home census tract	(Census tract HIV)	GIS (N=164 tracts)	HIV+ MSM influence distribution of HIV, associations with Alcohol distribution.
Frye (2010)	NYC	Home zip	Continuous: % SS-households	Cross sectional survey (N=385)	Gay neighborhood presence significantly associated with consistent condom use
Das (2010)	SF	Home zip	N/A	CVL	Decreases in CVL and new HIV cases, associations between CVL new HIV cases
Laraque (2011, 2013)	NYC	Home zip	N/A	CVL	Increased VL suppression, geographical CVL disparities similar to overall NYC HIV epidemic.
Egan (2011)	S.FLA (Kurtz)	Home zip	Anecdotal/common	Sexual risk reduction RCT (N=325)	Health deterioration associated with migration to S. FLA
	NYC (Egan)	Self defined home, social, sexual	Anecdotal/common – self defined	Qual., part. mapping (N=20)	Perceptions of neighborhoods, relationship to health/behavior and participant produced maps of home, social, and sexual neighborhoods
	Baltimore (Tobin)	(Social Networks)	N/A	Egocentric network analysis (N=188)	Predominately face to face partner selection, living with partner associated with larger socio-networks
Carpiano (2012)	NYC	Home zip	Dichotomous: % same sex + social mapping	Cross sectional survey (N=740)	Associations with gay enclave and use of meth. and ecstasy and with social networks and some substance use.
Kelly (2012)	NYC	Home zip	Dichotomous: % same sex + social mapping	Cross sectional survey (N=710)	Living in a gay enclave was not significantly associated with sexual risk other than increased PNP.
Jones (2012)	13 cities	Home zip	Continuous: % SS-households	RCT (N=2720)	Gay enclaves associated with increased HIV testing
Buttram (2012)	S.FLA	Home zip	Anecdotal/common	RCT (N=482)	More meth and RUAI; less cocaine, dependence, buy sex, and social engagement
Tobin (2013,2014)	Baltimore	Self defined, mapped	Self defined, mapped	Qual. (N=21), Quant (N=142)	MSM disclosure and HIV risk highly is contextual. Drug using spaces.
Koblin (2013)	NYC	Google Earth, self define	TBD	Qual, part. mapping, cross sectional survey (N=706)	Home, social and sexual neighborhoods differ in location and size.

Sexual Risk: Among these studies there is no consensus on the impact of living in a gay enclave on sexual risk. Some found no difference in risk (Mills et al., 2001) or risk for only specific sub-populations (i.e. PNP) (Kelly et al., 2012). Other findings suggest increased receptive unprotected anal intercourse (Buttram & Kurtz, 2013) and HIV seroconversion associated with migration to a gay enclave (Egan et al., 2011). Inability to conform to socio-sexual ideals may also lead to decreased self-efficacy and increased risk (Green, 2008), for example, independent of neighborhood, socializing with gay men has been associated with increased PNP (but not other HIV risk) (Kelly et al., 2012). Tobin found for Black MSM in Baltimore risk highly is contextual based on time, space and social factors. Half of the men in her sample relied on social networks

for partner acquisition and about half found the majority of their sex partners in their residential neighborhood which likely increases HIV risk given that many of these men live in communities with an elevated viral load (K. E. Tobin et al., 2013). There is also evidence that HIV services may be less available in areas where Black MSM live and participate in high-risk behaviors (Pierce et al., 2007) suggesting missed prevention opportunities. There is also evidence of the protective nature of a gay neighborhood including consistent condom use during IAI and RAI (Frye et al., 2010), less likelihood of buying sex (Buttram & Kurtz, 2013), and HIV testing practices (Jones, 2012; Mills et al., 2001).

Substance Use: In South Florida, men living in a gay enclave were more likely to use methamphetamine but less likely to use cocaine and less likely to report substance use dependence (Buttram & Kurtz, 2013). In NYC gay enclave residence was associated with increased use of methamphetamine and ecstasy but not cocaine, marijuana, poppers or polydrug use (Carpiano et al., 2011). Social networks may play a greater role in the promotion of substance use. In NYC, being part of a gay male intensive social network was associated with methamphetamine, ecstasy, cocaine, poppers and polydrug use but not marijuana (Carpiano et al., 2011).

Bio-Behavioral Mapping: The move toward mapping both the biological and behavioral is perhaps the most exciting and useful applications of neighborhood/geographical research. For example, Scribner found similar patterns in the spatial distribution of HIV-positive MSM and overall HIV, demonstrating that HIV-positive MSM highly influence the location of HIV in New Orleans (Scribner et al., 2008). He was further able to identify structural factors of neighborhoods associated with concentrations of HIV-positive MSM (e.g. alcohol distribution and urban decay)

as well as pockets of HIV-positive MSM that were not explained by predictor variables. Mapping HIV prevalence alone does not provide a complete picture of risk. Das and others have taken this a step further in looking at the impact of treatment and VL on infectiousness at both the individual and community level. Mapping these data shows the spatial distribution of CVL (risk) over time and geography (Das et al., 2010; Laraque et al., 2011; Laraque et al., 2013).

While these studies provide important insights into how social and physical environments – particularly neighborhoods and networks with highly concentrated MSM - influence behavior, methodological issues limit the scope of the findings.

Issues with identifying and operationalizing the Gayborhood: The UMHS was able to set a fairly high bar in identifying gay-centric neighborhoods by triangulating multiple data sources (e.g. using business, calling lists, rates of HIV). In doing so, they were able to move beyond relying on perceptions of historically entrenched communities (e.g. The Castro or Chelsea) in favor of newly constructed data estimating population and geographical dispersion of MSM communities. In contrast, both Green and Kurtz and Buttram started with historically identified neighborhoods. Green relied on men being physically present in this singular notion of a gay neighborhood. Kurtz and Buttram dichotomized men as within or outside of the gay neighborhood based on their residential zip code. Relying on historical gay enclaves often miss large portions of MSM, particularly men of color, older men (J. A. Catania et al., 2001), economically disadvantaged, and the emerging, shifting or previously unknown gayborhoods. Buttram addresses the limitation of their methods, acknowledging that they were unable to capture men who participated in the neighborhood but did not live within the predetermined area. Considering proximity to the identified neighborhood rather than the dichotomous inside/outside could have further strengthened the analysis.

Frye and Jones both used census data to identify neighborhoods with high concentration of same-sex couples as a proxy for identifying gay-centric areas. In the 2000 census people were allowed to identify themselves as "same sex unmarried partner" which allowed for the first time, nation-wide proxy estimate of the distribution of LGBT people. These numbers clearly do not represent the entire LGB population, as the census only records same-sex couples occupying the same residence and willing to answer the question on a government form.

Kelly and Carpiano were able to take this one step further including both an analysis of census data and "local knowledge obtained from social mapping" combined with systematic content analysis of gay institutions listed in gay-centric city publications. While intriguing, these methods were only briefly explained (e.g. "visible gay life" and "presence of multiple gay institutions"), there was no mention of how many neighborhoods were 'socially mapped', it was unclear how they reconciled zip code area with census data with neighborhood boundaries and there was no mention of how many of the NYC zip codes were included in their sample.

Reliance on Residential Administrative Boundaries: A limitation consistent across many of these papers is the use of zip codes and the restriction to residential neighborhood. While administrative boundaries are often unavoidable, zip codes often cover larger areas of little to no significance to communities or individuals. Collecting information on only residential neighborhood, while most common for neighborhood studies, does not account for the reality that most people inhabit multiple spaces over time; is therefore likely that behavior is influenced by multiple neighborhoods (e.g. where one works, socializes, plays). How different neighborhoods impact different behaviors

is most likely highly individualized. While meaningful, findings based on administrative boundaries of a single neighborhood are likely to miss the larger context, particularly in a highly mobile urban setting like NYC.

Several studies have begun to incorporate new methodologies, technologies and analyses to better understand the complex relationships between multiple levels including structural, neighborhood, community and individual.

While not entirely chronological, there seems is a progression to more sophisticated methods to the research on neighborhood impact on MSM. Early qualitative work by Green provided an initial sense of how MSM relate to an established gay enclave and the perceived behavior and health implications of being in that space. Egan built on this by asking men to self-define how multiple neighborhoods impact them and using new methods to better understand individual perception of neighborhood rather than relying on pre-conceived historical boundaries. Tobin extended the use of qualitative methods even further in asking men to map their daily movements thereby collecting even more specific data on where and how individuals spend time.

The use of quantitative cross-sectional surveys ((Carpiano et al., 2011; Frye et al., 2010; Kelly et al., 2012)) provided the opportunity to collect larger amounts of data with larger samples of men and improving the types of analyses possible. The use of quantitative surveys as part of an intervention study in South Florida (Buttram & Kurtz, 2013; Egan et al., 2011) and the CITY study (Jones, 2012; Pierce et al., 2007) provides even greater analytical opportunities with multiple follow up surveys. Both the UMHS and NYCM2M projects build on this by including specific geographical data and neighborhood variables essential for more sophisticated analyses (Koblin et al., 2013; Mills et al., 2001). Mills, Pierce, Scribner, Das and Koblin push the field even further in

their use of multiple neighborhoods of impact and multiple data sources (including biological outcomes) and geomapping to both visualize and analyze data at the individual and community level (Das et al., 2010).

3.0 MIGRATION AND RISK AMONG GAY, BIXEXUAL, AND OTHER MEN WHO HAVE SEX WITH MEN IN NEW YORK CITY

3.1 INTRODUCTION

There is a well-established history of gay migration to New York City (NYC) (Binson et al., 1995; Joseph A. Catania, Canchola, Pollack, & Chang, 2006; Chauncey, 1994; Kaiser, 1997). Large cities have historically offered gay, bisexual, and other men who have sex with men (MSM) more tolerant social policies allowing for less fear in enacting stigmatized behaviors and identities (D'Emilio, 2005; Gates & Ost, 2004), more opportunities to find social and sexual partners (Ellingson & Schroeder, 2004), a community within which to form and express identity (Fischer, 1975), and in some places carve out their own neighborhoods (Levine, 1978). The Urban Men's health study found that migrants made up a significant proportion of urban MSM communities (Joseph A. Catania et al., 2006). Effects of migration on both individuals and the overall community are an important aspect to understanding the health of urban MSM.

We believe that migration may be an important contextually driven moment of heightened risk for MSM. Introduction into new socio-sexual networks with unfamiliar expectations in a new city may impact a newly migrated man's ability to negotiate risk in the same way he may have at 'home'. Buttram and Kurtz identified that sexual risk-taking and substance use increase rapidly post-migration to South Florida. MSM living in South Florida for between 1 and 5 years reported more HIV sexual risk than those who had been there for less than 1 year and those who had been

there for more than 5 years. Nearly 1/3 of men seroconverted within 5 years of relocation (Buttram & Kurtz, 2013; Egan et al., 2011).

While much of HIV-intervention has focused on the individual, the new era of combination prevention demands that we also consider beyond the individual-level factors that continue to contribute to HIV transmission (Coates et al., 2008; Herbst et al., 2007; Stall et al., 2009). Millett has insightfully shown that it is not individual behavior that is driving the epidemic among Black MSM, but rather the epidemiologic background of the spaces within which men spend their time (Millett et al., 2007; Millett et al., 2012). The post-migration period may be an identifiable moment of increased risk.

Using data from the NYCM2M study, this paper hopes adds to the understanding of geo-temporal risk associated with migration to a gay-centric urban center. Informed by Kurtz's model of health risks associated with MSM urban migration (Egan et al., 2011), we hypothesized that recent migrants would experience a heightened period of HIV risk and substance use compared to those who had migrated less recently. Furthermore, we hypothesized that this increased risk would translate into HIV seroconversion within the first few years of migration.

3.2 METHODS

3.2.1 M2MNYC Study, Participants, and Procedures

The study methods, measures, and visit procedures have been described in detail elsewhere (Koblin et al., 2013). M2MNYC is a cross-sectional study designed to identify neighborhood-level characteristics within the urban environment that influence sexual risk behaviors, substance use and mental health among MSM living in NYC. Between 2010 and 2012, using modified venue-based time-space sampling (detailed in (Koblin et al., 2013)), men were recruited through face-to-face outreach and mobile apps with the priority of recruiting men from a diverse set of NYC neighborhoods (MacKellar et al., 2007). To be eligible to participate, individuals had to self-report: being a biological male at birth, being at least 18 years of age, currently reside within the 5 NYC Boroughs, have had anal sex with a man in the past 3 months, able to communicate in English or Spanish, and were willing and able to give informed consent. A total of 1,493 men completed the ACASI.

After street/mobile intercept, eligible participants were scheduled for a study visit in one of two Manhattan locations. The study visit included informed consent; staff implemented *Neighborhood Locator Questionnaire* (a study designed instrument to collect initial data on the home, social, and sexual neighborhoods, see (Koblin et al., 2013)); Audio Computer-Assisted Self-Interview (ACASI) questionnaire; and a staff implemented Social and Sexual Network Questionnaire. After completing all the assessments, participants then received HIV counseling and a rapid antibody testing (OraQuick). Positive tests were confirmed with Western Blot testing. Both newly and previously diagnosed HIV-positive men were asked to provide a blood sample for CD4/Viral Load

testing. Men received $50 and a two-way Metrocard for their participation. Study protocols were reviewed by the Institutional Review Board of the New York Blood Center as well as the institutions of Co-Investigators. The University of Pittsburgh IRB approved use of these data for this analysis.

3.2.2 Measures

Demographic Characteristics. The demographics include the following. Age was measured in years at time of interview and categorized into 4 groups: (1) 18-24, (2) 25-29, (3) 30-40, and (4) 41 and older. Race/ethnicity was categorized as either (1) non-White Hispanic (Latino), (2) Black, (3) White and (4) all others. Personal Income was measured on a 12-point scale which was recoded to include: (1) Less than $10,000, (2) $10,000-$39,999 (3) $40,000-59,000 and (4) $60,000 and greater.

Migration and time in NYC: Time in NYC was calculated by subtracting the participant's self-reported year of moving to NYC from date of interview and then recoded into (1) <1 year, (2) 2-5 years, (3) 6-10 years, (4) 11 years or more. Men who have been in NYC for 11 or more years ago were excluded from the analysis. Migration age was calculated by subtracting the participant's migration year from his year of birth. Men who were born in NYC and those who migrated before the age of 15 were excluded from the dataset and analyses (using age 15 as an estimate of sexual debut for young MSM (Outlaw et al., 2011)).

Sexual Behavior and Sexually Transmitted Infections: Participants were asked about numbers of male (recent, primary, and others), female (primary and others) and transgender (primary and

others) partners, total number of insertive and receptive anal sex acts, use of condoms, and concatenate use of drugs/alcohol within the past three months. For analysis these questions were combined to create dichotomous variables including: any condomless sex, condomless insertive sex, condomless receptive sex, serodiscordant condomless insertive sex, and serodiscordant condomless receptive sex. Participants were also asked if they had, in the past 3 months, been diagnosed (and if yes, treated) with syphilis, genital or rectal gonorrhea or chlamydia, genital or rectal herpes, and/or any other genital or rectal sores or discharge. This was recoded as dichotomous to include any sexually transmitted infection (STI) in the past three months.

Substance Use: Substance use questions included age of first use, frequency of use in the past three months and any lifetime or recent concerns or worries about the use of alcohol, tobacco, marijuana, inhaled nitrites, crack cocaine, powder cocaine, methamphetamine, heroin, other opiates, benzodiazepine, hallucinogens (including: Ketamine, MDMA, GHB, PCP, mushrooms, LSD), erectile dysfunction drugs, steroids and hormones. For this analysis we collapsed any use in the past three months of crack cocaine, powder cocaine, methamphetamine, heroin, and hallucinogens into a dichotomous variable. Three drug use outcomes were included in this analysis: (1) *Any Use*: use of any substance in the past 3-months, (2) *Moderate use*: use of any substance at least once a month over the past 3-months, and (3) *Heavy Use*: use of any substance 2-3 times per month over the past 3 months. To assess alcohol use the 3-question AUDIT-C (Bradley et al., 2007; Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998) was used to understand consumption amount and frequency (1) *hazardous drinking*: a score of 4 or higher on the AUDIT-C and (2) *heavy drinking*: reporting alcohol use 4 or more times a week/3 or more drinks.

HIV Status and Seroconversion: Current HIV status was measured as both self-report and HIV testing of self-reported HIV negative or unknown participants. Self-reported date of HIV infection was used as a proxy for HIV seroconversion. Self-reported HIV-positive men were asked, *when did you first test positive for HIV,* for men who tested positive during their study visit, the study visit date was used. Post migration HIV seroconversion was calculated using year of HIV diagnosis subtracted from year of migration.

3.3 ANALYSIS

All analyses were conducted using IBM SPSS 21 (Chicago, Il). Sociodemographics and the primary HIV risk behaviors were examined for the overall sample and the three categories of post-migration time in NYC (≤1, 2-5, and 6-10 years). Chi-square tests were used to determine between group differences. Logistic regression was used to determine odds ratios (OR), adjusted odds ratios (aOR) and confidence intervals (CI) for bivariate and multivariable associations between years in NYC and the dependent variables. A Cox proportional hazards multivariable regression (Cox, 1972) was conducted to model post-migration time to HIV seroconversion. The hazard ratio takes into account not if an individual is HIV-positive or negative, but how much time passed before seroconversion after migration. We focused on seroconversion within the first 10 years of migration to NYC (event=1). Men who remained HIV-negative or who seroconverted prior to NYC migration were right-censored (event=0).

3.4 RESULTS

Table 2 describes frequency (N and %) of the sociodemographics and primary HIV Risk and Substance use outcomes of the 738 recent NYC migrants. This excludes men who migrated more than 10 years ago (n=287), those who migrated before the age of 14 (n=101), and men born in NYC (n=458). The men in this sample were, 43% White, 21% Latino; 20% Black. 15% identified as another race. The majority of men (63%) were between 25-29 years old; about another quarter (23%) were 30-40. Most men (90%) reported having at least a college degree. Only about a quarter (23%) had an income of less than $10,000 per year. The majority of men self identified as gay or homosexual (89%); another 8% as bisexual; and 3% as heterosexual or other. Nearly all the men lived in either Manhattan (45%) or Brooklyn (34%). About half of the sample reported some sexual risk in the past 3 months including general unprotected (47%); receptive (41%) and/or insertive (43%) condomless sex; and receptive (16%) and/or insertive (16%) serodiscordant condomless sex. Only 8% reported having been recently diagnosed with a STI. 30% reported any drug use in the past 3 months. Far fewer reported moderate (14%) or heavy (8%) drug use. Nearly two-thirds (63%) scored high enough on the AUDIT to be considered hazardous drinkers; 15% were heavy drinkers. Significant between group differences were found for age ($p<0.001$), education ($p<0.01$), income ($p<0.01$), home borough ($p<0.01$), neighborhood concurrency ($p<0.01$), and general condomless sex ($p<0.05$).

Table 2. Sociodemographic Characteristics, HIV Risk and Substance Use and Time Living in NYC

	Total (N=739)		≤1YR (n=245)		2--5YRS (n=321)		6--10YRS (n=172)	
	n	%	n	%	n	%	n	%
Sexual Orientation								
Gay	658	89.2	219	89.4	289	90.0	150	87.2
Bisexual	57	7.7	22	9.0	21	6.5	14	8.1
Other	23	3.1	4	1.6	11	3.4	8	4.7
Race/Ethnicity		100.0						
Latino	153	20.8	52	21.2	58	18.1	43	25.1
Black	157	21.3	61	24.9	63	19.6	33	19.3
White	314	42.6	94	38.4	148	46.1	72	42.1
EveryoneElse	113	15.3	38	15.5	52	16.2	23	13.5
Age								
18-24	31	4.2	19	7.8	11	3.4	1	0.6***
25-29	465	63.0	167	68.2	227	70.7	71	41.3
30-40	171	23.2	38	15.5	61	19.0	72	41.9
41+	71	9.6	21	8.6	22	6.9	28	16.3
Education								
<HS	18	2.4	9	3.7	4	1.2	5	2.9**
HS/GED	56	7.6	30	12.2	15	4.7	11	6.4
Some college or 2 year degree	221	29.9	67	27.3	105	32.7	49	28.5
College degree or more	443	60.0	139	56.7	197	61.4	107	62.2
Income								
LessThan 10K	167	22.9	66	27.3	63	19.8	38	22.4**
10K-40K	305	41.8	113	46.7	132	41.5	60	35.3
40-60K	133	18.2	29	12.0	63	19.8	41	24.1
60K+	125	17.1	34	14.0	60	18.9	31	18.2
Home Borough								
Brooklyn	254	34.4	94	38.4	110	34.3	50	29.1**
Bronx	62	8.4	18	7.3	17	5.3	27	15.7
Manhattan	330	44.7	103	42.0	158	49.2	69	40.1
Queens	85	11.5	29	11.8	31	9.7	25	14.5
Staten Island	7	0.9	1	0.4	5	1.6	1	0.6
HIV Status								
HIV-positive	118	16.0	37	15.1	47	14.6	34	19.8
HIV-negative	585	79.3	193	78.8	263	81.9	129	75.0
UNKN/REF	35	4.7	15	6.1	11	3.4	9	5.2
Sexual HIV Risk (self-report yes)								
Any STI	56	7.6	17	6.9	28	8.7	11	6.4
General Unprotected	289	46.8	90	44.1	137	52.5	62	40.5*
Unprotected Receptive	183	41.2	61	40.9	82	44.1	40	36.7
Unprotected Insertive	191	43.4	53	37.6	92	49.5	48	40.7*
SD+Unprotected Receptive	116	15.7	39	15.9	53	16.5	24	14.0
SD+Unprotected Insertive	118	16.0	36	14.7	52	16.2	30	17.4
Substance Use (self-report yes)								
Any Drug Use	221	29.9	78	31.8	98	30.5	45	26.2
Moderate Drug Use	101	13.7	30	12.2	43	13.4	28	16.3
Heavy Drug Use	61	8.3	21	8.6	28	8.7	12	7.0
Hazardous Alcohol Use	462	62.8	146	59.6	215	67.2	101	59.1
Heavy Alcohol Use	111	15.1	34	13.9	60	18.8	17	9.9

(N=458 NYC BORN EXCLUDED, N=287 NYC MIGRATED 11+YRS, N=11 MIGRATED PRE-14 YEARS OLD)
* p < 0.05; ** p < 0.01; *** p < 0.001
+Serodiscordant

Table 3 describes the bivariate and multivariable associations of migration to NYC migration with sexual and substance use risk. In multivariable analyses (adjusted for race, age, and income), living in NYC for 2-5 years was associated with an increase in general unprotected sex (aOR=1.89, CI=1.22,2.88) and heavy drinking (aOR=1.92, CI=1.06,3.50) compared to those who had lived in NYC for 6-10 years. These results support our initial hypothesis that some men may experience a post-migration period of heightened sexual and alcohol related risk.

Table 3. Bivariate & Multivariable Associations of Sociodemographic Characteristics and Time in NYC with HIV

	BIVARIATE ASSOCIATIONS			MULTIVARIABLE ASSOCIATIONS		
	Years In NYC			Years In NYC		
	<1	2--5	6--10	<1	2--5	6--10
Sexual Risk	OR (95%CI)	OR (95%CI)	(REF)	aOR (95%CI)	aOR (95%CI)	(REF)
General Unprotective	1.16 (0.76,1.78)	1.62* (1.08,2.43)	1.00	1.33 (0.84,2.00)	1.89** (1.22,2.88)	1.00
Unprotective Insertive	0.88 (0.53,1.46	1.43 (0.89,2.29)	1.00	1.08 (0.62,1.87)	1.80* (1.08,2.98)	1.00
Unprotective Receptive	1.20 (0.72,2.00)	1.36 (0.84,2.21)	1.00	1.37 (0.80,2.36)	1.56 (0.93,1.56)	1.00
SD Condomless Sex	1.00 (0.64,1.58)	1.17 (0.76,1.79)	1.00	1.12 (0.69,1.81)	1.30 (0.83,2.04)	1.00
HIV-Positive	0.73 (0.43,1.22)	0.68 (0.42,1.11)	1.00	0.96 (0.52,1.73)	1.08 (0.61,1.90)	1.00
Any STI	1.09 (0.50,2.40)	1.49 (0.72,3.06)	1.00	1.37 (0.60,3.15)	1.91 (0.89,4.12)	1.00
Any Drug Use	1.32 (0.86,2.03)	1.34 (0.92,2.19)	1.00	1.25 (0.79,1.98)	1.16 (0.75,1.80)	1.00
Moderate Drug Use	0.72 (0.41,1.25)	0.80 (0.46,1.33)	1.00	0.66 (0.36,1.18)	0.74 (0.43,1.27)	1.00
Heavy Drug Use	1.25 (0.60,2.61)	1.27 (0.63,2.57)	1.00	1.20 (0.55,2.60)	1.24 (0.60,2.60)	1.00
Hazardous Drinking	1.02 (0.69,1.52)	1.42 (0.97, 2.08)	1.00	0.90 (0.58,1.40)	1.14 (0.75,1.73)	1.00
Heavy Drinking	1.50 (0.79,2.71)	2.10** (1.18,3.71)	1.00	1.45 (0.76,2.77)	1.92* (1.06,3.50)	1.00

Note. OR=Unadjusted Odds Ratio, aOR = Adjusted Odds Ratio; CI = Confidence interval; * p < 0.05; ** p < 0.01; *** p < 0.001.

Table 4 includes results from the Cox proportional hazards multivariable regression modeling post-migration HIV seroconversion. In all, 99 men seroconverted within the first 10 years of migrating to NYC. Bivariate omnibus tests (data not shown) were significant for race (p>0.001) but non-significant for age at migration (p=0.11) and year of migration (p=0.82). In the multilevel model controlling for migration age, compared to White men, Black men had a cox proportional hazard of 5.17 (p<0.001) and Latino men had a hazard ratio of 3.03 (p=0.01). Post-migration seroconverstion hazards by race are presented in Figure 1. This supports our initial hypothesis that post-migration risk may for some men – particularly men of color – lead to HIV seroconversion.

Table 4. Post-Migration HIV Seroconversion

Race	Hazard Ratio	*p*
White (Ref)	1.00	
Black	5.17 (2.32,11.53)	<0.001
Latino	3.02 (1.26,7.20)	0.013
All Others	1.68 (0.56,5.05)	0.353

controlled for migration age

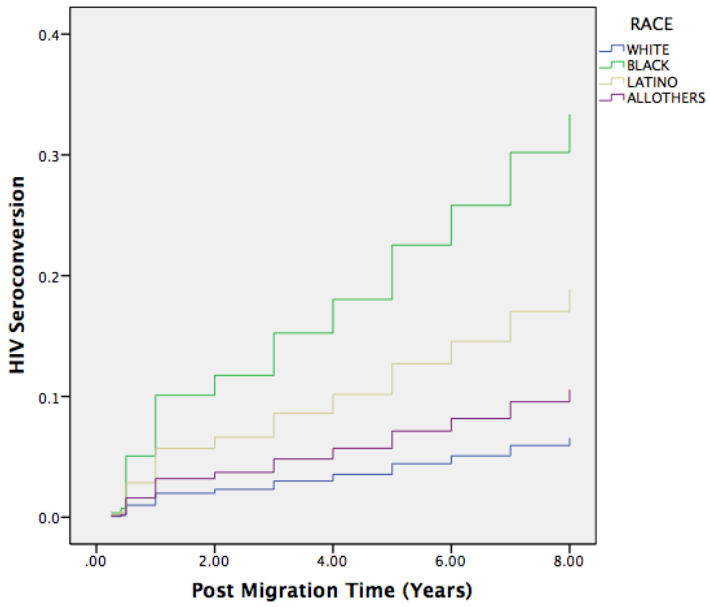

Figure 1. Post Migration HIV Seroconversion Hazard

3.5 DISCUSSION

This paper describes a sample of MSM who recently migrated to NYC. HIV sexual risk and substance use was examined for three specific post-migration time periods including those who had lived in NYC for one year or less, 2-5 years, and 6-10 years. Compared to men living in NYC for 6-10 years, more recent migrants, men living in NYC for between 2-5 years, had increased risk for unprotected sex and heavy drinking. We then looked at post-migration seroconversion. Compared to White men, Black men had a cox proportional hazard of 5.17 ($p<0.001$) and Latino men had a hazard ratio of 3.03 ($p=0.01$).

These findings support research suggesting that migration, space, and place likely play a significant role in exposure to risk and increased risk behaviors. Similar to Catania's findings from

the Urban Men's Health Study, many of these NYC-migrants were White and well educated (Joseph A. Catania et al., 2006; J. A. Catania et al., 2001). However, there were also had a significant number of Black and Latino men; and most of the men made less than $40,000 a year suggesting that they may not be so much different to the MSM from NYC in terms of economic status. Our finding that recent migration was associated with sexual and substance using risk is consistent with the findings from the formative qualitative phase of the M2MNYC project (Frye et al., 2011; Frye et al., 2014)) and the work of Kurtz and Buttram (Buttram & Kurtz, 2013). Kurtz presents a clear pathway between migration to and acculturation into urban gay enclaves of South Florida and increased risk-taking. NYCM2M qualitative findings suggested that men in NYC might be experiencing something similar. We found that migration to NYC (or gay spaces in NYC) put many men in closer proximity to risky behaviors and temptations and was often associated with individual periods of increased risk. One man compared his arrival to a *gay neighborhood* was like a kid walking into FAO Schwarz for the first time; everything one wanted was there. Men also discussed intentionally moving away from gay neighborhoods to limit their exposure to such temptations.

Unlike Kurtz, we did not find significant differences in drug use and far fewer overall men seroconverted compared to the nearly 1/3 of the men who seroconverted within the first 5 years of migrating to South Florida. It is not immediately clear why these data suggest that some men who migrate to NYC may fare better than men who migrate to South Florida. Are there differences in the men who choose NYC over Florida? Do the dramatic differences between the two cities in social and health services to support MSM and HIV-positive people impact the epidemiologic context to such an extent as to minimize migration-related behavioral risk? A greater

understanding will require more nuanced and longitudinal data on migration and risk patters over time (e.g. where men are infected, seek care, and 'end up'). It is interesting that the most risk was attributed to those who migrated not most recently, but had been in NYC for 2-5 years. This may suggest an acclimation period to NYC migration. That men living in NYC for over 10 years reported less risk, may suggest that migration-related risk lessons over time. A better understanding of the resiliencies of these men may help us better understand risk and inform intervention design.

More Information on the health risks and resiliencies associated with the migration of MSM to cities or other spaces with concentrated LGBT peoples/communities is limited. There are data that suggest some specific spaces (e.g. bathhouses and public sex environments) are associated with greater risk/risk taking (Somlai et al., 2001; Van Beneden et al., 2002; Woods et al., 2000). There are also data that suggest that some places such as being away from home may increase risk. Men attending circuit parties away from home, for example, reported increased substance use, unprotected anal sex with more partners, and more serodiscordant unprotected anal sex than when attending parties at home (G. N. Colfax et al., 2001; Mansergh et al., 2001). Vacationing in gay-centric places may also contribute to increased risk-taking behaviors (Benotsch, Mikytuck, Ragsdale, & Pinkerton, 2006; Mayer et al., 2014). Still other data suggest a more complex synergy of space, place, and socio-sexual interactions within different CVL contexts (Millett et al., 2007; Millett et al., 2012).

There are several limitations to the study design and analysis that must be mentioned. Both time location sampling and participant self-selection impact the composition of the study sample.

Despite our attempt to include a wide variety of public and virtual spaces in the TLS randomization, we likely missed men who did not participate in the chosen recruitment spaces or who felt unable to screen for the study. The survey was administered using ACASI in hopes that participants would feel more comfortable responding to questions on sexual behavior and drug use, as such we are reliant on self-report data. Assessing participant honesty and recall is impossible in such a study design. Men also had to have had anal sex within the past 3-months to participate which skews the sample toward sexually active men.

Migration itself is challenging to fully operationalize and understand in the context of this study design. While migration to and time in NYC were central themes of the study, we were unable to capture more nuanced movement(s) within and away from NYC. The cross sectional nature of data collection and only having access to men currently living in NYC prevented us from collecting a more complete picture of migration and migration related risk. We are unable to describe the behaviors and health of men who migrated in to and out of NYC before having the opportunity to be in the study. With these data we are unable to know who left NYC, why they left, how long they stayed and what they did while there. We are unable to know if the most risky men abandoned the city, while the more resilient men remained.

A cohort study would be an ideal design to explore some of these questions in more detail. If MSM could be enrolled just after migration to a city and followed for several years, we could learn more about the immediate and long-term effects of migration on health. This study design would also allow us to follow men as they move within and away from urban centers. These data would provide important insight on MSM neighborhood-related research as well as provide a far more

nuanced understanding of migration including reasons for in-out migration, how and why some stay and some leave, and the associated risks and resiliencies. Understanding the predictors of which men are more or less successful could translate into where and when to best implement prevention programs. Interventions could include such things as a *welcome wagon* of prevention tools (e.g. access to: medical care, PrEP/PEP, mental health counseling) or *fresh meet* events to attract and interact with newer migrants.

Despite these limitations, this paper raises important questions to consider as we enter the next generation of bio-behavioral HIV prevention. HIV behavioral literature and intervention has largely emphasized individual level behavior change contexts. Increasing evidence is being produced to highlight the importance of context as a driver of HIV risk (Millett et al., 2007; Millett et al., 2012). In this paper we attempted to better understand the interaction between the structural and behavioral through a specific contextual lens, migration to a new city with unknown socio-sexual networks, with unknown (and usually unwritten) behavioral codes/rules, and likely with previously unknown and/or untested opportunities. It is important that we continue to move forward with research that investigates potential moments of a geo-temporal contextually driven high-risk. Innovative bio-behavioral interventions can then be implemented to specifically target these spaces or moments to lower both individual and community related HIV risk.

Perhaps most striking are our findings that suggest that migration to NYC may pose far greater risk of seroconversion for Black and Latino MSM. These may data add support Millett's assertions that context has a great impact on HIV acquisition among Black MSM (Millett et al., 2007; Millett et al., 2012). Further analyses presented in the following paper describing the demographic

characteristics of men's home and sex neighborhoods and of sexual migration within the city provide additional insight on how the geographical segregation of NYC and the background HIV epidemiologic context of certain neighborhoods increase HIV risk for men of color.

4.0 THE WHERE OF RISK: COMPOSITION AND COMMUNITY VIRAL LOAD OF THE HOME AND SEXUAL NEIGHBORHOODS OF HIV-NEGATIVE GAY, BISEXUAL, AND OTHER MEN WHO HAVE SEX WITH MEN IN NEW YORK CITY

4.1 INTRODUCTION

Context is important. In considering fundamental causes of health and inequity, we are forced to think beyond individual-level risk and consider the interaction of multiple *levels* (e.g. social, political, biological) (Cerda, Tracy, Ahern, & Galea, 2014; Krieger, 1994, 2012; Link & Phelan, 1995). For, gay, bisexual, and other men who have sex with men (MSM) context may be particularly influential. Chronic stress related to being a sexual minority and experiencing discrimination have an enormous impact on physical and emotional health, to the point, for some, in decreasing life expectancy (Hatzenbuehler et al., 2014; Hatzenbuehler, Keyes, et al., 2011; Hatzenbuehler et al., 2010; Hatzenbuehler, Wieringa, et al., 2011; Lazarus & Folkman, 1984; Meyer, 2003b). The influence of different contexts, particularly neighborhoods, has been understudied in relation to HIV among MSM. As we continue to move further into the age of combination prevention and structural intervention approaches to HIV prevention – for example, the effectiveness that antiretroviral therapies have had on in improving survival and reducing individual viremia so as to diminish or eliminate the possibility of HIV transmission (M. S. Cohen & Baden, 2012; Ray et al., 2010; Vernazza et al., 2008) – it is essential that we have a better and more nuanced understanding of the impact of geography and other spaces (Coates et al., 2008; Rotheram-Borus et al., 2009).

Individual-level behavior is only part of the HIV-risk equation, where MSM live and have sex matters. Previous research has shown positive associations between increased individual HIV-risk behaviors and participation in specific spaces (e.g. bathhouses, public sex environments) (Somlai et al., 2001; Van Beneden et al., 2002; Woods et al., 2000) or being away from one's home (Benotsch et al., 2006; G. N. Colfax et al., 2001; Mansergh et al., 2001; Mayer et al., 2014). Millett and others have demonstrated that the epidemiological context within which socio-sexual networks exist may be a much greater determinant of HIV acquisition than behavior alone (Millett et al., 2007; Millett et al., 2012). An important factor in measuring the epidemiological context of HIV is community viral load (CVL). CVL describes the biological measure of viral load (VL) on aggregate for a defined geographical area and/or a defined socio-demographic group or sexual network. Das and colleagues were able to demonstrate decreases in both mean CVL, new HIV diagnoses and significant associations between CVL and new HIV cases (Das et al., 2010). Das, Laraque (in NYC) and others have used these data to look at the spatial distribution of CVL over time and geography, essentially visualizing HIV risk at the community level (Castel et al., 2012; CDC, 2011a; Das et al., 2010; Laraque et al., 2011; Laraque et al., 2013).

In this paper, we are attempting to describe the composition of neighborhoods with higher and lower CVL, and to characterize the men who move in between these spaces. In doing this we hope to identify spaces (e.g. higher CVL neighborhoods) and moments (e.g. individuals who travel to/from higher CVL risk neighborhoods) for targeted HIV combination interventions including both prevention (e.g. risk assessment skills, access to PrEP and PEP) and treatment (e.g. access to treatment, adherence skills). We first describe the Sociodemographics characteristics of HIV-negative MSM who live in and have sex in NYC neighborhoods with different levels of CVL. We

then describe the Sociodemographics characteristics of sexual migration to and from neighborhoods with different levels of CVL. Finally, we characterize the sexual risk associated with living in or migrating to higher CVL neighborhoods.

4.2 METHODS

4.2.1 M2MNYC Study, Participants and Procedures

The study methods, measures, and visit procedures have been described in detail elsewhere (Koblin et al., 2013). M2MNYC is a cross-sectional study designed to identify neighborhood-level characteristics within the urban environment that influence sexual risk behaviors, substance use and mental health among MSM living in NYC. Between 2010 and 2012, using modified venue-based time-space sampling (detailed in (Koblin et al., 2013)), men were recruited through face-to-face outreach and mobile apps with the priority of recruiting men from a diverse set of New York City (NYC) neighborhoods (MacKellar et al., 2007). To be eligible to participate, individuals had to self-report: being a biological male at birth, being at least 18 years of age, currently reside within the 5 NYC Boroughs, have had anal sex with a man in the past 3 months, able to communicate in English or Spanish, and were willing and able to give informed consent. A total of 1,493 men completed the ACASI (street=805, mobile=698).

After street/mobile intercept, eligible participants were scheduled for a study visit in one of two Manhattan locations. The study visit included informed consent; staff implemented *neighborhood locator questionnaire* (a study designed instrument to collect initial data on the home, social, and

sexual neighborhoods, see (Koblin et al., 2013)); Audio Computer-Assisted Self-Interview (ACASI) questionnaire; and a staff implemented Social and Sexual Network Questionnaire. After completing all the assessments, participants then received HIV counseling and a rapid antibody testing (OraQuick). Positive tests were confirmed with Western Blot testing. Both newly and previously diagnosed HIV-positive men were asked to provide a blood sample for CD4/Viral Load testing. Men received $50 and a two-way Metrocard for their participation. Study protocols were reviewed by the Institutional Review Board of the New York Blood Center as well as the institutions of Co-Investigators. The University of Pittsburgh IRB approved use of these data for this analysis.

4.2.2 Measures

Sociodemographic Characteristics. The demographics include the following. Age was collected in years at time of interview and categorized into 4 groups: (1) 18-24, (2) 25-29, (3) 30-40, and (4) 41 and older. Race/ethnicity was categorized as either (1) non-White Hispanic (Latino), (2) Black, (3) White, and (4) all others. Personal Income was measured on a 12-point scale which was recoded to include: (1) Less than $10,000, (2) $10,000-$39,999, (3) $40,000-59,000, and (4) $60,000 and greater.

Internet/Mobile App Use. The use of the Internet and/or apps on mobile devices to search for sex was measured with a single question (i.e. *During the last 3 months, how often have you looked for sex or a sex partner through the internet using a computer or through an app using a mobile device?*) answered on a 6-point Likert scale. This was then dichotomized into either 1=ever used or 0=not used in the past 3-months.

Community Viral Load (CVL). The neighborhood estimates of community viral load were calculated by the NYCDOHMH based on the United Hospital Foundation (UHF) home neighborhoods of HIV-positive MSM in NYC in 2011(Laraque et al., 2011; Laraque et al., 2013; Torian, 2014). For these data an undetectable viral load was defined as ≤200 copies/mL and presented categorically by percent undetectable VL for MSM in NYC (i.e. 1=60.8-68.1, 2=68.2-73.5, 3=73.6-78.2, 4=78.3-82.8, 5=82.9-88.3). These data were recoded as a dichotomous variable to denote ether 1= higher CVL (60.8%-73.5% undetectable MSM) neighborhood or 0=lower CVL (73.6%-88.3% undetectable MSM) neighborhood (see Figure 2).

We chose to use the percent of undetectable MSM as opposed to the mean or median viral load because the wide range in the median suggest that higher mean viral load neighborhoods may be driven by a smaller population of men on the edge of the distribution, whereby percent undetectable, describes the estimated number of men with detectable viral loads. As such, a higher CVL neighborhood is one where an individual has more opportunity to encounter an HIV-positive MSM with viral loads greater ≤200 copies/mL.

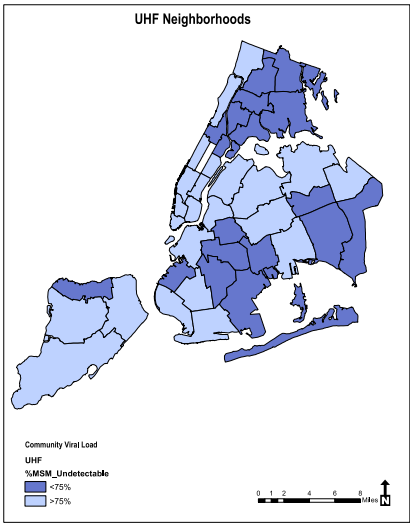

Figure 2. CVL by UHF Neighborhood

Definition of Home and Sexual Neighborhoods. Participants were asked to self-define their home and most recent sexual neighborhoods by 'dropping a pin' in Google Earth map of NYC. The latitude and longitude were recorded and plotted using ArcGIS 10.X (Redlands, CA). To protect participant anonymity, home neighborhood points were 'jittered' to correspond to different coordinates within the same census tract. This method allows for the continued use of census data without revealing the participant address. The census tracts associated with each point data were then aggregated to the UHF neighborhood level (New York City Deparment of Health and Mental Hygene, 2009) to match the NYCDOHMH CVL data.

Sexual Migration. Using the dichotomous higher/lower CVL variable, the sexual migration variable was created to describe participants who (1) migrated for sex to a higher CVL neighborhood (e.g. CVL home < CVL sex), (2) to a lower CVL neighborhood (e.g. CVL home > CVL sex), or (3) did not migrate or migrated to a neighborhood with an equal CVL (e.g. CVL home = CVL sex).

4.3 ANALYSIS

Analyses were conducted using IBM SPSS 21 (Chicago, Il). Sociodemographics were examined for the overall sample of HIV-negative men and then by those who report spending time in either a higher or lower risk home and sexual neighborhood. Chi-square tests were used to determine bivariate between group differences. Logistic regression was then used to determine odds ratios (OR), adjusted odds ratios (aOR) and confidence intervals (CI) multivariable associations. Significance was set at the $p \leq 0.05$. Geospatial data was managed and maps created using ArcGIS 10.X (Redlands, CA).

4.4 RESULTS

In Table 5 the sociodemographics are described for the total sample of HIV-negative men in the NYCM2M study (N=1106, 74% of overall study N) and the sociodemographic composition of the home and sexual neighborhoods by higher and lower CVL risk. The majority of the sample is gay (86.9%). Men in the sample identified as Black (22.3%), Latino (28.2%), White (36.1%), or something else (13.4%). Over half of the participants are either between 18-24 (29.5) or 25-29 (29.0%) years old and 17.3% are 40 years or older. Many of the men have completed a college degree (54.3%). A quarter of participants (24.1%) reported an income of less than $10,000. Just fewer than half the sample lives in (43.4%) and over a third have sex in (35.7) a higher CVL neighborhood. Participants were recruited almost equally from spaces online (47%) or in-person (53%), and 81% reported having used the Internet or mobile app to search for sex within the past

3-months. In Figure 3 describes the distribution of CVL by UHF neighborhood overlaid with points denoting each participant's reported home and sexual neighborhoods.

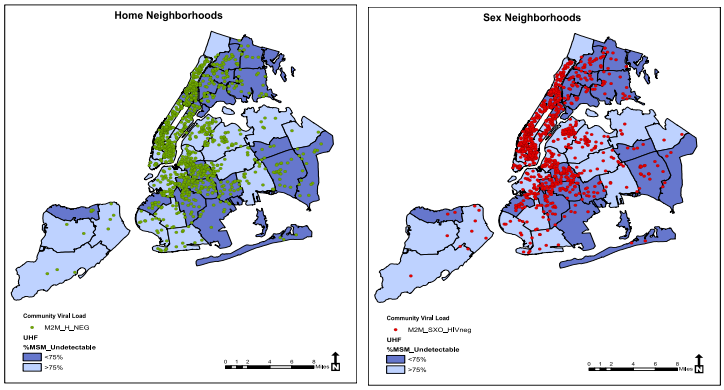

Figure 3. CVL and Home and Sex Neighborhoods

Table 5. Sociodemographics of HIV-negative Study Participants and CVL of Home and Sexual Neighborhoods

	HIV-negative Total Sample		HOME HOOD				SEX HOOD			
			LOWER RISK		HIGHER RISK		LOWER RISK		HIGHER RISK	
	n	%	n (%)	%	n	%	n	%	n	%
	1106		625	56.5	479	43.4	710	64.3	395	35.7
Sexual Orientation										
Gay	961	86.90	574	59.9	385	40.1***	644	67.1	316	32.9***
Bisexual	106	9.60	38	35.8	68	64.2	51	48.1	55	51.9
Other	39	3.50	13	33.3	26	66.7	15	38.5	24	61.5
Race/Ethnicity										
Latino	310	28.20	162	52.3	148	47.7***	186	60	124	40***
Black	246	22.30	71	29.0	174	71.0	89	36.3	156	63.7
White	398	36.10	288	72.4	110	27.6	324	81.4	74	18.6
EveryoneElse	147	13.40	101	69.2	45	30.8	107	72.8	40	27.2
Age										
18-24	326	29.50	147	45.2	178	54.8***	181	55.5	145	44.5***
25-29	320	29.00	183	57.2	137	42.8	206	64.6	113	35.4
30-40	268	24.30	164	61.2	104	38.8	184	68.7	84	31.3
41+	191	17.30	130	68.4	60	31.6	138	72.3	53	27.7
Education										
<HS	45	4.10	110	42.1	151	57.9***	13	28.9	32	71.1***
HS/GED	116	10.50	237	53.7	204	46.3	55	47.4	61	52.6
Some college/2 yr deg.	344	31.10	122	67.0	60	33.0	198	57.7	145	42.3
College degree+	601	54.30	148	74.4	51	25.6	444	73.9	157	26.1
Income										
LessThan 10K	261	24.10	13	28.9	32	71.1***	126	48.5	134	51.5***
10K-40K	441	40.70	45	39.1	70	60.9	283	64.2	158	35.8
40-60K	182	16.80	165	48.0	198	33.0	126	69.2	56	30.8
60K+	200	18.50	402	67.0	198	41.3	166	83	34	17
Internet										
Recruited online	519	47.00	291	56.1	228	43.9	329	63.4	190	36.6
Searched for sex online	686	81.10	397	58.0	287	42**	447	65.3	238	37.4***

Chi-square tests: *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Table 6 includes the adjusted odds of being in higher CVL home or sexual neighborhood compared to a lower home or sexual neighborhood. Compared to White men, Black men had four times greater odds of living in (aOR=4.37, $p \leq 0.001$) and nearly 5 1/2 times greater odds of having sex in (aOR=5.42, $p \leq 0.001$) higher CVL neighborhoods. Latino men had almost two times greater odds of having a higher CVL sexual neighborhood (aOR=1.88, p $p \leq 0.01$) compared to White men. Bisexually-identified men had twice the odds of living in a higher CVL neighborhood (aOR=2.01, p $p \leq 0.01$) compared to gay men. Men who did not identify as gay or bisexual had twice the odds of living in (aOR=2.29, $p \leq 0.05$) and two and a half times the odds of having sex in (OR=2.51, $p \leq 0.05$) higher CVL neighborhoods compared to gay men. Compared to men over 40, men aged 18-24 (aOR=2.12, $p \leq 0.05$), 25-29 (aOR=2.67, $p \leq 0.001$) and 30-40 (aOR=2.49, $p \leq 0.001$) all had at least two times greater odds of living in higher CVL neighborhoods. Men aged 30-40 also had higher odds of having a higher CVL sexual neighborhood (aOR=1.89, $p \leq 0.05$) than men over 40.

Table 6. Characteristics of MSM in High CVL Home and Sexual Neighborhoods

	Home Neighborhood aOR (CI) *p*	Sexual Neighborhood aOR (CI) *p*
Sexual Orientation		
Gay	1.00	1.00
Bisexual	2.10 (1.22,3.62)**	1.45 (0.86,2.45)
Other	2.29 (0.99,5.26)*	2.51 (1.11,5.65)*
Race/Ethnicity		
Latino	1.24 (0.84,1.85)	1.88 (1.23,2.85)**
Black	4.37 (2.82,6.76)***	5.42 (3.48,8.43)***
White	1.00	1.00
EveryoneElse	0.75 (0.47,1.22)	1.23 (0.74,2.04)
Age		
18-24	2.12 (1.03,4.40)*	1.44 (0.69,2.97)
25-29	2.67 (1.63,4.37)***	1.53 (0.93,2.51)
30-40	2.49 (1.44,4.31)***	1.89 (1.08,3.30)*
41+	1.00	1.00
Education		
<HS	2.02 (0.84,4.83)	1.94 (0.83,4.53)
HS/GED	1.83 (1.04,3.22)*	1.55 (0.89,2.72)
Some college/2 yr deg.	1.21 (0.85,1.74)	1.17 (0.81,1.69)
College degree+	1.00	1.00
Income		
LessThan 10K	1.72 (1.01,2.92)*	2.75 (1.57,4.83)***
10K-40K	1.56 (0.98,2.48)	1.94 (1.17,3.23)**
40-60K	1.20 (0.70,2.05)	1.96 (1.10,3.47)*
60K+	1.00	1.00
Internet		
Recruited online	1.17 (0.84,1.63)	1.17 (0.84,1.65)
Searched for sex online	0.56 (0.37,0.84)**	0.57 (0.38,0.86)**

*$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Socio-economic factors were also predictors of where men lived and had sex. Compared to those with a college degree, men who completed high school had greater odds (aOR=1.83, $p \leq 0.05$) of having a higher CVL home neighborhood. Compared to men who reported making over $60,000/year, men who reported making less than $10,000/year had greater odds of having a higher CVL home (aOR=1.72, $p \leq 0.05$) and sexual (aOR=2.75, $p \leq 0.001$) neighborhood. Men who reported making between $10,000-40,000/year and men making $40,000-60,000/year both had

higher odds of having a higher CVL sexual neighborhood (aOR=1.94, $p \leq 0.01$ and (aOR=2.29, $p \leq 0.05$, respectively) compared to men in the highest earning category.

Table 7 includes the characteristics of sexual migration (i.e. moving from one's home neighborhood to another for sex). A small number of men (4.2%) migrated to a lower CVL sexual neighborhood (i.e. High→Low); 11.8% of men migrated to a higher CVL neighborhood (i.e. Low→High). The majority of men (84.2%) had no CVL change between neighborhoods; they either did not migrate for sex (n=688, 74.2%) or they migrated to another neighborhood with equal CVL (n=239, 25.8%). Of these men 348 remained in higher (i.e. High→High; 31.6% of total) and 579 remained in lower (i.e. Low→Low; 52.5% of total) CVL neighborhoods.

Table 7. Characteristics of Participants and Sexual Migration

	High–>Low n (%)	Low–>High n (%)	High–>High n (%)	Low–> Low n (%)
	46 (4.2)	130 (11.8)	348 (31.6)	579 (52.5)
Sexual Orientation				
Gay	38 (4.0)	107 (11.2)	277 (28.9)	536 (55.9)***
Bisexual	6 (5.7)	19 (17.9)	49 (46.2)	32 (30.2)
Other	2 (5.1)	4 (10.3)	22 (56.4)	11 (28.2)
Race/Ethnicity				
Latino	20 (6.5)	44 (14.2)	104 (33.5)	142 (45.8)***
Black	13 (5.3)	30 (12.3)	143 (58.6)	58 (23.8)
White	7 (1.8)	43 (10.8)	67 (16.8)	281 (70.6)
EveryoneElse	6 (4.1)	12 (8.2)	33 (22.6)	95 (65.1)
Age				
18-24	17 (5.2)	51 (15.7)	127 (39.1)	130 (40.0)***
25-29	14 (4.4)	37 (11.6)	99 (31.0)	169 (53.0)
30-40	8 (3.0)	28 (10.4)	76 (28.4)	156 (58.2)
41+	7 (3.7)	14 (7.4)	46 (24.2)	123 (64.7)
Education				
<HS	3 (6.7)	3 (6.7)	29 (64.4)	10 (22.2)***
HS/GED	8 (7.0)	18 (15.7)	52 (45.2)	37 (32.2)
Some college/2 yr deg.	22 (6.4)	55 (16.0)	123 (35.9)	143 (41.7)
College degree+	13 (2.2)	54 (9.0)	144 (24.0)	389 (64.8)
Income				
LessThan 10K	18 (6.9)	34 (13.1)	116 (44.6)	92 (35.4)***
10K-40K	16 (3.6)	62 (14.1)	142 (32.2)	221 (50.1)
40-60K	9 (4.9)	13 (7.1)	47 (25.8)	113 (62.1)
60K+	2 (1.0)	19 (9.5)	32 (16.1)	146 (73.4)
Internet				
Recruited online	24 (4.6)	62 (11.9)	166 (32.0)	267 (51.4)
Search for sex online	29 (4.2)	78 (11.4)	208 (30.5)	368 (53.9)**

No Change: 927 did not migrate to a neighborhood with different CVL hood (e.g. High–>High) of those 688 did not migrate at all.
Chi-Square: *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

In Table 8 the odds associated with sexual migration are characterized. Bisexually-identified men had over two times higher odds (aOR=2.77, p≤0.05) of sexually migrating to a higher CVL neighborhood compared to gay men, as did Black men (aOR=2.35, p≤0.05) compared to White men, and those with only a high school diploma/GED (aOR=2.91, p≤0.05) compared to men with a college degree. Compared to men over 40, both men aged 25-29 (aOR=4.43, p≤0.001) and 30-40 (aOR=2.84, p≤0.05) had greater odds of Low→High sexual migration. There were no statistically significant findings predicting High→Low sexual migration.

Table 8. Sexual Migration

	High–>Low n (%)	Low–>High n (%)
	394 (35.7)	709 (63.8)
Sexual Orientation		
Gay	1.00	1.00
Bisexual	0.69 (0.22,2.22)	2.77 (1.26,6.12)*
Other	0.77 (0.16,3.81)	1.91 (0.46,8.03)
Race/Ethnicity		
Latino	02.24 (0.532,9.63)	0.94 (0.51,1.73)
Black	0.87 (0.23,3.20)	2.35 (1.19,4.63)*
White	1.00	1.00
EveryoneElse	2.24 (0.52,9.63)	0.46 (0.21,1.02)
Age		
18-24	0.35 (0.07,1.77)	3.20 (0.94,10.96)
25-29	0.31 (0.09,1.05)	4.43 (1.78,11.03)***
30-40	0.41 (0.11,1.53)	2.84 (1.03,7.85)*
41+	1.00	1.00
Education		
<HS	0.96 (0.16,5.87)	1.57 (0.36,6.87)
HS/GED	1.34 (0.36,4.90)	2.91 (1.24,6.81)*
Some college/2 yr deg.	1.71 (0.67,4.33)	1.58 (0.91,2.75)
College degree+	1.00	1.00
Income		
LessThan 10K	5.35 (0.59,48.10)	1.23 (0.50,2.55)
10K-40K	3.20 (0.37,27.93)	1.18 (0.59,2.35)
40K-60K	4.76 (0.52,43.72)	0.68 (0.28,1.66)
60K+	1.00	1.00
Internet		
Recruited online	1.17 (0.49,2.77)	1.32 (0.78,2.24)
Search for sex online	1.66 (0.57,4.81)	0.70 (0.36,1.37)

Logistic Regression: *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Finally, we looked at the sexual risk associated with being in or migrating to higher CVL neighborhoods. The sexual risk associated with being in a higher CVL home or sexual neighborhood is described in Table 9. Neither condomless sex nor serodiscordant condomless sex were significantly different for home and sexual neighborhoods. As race factored so strongly in where men lived and had sex, we conducted a post-hoc analysis stratifying sexual risk by race. This analysis did not produce any significant effects.

The same analysis with sexual migration is described in Table 10. When stratified by race, White MSM who migrated to from Low→High had over twice the odds of reporting condomless sex (aOR=2.70, $p \leq 0.05$) compared to White men who remained in or migrated to a lower CVL neighborhood.

Table 9. Sexual Risk in High CVL Home and Sexual

	Home Neighborhood aOR (CI) *p*	Sexual Neighborhood aOR (CI) *p*
Condomless Sex	1.13 (0.85,1.51)	1.07 (0.80,1.45)
Condomless SD Sex	1.09 (1.17,2.30)	1.19 (0.82,1.72)
Stratified by Race (post-hoc)		
Black Men Only		
Condomless Sex	1.05 (0.55,2.00)	1.36 (0.75,2.47)
Condomless SD Sex	0.94 (0.49,1.79)	1.06 (0.58,1.95)
White Men Only		
Condomless Sex	1.43 (0.85,2.39)	0.88 (0.49,1.58)
Condomless SD Sex	1.32 (0.78,2.23)	1.03 (0.57,1.87)
Latino Men Only		
Condomless Sex	0.99 (0.60,1.69)	0.96 (0.56,1.64)
Condomless SD Sex	1.06 (0.62,1.82)	1.01 (0.58,1.75)

Controlled for age, race, sexual identity, education, and income

Table 10. Sexual Migration and Risk

	High–>Low aOR (CI) *p*	Low–>High aOR (CI) *p*
Condomless Sex	0.86 (0.43,1.72)	1.20 (0.79,1.86)
Condomless SD Sex	0.88 (0.39,1.64)	1.13 (0.71,1.80)
Stratified by Race (post-hoc)		
Black Men		
Condomless Sex	2.16 (0.56,8.33)	1.04 (0.28,3.87)
Condomless SD Sex	2.36 (0.65,8.54)	1.28 (0.37,4.51)
White Men		
Condomless Sex	1.40 (0.22,9.08)	2.70 (1.23,5.90)*
Condomless SD Sex	1.68 (0.22,12.90)	1.92 (0.88,4.22)
Latino Men		
Condomless Sex	0.42 (0.12,1.51)	0.74 (0.31,1.74)
Condomless SD Sex	0.63 (0.18,2.27)	0.99 (0.42,2.34)

Controlled for age, race sexual identity, education, and income

4.5 DISCUSSION

Where MSM live and have sex in NYC is not random, but constructed by socio-historical factors. The findings from this paper suggest that these differences, particularly when considering CVL, may be an important determinant in the current social epidemiology of HIV among MSM in NYC. Black MSM had over four times greater odds of living in and nearly five and a half times greater odds of having sex in higher CVL neighborhoods compared to White MSM. Latino MSM had nearly twice the odds of having a higher CVL sexual neighborhood, compared to White MSM. This perhaps provides additional support to Millett's work connecting the disproportionate burden of HIV among Black MSM to the epidemiological context rather than individual risk behaviors (Millett et al., 2007; Millett et al., 2012). Identifying as bisexual, being younger (<40), and socio-economic disadvantage (i.e. lower income and education (sexual only)) were all also associated

with greater odds of having home and sexual neighborhoods with higher CVL. There were not significant sexual risk differences associated with home or sexual neighborhood.

There were also differences in sexual migration. Both Black MSM and bisexually identified men had over two times greater odds of migrating to a higher CVL neighborhood for sex (compared to White gay-identified men). Other characteristics of Low→High migration are men with only a high school diploma/GED and men aged 25-29 or 30-40. White MSM who migrated to from Low→High had over two times greater odds of reporting condomless sex, compared to White MSM who did not migrate to a higher CVL neighborhood.

There are several limitations to the study design and analysis. Both time location sampling and participant self-selection impact the composition of the study sample. Despite our attempt to include a wide variety of public and mobile app spaces in the time location sampling randomization, we likely missed men who did not participate in the chosen recruitment spaces or who felt unable/unwilling to screen for the study. We are reliant on self-report data. Participants may have been felt uncomfortable reporting illegal behavior (e.g. drug use) because of social desirability; however, survey was administered using ACASI in hopes that participants would feel more comfortable in responding to these questions. Men also had to have had anal sex within the past 3-months to participate, which biases the sample toward sexually active men. Furthermore, the cross-sectional nature of the data allow for only a limited temporal measure of highly complex behaviors (e.g. desire, sexuality, migration for sex) and therefore limits interpretation of causality.

Using community viral load data is not without controversy. Miller summarizes some of the concerns with measuring and interpreting CVL (Miller, Powers, Smith, & Cohen, 2013). There is skepticism about being able to accurately measure population level CVL given that the numbers of people retained in care varies depending on place. There is also concern as to how accurately aggregate such measures given the viral trajectory (e.g. acute infection) and variations in VL between individuals. Others take issue with the use of ecological-level data to calculate individual-level risk (i.e. ecological fallacy). The complexity of human behavior (e.g. sexual networks, desire, actions) further obfuscates how CVL data might be interpreted and utilized in designing public health interventions. That said, using CVL data has been an integral step in conceiving of HIV beyond the individual level. While not yet perfected, assuming that unidentified infections would tend to cluster in identified higher CVL spaces, the method likely gives a good sense of where to, at a minimum, begin to focus new efforts to identify and access untested positives, prevention efforts, and better quantification of CVL.

Of particular concern for the interpretation of these findings is that these CVL data are calculated based on where people live and does not take into account where people spend time and search for sexual partners. This analysis also proceeded under the assumption that MSM are not taking into consideration, or are even aware of, the CVL of the neighborhoods in which they live and have sex. With the advent of increased PrEP knowledge and accessibility it would be meaningful to learn more about whether MSM perceive certain neighborhoods/spaces as more or less risky, for what reasons, and if they modify their behavior or prevention techniques. Despite these limitations, we hope that these findings can contribute to the discussion of how to design interventions inclusive of geographic/structural contexts.

The study does have several strengths. The inclusion of multiple neighborhoods of influence (e.g. home, social, and sexual) is both novel and perhaps the greatest study strength, as it allows for multilevel analysis considering multiple spaces of influence. Data from the NYCM2M study do give some sense of where MSM are having sex and to some extent with whom they are having sex (Tieu, Nandi, Frye, et al., 2014). In her recent work, Tieu has begun to explore ways to expand how these data can be used to map CVL in different ways – for example, using individual viral load data of men who share a common social or sexual neighborhood to better estimate neighborhood CVL based on people who are using those spaces to search for sex (Tieu, Nandi, Egan, et al., 2014).

The integration of geography, biology, and behavior is an exciting new direction in HIV research and intervention. In calculating and mapping CVL, Das and others have been able to demonstrate the impact of treatment and VL on infectiousness at both the individual and community level. In mapping these data they have been able to describe the spatial distribution of risk (i.e. CVL) over time and geography (Das et al., 2010; Laraque et al., 2011; Laraque et al., 2013). Others have used techniques to describe the spatial distribution of HIV, identify gaps in HIV-services, consider the impact of neighborhood-level structural factors on HIV risk, and explore the social and spatial context of substance use and HIV risk (Duncan, Hatzenbuehler, & Johnson, 2014; Pierce et al., 2007; Scribner et al., 2008; K. E. Tobin et al., 2013).

Newer technologies (e.g. dried blood spot analysis (Le Vu et al., 2012; Semaille et al., 2013)) have the potential to greatly enhance our ability to use the ideas behind CVL. Being able to cost effectively measure, from small amounts of blood, information on HIV infection, viral load, cd4

count, and the presence/timing of antiretrovirals (i.e. TasP, PrEP, PEP) combined with the flexibility of being able to collect blood samples outside of clinical practice using non-providers, opens up enormous opportunities to completely re-think the space, time and composition of the 'communities' within which we measure viremia. In reconceiving CVL as a dynamic process (rather than a static count limited by predetermined administrative boundaries) influenced by temporal, geographical, and social forces, we can begin to characterize not only highly specific pools of viremia, but track the viremic tides over time and space.

A highly temporal-contextual understanding of the epidemiologic background of specific places and spaces (viremic tides) would allow for highly targeted bio-behavioral intervention to prevent viral replication and transmission. This provides the opportunity to create highly specific interventions intentionally targeted to spaces (e.g. neighborhoods, parties); individuals (e.g. those who move between spaces, new migrants, young MSM of color); times (e.g. night time, summer time, circuit party); or the contexts created by intersections of each. Such interventions will likely include the treatment of viremic individuals who are likely undiagnosed or without care (e.g. TasP), contextually-time specific use of episodic or long term PrEP to decrease the likelihood of transmission, and opportunities for individual risk assessment and PEP access. A better understanding of how different contexts influence where and how MSM have sex will help us to better explain HIV risk pathways to design interventions for HIV-negative men and to also find moments to intervene with HIV-positive men outside of care.

5.0 THE INFLUENCE OF HOME AND SOCIAL NEIGHBORHOODS ON DRUG AND ALCOHOL USE AMONG MSM IN THE NYCM2M STUDY

5.1 INTRODUCTION

Elevated substance use and substance use disorders have been documented among gay, bisexual, and other men who have sex with men (MSM), particularly those men living in large urban centers like New York City (NYC) (Clatts, Goldsamt, & Yi, 2005; Cochran et al., 2004; Fernandez et al., 2005; Greenwood et al., 2005; Stall et al., 2001; Stall & Purcell, 2000; Stall & Wiley, 1998). Estimates of substance use among lesbian, gay, and bisexual (LGB) populations range as high as 2-3 times that of heterosexual populations (Cochran et al., 2004). Studies have also demonstrated high levels of heavy or hazardous alcohol use among MSM (Pollock et al., 2012; Reisner et al., 2010; Stall et al., 2001; Stall & Wiley, 1998; K. Tobin, Davey-Rothwell, Yang, Siconolfi, & Latkin, 2014). Increased substance use is often associated with the stress of being a sexual minority (Hatzenbuehler, 2009; Hatzenbuehler, Corbin, & Fromme, 2008, 2011; Michael P. Marshal, Friedman, Stall, & Thompson, 2009; Zamboni & Crawford, 2007) placing MSM at a greater risk of dependence compared to non-MSM (King et al., 2008). Drug and alcohol use has also been associated with increased HIV/STI risk and infection (Baliunas, Rehm, Irving, & Shuper, 2010; Carey et al., 2009; Koblin et al., 2003; Reisner et al., 2010; Shuper et al., 2010; Stall et al., 2008b; Stall et al., 2001; Stall & Wiley, 1998). In the Explore study even moderate use (<1 time/week) was associated with increased serodiscordinant unprotected anal sex (G. Colfax et al., 2004).

Contextual level factors (e.g. socio-economic disadvantage, segregation) have been shown to influence substance use among non-LGB people (Galea et al., 2004; Galea, Rudenstine, & Vlahov, 2005). Far less is understood about how substance use behaviors among MSM are influenced by multiple neighborhood-level factors of an individual's home and social neighborhood is far less understood.

The few studies that have looked at neighborhood context have focused exclusively on the home neighborhood. Kurtz, et. al., has found that MSM living in the gay enclaves of South Florida were more likely to use methamphetamine but less likely to use cocaine and less likely to report substance use dependence, than men living outside of gay enclaves (Buttram & Kurtz, 2013). In NYC, Carpiano, et. al., found that gay enclave residence in NYC was associated with increased use of methamphetamine and ecstasy but not cocaine, marijuana, poppers or polydrug use (Carpiano et al., 2011). There is also evidence suggesting that social networks of MSM may play a greater role than neighborhood context in the promotion of substance use. In NYC, being part of a gay male intensive social network was associated with methamphetamine, ecstasy, cocaine, poppers and polydrug use (Carpiano et al., 2011).

This study was designed to consider how both individual and neighborhood-level factors contribute to substance use among MSM in NYC. We hypothesized that the home and social neighborhoods will have a significant and unique influence on substance use behaviors among MSM in NYC. Informed by Frye's conceptual model proposing multiple pathways of how neighborhood may impact MSM behaviors exploring potential relationships between identity, neighborhood (social and built environment) and risk and resiliencies of MSM (Frye et al., 2006).

We first described the variance across the home and social neighborhoods for drug and alcohol use. We then investigate individual level factors including: connection to the NYC gay community, internalized homophobia, sexual minority based discrimination, and substance use norms. Finally, we included neighborhood-level variables, including: gay male presence, the proportions of young people and of people living in poverty, and neighborhood substance use norms, explain any of the variance.

5.2 METHODS

5.2.1 M2MNYC Study, Participants and Procedures

The study methods, measures, and visit procedures have been described in detail elsewhere (Koblin et al., 2013). M2MNYC is a cross-sectional study designed to identify neighborhood-level characteristics within the urban environment that influence sexual risk behaviors, substance use and mental health among MSM living in NYC. Between 2010 and 2012, using modified venue-based time-space sampling (detailed in (Koblin et al., 2013)), men were recruited through face-to-face outreach and mobile apps with the priority of recruiting men from a diverse set of NYC neighborhoods (MacKellar et al., 2007). To be eligible to participate, individuals had to self-report: being a biological male at birth, being at least 18 years of age, currently reside within the 5 NYC Boroughs, have had anal sex with a man in the past 3 months, able to communicate in English or Spanish, and were willing and able to give informed consent. A total of 1,493 men completed the interview.

After street/mobile intercept, eligible participants were scheduled for a study visit in one of two Manhattan locations. The study visit included informed consent; staff implemented *Neighborhood Locator Questionnaire* (a study designed instrument to collect initial data on the home, social, and sexual neighborhoods, see (Koblin et al., 2013)); Audio Computer-Assisted Self-Interview (ACASI) questionnaire; and a staff implemented Social and Sexual Network Questionnaire. After completing all the assessments, participants then received HIV counseling and a rapid antibody testing (OraQuick). Positive tests were confirmed with Western Blot testing. Both newly and previously diagnosed HIV-positive men were asked to provide a blood sample for CD4/Viral Load testing. Men received $50 and a round trip Metrocard for their participation. Study protocols were reviewed by the Institutional Review Board of the New York Blood Center as well as the institutions of Co-Investigators. The University of Pittsburgh IRB approved use of these data for this analysis.

5.3 MEASURES

5.3.1 Individual-level

Gay Community Attachment. Attachment to the gay community was assessed using a 12-questions (Frost & Meyer, 2012) about how participants felt about their relationship to NYC's gay community (e.g. *I feel a bond with other men who are gay or bisexual* or *I feel a part of NYC's gay community*). Men responded using a 4-point likert scale. Three questions were removed due to internal inconsistency. An average was calculated for each participant using the completed questions. Lower responses indicate less connection with the gay community.

Substance Use Norms. Individual level substance use norms were assessed with 6-questions (e.g. *How do you feel about currently use drugs like adults who cocaine, crack or other stimulants? How do you feel about adults who regularly drink alcohol?*). Men were asked to respond using a 5-point Likert scale. A mean score was calculated for each participant. Lower scores indicate more permissive attitudes toward substance use.

Internalized homophobia. Internalized homophobia was assessed using the Herek's 7-question scale (Herek, Cogan, Gillis, & Glunt, 1998). A mean score was calculated for each participant. Lower scores indicate less internal conflict with being MSM.

Sexual Minority Discrimination. Assessment of perceived discrimination based on being a sexual minority was asked separately for both experiences in the man's home neighborhood and his social neighborhood. Men were asked, if they had, *ever experienced discrimination, been prevented from doing something, or been hassled or made to feel inferior in your home neighborhood because of your sexual orientation*. They were then asked how many times this had happened and how many times in the past 3-months. For this analysis, we dichotomized any discrimination in the past 3-months vs. no discrimination.

Sociodemographic Characteristics. The demographics include the following. Age was collected in years at time of interview and categorized into 4 groups: (1) 18-24, (2) 25-29, (3) 30-40, and (4) 41 and older. Race/ethnicity was categorized as either (1) non-White Hispanic (Latino), (2) Black, (3) White, and (4) all others. Personal Income was measured on a 12-point scale which was recoded

to include: (1) Less than $10,000, (2) $10,000-$39,999, (3) $40,000-59,000, and (4) $60,000 and greater.

Neighborhood Exposure. To get a sense of how much time participants spent in each neighborhood, men were asked to estimate how much time they spend in both their home and social neighborhood (In the past 3 months, during a typical week (i.e. *including weekdays and weekends) what percentage of the time did you spend in this neighborhood?).* Reponses ranged from *all the time* to *none of the time*. For this analysis, we calculated a dichotomous variable to categorizing men into those reported spending 50% or more of their time in the neighborhood and those who spent less than 50% of their time there.

5.3.2 Neighborhood-level.

Definition of Home and Social Neighborhoods. Participants were asked to self-define their home and social neighborhoods by 'dropping a pin' in Google Earth map of NYC. The latitude and longitude were recorded and plotted using ArcGIS 10.X (Redlands, CA). To protect participant anonymity, home neighborhood points were 'jittered' to correspond to different coordinates within the same census tract. This method allows for the continued use of census data without revealing the participant address. The census tracts associated with each point data were then aggregated to the Neighborhood Tabulation Areas (NTAs) level. NTAs are an aggregation of multiple census tracts that create subsets of NYC Public Use Microdata Areas (PUMAs). Each of NYC's 195 NTAs contain multiple neighborhoods. For example, MN13 includes the Hudson Yards, Chelsea, Flat Iron, and Union Square neighborhoods (New York City Deparment of City Planning, 2014).

Aggregating to the NTA level allows for the inclusion of a wide range of neighborhoods while increasing the likelihood of a greater number of participants within each space.

Gay Neighborhood Presence. The proportion of male-male headed households (MMH) was calculated using data from the 2008-2012 American Community Survey (ACS) (US Census). ACS Table B11009: Unmarried-partner Households by Sex of Partner includes the number of *Male Householder And Male Partner* households (B11009-003) and the number of *Total Households* (B11009-001). After downloading the data for each NYC census tract, we aggregated the total number of households and the total number of male-male households to the NTA level. Using this aggregated data we calculated the percent male-male households for each NTA as a proxy for the level of gay presence in each NTA.

NTA Poverty Level and Age. The percent of individuals living in poverty and the percentage of people between the ages of 15-34 within each NTA was calculated from tables created by the NYC Department of City Planning. These tables were calculated with data from the ACS 2012 5-year (2008-2012) estimate data, which is consistent with all other census based calculations used for this analysis. The total persons below the poverty level in each NTA was divided by the total persons in the same area to calculate a percentage of poverty for each NTA (New York City Deparment of City Planning, 2012a). NTA age was calculated using the number of individuals aged 15-34 over the total number of persons (New York City Deparment of City Planning, 2012b).

Neighborhood Substance Use Norms. Substance use norms for each NTA was calculated by aggregating the individual level norms of all participants to the NTA level (individual level norms

are described above). Individuals contributed data to each NTA in which they lived or socialized. As such, one participant's score may have contributed to two different NTAs. However, individual data could only contribute once per NTA. If a participant reported the same NTA for both home and social neighborhood, one of his scores was deleted to prevent over contribution by any single person. NTAs with fewer than 5 participants were excluded from the analysis. These calculations were based on 2,684 observations (277 observations were excluded with this methodology).

5.3.3 Dependent Variables

Drug Use. Drug use questions included age of first use, frequency of use in the past three months and any lifetime or recent concerns or worries about the use of alcohol, tobacco, marijuana, inhaled nitrites, crack cocaine, powder cocaine, methamphetamine, heroin, other opiates, benzodiazepine, hallucinogens (including: Ketamine, MDMA, GHB, PCP, mushrooms, LSD), erectile dysfunction drugs, steroids and hormones. For this analysis we collapsed any use in the past three months of crack cocaine, powder cocaine, methamphetamine, heroin, and hallucinogens into a dichotomous variable. Data on the use of poppers, marijuana, hormones (female and steroids), prescription opioids, and erectile dysfunction medications were collected but not included in this analysis. Three outcomes were used for this analysis: (1) *any use*: use of any substance in the past 3-months, (2) *moderate use*: use of any substance at least once a month over the past 3-months, and (3) *heavy use*: use of any substance 2-3 times per month over the past 3 months.

Alcohol Use: To assess alcohol use the 3-question AUDIT-C (Bradley et al., 2007; Bush et al., 1998) was used to understand consumption amount and frequency. In this analysis we are using two measures of alcohol use, (1) *hazardous drinking*: a score of 4 or higher on the AUDIT-C and

(2) *heavy drinking*: reporting alcohol use 4 or more times a week/3 or more drinks. Both have been used in population of MSM in NYC (G. Colfax et al., 2004; Koblin et al., 2003; Parsons, Starks, Millar, Boonrai, & Marcotte, 2014).

5.4 ANALYSIS

Hierarchical Generalized Linear Modeling (HGLM) was conducted using HLM7.01 (Scientific Software International, Inc., Skokie, IL) to assess bivariate and multi-level associations of substance use. As all of the dependent variables are dichotomous, the Bernoulli sampling method and logit link function were used (Raudenbush & Bryk, 2002). Laplace estimation was used to estimate fixed effects and assess model fit. Descriptive, individual-level bivariate statistics and neighborhood-level bivariate statistics were conducted using IBM SPSS 21 (Chicago, IL). Geographical data was managed and all maps created in ArcGIS 10.1 (Esri, Redlands, CA).

HGLM Database Development: Separate datasets were created for individual level (level 1) and neighborhood level (level 2) data for both the home and social neighborhoods. Neighborhoods, and the participants in them, were excluded if populated with 5 or fewer participants(Raudenbush & Bryk, 2001). Excluded neighborhoods were culled in the creation of the HGLM database. The final home neighborhood data included 1312 participants (n=1493 originally) and 94 NTAs (n=167 originally). The final social neighborhood data included 1325 participants (n=1493 originally) and 43 NTAs (n=119 originally). When added to the models, individual level factors were group centered for continuous variables and not centered for dichotomous. All neighborhood level variables were grand-centered when added to the models. Multicolinearity was assessed prior

to variables being included in models (no VIF score exceeded 2). Missing level 1 data were deleted listwise as each analysis was run. There was no missing Level 2 data.

HGLM Model Building: When significant variation (at $p<0.05$) of substance use between neighborhoods was identified in the initial unconditional model (e.g. Prob($ANYDRG_{ij}=1|\beta_j$) = ϕ_{ij} $\log[\phi_{ij}/(1 - \phi_{ij})] = \eta_{ij}$ $\eta_{ij} = \beta_{0j}$) we continued with a HGLM analysis to build models to systematically test if individual and neighborhood level variables to explain the variance of substance use. The subsequent models were constructed using theoretically important predictor variables and demographic factors. The initial model always includes demographic characteristics, HIV status, and neighborhood exposure (e.g. Prob($ANYDRG_{ij}=1|\beta_j$) = ϕ_{ij} $\log[\phi_{ij}/(1 - \phi_{ij})] = \eta_{ij}$ η_{ij} = β_{0j} + β_{1j}*($HISPANIC_{ij}$) + β_{2j}*($BLACK_{ij}$) + β_{3j}*($OTHER_{ij}$) + β_{4j}*($INC1_{ij}$) + β_{5j}*($INC2_{ij}$) + β_{6j}*($INC3_{ij}$) + β_{7j}*($AGE1_{ij}$) + β_{8j}*($AGE2_{ij}$) + β_{9j}*($AGE3_{ij}$) + β_{10j}*($HIVPOS_{ij}$) + β_{11j}*(H_50_{ij})). In the second model, we added the predictor variables of theoretical importance when bivariate results were significant at $p<0.15$ (Hosmer & Lemeshow, 200) (e.g. Prob($ANYDRG_{ij}=1|\beta_j$) = ϕ_{ij} $\log[\phi_{ij}/(1 - \phi_{ij})] = \eta_{ij}$ η_{ij} = β_{0j} + β_{1j}*($SUNM_{ij}$) + β_{2j}*($HISPANIC_{ij}$) + β_{3j}*($BLACK_{ij}$) + β_{4j}*($OTHER_{ij}$) + β_{5j}*($INC1_{ij}$) + β_{6j}*($INC2_{ij}$) + β_{7j}*($INC3_{ij}$) + β_{8j}*($AGE1_{ij}$) + β_{9j}*($AGE2_{ij}$) + β_{10j}*($AGE3_{ij}$) + β_{11j}*($HIVPOS_{ij}$) + β_{12j}*($IHSCR_{ij}$) + β_{13j}*(H_50_{ij})). Finally, neighborhood-level factors that were significant at the bivariate level were added to the intercept in the third model (e.g. $\beta_{0j} = \gamma_{00} + \gamma_{01}$*($MMH_j$) + γ_{02}*($P2.15.34_j$) + γ_{03}*($SUNNTA_j$) + u_{0j}).

Where between-neighborhood variance was not significant, HGLM was used to investigate the individual-level factors that contribute to substance use while still controlling for neighborhood

clustering. We followed the same model building criteria described above, with the exception of running a third model with neighborhood-level factors.

5.5 RESULTS

Table 11 includes the sociodemographics for the overall sample and each of the substance use groups. A quarter of the men (n=388, 26%) had used at least one of the drugs of interest (i.e. of crack cocaine, powder cocaine, methamphetamine, heroin, and hallucinogens) in the previous 3-months. 13% reported moderate drug use, or using any substance at least once per month over the past 3-months. 7% reported heavy drug use; using at least one drug 2-3 times per month over the past 3-months. Half of the men in the sample scored 4 or higher on the AUDIT-C meeting the criteria for hazardous drinking in the previous 3 months. Far fewer, 12% reported recent heavy drinking behaviors which includes drinking 3 or more drinks of alcohol 4 or more times a week.

Table 11. Characteristics of Participants Who Report Substance Use in the Past 3 Months

	Total Sample		Any Drug Use		Moderate Drug Use		Heavy Drug Use		Hazardous Drinking		Heavy Drinking	
	n	%	n	%	n	%	n	%	n	%	n	%
	1493		388	26.0	193	12.9	116	7.8	824	55.2	182	12.2
Sexual Orientation												
Gay	1303	87.3	351	90.5	175	91.1	105	90.5	745	90.4***	171	94.0*
Bisexual	140	9.4	29	7.5	13	6.8	8	6.9	60	7.3	9	4.9
Other	50	3.3	8	2.1	4	2.1	3	2.6	19	2.3	2	1.1
Race/Ethnicity												
Latino	452	30.4	118	30.4*	59	30.7	36	31.0	246	30.0***	50	27.8***
Black	375	25.2	75	19.3	44	22.9	31	26.7	168	44.9	27	15.0
White	747	31.9	151	38.9	69	35.9	40	34.5	307	37.4	78	43.3
EveryoneElse	186	12.5	44	11.3	20	10.4	9	7.8	100	54.1	25	13.9
Age												
18-24	384	25.7	94	24.2	42	21.9	26	22.4	218	26.5***	47	26.0
25-29	406	27.2	122	31.4	58	30.2	34	29.3	274	33.3	61	33.7
30-40	357	23.9	97	25.0	50	14.0	30	25.9	202	56.7	39	21.5
41+	345	23.1	75	19.3	42	12.2	26	22.4	129	15.7	34	9.9
Education												
<HS	84	5.6	16	4.1	9	4.7	7	6.0	32	3.9***	2	1.1***
HS/GED	169	11.3	46	11.9	23	12.0	15	12.9	77	9.3	17	9.3
Some college/2 yr degree	504	33.8	130	33.5	70	36.5	43	37.1	260	31.6	50	27.5
College degree or more	736	49.3	196	50.5	90	46.9	51	44.0	455	62.0	113	62.1
Income												
LessThan 10K	385	26.3	85	22.1*	48	25.3	33	28.9	164	20.1***	29	16.1**
10K-40K	608	41.5	176	45.8	81	42.6	45	39.5	356	43.7	75	41.7
40-60K	226	15.4	60	26.5	31	16.3	19	16.7	152	18.7	33	18.3
60K+	245	16.7	63	25.7	30	15.8	17	14.9	143	58.4	43	23.9
HIV Status												
HIV-positive	340	22.8	105	27.1	66	34.4***	36	31.0	137	16.6***	23	12.6**
HIV-negative	1082	72.5	270	69.6	119	62.0	73	62.9	645	78.3	151	83.0
UNKN/REF	71	4.8	13	3.4	7	3.6	7	6.0	42	5.1	182	4.4
Sexual Orient Disc (home hood)	120	8.0	36	9.3	19.0	9.9	11.0	9.5	60	7.3	14	7.7
Sexual Orient Disc (social hood)	69	4.6	26	6.7	21.0	11.0***	14.0	12.1*	37	4.5	11	6.0
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Gay Attachment	3.18	0.49	3.18	0.46	3.19	0.46	3.09	0.53	3.2	0.46	3.24	0.48
Internalized Homo Score	12.18	5.74	11.74	5.54	11.67	5.42	11.78	5.56	11.67	5.26**	10.92	4.58**
Indv Substance Use Norms	3.88	0.7	3.5	0.68***	3.31	0.62	3.25***	0.66***	3.74	0.64***	3.59	0.6***

Table 12 describes the types of drugs and total number of different drugs used in the past 3-months. The drugs most frequently used included marijuana (79.9% among *Any Drug* users), cocaine (74.5%), poppers (54.6%), and club drugs (41.5%). Most of the men in each drug use category used between 2-4 different drugs in the past 3-months (any drug use = 78.6%, moderate use = 72.9%, heavy use = 71.6%). Nearly a quarter of heavy drug users (24.1%) used 5 or more drugs in the past 3-months.

Table 12. Frequency of Substances Used in the Past 3 Months

Drugs	Any Drug N(%)	Mod Drug N(%)	Hvy Drug N(%)
Marijuana	310 (79.9)	145 (75.5)	85 (73.3)
Poppers	212 (54.6)	108 (56.3)	51 (44.0)
Crack	40 (10.3)	30 (7.5)	20 (17.2)
Coke	289 (74.5)	148 (77.1)	94 (81.0)
Methamphetamine	81 (20.9)	57 (29.7)	32 (27.6)
Heroin	2 (0.5)	2 (1.0)	2 (1.7)
Club Drugs	161 (41.5)	86 (44.8)	56 (48.3)
Injection (any)	9 (2.4)	6 (3.4)	1 (1.0)
Other Opiates/ Benzos	101 (26.0)	54 (28.1)	36 (31.0)
Steroids	14 (18.3)	7 (3.6)	4 (3.4)
Erectile Dysfunction	71(18.3)	42 (21.9)	27 (23.3)
Femaile Hormones	2 (0.5)	1 (0.5)	1 (0.9)
Number of drugs used P3M			
1	18 (4.60)	8 (4.2)	5 (4.3)
2	96 (24.7)	39 (20.3)	22 (19.0)
3	124 (32.0)	57 (29.7)	31 (26.7)
4	85 (21.9)	44 (22.9)	30 (25.9)
5	50 (12.9)	30 (15.6)	17 (14.7)
6	10 (2.6)	9 (4.7)	7 (6.0)
7	5 (1.3)	5 (2.6)	4 (3.4)

Findings from the unconditional models are presented in Table 13. These results indicated significant variance in any drug use across both the home (p=0.01) and social (p=0.01) neighborhoods. Similarly, there were significant differences in hazardous drinking for both home (p=0.05) and social (p=0.05) neighborhoods. There was also significant difference between social neighborhoods in heavy drinking (p=0.05), but not for home neighborhoods. There was not significant variance for heavy drug use in either home or social neighborhoods.

Results from the HGLM analyses of each substance use group by type of neighborhood are included in Tables 14-18 and presented below by outcome (e.g. *Any Drug Use* or *Hazardous*

Drinking) and then by neighborhood type. Chi-Square estimates and p-values assessing model fit are included in the tables for each model.

Table 13. Substances Use Variation Between Neighborhoods

Dependent Variable u_0	ICC	Variance	d.f.	X^2	p
Home Neighborhood					
Any Drug Use	0.1172	0.13893	93	127.2	0.01
Moderate Drug Use	0.0720	0.08282	93	99.39	0.31
Heavy Drug Use	0.1194	0.02933	93	88.75	>0.50
Hazzardous Drinking	0.0733	0.08124	93	116.6	0.05
Heavy Drinking	0.0273	0.14197	93	108.4	0.13
Social Neighborhood					
Any Drug Use	0.1117	0.13166	41	63.55	0.01
Moderate Drug Use	0.0865	0.09911	41	50.65	0.14
Heavy Drug Use	0.0551	0.06101	41	44.88	0.31
Hazardous Drinking	0.2841	0.41532	41	135	<0.001
Heavy Drinking	0.1960	0.25518	41	62.26	0.02

Table 14: Any Drug Use. Several factors were associated with lower odds of using any drug in the past three months including: individual substance use norms (aOR=0.33, p<0.001) and being Black (compared to White men, aOR=0.51, p<0.01). HIV-positive men had one and a half times more odds of any drug use compared to HIV-negative men (aOR=1.53, p=0.02). At the neighborhood level, substance use norms were significantly associated with less drug use (aOR=0.18, p<0.001).

As with the home neighborhood, individual substance both use norms (aOR=0.32, p<0.001) and being Black (compared to White men, aOR=0.50, p<0.001) were associated with lower substance use. Being HIV-positive (aOR=1.50, p=0.02) and having experienced sexual orientation discrimination in the social neighborhood (aOR=1.83, p=0.05) were both associated with increased odds of drug use. At the neighborhood level, the percent of the population aged 15-34 (aOR=1.04, p=0.01) was associated with a very moderate increase in substance use.

Table 14. Individual and Neighborhood Level Factors Associated with Any Drug Use

	Home Neighborhood				Social Neighborhood			
	Bivariate	Model 1	Model 2	Model 3	Bivariate	Model 1	Model 2	Model 3
AnyDrug	OR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*	OR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*
Gay Attachment (mean)	0.99 (0.77,1.30) 0.98				0.96 (0.74,1.25) 0.77			
Sexual Orient Disc+	1.32 (0.86,2.04) 0.21				1.86 (1.08,3.21)*		1.79 (0.97,3.32)	1.83 (0.99,3.41)*
Internalized Homophobia	0.98 (0.96,1.01) 0.12		1.00 (0.98,1.03)	1.00 (0.98,1.03)	0.98 (0.96,1.01) 0.15			
Indv Substance Use Norms	0.31 (0.26,0.38)***		0.33 (0.27,0.41)***	0.33 (0.27,0.41)***	0.31 (0.26,0.38)***		0.32 (0.26,0.40)***	0.32 (0.26,0.40)***
Intercept		0.37 (0.23,0.61)***	0.36 (0.21,0.61)***	0.31 (0.18,0.53)***		0.23 (0.14,0.36)***	0.25 (0.15,0.40)***	0.22 (0.14,0.36)***
Race/ethnicity								
Hispanic	0.85 (0.62,1.16) 0.30	0.72 (0.52,1.01)	0.82 (0.57,1.18)	0.91 (0.63,1.30)	0.79 (0.58,1.08) 0.14	0.64 (0.46,0.90)*	0.70 (0.49,0.97)*	0.72 (0.51,1.03)
Black	0.55 (0.39,0.79)***	0.46 (0.32,0.68)***	0.49 (0.33,0.74)***	0.53 (0.35,0.80)*	0.61 (0.43,0.86)**	0.50 (0.35,0.73)***	0.47 (0.32,0.70)***	0.50 (0.34,0.75)***
White	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Everyone Else	0.70 (0.46,1.06) 0.09	0.67 (0.43,1.03)	0.76 (0.48,1.20)	0.79 (0.50,1.25)	0.75 (0.50,1.12) 0.16	0.69 (0.46,1.06)	0.71 (0.46,1.10)	0.73 (0.47,1.13)
Income								
<10K	0.92 (0.62,1.38) 0.70	0.98 (0.63,1.53)	0.83 (0.52,1.34)	0.88 (0.55,1.42)	0.96 (0.64,1.43) 0.84	0.96 (0.62,1.48)	0.85 (0.54,1.35)	0.85 (0.53,1.34)
10-40K	1.31 (0.92,1.86) 0.14	1.35 (0.92,1.96)	1.23 (0.82,1.84)	1.31 (0.87,1.95)	1.31 (0.93,1.85) 0.13	1.32 (0.91,1.92)	1.26 (0.85,1.87)	1.25 (0.85,1.85)
40-60K	1.17 (0.76,1.81) 0.47	1.17 (0.75,1.82)	1.17 (0.73,1.87)	1.21 (0.76,1.93)	1.15 (0.75,1.75) 0.53	1.16 (0.75,1.80)	1.15 (0.73,1.81)	1.15 (0.73,1.82)
>60K	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Age								
18-24	0.95 (0.52,1.73) 0.86	1.28 (0.65,2.53)	1.21 (0.59,2.52)	1.14 (0.54,2.38)	0.99 (0.54,1.81) 0.97	1.42 (0.72,2.80)	1.28 (0.63,2.61)	1.22 (0.59,2.50)
25-29	1.29 (0.93,1.81) 0.13	1.47 (1.02,2.13)*	1.32 (0.89,1.96)	1.25 (0.84,1.85)	1.36 (0.97,1.91) 0.07	1.68 (1.16,2.43)**	1.53 (1.04,2.25)*	1.45 (0.98,2.13)
30-40	1.21 (0.82,1.77) 0.33	1.31 (0.88,1.95)	1.14 (0.75,1.75)	1.13 (0.74,1.73)	1.19 (0.81,1.76) 0.38	1.33 (0.89,1.99)	1.21 (0.79,1.84)	1.19 (0.78,1.81)
40+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
HIV-positive	1.36 (1.01,1.83)*	1.63 (1.18,2.25)**	1.48 (1.04,2.09)*	1.50 (1.06,2.13)*	1.41 (1.05,1.90)*	1.71 (1.24,2.35)***	1.46 (1.04,2.05)*	1.50 (1.07,2.11)*
Hood Exposure (+50%)	0.73 (0.55,0.96)*	0.72 (0.54,0.96)*	0.76 (0.56,1.05)	0.71 (0.52,0.98)	1.38 (1.07,1.79)**	1.42 (1.09,1.84)**	1.27 (0.97,1.68)	1.29 (0.98,1.70)
Neighborhood Level (NTA)++								
Proportion MMH	1.13 (1.00,1.27)*			1.16 (0.96,1.40)	1.00 (0.01,1.10) 0.98			
Substance Use Norms	1.04 (1.02,1.07)***			0.18 (0.07,0.46)***	1.04 (1.01,1.06)**			0.41 (0.10,1.78) 0.23
Percent Poverty	0.55 (0.15,1.96) 0.36				0.79 (0.19,3.24) 0.74			
Percent Age 15-34	0.21 (0.10, 0.44)***			1.02 (0.99,1.05)	0.11 (0.03,0.37)***			1.04 (1.01,1.07)**
Model								
Likelihood Ratio Test x2, p			181.61***	20.22***			135.92***	9.70**

*$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Table 15: Moderate Drug Use. Individual substance use norms were associated with lower odds (aOR=0.25, p<0.001) and being HIV-positive higher odds (aOR=1.91, p=0.004) of using any substance at least once a month over the past 3-months.

As with the home neighborhood, individual substance use norms were associated with lower odds (aOR=0.26, p<0.001) and being HIV-positive higher odds (aOR=2.09, p=0.001) of drug use. Men who experienced discrimination based on sexual orientation in the social neighborhood had nearly 3 times the odds (aOR=2.68, p=0.01) of moderate drug use than those who had not recently experienced discrimination.

Table 15. Individual Level Factors Associated with Moderate Drug Use

	Home Neighborhood			Social Neighborhood		
	Bivariate	**Model 1**	**Model 2**	**Bivariate**	**Model 1**	**Model 2**
ModerateDrug	OR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*	OR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*
Gay Attachment (mean)	0.98 (0.70,1.38) 0.91			0.90 (0.63,1.29) 0.58		
Sexual Orientation Disc	1.48 (0.87,2.52) 0.15		1.41 (0.79,2.52)	2.98 (1.63,5.45)***		2.68 (1.31,5.46)**
Internalized Homophobia	0.98 (0.95,1.01) 0.27			0.98 (0.95,1.02) 0.29		
Indv Substance Use Norms	0.24 (0.19,0.31)***		0.25 (0.19,0.33)***	0.25 (0.19,0.33)***		0.26 (0.20,0.35)***
Intercept		0.14 (0.07,0.26)***	0.11 (0.06,0.23)***		0.07 (0.04,0.14)***	0.06 (0.03,0.13)***
Race/ethnicity						
Hispanic	0.96 (0.64,1.43) 0.83	0.72 (0.46,1.11)	0.77 (0.48,1.24)	0.82 (0.54,1.25) 0.36	0.59 (0.37,0.95)*	0.66 (0.40,1.10)
Black	0.76 (0.49,1.18) 0.22	0.60 (0.37,0.97)*	0.64 (0.38,1.07)	0.85 (0.54,1.33) 0.48	0.68 (0.42,1.10)	0.71 (0.42,1.20)
White	1.00	1.00	1.00	1.00	1.00	1.00
Everyone Else	0.67 (0.38,1.19) 0.18	0.63 (0.35,1.13)	0.68 (0.37,1.28)	0.81 (0.47,1.42) 0.47	0.74 (0.41,1.32)	0.79 (0.43,1.46)
Income						
<10K	1.23 (0.73,2.06) 0.44	1.33 (0.74,2.36)	1.00 (0.54,1.87)	1.20 (0.70,2.05) 0.51	1.20 (0.66,2.18)	0.99 (0.52,1.90)
10-40K	1.25 (0.78,2.01) 0.36	1.31 (0.78,2.20)	1.17 (0.68,2.02)	1.20 (0.74,1.95) 0.46	1.21 (0.72,2.05)	1.09 (0.62,1.92)
40-60K	1.30 (0.74,2.30) 0.36	1.41 (0.78,2.56)	1.41 (0.76,2.63)	1.23 (0.69,2.19) 0.48	1.35 (0.74,2.46)	1.40 (0.74,2.66)
>60K	1.00	1.00	1.00	1.00	1.00	1.00
Age						
18-24	0.73 (0.33,1.66) 0.46	1.13 (0.47,2.74)	1.03 (0.40,2.70)	0.79 (0.33,1.86) 0.58	1.29 (0.51,3.27)	1.15 (0.42,3.15)
25-29	1.06 (0.70,1.60) 0.80	1.28 (0.82,2.03)	1.12 (0.68,1.85)	1.17 (0.75,1.82) 0.50	1.51 (0.92,2.46)	1.40 (0.82,2.39)
30-40	0.97 (0.60,1.59) 0.92	1.03 (0.61,1.73)	0.81 (0.47,1.41)	1.04 (0.62,1.75) 0.90	1.10 (0.64,1.90)	1.00 (0.55,1.80)
40+	1.00	1.00	1.00	1.00	1.00	1.00
HIV-positive	1.88 (1.31,2.70)***	2.14 (1.44,3.19)***	1.91 (1.24,2.94)**	1.96 (1.35,2.86)***	2.31 (1.53,3.48)***	2.09 (1.33,3.27)***
Hood Exposure (50% +)	0.73 (0.51,1.04) 0.08	0.75 (0.51,1.08) 0.12	0.82 (0.55,1.23)	1.51 (1.07,2.15) 0.02	1.62 (1.12,2.33)**	1.41 (0.95,2.10)
Neighborhood Level (NTA)						
Porportion MMH	1.14 (0.99,1.33) 0.08			1.15 (1.02,1.31) 0.03		
Substance Use Norms	1.02 (0.99,1.05) 0.29			1.02 (0.99,1.06) 0.15		
Percent Poverty	0.91 (0.17,4.79) 0.91			0.32 (0.4,2.42) 0.27		
Percent Age 15-34	0.26 (0.10,0.68)**			0.24 (0.05,1.19) 0.08		
Model						
Liklihoood Ratio Test x2, p			134.39 ***			124.40 ***

*$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Table 16: Heavy Drug Use. In the final model, both gay community attachment (aOR=0.54, p=0.009) and individual substance use norms (aOR=0.26, p<0.001) were associated with lower odds of use using any drug 2-3 times per month over the past 3 months (i.e. heavy use). As in the home neighborhood, gay community attachment (aOR=0.48, p=0.001) and individual substance use norms (aOR=0.29, p<0.001) were associated with lower odds of heavy drug use. Being HIV-positive (aOR=1.89, p=0.02) and men who reported spending 50% or more of their time in their social neighborhood (aOR=1.80, p=0.02) were more likely to be heavy drug users.

Table 16. Individual Level Factors Associated with Heavy Drug Use

		Home Neighborhood			Social Neighborhood	
HeavyDrug	**Bivariate**	**Model 1**	**Model 2**	**Bivariate**	**Model 1**	**Model 2**
	OR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*	OR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*
Gay Attachment (mean)	0.66 (0.44,0.995)*		0.54 (0.35,0.86)**	0.64 (0.42,0.97)*		0.48 (0.31,0.75)***
Sexual Orientation Disc	1.47 (0.78,2.78) 0.24			2.59 (1.27,5.28)**		1.99 (0.86,4.60)
Internalized Homophobia	0.99 (0.96,1.03) 0.63			0.99 (0.95,1.03) 0.52		
Indv Substance Use Norms	0.26 (0.20,0.35)***		0.26 (0.19,0.37)***	0.28 (0.21,0.37)***		0.29 (0.22,0.40)***
Intercept		0.10 (0.05,0.21)***	0.09 (0.04,0.20)***		0.04 (0.02,0.09)***	0.04 (0.02,0.09)***
Race/ethnicity						
Hispanic	1.01 (0.63,1.65) 0.95	0.76 (0.44,1.30)	0.86 (0.48,1.53)	0.94 (0.56,1.55) 0.80	0.64 (0.37,1.12)	0.74 (0.41,1.33)
Black	0.90 (0.53,1.52) 0.69	0.73 (0.42,1.29)	0.75 (0.40,1.39)	1.03 (0.61,1.74) 0.91	0.83 (0.47,1.46)	0.87 (0.48,1.58)
White	1.00	1.00	1.00	1.00	1.00	1.00
Everyone Else	0.53 (0.24,1.17) 0.12	0.52 (0.23,1.15)	0.60 (0.26,1.38)	0.61 (0.28,1.31) 0.20	0.55 (0.25,1.21)	0.61 (0.27,1.35)
Income						
<10K	1.38 (0.73,2.58) 0.44	1.59 (0.78,3.25)	1.37 (0.64,2.93)	1.35 (0.72,2.53) 0.35	1.40 (0.69,2.85)	1.16 (0.55,2.42)
10-40K	1.15 (0.64,2.08) 0.64	1.31 (0.68,2.53)	1.16 (0.58,2.29)	1.09 (0.61,2.00) 0.80	1.13 (0.59,2.17)	0.96 (0.49,1.88)
40-60K	1.31 (0.66,2.63) 0.44	1.57 (0.75,3.29)	1.43 (0.66,3.15)	1.15 (0.57,2.31) 0.70	1.39 (0.67,2.89)	1.25 (0.58,2.69)
>60K	1.00	1.00	1.00	1.00	1.00	1.00
Age						
18-24	0.88 (0.35,2.24) 0.79	1.06 (0.38,2.93)	1.00 (0.33,2.97)	0.93 (0.35,2.45) 0.88	1.34 (0.47,3.82)	1.31 (0.44,3.90)
25-29	0.98 (0.59,1.63) 0.94	1.01 (0.58,1.77)	0.82 (0.45,1.50)	1.05 (0.62,1.79) 0.85	1.28 (0.71,2.29)	1.12 (0.61,2.04)
30-40	0.92 (0.51,1.68) 0.80	0.87 (0.46,1.65)	0.63 (0.32,1.25)	1.02 (0.55,1.90) 0.95	1.01 (0.52,1.93)	0.81 (0.41,1.60)
40+	1.00	1.00	1.00	1.00	1.00	1.00
HIV-positive	1.48 (0.94,2.32) 0.09	1.54 (0.94,2.53)	1.36 (0.79,2.34)	1.85 (1.18,2.89)**	2.03 (1.24,3.32)***	1.89 (1.11,3.20)*
Hood Exposure (50% +)	0.64 (0.42,0.98)*	0.65 (0.42,1.02)	0.70 (0.43,1.14)	1.66 (1.08,2.55)*	1.80 (1.15,2.83)**	1.80 (1.11,2.93)*
Neighborhood Level (NTA)						
Porportion MMH	1.12 (0.93,1.34) 0.24			1.22 (1.04,1.43)*		
Substance Use Norms	1.01 (0.97,1.05) 0.55			0.98 (0.94,1.02) 0.34		
Percent Poverty	1.57 (0.20, 12.17) 0.67			0.42 (0.04,4.89) 0.49		
Percent Age 15-34	0.38 (0.12,1.22) 0.10			0.36 (0.05,2.50) 0.30		
Model						
Liklihoood Ratio Test x2, p			229.76***			219.86***

*$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Table 17: Hazardous Drinking. Neither home neighborhood poverty nor age significantly predicted hazardous drinking. Internalized homophobia (aOR=0.98, p=0.04), individual substance use norms (aOR=0.41, p<0.001), and being HIV-positive (aOR=0.56, p<0.001) were all associated with lower odds of hazardous drinking. Compared to White men, Black men (aOR=0.54, p<0.001) and men who did not identify as Black or Latino (aOR=0.65, p=0.04) had lower odds of drinking as did men who made less than $10,000 (aOR=0.49, p<0.001) compared to those who made more

than $60,000. Compared to men over 40, those aged 25-29 (aOR=2.90, p<0.001) had greater odds and those aged 30-40 (aOR=1.63, p=0.01) had lower odds of hazardous drinking.

Neither social neighborhood age nor substance use norms significantly predicted hazardous drinking. Individual substance use norms (aOR=0.47, p<0.001) and being HIV-positive (aOR=0.65, p=0.009) were both associated with lower odds of drinking. As in the home neighborhood, Black men (aOR=0.62, p=0.008) and men who did not identify as Black or Latino (aOR=0.61, p=0.02) and men who made less than $10,000 (aOR=0.51, p=0.001) had lower odds of hazardous drinking. Men between 25-29 (aOR=2.58, p<0.001) and men between 30-40 (aOR=1.58, p=0.02) had significantly higher odds of heavy drinking than men over 40.

Table 17. Individual and Home Neighborhood Factors Associated with Hazardous Drinking

		Home Neighborhood				Social Neighborhood		
	Bivariate	Model 1	Model 2	Model 3	Bivariate	Model 1	Model 2	Model 3
HazardDrink	OR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*	OR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*
Gay Attachment (mean)	1.19 (0.94,1.50) 0.15				1.11 (0.88,1.40) 0.39			
Sexual Orientation Disc	0.94 (0.63,1.41) 0.76				0.79 (0.47,1.35) 0.40			
Internalized Homophobia	0.96 (0.95,0.99)***		0.98 (0.95,1.00)*	0.98 (0.95,0.999)*	0.98 (0.96,0.99)*		0.98 (0.96,1.01)	0.98 (0.96,1.01)
Indv Substance Use Norms	0.46 (0.39,0.55)***		0.41 (0.4,0.51)***	0.41 (0.34,0.51)***	0.51 (0.43,0.61)***		0.47 (0.39,0.57)***	0.47 (0.38,0.57)***
Intercept		1.23 (0.80,1.90)	1.33 (0.85,2.09)	1.24 (0.78,1.97)		0.92 (0.58,1.44)	0.96 (0.60,1.54)	0.94 (0.60,1.50)
Race/ethnicity								
Hispanic	0.69 (0.52,0.92)**	0.74(0.54,1.02)	0.83 (0.60,1.17)	0.88 (0.63,1.24)	0.77 (0.58,1.02) 0.07	0.76 (0.56,1.04)	0.87 (0.63,1.21)	0.89 (0.64,1.23)
Black	0.43 (0.32,0.58)***	0.48 (0.35,0.67)***	0.51 (0.36,0.72)***	0.54 (0.38,0.78)***	0.57 (0.42,0.76)***	0.57 (0.41,0.79)***	0.62 (0.44,0.88)**	0.62 (0.44,0.89)**
White	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Everyone Else	0.63 (0.44,0.91)**	0.61 (0.41,0.90)**	0.64 (0.42,0.97)*	0.65 (0.43,0.99)*	0.63 (0.44,0.90)*	0.60 (0.41,0.88)**	0.62 (0.41,0.93)*	0.61 (0.41,0.92)*
Income								
<10K	0.60 (0.43,0.85)**	0.56 (0.38,0.83)**	0.48 (0.32,0.72)***	0.49 (0.33,0.74)***	0.67 (0.48,0.95)*	0.57 (0.39,0.84)**	0.51 (0.34,0.77)***	0.51 (0.34,0.77)***
10-40K	1.11 (0.82,1.51) 0.50	1.03 (0.74,1.45)	0.95 (0.66,1.36)	0.98 (0.68,1.41)	1.18 (0.87,1.59) 0.30	1.04 (0.74,1.45)	0.99 (0.70,1.41)	0.99 (0.69,1.40)
40-60K	1.52 (1.03,2.23)*	1.28 (0.85,1.91)	1.18 (0.78,1.81)	1.20 (0.78,1.83)	1.51 (1.03,2.19)*	1.30 (0.88,1.93)	1.26 (0.84,1.90)	1.27 (0.84,1.91)
>60K	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Age								
18-24	1.31 (0.79,2.17) 0.30	1.60 (0.90,2.85)	1.64 (0.89,3.04)	1.66 (0.90,3.06)	1.10 (0.65,1.86) 0.72	1.50 (0.83,2.72)	1.48 (0.80,2.75)	1.47 (0.79,2.75)
25-29	2.98 (2.22,3.99)***	2.86 (2.06,3.95)***	2.88 (2.04,4.06)***	2.90 (2.05,4.09)***	2.46 (1.83,3.31)***	2.64 (1.91,3.67)***	2.61 (1.86,3.68)***	2.58 (1.83,3.64)***
30-40	1.81 (1.30,2.53)***	1.76 (1.24,2.50)**	1.62 (1.12,2.34)	1.63 (1.13,2.37)**	1.57 (1.12,2.20)**	1.64 (1.15,2.33)**	1.56 (1.08,2.26)*	1.58 (1.09,2.29)*
40+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
HIV-positive	0.45 (0.35,0.60)***	0.63 (0.47,0.85)**	0.55 (0.40,0.76)***	0.56 (0.41,0.77)***	0.57 (0.43,0.75)***	0.74 (0.55,0.99)*	0.65 (0.48,0.89)**	0.66 (0.48,0.90)**
Hood Exposure (50% +)	0.86 (0.67,1.11) 0.26	0.86 (0.65,1.14)	0.89 (0.66,1.19)	0.87 (0.65,1.16)	1.07 (0.86,1.34) 0.55	1.05 (0.83,1.33)	1.01 (0.79,1.30)	1.01 (0.79,1.30)
Neighborhood Level (NTA)								
Porportion MMH	1.08 (0.97,1.21) 0.17				1.03 (0.94,1.12) 0.52			
Substance Use Norms	1.05 (1.02,1.07)***			0.67 (0.32,1.43)	1.05 (1.02,1.07)***			0.23 (0.04,1.17)
Percent Poverty	0.24 (0.08, 0.74)**			0.39 (0.09,1.74)	1.12 (0.32,3.94) 0.86			
Percent Age 15-34	0.66 (0.36,1.22) 0.19				0.16 (0.05,0.49)***			1.03 (0.99,1.07)
Model								
Liddihoood Ratio Test x2, p			161.96***	2.12 *p*=0.35			132.11***	5.31 *p*=0.07

*$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Table 18: Heavy Drinking. Internalized homophobia (aOR=0.46, p<0.001), being Black (aOR=0.46, p=0.003), men who earned $10,000 or less (aOR=0.53, p=0.03); and being HIV-positive (aOR=0.49, p=0.001) were all associated with lower odds of heavy drinking than men over 40.

Table 18. Individual and Neighborhood Level Factors Associated with Hazardous Drinking

		Home Neighborhood			Social Neighborhood		
	Bivariate	Model 1	Model 2	Bivariate	Model 1	Model 2	Model 3
HeavyDrink	OR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*	OR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*	aOR (CI) *p*
Gay Attachment (mean)	1.30 (0.90,1.87) 0.16			1.27 (0.89,1.82) 0.19			
Sexual Orientation Disc	1.01 (0.54,1.89) 0.97			1.40 (0.67,2.91) 0.37			
Internalized Homophobia	0.96 (0.92,0.99)**		0.98 (0.94,1.01)	0.96 (0.93,0.99)*		1.01 (0.97,1.05)	1.01 (0.97,1.05)
Indv Substance Use Norms	0.52 (0.42,0.65)***		0.46 (0.36,0.60)***	0.55 (0.44,0.70)***		0.30 (0.22,0.40)***	0.30 (0.22,0.41)***
Intercept		0.23 (0.13,0.43)***	0.23 (0.12,0.42)***		0.20 (0.11,0.37)***	0.041 (0.02,0.09)***	0.044 (0.02,0.10)***
Race/ethnicity							
Hispanic	0.64 (0.43,0.95)*	0.68 (0.45,1.05)	0.76 (0.49,1.17)	0.68 (0.45,1.02) 0.06	0.66 (0.43,1.02)	0.69 (0.39,1.24)	0.67 (0.37,1.20)
Black	0.38 (0.23,0.61)***	0.42 (0.25,0.70)***	0.46 (0.27,0.77)**	0.39 (0.23,0.64)***	0.39 (0.23,0.66)***	0.90 (0.49,1.63)	0.86 (0.47,1.57)
White	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Everyone Else	0.72 (0.43,1.20) 0.21	0.69 (0.40,1.18)	0.77 (0.44,1.32)	0.81 (0.48,1.35) 0.41	0.77 (0.45,1.31)	0.59 (0.27,1.32)	0.60 (0.27,1.34)
Income							
<10K	0.46 (0.27,0.78)**	0.59 (0.33,1.05)	0.53 (0.29,0.95)*	0.46 (0.27,0.79)**	0.57 (0.32,1.03)	1.14 (0.54,2.41)	1.14 (0.54,2.39)
10-40K	0.88 (0.53,1.47) 0.64	0.84 (0.53,1.32)	0.78 (0.49,1.24)	0.77 (0.50,1.18) 0.24	0.89 (0.56,1.41)	0.96 (0.49,1.88)	0.95 (0.49,1.85)
40-60K	0.74 (0.49,1.14) 0.17	0.87 (0.51,1.47)	0.8 (0.49,1.43)	0.82 (0.49,1.39) 0.46	0.82 (0.48,1.40)	1.42 (0.67,3.01)	1.41 (0.67,2.97)
>60K	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Age							
18-24	0.72 (0.31,1.72) 0.46	0.99 (0.39,2.48)	0.92 (0.36,2.35)	0.49 (0.18,1.32) 0.16	0.63 (0.22,1.79)	1.33 (0.44,3.99)	1.33 (0.44,3.97)
25-29	1.32 (0.86,2.02) 0.21	1.34 (0.85,2.14)	1.27 (0.79,2.04)	1.18 (0.76,1.82) 0.46	1.24 (0.78,1.98)	1.16 (0.63,2.14)	1.12 (0.61,2.06)
30-40	0.95 (0.57,1.59) 0.84	0.85 (0.50,1.45)	0.76 (0.44,1.32)	0.79 (0.47,1.35) 0.39	0.74 (0.43,1.28)	0.96 (0.49,1.89)	0.96 (0.49,1.87)
40+	1.00	1.00	1.00	1.00	1.00	1.00	1.00
HIV-positive	0.45 (0.28,0.72)***	0.55 (0.33,0.92)*	0.49 (0.29,0.82)***	0.55 (0.34,0.88)**	0.66 (0.40,1.08)*	1.84 (1.10,3.10)*	1.80 (1.08,3.03)*
Hood Exposure (50% +)	1.11 (0.76,1.63) 0.59	1.14 (0.76,1.70)	1.19 (0.79,1.79)	1.51 (1.06,2.15)*	1.54 (1.08,2.20)**	1.61 (1.01,2.58)*	1.62 (1.02,2.59)*
Neighborhood Level (NTA)							
Porportion MMH	1.20 (1.04,1.38)**			0.97 (0.85,1.10) 0.60			
Substance Use Norms	1.05 (1.02,1.08)**			1.04 (1.00,1.07) 0.34			
Percent Poverty	0.08 (0.01,0.43)**			2.96 (0.54,16.17) 0.21			
Percent Age 15-34	0.91 (0.37,2.24) 0.83			0.06 (0.01,0.31)***			1.00 (0.95,1.05) 0.84
Model							
Liklihoood Ratio Test x2, p			92.35***			329.25***	1.05, *p*=0.31

*$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Individual substance use norms (aOR=0.30, p<0.001) and spending 50% or more of their time in their social neighborhood (aOR=1.62, p=0.04) were associated with lower odds of heavy drinking. Unlike the home neighborhood, being HIV-positive (aOR=1.80, p=0.03) was associated with nearly two times higher odds of heavy drinking. NTA age did not significantly explain between neighborhood differences.

5.6 DISCUSSION

With only a quarter of the sample (26%) reported any substance use in the past 3-months, regular drug use in this study was within the range of other samples of MSM (Stall et al., 2001). The number of men who reported heavy drug and heavy alcohol use was also fairly low, although consistent with findings from the EXPLORE study. 12.2% of these men met the criteria for heavy alcohol use (11% in Explore) and 7.8% reported weekly use of drugs, compared to 11% and 3%, respectively, in EXPLORE (G. Colfax et al., 2004).

Novel to this study, significant between neighborhood differences were found in the use of any drug in both the social and home neighborhoods, hazardous drinking in both the social and home neighborhoods, and heavy drinking in the social neighborhood. This supports our initial hypothesis that neighborhood factors influence substance use behaviors among MSM. Furthermore, these findings also suggest that different neighborhoods (i.e. home and social) may have unique influence on MSM behaviors.

The neighborhood level variables included in these analyses performed less well than anticipated. Neighborhood level substance use norms was a significant with only very moderate effects for less use of any substance at the home neighborhood level (aOR=0.18). A younger neighborhood (percent of population aged 15-34) also had very moderate effects on increased use of any drug in the social neighborhood (aOR=1.04).

That the percent of male-male households did not significantly impact substance use is different than other studies in South Florida and NYC (Buttram & Kurtz, 2013; Carpiano et al., 2011; Kelly

et al., 2012) where men living in ‘gay-neighborhoods’ were more likely to report substance use. This may be due to our use of only census data to calculate ‘gay-neighborhoods’, rather than considering other factors (e.g. historically recognized spaces, qualitative assessments) to create more of a composite score. Similarly, having a greater attachment to gay community was protective against heavy drug use, which is quite different from the findings of Carpiano, Kelly, and colleagues who found that gay male intensive social networks often reinforced substance use (Carpiano et al., 2011; Kelly et al., 2012).

Several individual level factors were associated with drug and alcohol use. A less permissive view of substance use was consistently associated with lower odds of drug and alcohol use. While it is unsurprising that men with a more strict view of drugs and alcohol report using less, it is interesting that the largest effects were related to alcohol use, where men had half the odds of hazardous or heavy drinking. Having more internalized homophobia was associated very moderate effects of less hazardous drinking at the home neighborhood level, but had a large impact on less heavy drinking at the social neighborhood level. Men who had experienced discrimination for being a sexual minority in their social neighborhoods were over twice as likely to report any or moderate drug use. Spending more time in the social neighborhood was associated with greater odds of moderate and heavy drug use as well as heavy alcohol use.

HIV-positive men were overall more likely to use drugs and less likely to drink compared to HIV-negative men. For nearly all substance use categories, HIV-positive men had higher odds of using drugs with little difference between home and social neighborhoods. Heavy drug use was an exception; HIV status was not a significant when considering individual level factors in the home

neighborhood, however for social neighborhood factors HIV-positive men had nearly twice the odds of drugs use. HIV-positive men had lower odds of hazardous drinking in both the home and social neighborhoods and of heavy drinking in the home neighborhood. However, when considering social neighborhood factors, HIV-positive had nearly twice the odds of heavy drinking.

There are several limitations to the study design and analysis that must be mentioned. Both time location sampling and participant self-selection impact the composition of the study sample. Despite our attempt to include a wide variety of public and virtual spaces in the TLS randomization, we likely missed men who did not participate in the chosen recruitment spaces or who felt unable to screen for the study. Furthermore, the sample was collected in NYC so results may not be generalizable to a wider population of MSM. We were reliant on self-report data. Participants may have felt uncomfortable reporting illegal behavior (i.e. drug use) or wished to give more socially desirable responses. The survey was administered using ACASI in hopes that participants would feel more comfortable and candid with their responses. Men also had to have had anal sex within the past 3-months to participate which skews the sample toward sexually active men. The study design did not include an assessment of where drug and alcohol use occurred. While we know a great deal about both the home and social neighborhoods (e.g. neighborhood connection, the built environment) we are unable to analyze drug and alcohol use by neighborhood. In this paper we make use of neighborhood level factors of each neighborhood that may impact overall substance use. Finding the right ‘neighborhood’ to use is also challenging. Using the NTA level likely had both positive and negative impacts on the analysis and findings. As a first step, using NTAs allowed for a diverse sample of NYC without getting too small so as to only have

only just a few men from the sample there. Future analysis will include a range of neighborhood sizes to try and tease out how different administrative or self-defined boundaries impact the findings.

There were also several benefits to the study design. Primary of which was collecting data for multiple neighborhoods of theoretical importance. This allows for multilevel analyses of multiple spaces as well as providing the opportunity to construct neighborhood level variables (aggregation of individual level data to higher levels) for constructs often unavailable in traditional neighborhood data (e.g. neighborhood homophobia). Also significant in this study, participants were asked to self-define their neighborhood size, allowing for a more nuanced neighborhood analysis.

Future research agendas concerned with neighborhood influences on substance use should continue to include multiple spaces of influence, but with more detail. To know where MSM are using what substances where and why would help to better understand what impact the neighborhood (or other space) may have beyond individual-level predictors. How socio-sexual networks interact with drug using networks would also be an essential element to be able to more meaningfully untangle the structural – interpersonal – individual influences on MSM, substance use, and associated risks and resiliencies. These multiple data points will require much more sophisticated spatial analysis methods and tools.

Despite these limitations, this paper offers a novel approach to considering multiple neighborhoods of influence. That between neighborhood differences were found for several of the outcomes,

provides some evidence that different neighborhoods likely have unique impacts on MSM behavior. Further analysis and research is needed to more fully explore the neighborhood-level factors that contribute to individual substance use among MSM in NYC. Hopefully these findings will add to the literature and support the development and testing of geographically and contextually driven prevention efforts.

6.0 FINAL DISCUSSION AND FUTURE DIRECTIONS

6.1 SUMMARY OF THE MAIN FINDINGS

Thirty years into the HIV pandemic men gay, bisexual, and other men who have sex with men (MSM) are still disproportionately impacted by HIV/AIDS, accounting for two-thirds of the epidemic in the United States (U.S.). Structural and context-specific interventions have been largely ignored, in favor of interventions designed to operate at the level of individual behavior change. If we are to hold as fundamental that HIV-risk is greater than individual behavior, our approach to HIV research and intervention must radically change. As we continue into this new era of combination prevention, the focus must be on bio-behavioral and structural-level interventions. To do this will require a far better understanding of the social and physical contexts in which gay, bisexual, and other men who have sex with men (MSM) build their lives.

There is increasing evidence suggesting that context is an important driver of HIV risk (Hatzenbuehler et al., 2014; Hatzenbuehler, Keyes, et al., 2011; Hatzenbuehler et al., 2010; Hatzenbuehler, Wieringa, et al., 2011; Millett et al., 2007; Millett et al., 2012). This dissertation was designed to explore three contextual moments or spaces where HIV risk may be heightened. The contextual situations of interest include: migration to an urban gay center; the influence of the epidemiologic background of HIV in the neighborhoods where MSM live and choose to have sex; and the influence of individual-level and home and social neighborhood-level factors on drug and alcohol use among MSM.

In the first chapter, a background was provided on how interaction in public space and the environment influences behavior, health and wellbeing of MSM. Considering the literature, the social and physical environments of the gay neighborhood seems to be a double edged sword both promoting and preventing sexual risk and substance use. While these studies provide important insights into how social and physical environments – particularly neighborhoods and networks with highly concentrated GBM - influence behavior, methodological issues limit the scope of the findings. There remains, however, a lack of research investigating the influence of neighborhoods on the health and behaviors of MSM. A better understanding of neighborhoods and other contexts is essential to moving HIV treatment and prevention beyond individual-level change and toward structural intervention.

The second chapter describes a sample of MSM who recently migrated to NYC. HIV sexual risk and substance use was examined for three specific post-migration time periods including those who had lived in NYC for one year or less, 2-5 years, and 6-10 years. Compared to men living in NYC for 6-10 years, more recent migrants, men living in NYC for between 2-5 years, had increased risk for condomless sex and heavy drinking. Compared to white men, black men had a cox proportional hazard of 5.17 ($p<0.001$) and non-black Hispanic men had a hazard ratio of 3.03 ($p=0.01$) for HIV seroconversion within the first 10 years of migrating to NYC.

The intention in this chapter was to better understand the interaction between the structural and behavioral through the specific contextual lens of migration to a new city. Arriving in a new city with new, unknown socio-sexual networks; often unknown behavioral codes/rules; and absent any social capital or support he may have had previously, likely creates a period of heightened risk. A

better understanding of migratory patterns of MSM and related risks and resiliencies could inform innovative bio-behavioral interventions targeted toward specific geographies.

The third chapter describes the epidemiologic background of HIV in the home and sexual neighborhoods of HIV-negative MSM. Community Viral Load (CVL) is a measure of the level of HIV infectiousness within a community, in this case, the number of MSM who have or do not have an undetectable HIV status. There were a number of sociodemographic factors associated with having a higher CVL home and/or sexual neighborhood. Of particular consequence, the findings suggest that Black MSM had over four times greater odds of living and nearly five and a half times greater odds of having sex in higher CVL neighborhoods compared to white MSM. Both black MSM and bisexually identified men also had over two times greater odds of migrating to a higher CVL neighborhood for sex (compared to white gay-identified men). A better understanding of who is more likely to live or have sex in higher CVL neighborhoods is essential in making use of CVL data in a more meaningful way. Understanding the importance of context as risk might inform interventions that consider not only individual behavior but also structural change.

Newer technologies have the potential to greatly enhance our ability to measure, understand, and utilize CVL data. Reconceiving CVL as a dynamic process dependent on the space, time and composition of the 'communities' being measured would allow greater flexibility in how the methodology might be used to measure highly specific pools of viremia based on geography or context or the ability to track viremic tides over time and space. Greater specificity of CVL would allow for highly targeted bio-behavioral interventions (e.g. specific contexts at specific times).

Such interventions will likely include multiple biologic (e.g. TasP, PrEP, PEP) and behavioral (e.g. ability to identify risk, access and adhere to biological tools, and opting for the best suitable ongoing intervention) components.

The forth chapter was designed to consider the unique impact of multiple neighborhoods on behavior and risk among MSM. Specifically, the chapter looks at the home and social neighborhoods of MSM in NYC. The findings suggest between neighborhood differences in the use of any drug in both the social and home neighborhoods, hazardous drinking in both the social and home neighborhoods, and heavy drinking in the social neighborhood. Both individual level and neighborhood level variables were associated with both greater (e.g. Neighborhood-level age, individual experience of sexual minority discrimination) and lower (Neighborhood-level substance use norms, Individual-level substance use norms) odds of drug and alcohol use.

These findings provide support for the initial hypothesis that neighborhood factors influence substance use behaviors among MSM. Furthermore, these findings also suggest that different neighborhoods (i.e. home and social) may have unique influence on MSM behaviors. Considering how multiple spaces may have different influence on behavior might help inform where and how best to intervene with whom to reduce HIV-risk.

6.2 FUTURE RESEARCH AGENDA

Three and a half years ago, I entered the PhD program in the Graduate School of Public Health at the University of Pittsburgh, determined to study how multiple neighborhoods influence the health and wellbeing of MSM. Now, as I'm typing these final words, much of the pride that I feel in this document is how very different it is to what I once thought it would be. Using all that I came in with and all I've learned since, I can see the beginnings of my future research agenda(s).

Paramount to me is continuing to find ways to best integrate biology and behavior. Now, firmly located in the age of combination prevention, we are called upon to create new possibilities of how to combine the best of both the bio-medical and behavioral sciences. We must take what can be learned to create meaningful structural interventions that include focus on both individuals and the multiple contexts of influence. Geographies (e.g. neighborhoods) and contexts (e.g. spaces and micro-events) will remain a key component to my future research agenda. New technologies can help to create far more focused interventions based on the intersection of space, behavior, and time. Locating specific contexts where interventions can be specially designed and implemented directly for the space or population you are trying to reach. The age of *one size fits all* HIV prevention and treatment is over. *Blanket bombing* traditional gay spaces with condoms and *instructions* on what you can and cannot do has most likely achieved all it will achieve. We can and must do better.

Migration and Neighborhood Risk. A cohort study would be an ideal design to further exploring migration risk and ongoing neighborhood-based risk (e.g. substance use, sexual behavior). Men could be enrolled into the cohort within the first few months post-migration to a gay urban center.

Follow up could continue for several years for periodic lab visits to collect bio-data and using new technologies for electronic communication to decrease participant burden, while maximizing data collection opportunities. Such a design might provide more nuanced information on migration to and from gay urban centers (e.g. how and why some stay and some leave) as well as migration between neighborhoods within the city. A longitudinal understanding of migration, pathways of risk in multiple contexts, how men conceive of multiple contexts (i.e. permeability, size, temporal components), and the production of resiliencies over time could inform where and when to best implement prevention programs.

Interventions might include such things as a *welcome wagon* of prevention tools (e.g. access to: medical care, PrEP/PEP, mental health counseling) or *fresh meet* events to attract and interact with newer migrants. Other interventions might target specific types of drug use in specific contexts (e.g. men slamming meth at private *party and play* parties). In such a situation, a general *this is your brain on drugs* message is likely to be ineffective. Rather, one might make use of all the information from the overlapping space-time components (e.g. the individual, the behavior, the space, socio-sexual-drug networks) to construct an intervention highly specific to that space or to that space plus related socio-sexual-drug networks.

Combining Context, CVL, and PrEP. The integration of geography, biology, and behavior is an exciting new direction in HIV research and intervention. Newer technologies (e.g. dried blood spot analysis, DBS (Le Vu et al., 2012; Semaille et al., 2013)) have the potential to greatly enhance our ability to use the ideas behind CVL. Being able to cost effectively measure, from small amounts of blood, information on HIV infection, viral load, cd4 count, and the presence/timing of

antiretrovirals, and other substances, combined with the flexibility of being able to collect blood samples outside of clinical practice using non-providers, opens up enormous opportunities to completely re-think the space, time and composition of the contexts we might measure and highlight for intervention. As one example of this currently being done, Semaille and colleagues have looked at used DBS analysis to examine the CVL at a circuit party in France, comparing known and unknown positives (Semaille et al., 2013).

I hope to reconceive CVL as a dynamic process influenced by temporal, geographical, and social forces. We can then begin to characterize both *pools* and *tides* viremia. Identifying where there are deep pools of viremia, understanding the underlying structural forces that reinforce such spaces, and the embedded (or pas through) socio-sexual and drug networks might inform interventions beyond the individual level. Tracking viremic tides allows for increased flexibility by considering individual interaction with both time and space. These tides might be seasonal and geographical (e.g. increased risk associated with leaving one's home and going to a higher CVL city for vacation); the risk of certain spaces might change depending on the day of week or time of day (e.g. certain bar on Friday nigh or bathhouse on Wednesday morning), or developmental and geographical (e.g. migration to a new city). A highly temporal-contextual understanding of the epidemiologic background of specific places and spaces (viremic tides) would allow for highly targeted bio-behavioral intervention perhaps targeted to spaces (e.g. neighborhoods, parties); individuals (e.g. those who move between spaces, new migrants, young MSM of color); or times (e.g. night time, summer time, circuit party) to prevent viral replication and transmission.

These ideas have informed much of my current work (along with Drs. Stall, Herrick, Ho and colleagues from Fenway Community Health in Boston, MA) investigating the feasibility of

episodic PrEP (Epi-PrEP). I hope to continue to expand my understanding of how individuals interact with *viral tides* to identify spaces where short-term Epi-PrEP may be a useful tool to include in a comprehensive bio-behavioral intervention (e.g. regular testing, access to PrEP, risk assessment, and access to a mobile app for adherence support).

6.3 ONGOING CONSIDERATIONS FOR THE STUDY OF NEIGHBORHOODS AND MSM

An ongoing issue with neighborhood-related research is how to define and operationalize neighborhood (Diez-Roux & Mair, 2010). Future studies should make use of emerging technologies to include multiple neighborhoods of potential influence. To improve analytical possibilities studies must also include neighborhood-focused and geo-specific variables. Including a temporal aspect would further enhance this research. Collecting multiple temporal data points would help to better elucidate the risks and resiliences associated with inner and intra migration patterns (e.g. into/out of the city and in/out of neighborhoods within the city). This would require longitudinal study designs and creative use of technology.

Of particular importance to public health is the continued use of intersecting biological, behavioral and geographical data to generate a more comprehensive picture of MSM risk and resilience in specific contexts – including both place and time. Such insight is essential to the design and implementation of structural interventions in the age of combination prevention. Mapping these data together is fundamental to better understanding patterns of HIV risk at multiple levels (e.g. individual, structural, contextually-driven). Research including these and other neighborhood (e.g.

census, crime, built environment) data has the potential to provide a far more comprehensive picture of the spatial distribution of disease, risk and resilience providing insight into casual pathways. Such a picture might provide important insight into the design and delivery of future place-specific structural interventions to reduce the HIV transmission; engage and retain HIV-positive MSM in care, and improve the overall health of all MSM.

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