The role of individual or neighborhood factors: HIV acquisition risk among high-risk populations in San Francisco.

By

Henry Fisher Raymond III

A dissertation submitted in partial satisfaction of the

Requirements for the degree of

Doctor of Public Health

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor S. Leonard Syme, Chair

Professor Ralph Catalano

Professor Malo André Hutson

Professor Willi McFarland

Fall 2011

Abstract

The role of individual or neighborhood factors: HIV acquisition risk among high-risk populations in San Francisco.

By

Henry Fisher Raymond III

Doctor of Public Health

University of California, Berkeley

Professor S. Leonard Syme, Chair

The majority of new HIV infections occur among high-risk groups such as men who have sex with men (MSM) and transfemales. Segments of these populations are also more likely to be economically disadvantaged. Economic disadvantage or low socioeconomic status has been linked to disease acquisition, morbidities and mortality. Interventions have been proposed to address these health issues through the reduction of poverty. However, this approach to intervention does not address underlying structural factors such as high HIV prevalence in impoverished neighborhoods and thus in social and sexual networks.

The present analysis examines low individual socioeconomic status and /or social and sexual network factors and their relationship to HIV acquisition risk among three populations at high-risk for HIV infection. Geographic analysis examined residential patterns and neighborhood patterns of HIV prevalence in San Francisco. Data collected in San Francisco from White MSM, Black MSM and transfemales were analyzed using Poisson regression to determine the factors associated with engaging in more episodes of potentially serodiscordant unprotected receptive anal intercourse.

As expected, transfemales and Black MSM were more likely to live in areas of higher HIV prevalence and lower income compared to White MSM. Interestingly the areas of higher HIV prevalence and lower income were also the areas with greater numbers of HIV prevention and care services. Black MSM and transfemales had lower socioeconomic status (SES) scores compared to White MSM. Black MSM were more likely to report serodiscordant partnerships and higher numbers of potentially serodiscordant unprotected sex acts. Decreasing SES and increasing neighborhood HIV/AIDS case density did not predict serodiscordant partnerships in any group. Increasing neighborhood HIV prevalence predicted an increase in the number of potentially serodiscordant unprotected sex acts among transfemales and Black MSM but only significantly so for transfemales.

HIV prevention interventions must also consider neighborhood factors such as neighborhood HIV prevalence in addition to considering individual level behavior change.

To my father

Henry Fisher Raymond Jr.

Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction

Since the late 1800's epidemiologists have noted differences in disease outcomes when stratified by levels of income. Krieger (2001a) references Villerme's seminal work that first illustrated the link between economic status and mortality in her discussion of the history of social epidemiology and calls for the field to not ignore the consequences of social patterns on inequalities [Kreiger 2001a]. As the understanding of disparities has grown so too has the conceptualization of the factors that contribute to those disparities. Researchers cannot simply focus on biological or individual behavioral factors when developing health improving interventions without also considering structural social factors such as poverty / low income when trying to understand and respond to disease and negative health outcomes that affect groups differentially [Kreiger, 2007]. Investigating income as a determinant of health alone is not sufficient to enable researchers to understand the root causes and associations contributing to disparities in health status across groups. Along with income, educational attainment and employment status form a composite measure of individual socioeconomic status (SES). Individual SES has been linked to many negative health outcomes including increased morbidity and mortality from a range of diseases including HIV. Beyond individual SES, other community and network factors, such as community viral load and the composition of sexual networks, may play a role in HIV acquisition and may also play a role in the ongoing disparities in HIV prevalence and incidence among high-risk populations.

Almost thirty years into the HIV epidemic in the United States, there are about 40,000 new HIV infections each year [Centers for Disease Control and Prevention (CDC), 2010a; CDC 2010b]. The majority of new infections occur among high-risk groups such as men who have sex with men (MSM) (who may or may not be poor), injection drug users (IDU) (whose presence is high in impoverished neighborhoods) and certain populations of heterosexual men and women who do concentrate in areas of poverty [CDC 2010c; Denning & DiNenno, 2010]. Many of these groups, particularly African Americans, experience some of the highest levels of poverty [US Census, 2008] and disproportionate burden of HIV nationally [CDC, 2010d]. In some populations the risks associated with poverty are compounded by also being a member of a group that is also high-risk for reasons other than poverty (e.g. poor African American MSM, transfemales). This intersection may increase the risk of disease acquisition. Evidence suggests that poverty decreases access to social and health resources thus increasing the likelihood of disease and subsequent poor health outcomes. [Kahn & Fazio, 2005]. The relationship of poverty and low SES to HIV infection and its consequences is not clear, thus hampering attempts to develop effective prevention interventions based on poverty reduction [Fenton, 2004]. Some poor populations have much lower prevalence of or risk for HIV than would be predicted by their SES [Arnold, Raymond & McFarland, 2009]. Overly simplistic HIV prevention interventions directed only at the individual level, either to address their behavior or their poverty, are not sufficient to reduce the incidence of new infections. Interventions must also address structural factors, such as the composition of social and sexual network which may contribute to HIV infection. How this should be done is unclear. To that end the present analysis seeks to examine the relationship between low individual SES and / or social and sexual networks and HIV transmission risk through an ecosocial lens in order to elucidate these relationships and contribute to a clearer conceptualization and more effective design of HIV prevention interventions among three populations at high-risk for HIV infection in San Francisco.

Chapter 2

Literature Review

Poverty is a complex construct with multiple meanings depending on the setting. Simply put, poverty is the lack of resources to meet basic human needs [Encarta, 2010]. Poverty is operationally defined by US Health and Human Services as a specific level of income per family size and by gradations of poverty [Health and Human Services (HHS), 2010]. For example, for an individual 100% poverty is defined as an annual income of $10,830 USD while 200% poverty is $21,660 USD per year [HHS, 2009].

The existing literature regarding income and health status suggests that income (specifically poverty) is linked both to poor overall health status and health disparities such as higher prevalence of disease, morbidity and mortality, in many populations [Kahn & Fazio, 2005]. Furthermore, income, or lack thereof, has been linked to poor health outcomes for HIV-infected individuals [Arnold, Hsu, Pipkin, McFarland & Rutherford. 2009; McFarland, Chen, Hsu, Schwarcz & Katz, 2003]. Less clear is the association between low income (poverty) / low SES and HIV infection with a number of researchers arguing both for and against the relationship of these two factors. Farmer, Lindenbaum & Delvecchio-Good, 1993; Fenton, 2004; Gillespie, Kadiyala & Greener. 2007; Kreuger, Wood, Diehr & Maxwell, 1990; Nattrass, 2009; Mishra et al. 2007; Msisha, Kapiga, Earls & Subramanian, 2008; Shelton, Cassell & Adetunji, 2005]. Despite the equivocal findings in the published research on the relationship between income and HIV infection, there have already been recommendations for HIV prevention interventions based on income generating schemes such as jewelry making among female sex workers [Stratford, Mizuno, Williams, Courtenay-Quirk & O'Leary, 2008]. Moreover, research to date has mainly focused on heterosexual populations [Arnold, Raymond & McFarland, 2009]. Additional research among other diverse high-risk populations is needed.

Research into the link between socioeconomic status (SES) and HIV infection has also been complicated by using HIV-infection status as the outcome when it is also possible that lower SES is the result of becoming HIV infected (i.e. effect-cause bias). Thus, this analysis therefore focuses investigation into the link between SES and HIV risk taking- and antecedent for HIV acquisition. This mechanism includes, for example, high HIV/AIDS case density or HIV prevalence in poorer neighborhoods which increases the potential that sexual networks contain more HIV-positive individuals. This analysis focuses on HIV risk taking and not HIV-positive status as the outcome thus avoiding the potential of reverse causation contributing to misinterpretation of findings [Link & Phelan, 1995]. Adding to this paradigm is the hypothesis that SES also plays a role in low HIV treatment adherence which in turn leads to increased viral load among the non-adherent. If the individuals with higher viral load are part of sexual networks in poorer neighborhoods this would increase the chance that even low levels of risk may result in higher numbers of transmissions due to higher levels of infectivity. Higher individual viral loads increase the background level of infectivity in communities and networks leading to increases in transmissions even in the absence of higher levels of risk behavior [Adimora, Schoenbach & Doherty, 2006; Adimora & Schoenbach, 2005; Das et al., 2010; Raymond & McFarland, 2009]. Similarly, a lack of diagnostic services or limited use of HIV testing programs by residents of the same neighborhoods would result in relatively higher numbers of HIV-infected persons who are unaware of their status, therefore not taking viral suppressive therapy and therefore further contributing to the community viral load. Taken together these factors with (neighborhood factors such as limited sexual networks, HIV/AIDS case density, high HIV prevalence and high community viral load) contribute to an environment where HIV transmission risk and subsequent poor health outcomes are magnified. Figure 1 illustrates the hypothesized relationship of these factors in low socioeconomic status (SES) neighborhoods. In this conceptual framework, individuals and their risk behaviors are only one part of a complex environment that can result in HIV infection even when risk behaviors are low. The risk environment is affected in many ways that raise risk of HIV infection. These effects include higher rates of unrecognized HIV infection, poor treatment and adherence, higher morbidity including STDs, higher community viral load, greater proportions of HIV-infected individuals in sexual networks and higher background HIV prevalence.

Clearly the factors linking low SES, HIV transmission risk, low treatment uptake, low adherence, high viral loads, and higher morbidity are complex and not readily amenable to simplistic investigations. A careful examination of each relationship that builds stepwise towards an integrated approach to this complex question may lead to a clearer understanding of the underlying mechanisms. This proposal is designed to be the first step in building this integrated approach. Results of this analysis can be used to inform potential interventions at the social and structural levels in addition to the individual level.

Measures of Socioeconomic Status

Socioeconomic status (SES) has been developed as an indicator of the relative position of individuals, groups and communities to each other [Lynch & Kaplan, 2000]. SES is often used as a key indicator in epidemiology and the study of health disparities. Most often individual SES is a composite measure of occupation, income and educational attainment [Liberatos, Link & Kelsey, 1998]. Other researchers have proposed adding a life course aspect to measures of SES as the cumulative effect of income level may be a better predictor of current SES [Kreiger, Williams & Moss, 1997]. Yet others have suggested measuring wealth, arguing that assets are a better indicator of access to health care than current income [Shavers, 2007]. SES measures are often collected directly from respondents but at times are imputed from neighborhood level data available from census data [Deonandan et al. 2000]. Neighborhoods can be defined by geography, culture or language. In many cases zip codes, census tracts or census block groups have been used to define neighborhoods [Shavers, 2007]. The commonality of these measures is reflected in their use in HIV research where a key indicator is SES. For example, Katz et al. (1998) in their study of HIV mortality used poverty, working class neighborhood and low educational attainment as measures of SES.

Socioeconomic Status, Disease, Health and Disparities

In general, people with lower SES have higher rates of morbidity and mortality related to diseases than other groups [Adler et al., 1993; &erson, Sorlie, Backlund, Johnson & Kaplan, 1996; Davey Smith, Hart, Watt, Hole & Hawthorne, 1998; Diez-Roux et al. 1997; Fein, 1995; Haan, Kaplan & Camacho, 1987; Hochstim, Athanasopoulos & Larkins, 1968; Kreiger, 1992; O'Campo, Xue, Wang, O'Brian Caughy, 1997; Pappas et al., 1993; Reijneveld, 1998; Slogget & Joshi, 1998; Waitzman & Smith, 1998]. Additionally, research has suggested that economic status over the life course contributes to health disparities and that access to health care does not reduce SES' effects on those disparities as current access does not ameliorate a lifetime of accumulated stress and health problems. [Adler et al.1993; Khan & Fazio, 2005].

Socioeconomic Status and STD / HIV Risk

A number of researchers have investigated the role SES plays in terms of STD and HIV acquisition and transmission and subsequent health disparities such as higher prevalence, higher incidence, higher co-morbidities and shorter survival from time of diagnosis. Poverty and educational attainment have been linked to STI and HIV infection risks [Adimora et al., 2006; Anang et al. 2010]. Other research has examined composite or multiple SES factors and STD / HIV risk [Thomas & Thomas, 1999]. Hogben and Leichliter (2008) found four specific determinants of disparities in STD rates by race / ethnicity. Three of these, social segregation, SES and access to health care, are relevant to the broadest range of populations while the fourth, incarceration, applies more specifically to only a few. Social segregation and poverty leads to concentrated and limited social and sexual networks that may be highly affected by higher rates of STD infection [Aral, Adimora & Fenton, 2008; Hogben & Leichliter, 2009]. These limited networks, particularly sexual networks, often result in higher levels of concurrent partnerships, that is when individuals have more than one sexual partner during the same period of time [Aral, Adimora & Fenton, 2008]. Concurrent partnerships are highly effective in facilitating the rapid transmission of STD and HIV [Morris & Kretzschmar, 1995; Morris & Kretzschmar, 1997]. Concurrency would suggest that it is in fact the neighborhood or network factors rather than individual behaviors that increase individuals' risk of HIV infection. While there is a preponderance of literature that suggests that those individuals with low SES engage in higher risk behaviors, at least one study found risk factors such as rate of condom use were similar between low and high SES Black women [Cornelius, Okundaye & Manning, 2000]. Finally, while much of the research has focused on the risk of acquiring HIV, some research suggests that poverty and unemployment and their effect on health insurance status may be related to higher levels of unrecognized HIV infection [Kates & Levi, 2007]. Individuals with unrecognized HIV infection, that is when someone is infected but unaware of their infection, may lead to over three times as many new HIV infections as from those individuals who are aware of their HIV-positive status [Marks, Crepaz & Janssen, 2006]. Unfortunately, very little research has examined poverty, unemployment, health insurance status, sexual network characteristics and unrecognized HIV infection among sub-populations at risk for STD and HIV infection such as MSM and transfemales (male to female transgenders).

Socioeconomic Status and HIV Disease Outcomes

Complicating the role of SES in HIV acquisition is the role individual SES plays in disease progression – the morbidity and mortality experienced by those with HIV infection. Although some research prior to the era of highly active antiretroviral therapy (HAART) suggested that SES did not contribute to poor disease outcomes among HIV infected individuals [Katz, Hsu, Lingo, Woelffer & Schwarcz, 1998]. The preponderance of the literature suggests that there is in fact a negative relationship between SES and poor HIV disease outcomes including higher rates of mortality both before but particularly after the HAART era [Hogg et al., 1994; McDavid-Harrison, Ling, Song & Hall, 2008; McMahon, Wanke, Terrin, Skinner & Knox, 2010]. For example, Schecter et al. (1994) showed that higher levels of SES markers (e.g. higher educational status and higher annual incomes) were associated with slower HIV disease progression. Poor disease outcomes, particularly higher morbidity, are a marker for poor treatment coverage and adherence [Arnold et al. 2009]. Neighborhood SES indicators such as unemployment rates and percent of residents below the federal poverty line have been found to be associated with delayed treatment and mortality [Cunningham et al., 2005; Joy et al., 2008]. There is also evidence that even when treatment such as HAART is available free of charge, individuals with low SES do not access or delay access to HAART [Joy et al., 2008] Some published studies suggest that access and adherence to HAART may be lower among people of lower SES [Borrell et al., 2006]. Researchers in San Francisco have also suggested that higher rates of mortality among low SES individuals persist even when HAART is available [McFarland et al., 2003].

Access to care is not the only factor in HIV related morbidity. Adherence to treatment (i.e. HAART) is also a key factor in disease progression. The relationship between treatment adherence and SES is not entirely clear. Falagas et al. (2008) did not find conclusive support for an association between SES and adherence but did find associations between elements of SES such as income, education and occupation. Poor treatment coverage and adherence in turn have been shown to contribute to higher individual and community viral loads [Das et al., 2010]. In an ecological analysis of San Francisco, networks or communities with higher viral loads had risk of HIV acquisition / transmission [Das et al., 2010]. Conversely, where community viral loads are lower, rates of HIV transmission are lower [Das et al., 2010]. Finally, there appears to be a relationship between overall health problems and increased numbers of AIDS cases in a given area. Peterman, Lindsey and Selik (2005) found that compared to US counties with lower AIDS incidence, counties with higher AIDS incidence also had higher levels of low birth weight, syphilis, unintentional injury, stroke, lung cancer, homicide, coronary heart disease and colon cancer.

Social and Sexual Networks

Social networks, and the sexual networks stemming from them, have been implicated as key elements in the spread of infectious diseases including STDs and HIV [Friedman et al. 1997; Hogben & Leichliter, 2008; Kottiri et al. 2002; Morris & Kretzschmar, 1995]. These networks are often geographically based [Adimora, Schoenbach & Doherty, 2006; Adimora & Schoenbach, 2005] and the product of societal factors including economics and politics [Doherty, Padian, Marlow & Aral, 2005]. Network features such as concurrency (partner overlap in time), mixing (within and across behavioral levels or characteristics, such as race/ethnicity) and density (the number of connections per person) affect the likelihood that members of a given network may encounter higher-risk partners or be exposed to higher-risk individuals through intermediate partners [Doherty, Padian, Marlow & Aral, 2005]. Social and sexual network characteristics have been suggested to play a role in ongoing disparities in HIV infection among MSM in San Francisco through the mechanism of a higher probability of having an HIV-positive partner [Berry, Raymond & McFarland, 2007; Bohl, Raymond, Arnold & McFarland, 2009]. However these analyses did not consider neighborhood effects (e.g., poverty) on social and sexual networks nor did they address these factors among other high-risk populations. Finally, certain sub-groups may be constrained to participation in specific social and sexual networks based on their neighborhood of residence.

Substance use and HIV risk / HIV infection

A number of studies have described the relationship between substance use, most typically stimulants (including cocaine, crack and methamphetamine), club drugs (ecstasy, ketamine, gamma-hydroxybutyric acid (GHB) and amyl nitrate (poppers) use, HIV risk taking and HIV infection among many populations including MSM and transfemales. Researchers have documented that stimulant use is often associated with increased libido, long sessions of sexual activity, having multiple partners and unprotected sex [NIH, 2002; Molitor et al. 1998]. Plankey and colleagues (2007) documented the relationship between use of methamphetamine (MA) and poppers in a longitudinal study of MSM in the United States. They found that relative hazards for HIV infection for men who used MA and poppers were 1.46 and 2.10, respectively. [Plankey et al. 2007] Moreover, in San Francisco methamphetamine use has been shown to be associated with four-fold higher HIV incidence among users compared to non-users. Regarding club drugs, a review by Colfax and Guzman (2006) found evidence suggesting that club drugs are associated with sexual risk taking and in some cases demonstrating an independent association with HIV infection. Research among MSM in San Francisco found popper, stimulant and / or club drug use to be associated with engaging in unprotected receptive anal intercourse among HIV-negative MSM with partners whose HIV status was HIV-positive or unknown [Schwarcz et al. 2007]

Among HIV-negative MSM in San Francisco rates of use of stimulants (omitting MA), club drugs and poppers have been reportedly steady over recent years while rates of MA use have declined [Vaudrey et al. 2007]. Vaudrey et al. (2007) also estimated that the prevalence of cocaine, MA, poppers and ecstasy use among HIV-negative MSM were about 15%, 9%, 17% and 12%, respectively. The literature also suggests that transfemales also engage in stimulant, club drug and popper use. Rapues et al. (2011) reported that 42% of transfemales in San Francisco engage in non-injection drug use over the past 12 months.

While poverty does not induce substance use, a recent review suggests that factors such as fragile family bonds, mental discomfort and unemployment, which are found in areas of poverty, are also linked to substance use [Shaw, Egan & Gillespie, 2007]. Finally, the intersection of poverty, HIV/AIDS and substance use has been documented in the literature. Kuo and colleagues (2011) found that high rates of substance use among heterosexuals were centered in neighborhoods which also had high levels of AIDS and poverty.

Populations at High-Risk for HIV Infection

The Centers for Disease Control and Prevention (CDC) list men who have sex with men (53% of new infections) and African Americans (45% of new infections) as groups at highest risk for HIV infection [CDC 2010b]. Unfortunately, CDC does not yet track HIV infections among transgendered persons, particularly transfemales. However, data from San Francisco and other cities in the United States suggest that transgender persons are also at high risk for HIV infection [Herbst et al., 2008]. Moreover, Black MSM have a higher HIV prevalence compared to White MSM [CDC 2010b; CDC 2010e]. While membership in a high-risk group broadly accounts for higher levels of HIV in these populations, membership alone does not account for within high-risk group differences in rates of infection, morbidity and mortality. Individual SES and / or neighborhood factors may play a significant role in increasing the chance that ongoing HIV transmission will occur in these sub-groups.

Summary

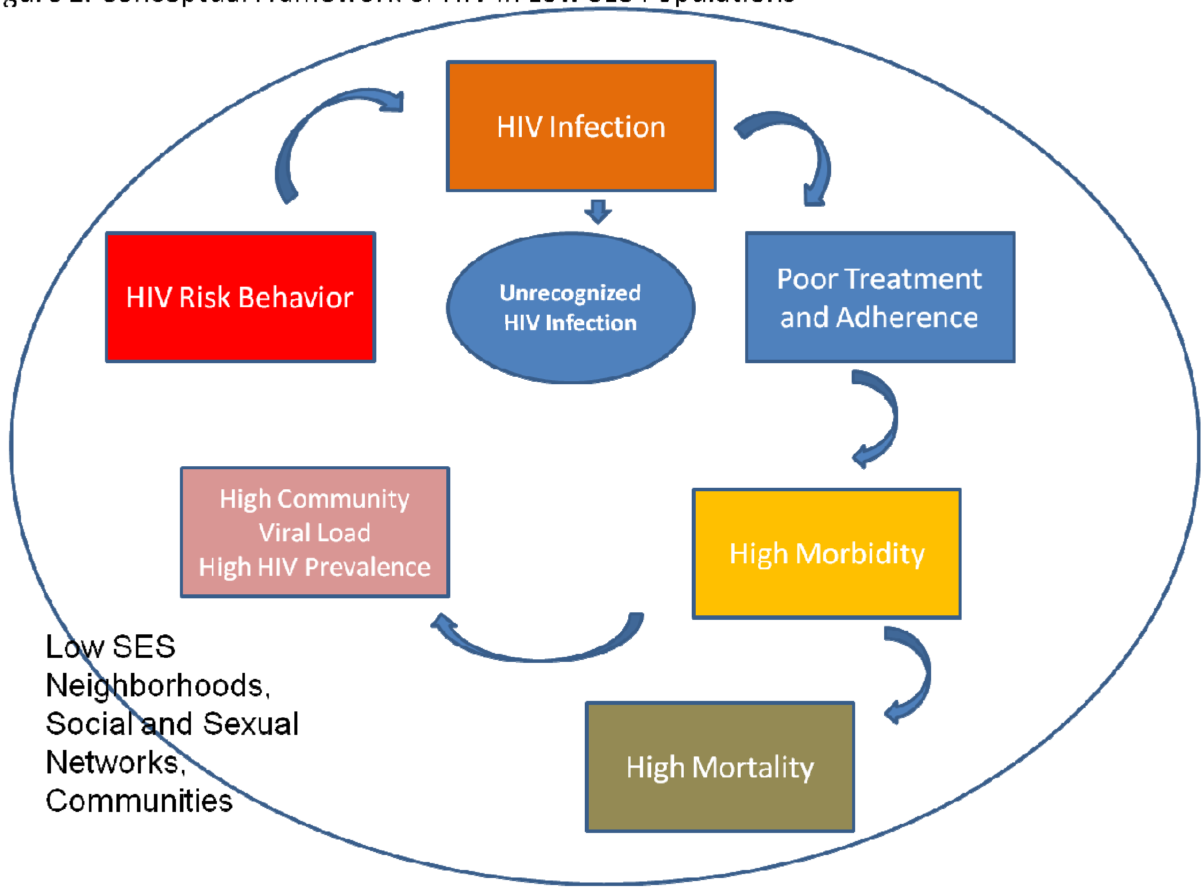
While all the dimensions of SES are complex and hard to measure, measures of poverty have been linked in associational studies to HIV risk taking and HIV infection. Reasons for this observed link are unclear as there is no direct causal link between poverty and HIV risk taking. However, the range of factors surrounding poverty and those living in poverty appear to contribute to an environment where if HIV risk taking occurs, HIV infection will more often occur than in other environments. Compounding the higher occurrence of infection are its subsequent consequences that appear to be related to poverty such as low treatment adherence leading to increased morbidity and mortality.

However, if poverty itself does not cause risk taking and subsequent infection, poverty may be a proxy for other factors that determine risk taking such as social and sexual networks. Poverty may shape the sexual networks in neighborhoods to the effect that these networks are more likely to contain individuals who are already HIV-positive thus HIV-negative residents in areas of poverty may more likely have HIV-positive partners.

Compounding HIV risk taking in sexual networks that may already contain more HIV-positive individuals are other factors associated with poverty such as substance use. Independent of SES, substance use has been shown to be strongly related to HIV risk taking and HIV infection. Furthermore, some populations at high-risk for HIV infection are also marginalized and have low SES such as Black MSM and transgendered persons.

Taken together these suggest a potent mix of factors that have either negative effects or compound those negative effects among populations who are already vulnerable to HIV risk taking and HIV infection. Research must address these underlying complexities to begin to understand how to effectively reduce ongoing HIV infections among marginalized populations.

Figure 1. Conceptual Framework of HIV in Low SES Populations



Chapter 3

Research Design and Methods

Theoretical Framework

A social epidemiologic framework guided the construction of the hypothesized relationship between individual SES, composition of sexual networks and HIV risk (Figure 2). The health outcome, HIV infection is at the core of this framework. The next layer outward includes the specific behaviors that put individuals at risk for HIV acquisition or transmission. Around the risk layer are the individual level factors that contribute to HIV risk taking (e.g. number of partners, substance use). The final two levels contain the social and structural factors that have an influence on HIV related risk taking and subsequent HIV infection. The analysis will focus on the first and fourth layers of this framework, HIV risk taking and the composition of social and sexual networks (i.e. the potential partner pool) while also taking into consideration the individual level factors in the third level.

Supplementing this framework, this analysis drew from the ecosocial lens promoted by Krieger and others [Kreiger, 2001b]. Four constructs have been proposed for an ecosocial theory of health, disease and disparities. These are embodiment, pathways to embodiment, cumulative interplay between exposure, susceptibility and resistance, and accountability and agency [Kreiger, 2001b]. Embodiment refers to how individuals physically incorporate, across their lifetimes, both physiological and social factors that affect health outcomes. Simply put, people's health is a product of both biology and social forces that accumulate over the life course or in the words of Krieger (2001c), "biological expressions of social inequality." The pathways of embodiment are the social forces in the form of power and property that dictate access to and consumption of material goods and services. Cumulative interplay examines how different factors are differentially distributed and interact with each other by neighborhood and individual. Finally, accountability and agency deal with how individuals, those responsible for public health and even epidemiologists, either seek to understand and / or act on the preceding constructs or simply ignore them [Kreiger, 2001b]. Expanding on these constructs can help build a framework that increases the ability to understand complex phenomenon such as the relationship of low SES and composition of sexual networks to HIV transmission risk. Table 1 links the constructs of an ecosocial framework to potential pathways (and hypothesized manifestations among low SES individuals and communities) that operate together to increase vulnerability to HIV among low SES individuals.

Research Questions

1. Does individual SES or living in areas with high density of HIV/AIDS cases and thus sexual networks with potentially more HIV-positives within them explain HIV acquisition risk among high-risk HIV-negative populations?
2. Are the relationships between living in areas with high density of HIV/AIDS cases and risk of HIV acquisition similar or different across high-risk populations?

Hypothesized Model

Drawing on the socio-ecological framework and an ecosocial framework, I hypothesize a focal relationship between neighborhood factors (i.e. HIV/ AIDS case density and the resulting composition of sexual networks) and HIV acquisition risk (i.e. potential transmission events (PTE), sexual events that may put an individual at risk of acquiring HIV) (Figure 3.).

The main hypothesis of this analysis is that neighborhood factors such HIV/AIDS case density or HIV prevalence and how it shapes sexual network composition may have a stronger relationship to risk behaviors related to HIV acquisition than does individual SES or individual risk behavior. Substance use is a potential confounder of this main relationship and thus was tested as such. Those persons using substances are more likely to engage in HIV acquisition risk regardless of the density of HIV/AIDS cases or HIV prevalence in their neighborhood of residence or sexual network.

Research Design and Methods

Overview

Quantitative analyses will utilize pre-existing datasets from populations of White MSM, Black MSM and transfemales obtained using quasi-population based sampling methods. Neighborhood HIV/AIDS case density will be obtained from the HIV/AIDS case registry in San Francisco. Generalized estimating equation (GEE) analysis will be used to characterize neighborhood risk levels while accounting for clustering of individuals [Hubbard et al., 2010].

Populations and Data Sources

White MSM

MSM were sampled in National HIV Behavioral Surveillance (NHBS) during 2008 (n=521). Gallagher et al. (2007) provide a description of the NHBS system. NHBS employs a quasi-population based sampling method (time location sampling (TLS) that is recommended for reach hard to reach populations [MacKellar et al., 2007; Mangani, Sabin, Saidel and Heckathorn, 2005]. Participants completed a detailed behavioral risk assessment via an interviewer administered survey. In addition to the survey, participants are tested for HIV infection. The characteristics of the overall sample have been reported elsewhere [Bohl, Raymond, Arnold & McFarland, 2009; Snowden, Raymond & McFarland, 2009]. White MSM comprised just over half of the sample (n=275) and of these, 197 self-reported being HIV-negative.

Black MSM

In 2009, the HIV Prevention Section of the San Francisco Department of Public Health piloted a novel HIV testing program among Black MSM. The project utilized a peer based recruitment strategy that was developed originally to deliver peer based harm reduction information to injecting drug users [Heckathorn, 1997]. In addition to delivering an intervention, the referral method, known as Respondent Driven Sampling (RDS), also enables researchers to adjust for biases in recruitment and to then make inferences to the population from which the sample is drawn and is often used to reach hard to reach populations [Heckathorn, 1997; Heckathorn, 2007; Mangani et al, 2005]. A total of 235 Black MSM participated in the project. In addition to participating in HIV testing, men completed a detailed behavioral assessment via an interviewer administered survey. Basic characteristics of the sample and HIV prevalence data have been reported elsewhere [Fuqua et al. 2011]. Of these 235 men, 165 reported being HIV-negative.

Transfemales

The HIV Prevention Section at the San Francisco Department of Public Health conducted a risk assessment among transfemales in 2010. Again, RDS was used to reach this hidden population through peer referral. Participants completed a detailed behavioral survey that was administered by trained interviewers. Blood samples were also collected for HIV testing. The total sample is 314 transfemales, of which 186 self-reported being HIV-negative.

Community Viral Load

Viral load measures are collected on all HIV/AIDS cases in the statutorily mandated case registry. All laboratories conducting viral load testing automatically report these data to local HIV/ AIDS case registries. Laboratory results are matched with cases which also include residential addresses. These data can then be aggregated by census tract, zip code or by neighborhood [Das et al. 2010].These data will be used to illustrate the implications of having sexual networks that may have higher numbers of HIV-positive partners.

HIV/AIDS Case Data

HIV/AIDS case reporting is a legally mandated disease reporting system. The San Francisco Department of Public Health receives all reports of AIDS and HIV-non AIDS cases. These cases are entered in the HIV/AIDS case registry and are continually updated with active surveillance (e.g. visiting doctors' offices to conduct chart abstractions). Residential address is included in the registry. These data can be requested from SFDPH and compiled into neighborhood level reports.

Quantitative Analysis Methods

Measures

Demographic measures, including race, age, income, education were collected with the same measures across all three populations. Neighborhood of residence was measured by eliciting residential ZIP code and /or census tract. Often risk taking is measured at the partnership level, that is, a person is said to have risk if they have potentially serodiscordant partnerships. However, measuring risk in that manner misses measuring the magnitude of the risk from a given partner. For example, if two HIV-negative people have two partners each where one is HIV-negative and one is HIV-positive using potentially serodiscordant partners as the measure of risk these two individuals would appear to have equal risk. However this then presents two potential sources of misclassification. First, the measure misses whether condoms are used during sexual intercourse. Secondly, the measure misses the potential situation where one individual has only a few episodes of unprotected sex and the other has many episodes. Furthermore, Vittinghoff et al. (1999) have shown that probability of HIV infection is a function of the type sex engaged in and the number of times it occurs. The per contact (episode) risk of acquiring HIV when engaging in unprotected receptive anal intercourse with an HIV-positive or unknown status insertive partners is estimated to be 0.82%. [Vittinghoff et al. 1999] Thus for this analysis HIV risk taking was defined as an HIV-negative individual engaging in unprotected anal intercourse with a partner of discordant or unknown HIV serostatus (i.e. PTE). Sexual behavior was collected using a partner by partner series of questions for up to five partners. This type of assessment allows for detail information on number of partners, number of sexual events and background characteristics of partners to be measured and is superior in investigating complex phenomenon for which aggregated sexual history data is unsuited. [Pinkerton et al. 2010] For each partner descriptors were recorded, including serostatus of the partner. Sexual activity was recorded as counts. For example, "How many times did you have receptive anal intercourse in the past six months with Partner 1? Of these times, how many times did you not use a condom?" Number of partners was measured as the total number of anal sex partners in the past six months. Number of potentially serodiscordant partners was measures as the total number of partners reported to be HIV-positive or HIV status unknown. Number of unprotected serodiscordant sex acts were summed for each respondent for use in this analysis. Substance use was measured with a substance by substance assessment for use over the past 12 months. This assessment included questions on crack cocaine use, cocaine use and MA use (i.e. stimulants). The current measure of SES was constructed using responses to two questions. "What is the highest level of education that you have completed?" and "What is your annual income?" Responses to these two questions were categorical (eight categories each). They were scaled in similar directions (i.e. higher income and higher education both had higher values on each separate scale). Responses for each were summed and then divided by two for the final SES scale with values from 1 to 8. Neighborhood HIV/AIDS case density was calculated simply by using the absolute number of cases in a neighborhood. Neighborhood HIV prevalence was calculated by dividing HIV/AIDS cases in each neighborhood by the Census population denominator for each neighborhood.

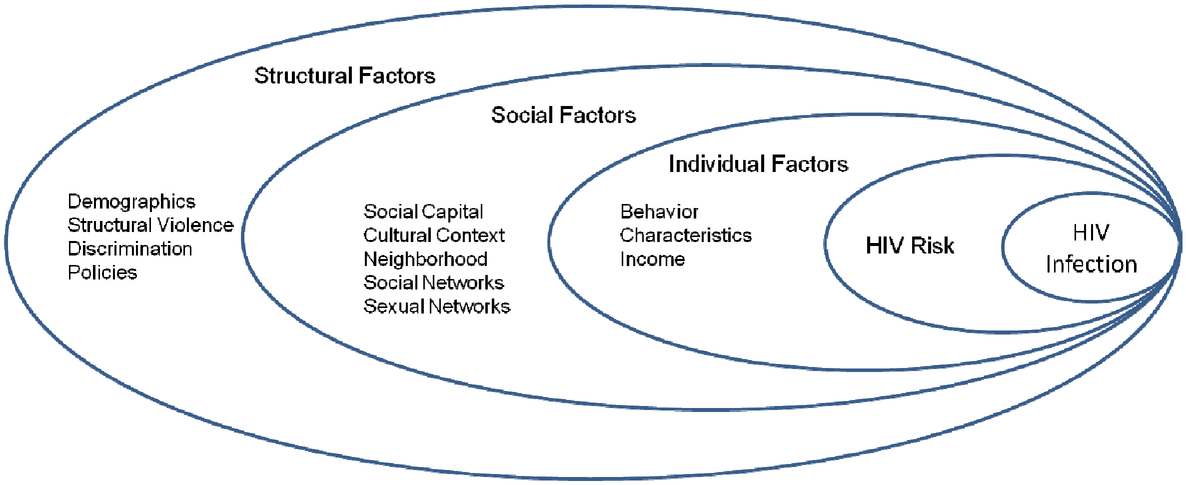
Human Subjects

IRB approval was obtained for the original primary data collection for each of the populations included in this proposal. HIV/AIDS cases registry data is legally mandated disease reporting data thus not human subjects research. Data extracted from the case registry was provided as counts stratified by zip code only. US Census data are also not human subjects research and is freely available from www.census.gov. The University of California Berkeley Office for the Protection of Human Subjects determined that this study did not constitute human subjects research.

Table 1. Ecosocial constructs and their hypothesized manifestations among low SES individuals and communities.

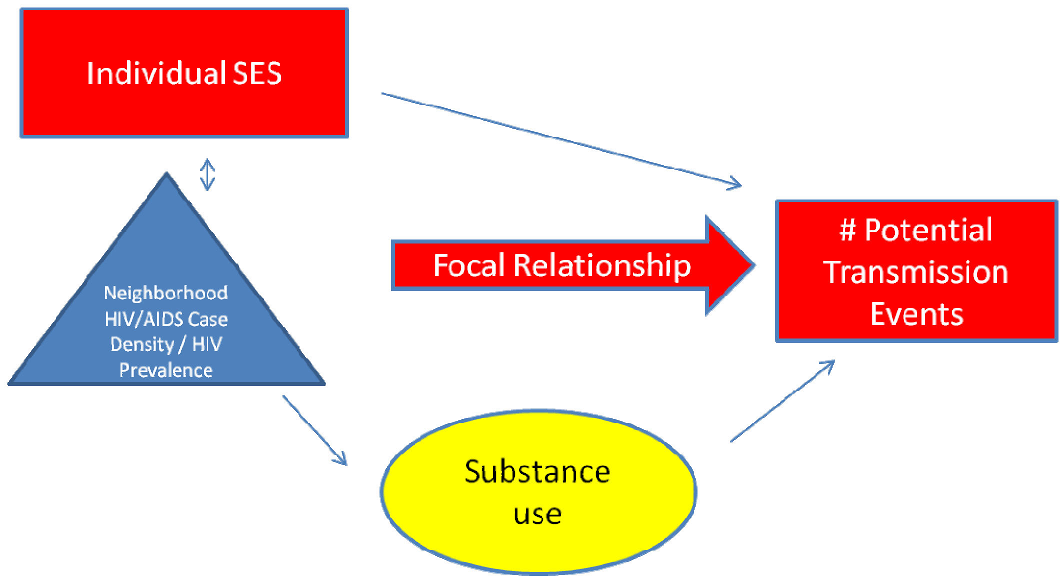
Construct	Pathway	Manifestation among low SES individuals and communities
Embodiment	Economic and social disadvantage	- Low treatment uptake and adherence. - HIV-positive individuals increased infectivity
Pathways of Embodiment	Inadequate health care	-Poverty pushes low SES individuals tightly into increasingly poor communities -HIV infection leads to loss of income potentially pushing more HIV-positive individuals into poor communities
Cumulative Interplay	Hazardous conditions	-Increased HIV prevalence and viral load in low SES communities and networks -Limited sexual partner pools -Drug and alcohol use
Accountability	Inadequate health care	-Reduced funding for AIDS Drug Assistance Program (ADAP) leading to increased CVL

Figure 2. A social epidemiologic framework for HIV infection



Adapted from Poundstone et al., 2004

Figure 3. Hypothesized relationship between HIV/AIDS case density / HIV prevalence and HIV risk taking including potential confounding variable



Chapter 4

Data Analysis

Analytic Approach

The first step in the analysis was to examine patterns of residence across the three risk groups. Individual residential neighborhood was mapped for each group using residence zip code. Historically and currently HIV/AIDS case analyses and community planning bodies use neighborhood as the geographic unit of analysis [San Francisco Department of Public Health, 2001; San Francisco HIV Prevention Planning Council, 2010]. Neighborhoods are defined culturally and not typically by zip code or census tract boundaries; however, zip codes are often used as proxies for neighborhoods. These maps were evaluated qualitatively to determine if historic patterns of residence in the three risk groups were still in effect.

Next maps of per capita income, HIV care services, HIV prevention services, HIV/AIDS case density, HIV prevalence and mean community viral load were constructed also using zip codes as the unit of analysis. These maps were also evaluated qualitatively to determine whether consistent themes emerged between residential patterns of the risk groups and the presence of enablers or inhibitors of risk were present in neighborhoods.

Univariate analyses were conducted to describe the demographics and major risk behaviors of each population group. These indicators were compared side by side across the three risk groups. SES scores, as defined for this study, were calculated and univariate descriptors (e.g. range, mean, median) were compared side by side across the three risk groups.

Next a series of stepwise bivariate analyses were conducted to evaluate elements of the study's hypothesis. First, decreasing SES was tested as a predictor of having any serodiscordant partnerships in a bivariate logistic regression model. Odds ratios, 95% confidence intervals and $\chi 2$ values were calculated to determine the effect size of the predictor and whether the effect was significant. The second relationship tested was increasing HIV/AIDS case density as a predictor of having any potential serodiscordant partnerships again using a bivariate logistic regression model.

Bivariate models were also tested using decreasing SES and increasing neighborhood HIV prevalence independently as predictors of potentially serodiscordant unprotected sex acts. As the outcome was count data a Poisson regression model was used specifying a log link and Poisson distribution. Coefficients and tests of significance were calculated. Coefficients were exponentiated producing rate ratios for easier interpretation.

Finally, step wise models were constructed to test the hypothesis that neighborhood HIV prevalence had an effect on the number of potentially serodiscordant unprotected sex acts across the three risk groups. First neighborhood HIV prevalence, individual SES and stimulant use were tested independently as predictors of the number of potentially serodiscordant unprotected sex acts. Next variables were entered stepwise into a model testing each predictor controlling for other variables in the model. Coefficients and tests of significance were produced. Coefficients were then exponentiated producing rate ratios.

Chapter 5

Results

Demographics

Included in this analysis were 165 Black men who have sex with men sampled in the Black Men Testing (BMT) Project conducted by the SFDPH HIV prevention section in 2009, 170 transfemales sampled in TEACH conducted by SFDPH HIV prevention section in 2010 and 188 White MSM sampled in NHBS in 2008. Demographic and risk characteristics are shown in Table 2. Black MSM were slightly older than both transfemales and white MSM, 70.9%, 54.2% and 40.4% of Black MSM, transfemales and White MSM were 41 years old or greater, respectively. A majority of White MSM had a college degree or greater (62.2%) while 14.7% and 13.5% of Black MSM and transfemales had a similar educational attainment, respectively. In terms of income, 54.6%, 75.3% and 11.7% of Black MSM, transfemales and White MSM reported an income of less than $15,000 USD per year, respectively. Only 54.5% of Black MSM reported having health insurance compared to 82.0% of transfemales and 77.7% of White MSM. Much higher proportions of Black MSM (38.2%) and transfemales (29.4%) reported ever injection drug use compared to 6.4% of White MSM. A large proportion of all groups reported using illicit substances in the past 12 months. Among Black MSM 71.5% reported substance use while 45.9% and 65.4% of transfemales and White MSM also reported substance use, respectively. In terms of the number of sexual partners in the past six months, 27.9% of Black MSM, 39.4% of transfemales and 43.7 % of White MSM reported having none or one partner.

HIV Risk

Sexual risk taking occurred among all three groups with 24.2%, 22.9% and 29.8% of Black MSM, transfemales and White MSM reported having any unprotected receptive anal intercourse in the past six months. Similar proportions of transfemales (40.0%) and White MSM (38.3%) reported having potentially serodiscordant partnerships while Black MSM (55.8%) reported a much higher rate of potentially serodiscordant partnerships. In terms of mean unprotected acts of sexual intercourse, Black MSM reported more acts (3.9) compared to transfemales (1.2) and White MSM (0.64).

Using educational attainment and income to create a socioeconomic status indicator, Black MSM had a mean score of 3.96, transfemales 3.59 and White MSM 6.32. Median scores for Black MSM and transfemales were similar at 4 and 3.5, respectively, while White MSM had a median score of 7. (Table 3 and Figure 4)

Using residential zip code, provided by participants, residential patterns were geocoded. The majority of Black MSM live in the Civic Center / Tenderloin, Western Addition and South of Market (SOMA) areas of the City. Transfemales generally live in the Civic Center / Tenderloin, SOMA and in the Mission. White MSM largely live in the Castro, Twin Peaks, Haight and SOMA areas. (Figures 5, 6, 7)

The areas of San Francisco with lowest income are Civic Center / Tenderloin, Excelsior, Bayview / Hunters Point and Visitacion Valley (10,000 – 19,999 USD per capita). The Mission and South of Market are also lower income (20,000 – 30,000 USD per capita) (Figure 8). HIV prevention and HIV care services appear to cluster in the Civic Center / Tenderloin, SOMA and Mission areas. (Figures 9, 10)

In terms of absolute number of HIV / AIDS cases, the Castro is highest (1,500 – 3,000 cases) while Mission, SOMA, Civic Center / Tenderlion have 1,000 – 1,499 cases in each area. HIV prevalence however, is clearly concentrated in the Castro, SOMA and Civic Center

Tenderloin (5-12% prevalence in each). Mean viral load by geographic area does not follow the pattern of HIV cases or HIV prevalence. Mean viral load is highest in the Visitacion Valley, Civic Center / Tenderloin and Polk / Russian Hill areas (Figures 11, 12, 13).

Bivariate analysis, using individual SES as a predictor of having any potentially discordant partnerships, failed to show a relationship between these two variables for transfemales (Odds Ratio [OR] 0.92, 95% Confidence Interval [CI] 0.68, 1.22, p = 0.57), Black MSM (OR 1.02, 95% CI 0.82, 1.27, p = 0.85) and White MSM (OR 1.02, 95% CI 0.86, 1.33, p=0.53). (Table 4) Bivariate analysis using increasing HIV/AIDS case density of residential zip code as a predictor of having potentially discordant partnerships failed to show significant relationships for transfemales (OR 0.76, 95% CI 0.6, 1.3, p = 0.18), Black MSM (OR 1.3, 95% CI 0.87, 1.9, p = 0.18) and White MSM (OR 0.85, 95% CI 0.65, 1.1, p =0.25. (Table 5) As a third approach, using a logistic regression model with a Poisson distribution for a continuous outcome, decreasing individual SES was tested as a predictor of the number potentially serodiscordant unprotected sex acts. Among transfemales the rate ratio suggests an almost 60% reduction in the mean number of potentially serodiscordant unprotected sex acts (β -0.45, Rate Ratio (RR) 1.6, p <0.0001) while among Black MSM the rate ratio suggests an increase of 10% in the mean number of potentially serodiscordant unprotected sex acts with each decreasing level of SES (β 0.12, RR 1.1, P <0.0001) and among White MSM the rate ratio suggests a 130% increase in the number of potentially serodiscordant unprotected sex acts with each decreasing level of SES (β 0.8, RR 2.3, p <0.0001) (Table 6).

Finally, again using a logistic regression model with a Poisson distribution for a continuous outcome, increasing residential zip code HIV prevalence was modeled as a predictor of the number of potentially discordant unprotected sex acts (Table 7). Among transfemales the rate ratio suggests a 30% increase in potentially serodiscordant unprotected sex acts for each 1% increase in residential zip code HIV prevalence (β 0.26, RR 1.3, p <0.0001). Among Black MSM the rate ratio suggests a small but not significant increase in number of potentially serodiscordant unprotected sex acts of 3% as residential zip code HIV prevalence increases each 1% (β 0.03, RR 1.03, p = 0.16). However, among White MSM the rate ratio suggests a large and significant decrease of 140% in number of potentially serodiscordant unprotected sex acts as residential zip code HIV prevalence increases each 1% (β -0.89, RR 2.4, p <0.001).

The relationship between potentially serodiscordant unprotected sex acts, residential area HIV prevalence and SES was further explored with multivariable analysis using a Poisson regression for transfemales and Black MSM. White MSM were omitted from this step as this group did not show a positive relationships between residential zip code HIV prevalence and potentially serodiscordant unprotected sex acts (i.e. there was an inverse relationship).. Results for transfemales are shown in Table 8. Steps 1 and 2 recapitulate the results from Tables 6 and 7. At Step 3 any stimulant use in the past 12 months was tested as an independent predictor of the number of potentially serodiscordant unprotected sex acts. The rate ratio for stimulant use alone suggests that those using stimulants there is on average 100% fewer acts of potentially serodiscordant unprotected sex acts compared to those who do not use stimulants (β -0.7, RR2.0, p = 0.0004). In Step 4 residential zip code HIV prevalence and individual SES were tested together as predictors of the number of potentially serodiscordant unprotected sex acts. When controlling for individual SES residential zip code HIV prevalence's rate ratio suggests that for every 1% increase in HIV prevalence there is on average 40% more potentially serodiscordant unprotected sex acts among transfemales (β 0.34, RR 1.4, p <0.0001). The rate ratio for individual SES suggests a 90% decrease in potentially serodiscordant unprotected sex acts when controlling for residential zip code HIV prevalence (β -0.66, RR 1.9, $p < 0.0001$). Step 5 tests residential zip code HIV prevalence, individual SES and stimulant use together. The results suggest that while adjusting for the other variables in the model that a 1% increase in residential zip code HIV prevalence produces, on average, a 50% increase in potentially serodiscordant unprotected sex acts (β 0.4, RR 1.5, $p < 0.0001$) while each decreasing level of individual SES produces a 100% decrease and stimulant use a 230% decrease in the number of potentially serodiscordant unprotected sex acts (β -0.7, RR 2.0, $p < 0.0001$ and β -1.2, RR 3.3, $p < 0.0001$, respectively).

In the multivariable analysis among Black MSM, Steps 1 and 2 recapitulate the findings in Tables 6 and 7. Step 3 introduces any stimulant use in the past 12 months as an independent predictor of the number of potentially serodiscordant unprotected sex acts. Stimulant use alone among Black MSM may account for a 390% increase in the average number of potentially serodiscordant unprotected sex acts (β 1.6, RR 4.9, $p < 0.0001$). Step 4 tested residential zip code HIV prevalence and individual SES together. While controlling for individual SES, residential zip code HIV prevalence had no effect on the number of potentially serodiscordant unprotected sex acts (β 0.03, RR 1.0, $p = 0.13$) while individual SES, when controlling for residential zip code HIV prevalence, had a modest effect of an increase of 10% in the average number of potentially serodiscordant unprotected sex acts (β 0.13, RR 1.1, $p < 0.0001$). Step 5 added stimulant use to the model. In this model residential zip code HIV prevalence also had no effect on the number of potentially serodiscordant unprotected sex acts while controlling for the other variables in the model (β -0.02, RR1, $p = 0.4$). The rate ratios for individual SES and stimulant use were 1.1 and 4.9, respectively in the final model suggesting a rise of 10% and 390% in the mean number of potentially serodiscordant unprotected sex acts due to individual SES and stimulant use, respectively (Table 9).

Table 2. Demographic and risk characteristics all studies

	Black MSM (BMT) N = 165		Transfemales (TEACH) n= 170		White MSM (NHBS) n = 188	
Age	n	%	n	%	n	%
18-20	1	0.61	4	2.4	0	0.0
21-25	10	6.1	21	12.4	25	13.3
26-30	13	7.9	20	11.8	28	14.9
31-35	12	7.3	13	7.6	27	14.4
36-40	12	7.3	20	11.8	32	17.0
41-45	36	21.8	29	17.1	28	14.9
46-50	34	20.6	25	14.7	17	9.0
51+	47	28.5	38	22.4	31	16.5
Education						
None	0	0	1	0.6	0	0.0
1 to 8	2	1.2	16	9.4	0	0.0
9 to 11	23	13.9	28	16.5	1	0.5
HS / GED	64	38.8	42	24.7	14	7.4
Some College	55	33.3	60	35.3	56	29.8
Bachelors	15	9.1	17	10.0	79	42.0
Any post grad	6	3.6	6	3.5	38	20.2
Income						
0-4,999	49	29.7	38	22.4	11	5.9
5-9,999	25	15.2	30	17.6	4	2.1
10-14,999	16	9.7	60	35.3	7	3.7
15-19,999	16	9.7	16	9.4	8	4.3
20-29,999	25	15.2	14	8.2	17	9.0
30-39,999	14	8.5	6	3.5	18	9.6
40-49,999	5	3	5	2.9	21	11.2
50-74,999	10	6.1	1	0.6	27	14.4
75,000+	3	1.8	0	0.0	73	38.8
Missing	2	1.2	0	0.0	2	1.1
Health insurance						
Yes	90	54.5	140	82.4	146	77.7
No	75	45.5	30	17.6	42	22.3
Seen health care provider past 6 months						
Yes	78	47.3	139	81.8	153	81.4
No	86	52.7	31	18.2	35	18.6
IDU* ever						
Yes	63	38.2	50	29.4	12	6.4
No	102	61.8	120	70.6	176	93.6

Current IDU*						
Yes	27	16.4	14	8.2	-	0.0
No	138	83.6	156	91.8	-	0.0
Any substance use						
Yes	118	71.5	78	45.9	123	65.4
No	47	28.5	92	54.1	65	34.6
Stimulant use						
Yes	98	59.4	45	26.5	54	28.7
No	67	40.6	125	73.5	134	71.3
Club drugs						
Yes	18	10.9	13	7.6	36	19.1
No	147	89.1	157	92.4	152	80.9
Popper use						
Yes	12	7.2	10	6.0	43	22.9
No	153	92.7	160	9.4	145	77.1
# partners past 6 months						
0	11	6.7	35	20.6	27	14.4
1	35	21.2	32	18.8	55	29.3
2	23	13.9	18	10.6	29	15.4
3 to 5	56	33.9	33	19.4	40	21.3
6 to 10	16	9.7	18	10.6	18	9.6
11+	24	14.6	34	20.0	17	9.0
Partner gender						
Female	57	34.6	11	6.5	5	2.7
Male	140	84.9	111	65.3	157	83.5
Transgender	15	9.1	10	5.9	1	0.5
Sexual risk						
URAI**	40	24.2	39	22.9	56	29.8
Any potentially discordant partnerships	92	55.8	68	40.0	72	38.3
Number of potentially discordant unprotected sex acts (mean, SD)	3.9	14.9	1.2	8.1	0.64	7.0

*intravenous drug user
**unprotected receptive anal intercourse

Table 3. SES Scores, Black MSM (BMT), transfemales (Teach) and White MSM (NHBS)

SES Score	BMT	Teach	NHBS
Range	1.5-7.5	1.0-7.0	2.5-8
Mean	3.96	3.59	6.32
Median	4	3.5	7
Mode	2.5	4	7
Interquartile Range Width	2.5	1	2

Table 4. Decreasing SES as a predictor of any potential serodiscordant partnerships, Black MSM (BMT), transfemales (Teach) and White MSM (NHBS)

Sample	OR	95% CI	P
Teach	0.922	0.68, 1.22	0.569
BMT	1.02	0.82, 1.27	0.85
NHBS	1.02	0.86, 1.33	0.53

Table 5. Increasing HIV/AIDS Case density as a predictor of any potential serodiscordant partnerships, Black MSM (BMT), transfemales (Teach) and White MSM (NHBS)

Sample	OR	95% CI	P
Teach	0.76	0.56, 1.3	0.18
BMT	1.3	0.87, 1.9	0.18
NHBS	0.85	0.65, 1.1	0.25

Table 6. Decreasing individual SES as a predictor of number of potentially serodiscordant unprotected sex acts, Black MSM (BMT), transfemales (Teach) and White MSM (NHBS)

Sample	β	95% CI β	RR	P
Teach	-0.45	-0.56, -0.35	1.56	< 0.0001
BMT	0.12	0.07, 0.12	1.13	< 0.0001
NHBS	0.8	0.7, 0.9	2.25	< 0.0001

Table 7. Increasing neighborhood HIV prevalence as a predictor of number of potentially serodiscordant unprotected sex acts, Black MSM (BMT), transfemales (Teach) and White MSM (NHBS)

Sample	β	95% CI β	RR	P
Teach	0.26	0.2, 0.3	1.29	<0.0001
BMT	0.03	-0.01, 0.07	1.03	0.16
NHBS	-0.89	-1.07, 0.72	2.40	<0.001

Table 8. Predictors of increasing number of potentially serodiscordant unprotected sex acts, transfemales (TEACH).

	Variable	β	RR	P
Step 1	ZipHP	0.26	1.29	< 0.0001
Step 2	ISES	-0.45	1.6	< 0.0001
Step 3	Stimulant Use	-0.7	2.0	0.0004
Step 4	ZipHP	0.34	1.4	< 0.0001
	ISES	-0.66	1.9	< 0.0001
Step 5	ZipHP	0.4	1.5	<0.0001
	ISES	-0.7	2.0	<0.0001
	Stimulant Use	-1.2	3.3	<0.0001

ZipHP – residential zip code HIV prevalence, increasing
ISES – individual SES measure, decreasing

Table 9. Predictors of increasing number of potentially serodiscordant unprotected sex acts, Black MSM (BMT).

	Variable	β	RR	P
Step 1	ZipHP	0.03	1.0	0.16
Step 2	ISES	0.13	1.1	< 0.0001
Step 3	Stimulant Use	1.6	4.9	<0.0001
Step 4	ZipHP	0.03	1.0	0.13
	ISES	0.13	1.1	< 0.0001
Step 5	ZipHP	-0.02	1.0	0.4
	ISES	0.1	1.1	0.002
	Stimulant Use	1.6	4.9	<0.0001

ZipHP – residential zip code HIV prevalence, increasing
ISES – individual SES measure, decreasing

Figure 4. SES scores, Black MSM, transfemales, White MSM, San Francisco

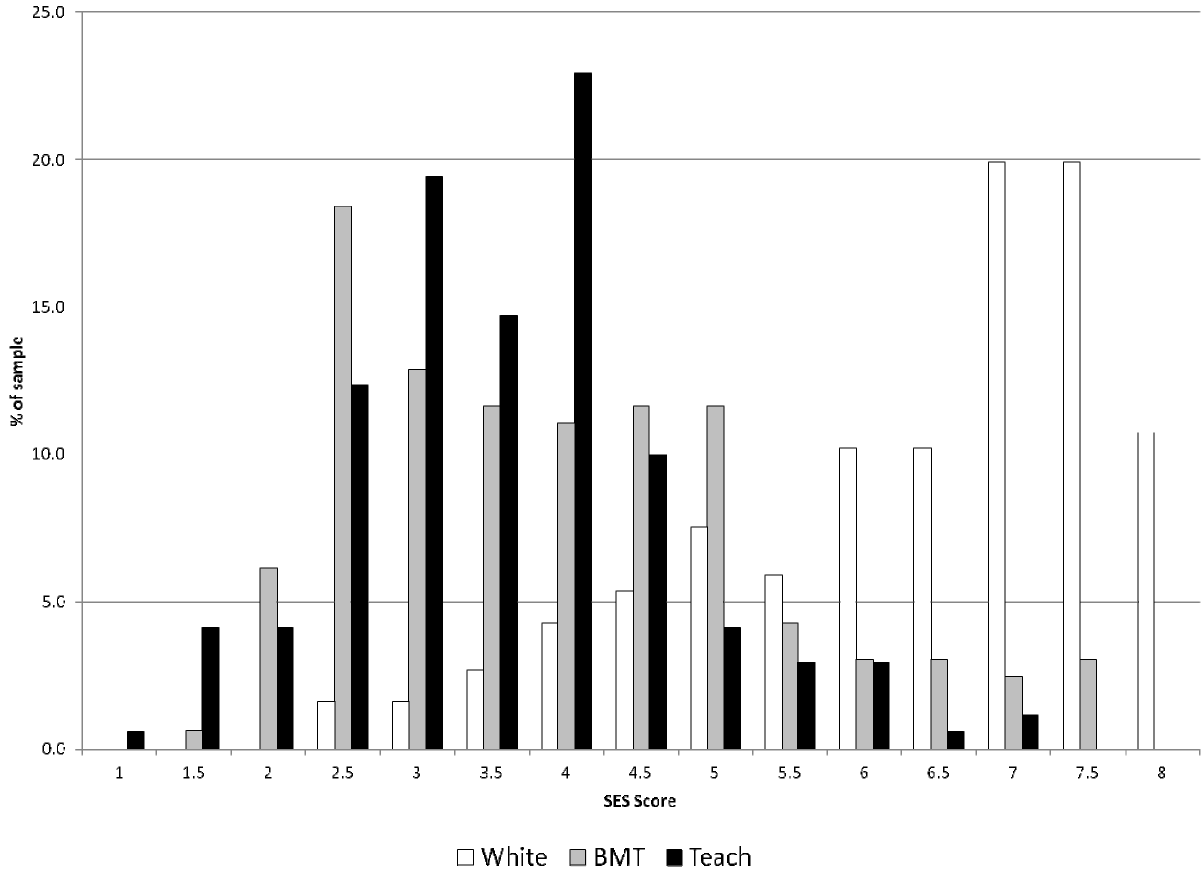


Figure 5. Geographic Distribution of Black MSM by Residence

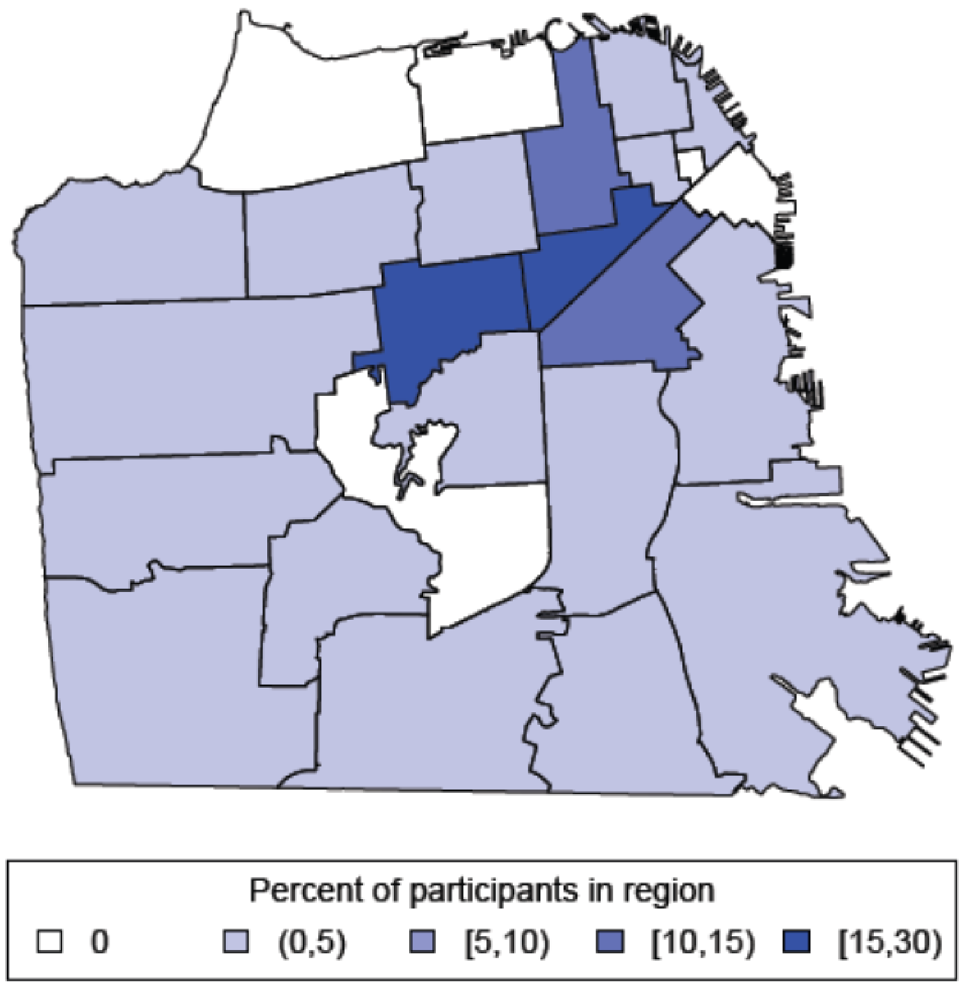


Figure 6. Geographic Distribution of transfemales by Residence

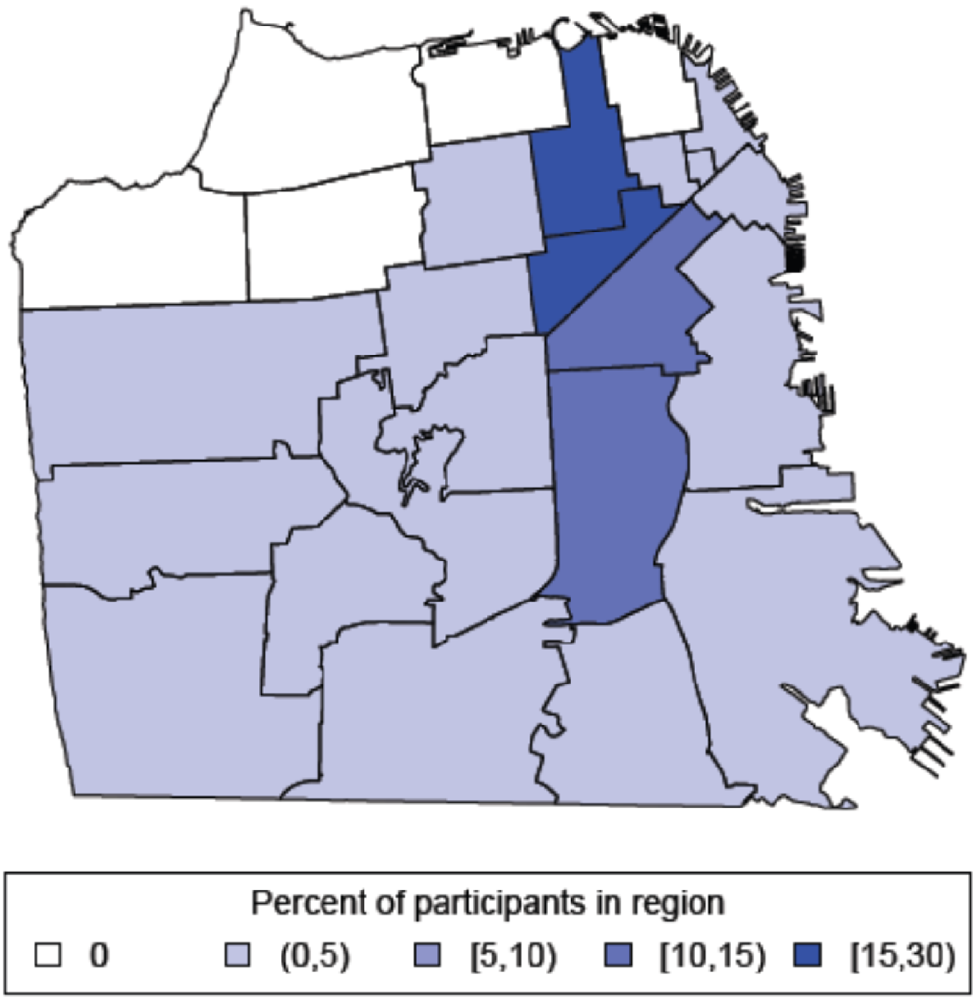


Figure 7. Geographic Distribution of White MSM by Residence

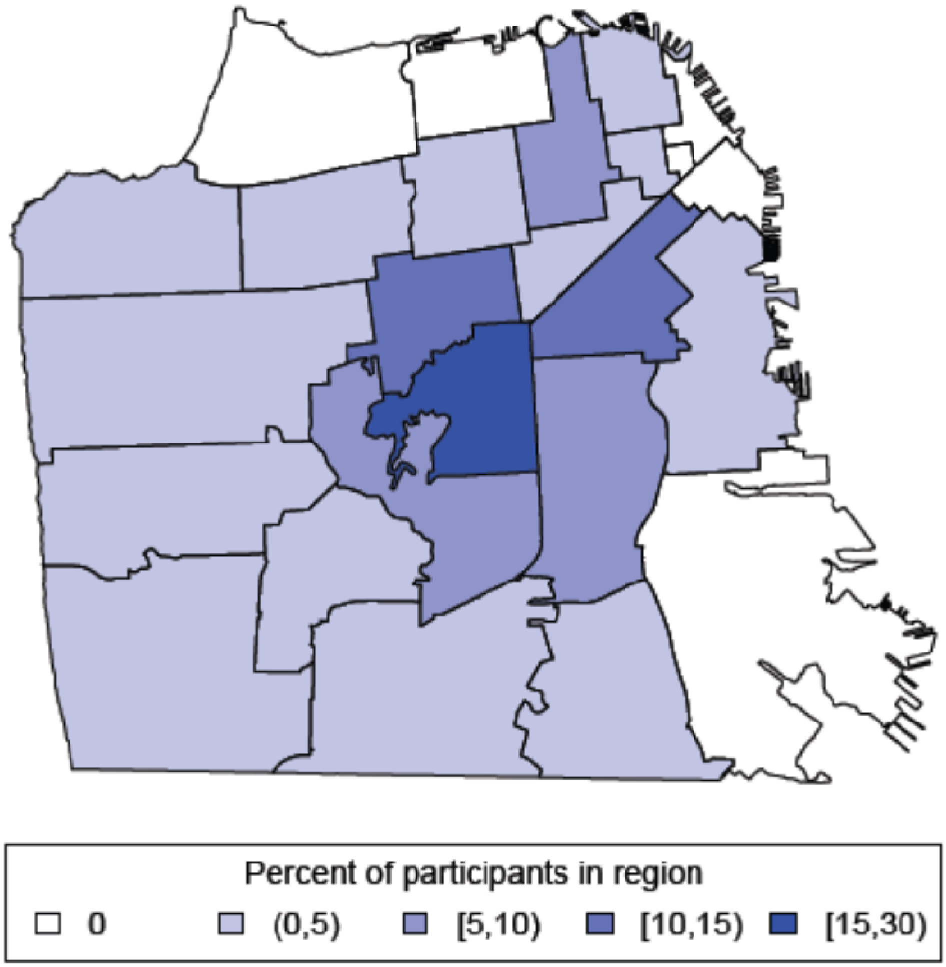


Figure 8. Geographic Distribution of Income, San Francisco

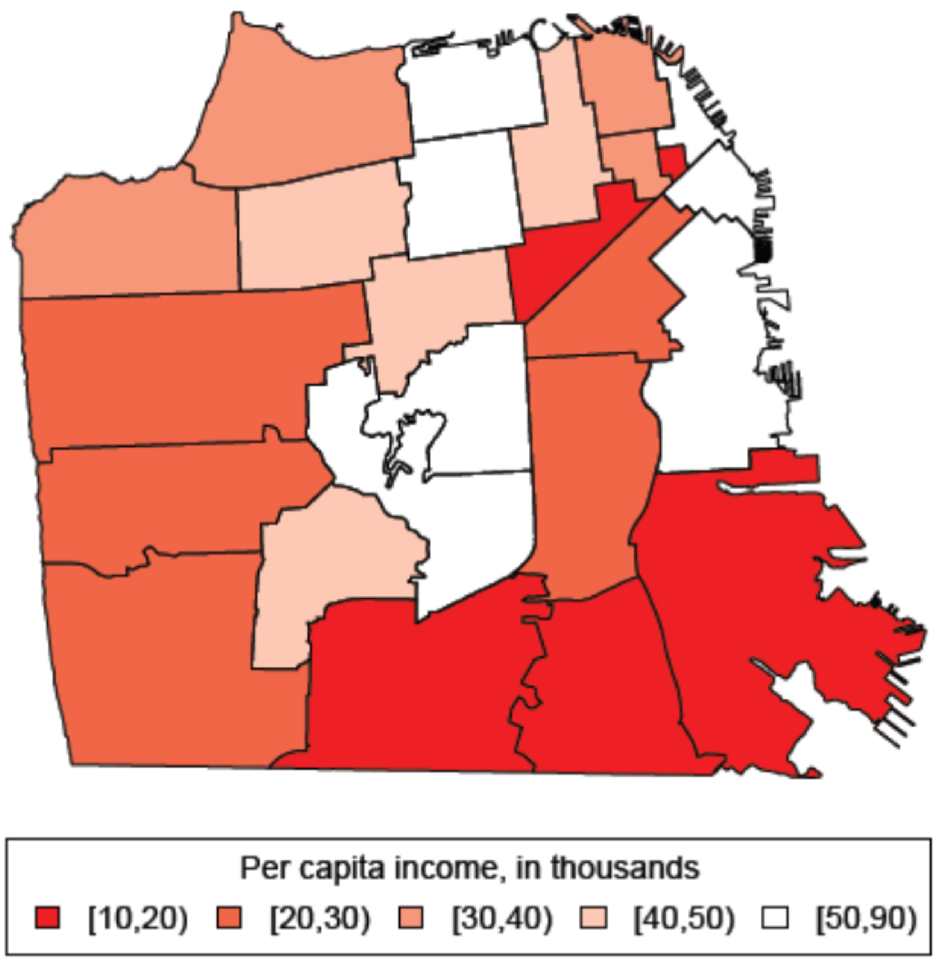


Figure 9. Geographic Distribution of HIV Care Services, San Francisco

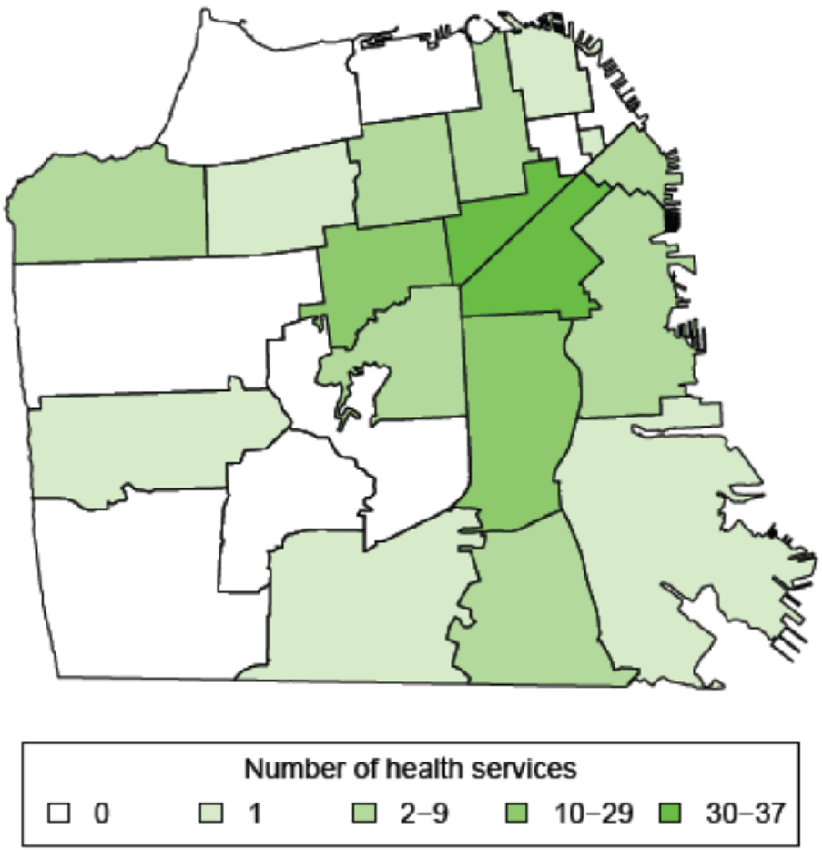


Figure 10. Geographic Distribution of Prevention Services, San Francisco

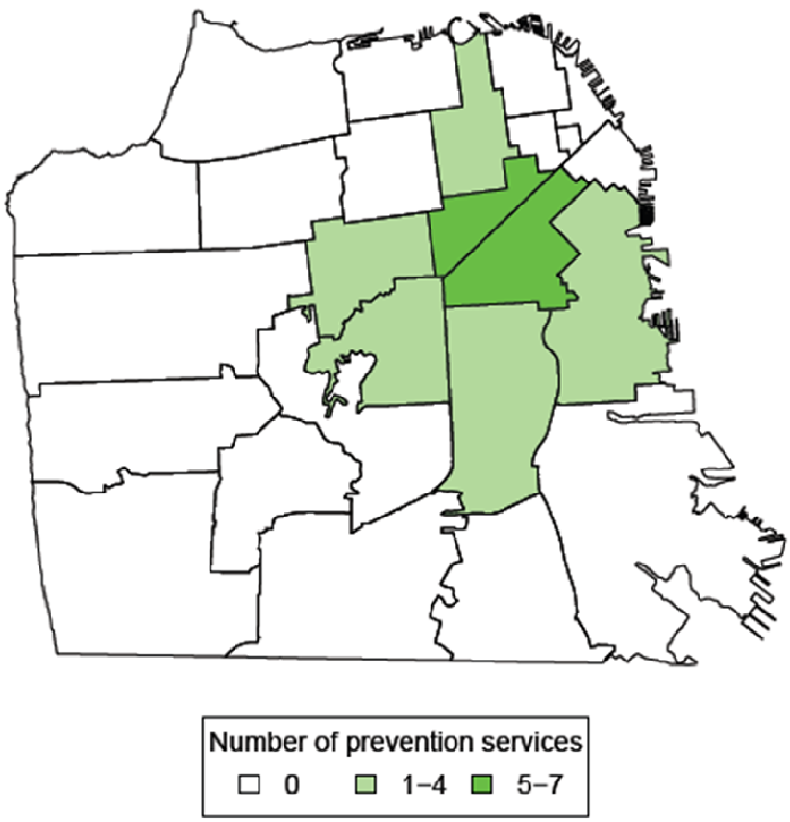


Figure 11. Geographic Distribution of HIV/AIDS cases, San Francisco

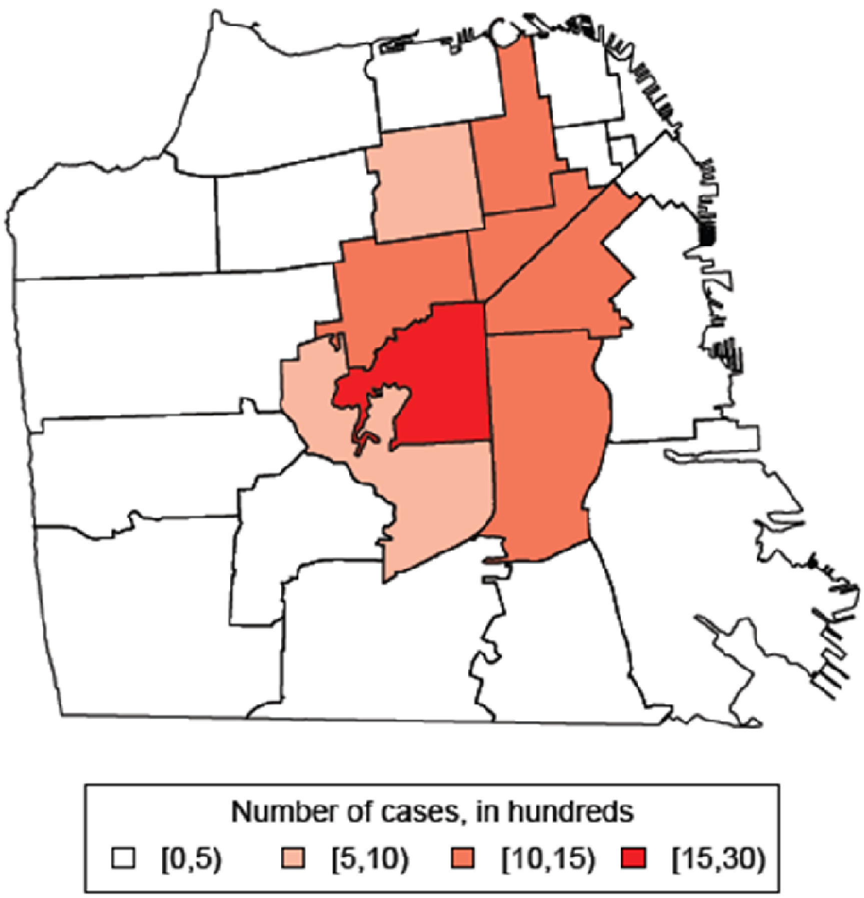


Figure 12. Geographic Distribution of HIV prevalence, San Francisco

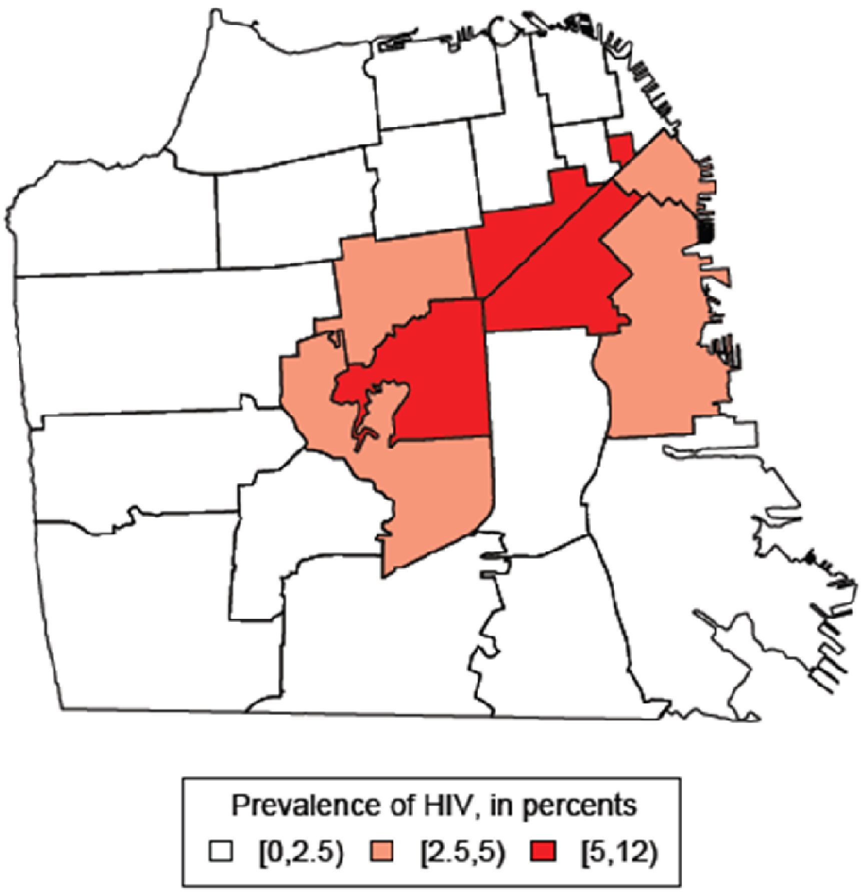
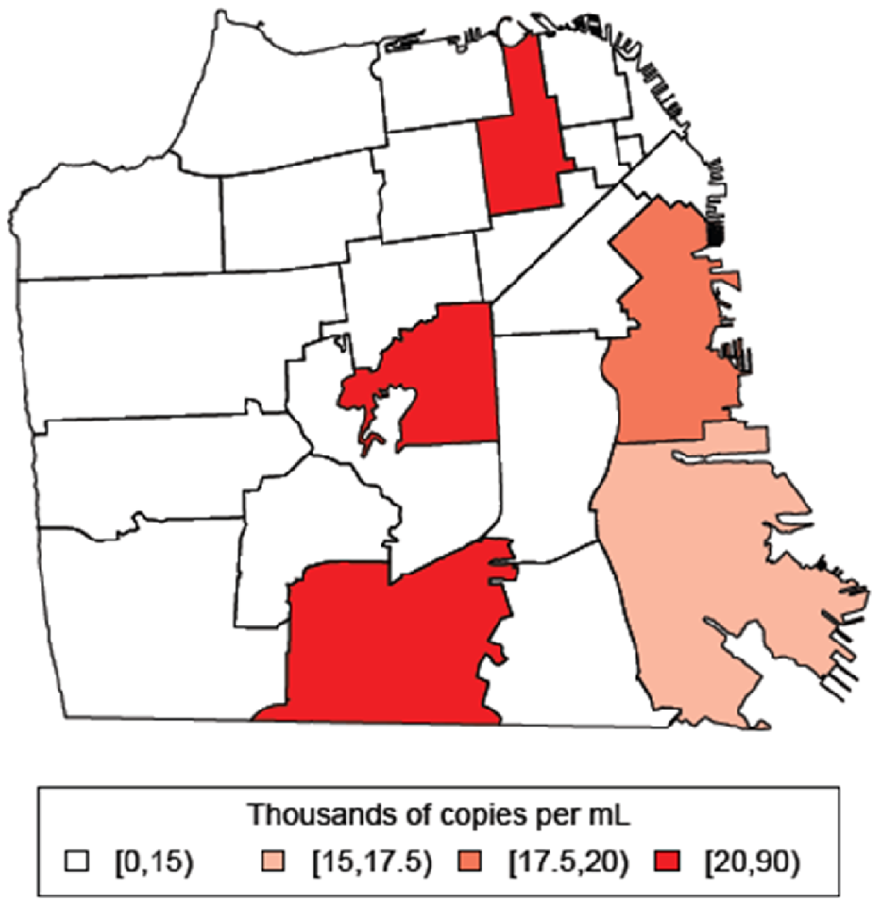


Figure 13. Geographic Distribution of Mean Community Viral Load, San Francisco



Chapter 6

Discussion

The geographic analysis of neighborhood characteristics in San Francisco suggest that Black MSM and transfemales are residentially clustered in neighborhoods which also have low income levels while White MSM are more heterogenous in their neighborhoods of residence. In broad strokes, low income neighborhoods are not necessarily the neighborhoods with highest levels of HIV prevalence of HIV/AIDS case density. Neighborhoods such as Vistitacion Valley and Bayview Hunters Point are at the lowest levels of income in San Francisco but have fewest numbers of HIV/AIDS cases and lowest HIV prevalence. As expected however, low income, being transfemale or a Black MSM, high HIV/AIDS case density and high HIV prevalence do cluster in just a few neighborhoods of San Francisco such as the Tenderloin and South of Market. At the same time, HIV care and HIV prevention services are also located in these same neighborhoods. This suggests that services are to some extent correctly targeted to the locations where they are needed most. Finally, there was one glaring exception to the apparent clustering seen neighborhood characteristics. Mean community viral load did not cluster in the same areas as high HIV prevalence, but rather the highest levels of mean viral load were spread out across the city.

In terms of the populations of interest, the present analysis was able to use data from reasonably large samples of each of the populations thus permitting some general level of reliability in the present findings. In general, Black MSM and transfemales are more similar demographically than they are to White MSM. White MSM are more likely to have college education or greater, have higher incomes and have health insurance. In terms of SES, as measured in this analysis, White MSM had the highest SES scores while Black MSM and transfemales had similar, lower levels of SES. In terms of risk behavior, Black MSM and transfemales appeared to have higher levels of intravenous drug use than White MSM. However, in terms of other drug use, numbers of partners in the past six months and sexual risk taking, all three populations were in a broad sense similar.

The present analysis has mixed findings in regards to the hypothesized relationships of HIV/AIDS case density / HIV prevalence, individual SES and HIV risk taking behaviors among three groups at high-risk for HIV infection. In all three populations decreasing SES was not related to having potentially serodiscordant partnerships. Exploration of neighborhood HIV/AIDS case density as a predictor of potentially serodiscordant partnerships also found no relationship across the three populations. However, when using the number of potentially serodiscordant unprotected sex acts as the outcome of interest divergent patterns emerged. Among transfemales, decreasing SES had an inverse relationship to the number of potentially serodiscordant unprotected sex acts while among Black and White MSM decreasing SES appears to be related to engaging in, on average, more acts of potentially serodiscordant unprotected sex. In terms of neighborhood HIV prevalence, among transfemales increasing neighborhood HIV prevalence was significantly related to an almost 30% increase in the mean number of potentially serodiscordant unprotected sex acts while among Black MSM the relationship was nil. Among White MSM however, increasing neighborhood HIV prevalence was significantly related to an almost 140% decline in the mean number of potentially serodiscordant unprotected sex acts.

Multivariable models of increasing numbers of potentially serodiscordant unprotected sex acts among transfemales and Black MSM also showed divergent patterns. Among transfemales increasing neighborhood HIV prevalence was consistently and significantly associated with increases in mean numbers of potentially serodiscordant unprotected sex acts when controlling for individual SES and stimulant use. Among Black MSM stimulant use was by far more strongly related to increases in the mean number of potentially serodiscordant unprotected sex acts while controlling for neighborhood HIV prevalence and SES.

Limitations

This analysis is not without limitations. First, all risk behaviors were self-reported and as such could suffer from reporting bias particularly recalling number of episodes of sex. Second, participants were limited to reporting on five partners each. It is possible that those individuals with greater numbers of partners also engage in higher numbers of potentially serodiscordant unprotected sex acts and thus those data were not available for this analysis. However, the partner by partner assessments did capture the majority of respondent's entire sexual partnerships over the recall period as most had five partners or fewer. Third and related to the limitation above, the present analysis relied on very few reported acts of potentially serodiscordant unprotected sex. Fourth, the current measure of SES omitted some factors thought critical to a complete conceptualization and operationalization of SES such as income over time, wealth and societal esteem. Nonetheless, the crude measure of SES presented here did allow differences between populations to be described. Finally, the findings in this analysis are not necessarily generalizable to other populations and contexts. Despite these limitations, the current analysis does extend our understanding of the complexities of the relationship of SES, neighborhood characteristics and HIV risk taking among three populations at high-risk for HIV infection.

Chapter 7

Implications

The HIV epidemic in the United States is characterized by infections disproportionately affecting socially marginalized groups. These groups, such as MSM and IDU, have borne a higher burden of disease [CDC, 2010c]. Other marginalized groups such as transfemales, Black MSM and the poor are also disproportionately affected in terms of HIV prevalence [CDC, 2010d; CDC, 2010e; Herbst et al., 2009]. In addition to being stigmatized for being MSM and transfemales, these populations also often suffer economic deprivation and social isolation [CDC 2010e; Raymond and McFarland, 2009; Transgender Law Center, 2009]. Much of the intervention research conducted to date among MSM has focused on intrapersonal or interpersonal risk reduction strategies [Johnson et al., 2008] while a few have focused on community building [Kegeles, Hays & Coates, 1996; Kegeles, Hays, Pollack & Coates, 1999; Hayes, Rebchook & Kegeles, 2003]. Interventions with evidence of efficacy have been assembled in the CDC's 2009 Compendium of Evidence Based HIV Prevention Interventions [CDC, 2010f]. None of these interventions address structural or systems level factors and none are designed for transfemales. After over 25 years of pursuing risk reduction with these approaches and still not diminishing disparities in HIV burden, new approaches that address underlying structural issues such as poverty and racism have been called for [Auerbach, 2009; Blankenship, Freidman, Dworkin & Mantell, 2006; Gupta, Parkhurst, Ogden, Aggleton & Mahal, 2008; Sumartojo, Doll Holtgrave, Gayle & Merson, 2000; Sumajarto, 2000; Wohleilfer, 2000].

The present analysis suggests that interventions must take into account the very specific contexts and patterns of behavior related to HIV risk taking on a sub-population basis. Interventions that consider the role of SES in efforts to reduce risk of HIV infection may be useful for Black MSM but not for transfemales and White MSM. These SES based interventions have included direct individual economic benefits [Riley et al., 2005], economic empowerment [Greig & Koopman, 2003; Kim et al., 2008], housing [Shubert & Bernstine, 2007] and microenterprise [Sherman et al., 2006; Stratford et al., 2008]. While these proposed interventions appear to have some effect in reducing HIV infection and its consequences, they typically only address individual level SES. Further work will be needed to tailor these and / or develop new interventions for Black MSM. Moreover, the current findings also underscore that for some populations individual level behaviors, such as stimulant use, still have a stronger relationship to risk taking compared to more distal factors such as individual SES. Undoubtedly interventions will need to address multiple factors to reduce HIV risk taking.

Individual level SES interventions may not by themselves be effective. Structural interventions that address the effects community or social / sexual network factors on HIV risk taking are needed [Levins & Lopez, 1999]. The findings in this analysis support the call for structural interventions for transfemales. Clearly higher HIV prevalence in particular neighborhoods in San Francisco is linked to higher average numbers of risky sexual acts and thus the potential for ongoing HIV infections. Efforts to ensure that the potential for high HIV prevalence leading to ongoing transmission is ameliorated on the population level by reducing infectiousness at the individual level are needed. These interventions could include improved treatment coverage targeted not at specific populations only but also at geographic areas with high levels of HIV infection already.

An additional finding deserves mention here. HIV related services appear to be located in neighborhoods of ongoing high levels of HIV prevalence, HIV/AIDS case density and presumably higher rates of HIV transmission than in other neighborhoods. On one level that the services are located in highly affected areas is encouraging in their appropriate targeting. On another level, it is dismaying to see that their concentration in such affected neighborhoods has not translated to the reduction in indicators of risk reduction and treatment impact. Further research and program evaluation on how they can operate within their SES context beyond simply locating them there is needed.

References

Adimora, A.A., Schoenbach, V.J. & Doherty, I.A. (2006). HIV and African Americans in the Southern United States: Sexual networks and social context. *Sexually Transmitted Diseases.* 33(7): S39-S45.

Adimora, A.A., Schoenbach, V.J., Martinson, F.E.A., Coyne-Beasley, T., Doherty, I., Stancil, T.R. & Fullilove, R.E. (2006). Heterosexually transmitted HIV infection among African Americans in North Carolina. *Journal of Acquired Immune Deficiency Syndromes.* 41(5): 616-623.

Adimora, A.A. & Schoenbach, V.J. (2005). Social context, sexual networks, and racial disparities in rates of sexually transmitted infections. *The Journal of Infectious Diseases.* 191(S1):S115-S122.

Adler, N.E., Boyce, T., Chesney, M.A., Folkman, S. & Syme, L. (1993). Socioeconomic inequalities in health. No easy solution. *JAMA*. 269: 3140-3145.

Anderson, R.T., Sorlie, P., Backlund, E., Johnson, N. & Kaplan, G.A. (1996). Mortality effects of community socioeconomic status. *Epidemiology.* 8(1): 42-47.

Annang, L.,Walsemann, K.M., Maitra, D. & Kerr, J.C. (2010). Does education matter? Examining racial differences in the association between education and STI diagnosis among Black and White young adult females in the U.S. *Public Health Reports.* 125 (S4): 110-121.

Aral, S.O., Adimora, A.A. & Fenton, K.A. (2008). Understanding and responding to disparities in HIV and other sexually transmitted infections in African Americans. *Lancet.* 372:337-340.

Arnold, M., Hsu, L., Pipkin, S., McFarland, W. & Rutherford, G.W. (2009a). Race, place and AIDS: The role of socioeconomic context on racial disparities in treatment and survival in San Francisco. *Social Science and Medicine.* 69(1): 121-128.

Arnold, M.P., Raymond, H.F. & McFarland, W. (2009b). Socioeconomic position and HIV risk-relevant behavior among lower-income heterosexuals in San Francisco. *AIDS and Behavior.* E Pub.

Auerbach, J. (2009). Transforming social structures and environments to help in HIV prevention. *Health Affairs.* 28(6): 1655-1665.

Berry, M., Raymond, H.F. & McFarland, W. (2007). Same race and older partner selection may explain higher HIV prevalence among black men who have sex with men. *AIDS.* 21 (17): 2349-2350.

Blankenship, K.M., Friedman, S.R., Dworkin, S. & Mantell, J.E. (2006). Structural interventions: Concepts, challenges and opportunities for research. *Journal of Urban Health.* 83(1): 59-72.

Bohl, D.D., Raymond, H.F., Arnold, M.P. & McFarland, W. (2009). Concurrent sexual partnerships and racial disparities in HIV infection among men who have sex with men. *Sexually Transmitted Infections.* 85(5):367-9.

Borrell, C., Rodriguez-Sanz, M., Pasarin, M.I., Brugal, M. T., Garcia-de-Olalla, P., Mari-Dell'Olmo, M. & Cayla, J. (2006). AIDS mortality before and after the introduction of highly active antiretroviral therapy: does it vary with socioeconomic group in a country with a National Health System? *European Journal of Public Health.* 16(6): 601-608.

Centers for Disease Control and Prevention (2010a). Estimated numbers of cases of HIV/AIDS, by year of diagnosis and selected characteristics, 2004–2007—34 states and 5 U.S. dependent areas with confidential name-based HIV infection reporting Available at http://www.cdc.gov/hiv/topics/surveillance/resources/reports/2007report/table1.htm Accessed April 24, 2010.

Centers for Disease Control and Prevention. (2010b). HIV/AIDS Cases by race/ethnicity. Available at http://www.cdc.gov/hiv/topics/surveillance/basic.htm#hivaidsrace Accessed April 24, 2010.

Centers for Disease Control and Prevention. (2010c). HIV/AIDS in the United States. Available at http://www.cdc.gov/hiv/resources/factsheets/us.htm. Accessed August 21, 2010.

Centers for Disease Control and Prevention. (2010d). HIV among gay, bisexual and other men who have sex with men (MSM). Available at http://www.cdc.gov/nchhstp/newsroom/docs/FastFacts-MSM-FINAL508COMP.pdf . Accessed August 21, 2010.

Centers for Disease Control and Prevention (2010e). Prevalence and awareness of HIV infection among men who have sex with men- 21 cities, United States, 2008. *MMWR.* 59(37):1201-1207.

Centers for Disease Control and Prevention (2010f). 2009 Compendium of Evidence Based HIV prevention Interventions. Available at http://www.cdc.gov/hiv/topics/research/prs/evidence-based-interventions.htm Accessed October 1, 2010.

Cornelius, L.J., Okundaye, J.N. & Manning, M.C. (2000). Human Immunodeficiency Virus-related risk behavior among African-American females. *Journal of the National Medical Association.* 92: 183-195.

Cunningham, W.E., Hays, R.D., Duan, N., Andersen, R.M., Nakazono, T.T., Bozzette, S.A. & Shapiro, M.F. (2005). The effect of socioeconomic status on the survival of people receiving care for HIV infection in the United States. *Journal of Health Care for the Poor and Underserved.* 16: 655-676.

Das, M., Chu, P.L., Santos, G-M., Scheer, S., Vittinghoff, E., McFarland, W. & Colfax, G. (2010). Decreases in community viral load are accompanied by reductions in new HIV infections in San Francisco. *PLOS One.* DOI: 10.1371/journal.pone.0011068.

Davey Smith, G., Hart, C., Watt, G., Hole, D. & Hawthorne, V. (1998). Individual social class, area-based deprivation, cardiovascular disease risk factors, and mortality: the Renfrew and Paisley study. *Journal of Epidemiology and Community Health.* 52:399-405.

Denning, P. & DiNenno, L. (2010). Communities in crisis: Is there a generalized epidemic in impoverished urban areas of the United States? *Poster Presentation WEPDD101.* XVIII International AIDS Conference. Vienna, Austria. July, 2010.

Deonandan, R., Campbell, K., Ostbye, T., Tummon, I. & Robertson, J. (2000). A comparison of methods for measuring socio-economic status by occupation or postal area. *Chronic Diseases in Canada.* 21(3): 114-118.

Diez-Roux, A.V. Nieto, F.N. Muntaner, C., Tyroler, H.A, Comstock, G.W., Shahar, E., Cooper, L.S., Watson, R.L. & Szklo, M. (1997). Neighborhood environments and coronary heart disease: A multilevel analysis. *American Journal of Epidemiology.* 146(1):48-63.

Doherty, I.A., Padian, N.S., Marlow, C. & Aral, S.O. (2005). Determinants and consequences of sexual networks as they affect the spread of sexually transmitted diseases. *Journal of Infectious Diseases.* 191(Supp1. 1): S42-S54.

Encarta. (2010). Poverty. Available at http://encarta.msn.com/encnet/features/dictionary/DictionaryResults.aspx?lextype=3&search=poverty Accessed October 1, 2010.

Falagas, M.E., Zarkadoulia, E.A., Pliatsika, P.A. & Panos, G. (2008). Socioeconomic status (SES) as a determinant of adherence to treatment in HIV infected patients: a systematic review of the literature. *Retrovirology.* 5:13. Doi: 10.1186/1742-4690-5-13.

Farmer, P., Lindenbaum, S. & Devecchio-Good, M. (1993). Women, poverty and AIDS: An introduction. *Culture, Medicine and Pyschiatry.* 17: 387-397.

Fein, O. (1995). The influence of social class on health status: American and British research on health inequalities. *Journal of General Internal Medicine.* 10:577-586.

Fenton, L. (2004). Preventing HIV/AIDS through poverty reduction: the only sustainable solution? 2004. *Lancet.* 64:1186-1187.

Friedman, S.R., Neaigus, A., Jose, B., Curtis, R., Goldstein, M., Ildefonso, G., Rothenberg, R.B. & Des Jarlais, D.C. (1997). Sociometric risk networks and risk for HIV infection. *AJPH.* 87(8): 1289-1296.

Fuqua, V., Chen, Y.H., Packer, T., Dowling, T., Ick, T.O., Nguyen, B.H, Colfax, G.N. & Raymond, H.F. (2011). Using social networks to reach Black MSM for HIV testing and linkage to care. *AIDS and Behavior.* In Press.

Gallagher, K.M., Sullivan, P.S., Lansky, A. & Onorato, I.M. (2007). Behavioral surveillance among people at risk for HIV infection in the U.S.: the National Behavioral Surveillance System. *Public Health Reports.* 122 Sup. 1: 32-8.

Gillespie, S., Kadiyala, S. & Greener, R. (2007). Is poverty or wealth driving HIV transmission. *AIDS.* 21(S7): S5-S16.

Greig, F.E. & Koopman, C. (2003). Multilevel analysis of women's empowerment and HIV prevention: Qualitative survey results from a preliminary study in Botswanna. *AIDS and Behavior.* 7(2): 195-208.

Gupta, G.R., Parkhurst, J.O., Ogden, J.A., Aggelton, P. & Mahal, A. (2008). Structural approaches to HIV prevention. *Lancet.* 372:764-775.

Colfax, G. & Guzman, R. (2006). Club drugs and HIV infection: a review. *Clin Infect Dis.* 42(10):1463-9.

Haan, M., Kaplan, G.A. & Camacho, T. (1987). Poverty and Health: Prospective evidence from the Alameda County study. *American Journal of Epidemiology.* 1125(6):989-998.

Hayes, R.B., Rebchook, G.M. & Kegeles, S.M. (2003). The Mpowerment Project: Community-building with young gay and bisexual men to prevent HIV. *American Journal of Community Psychology.* 31(3/4): 301-312.

Health and Human Services. (2009). 2009 Poverty Guidelines. *Federal Register.* 74(14): 4199-4201.

Health and Human Services. (2010). The 2009 Federal Poverty Guidelines. Available at http://aspe.hhs.gov/poverty/09poverty.shtml Accessed October 1, 2010.

Heckathorn, D. D. (1997). Respondent-driven Sampling: A New Approach to the Study of Hidden Populations. *Social Problems,* 44, 174-199.

Heckathorn, D.D. (2007). Extensions of respondent driven sampling: Analyzing continuous variable and controlling for differential recruitment. *Sociological Methodology.* 37 (1): 151-207.

Herbst, J.H., Jacobs, E.D., Finlayson, T.J., McKleroy, V.S., Neumann, M.S. & Crepaz, N. (2008). Estimating HIV prevalence and risk behaviors of transgender persons in the United States: A systematic review. *AIDS and Behavior.* 12(1): 1-7.

Hochstim, J.R., Athanasopoulos, D.A. & Larkins, J.H. (1968). Poverty area under the microscope. *American Journal of Public Health.* 58 (10): 1815-1827.

Hogben, M. & Leichliter, J.S. (2008). Social determinants and sexually transmitted disease disparities. *Sexually Transmitted Diseases.* 35(12): S13-S18.

Hogg. R.S., Strathdee, S.A., Craib, K.J.P., O'Shaughnessy, M.V., Montaner, J.S.G. & Schechter, M.T. (1994). Lower socioeconomic status and shorter survival following HIV infection. *Lancet.* 344: 1120-1124.

Hubbard, A.E., Ahern, J., Fleischer, N.L., Van der Laan, M., Lippman, S.A., Jewell, N., Bruckner, T. & Satariano, W.A. (2010). To GEE or not to GEE: comparing population average and mixed models for estimating the associations between neighborhood risk factors and health. *Epidemiology.* 21 (4):467-74.

Johnson, W.D., Diaz, R.M., Flanders, W.D., Goodman, M., Hill, A.N., Holtgrave, D. et al. (2008). Behavioral interventions to reduce risk for sexual transmission of HIV among men who have sex with men. *Cochrane Database of Systematic Reviews.* 16, (3): CD001230.

Joy, R., Druyts, E.F., Brandson, E.K., Lima, V.D., Rustad, C.A., Zhang, W., Wood, E., Montaner, J.S.G. & Hogg, R.S. (2008). Impact of neighborhood-level socioeconomic status on disease progression in a universal health care setting. *Journal of Acquired Immune Deficiency Syndromes.* 47(4): 500-505.

Kahn, J.R. & Fazio, E.M. (2005). Economic status over the life course and racial disparities in health. *Journal of Gerontology.* 60B (Special Issue II): 76-84.

Kates, J. & Levi, J. (2007). Insurance coverage and access to HIV testing and treatment: Considerations for individuals at risk for infection and for those with undiagnosed infection. *Clinical Infectious Diseases.* 45(S4):S255-S260.

Katz, M.H., Hsu, L., Lingo, M., Woelffer, G. & Schwarcz, S.K. (1998). Impact of socioeconomic status on survival with AIDS. *American Journal of Epidemiology.* 148(3): 282-291.

Kegeles, S.M., Hays, R.B. & Coates, T.J. (1996). The Mpowerment Project: A community level intervention for young gay men. *American Journal of Public Health*. 86(8): 1129-1136.

Kegeles, S.M., Hays, R.B., Pollack, L.M.& Coates, T.J. (1999). Mobilizing young gay and bisexual men for HIV prevention: a two-community study. *AIDS*, 13(13):1753-1762.

Kim, J., Pronyk, P., Barnett, T. & Watts, C. (2008). Exploring the role of economic empowerment in HIV prevention. *AIDS.* 22 (S4): S57-S71.

Krieger, N. (1992). Overcoming the absence of socioeconomic data in medical records: validation and application of a census-based methodology. *American Journal of Public Health.* 82(5):703-709.

Krieger, N., Williams, D.R. & Moss, N.E. (1997). Measuring social class in US public health research: concepts, methodologies and guidelines. *Annual Review of Public Health.* 18: 341-378.

Krieger, N. (2001a). Historical roots of social epidemiology: socioeconomic gradients in health and contextual analysis. *International Journal of Epidemiology.* 30:899-900.

Krieger, N. (2001b). Theories for social epidemiology in the 21st century: an ecosocial perspective. *International Journal of Epidemiology.* 30: 668-677.

Krieger, N. (2001c). A glossary for social epidemiology. *Journal of Epidemiology and Community Health.* 55:693-700.

Krieger, N. (2007). Why epidemiologists cannot afford to ignore poverty. *Epidemiology.* 18(6): 391-396.

Krueger, L.E., Wood, R.W., Diehr, P.H. & Maxwell, C.L. (1990). Poverty and HIV seropositivity: the poor are more likely to be infected. *AIDS.* 4:811-814.

Kottiri, B.J., Friedman, S. R., Neaigus, A., Curtis, R. & Des Jarlais, D.C. (2002). Risk networks and racial / ethnic differences in the prevalence of HIV infection among injection drug users. *JAIDS.* 30:95-104.

Kuo, I., Greenberg, A.E., Magnus, M., Phillips, G., Rawls, A., Peterson, J., Hamilton, F., West-Ojo, T. & Hader, S. (2011). High prevalence of substance use among heterosexuals living in communities with high rates of AIDS and poverty in Washington, DC. *Drug Alcohol Depend*. 2011 Sep 1;117(2-3):139-44

Liberatos, P., Link, B. & Kelsey, J. (1988). The measurement of social class in epidemiology. *Epidemiologic Reviews.* 10: 87-121.

Link, B.G. & Phelan, J. (1995). Social conditions as fundamental causes of disease. *Journal of Health and Social Behavior.* Spec. No., 80-94.

Levins, R. & Lopez, C. (1999). Toward an ecosocial view of health. *International Journal of Health Services.* 29(2): 261-293.

Lynch, J. W. & Kaplan, G. A. (2000). Socioeconomic position and health: The independent contribution of community socioeconomic context. In L. F. Berkman & I. Kawachi (Eds.), *Social Epidemiology* (pp. 13-35). New York: Oxford University Press.

MacKellar, D., Gallagher, K.M., Finlayson, T., *et al*. (2007). Surveillance of HIV risk and prevention behaviors of men who have sex with men—a national application of venue based, time-space sampling. *Public Health Reports*. 122(Suppl. 1):39-47.

Magnani, R., Sabin, K, Saidel, T. & Heckathorn, D. (2005). Review of sampling hard-to-reach and hidden populations for HIV surveillance. *AIDS,* 19, S67-S72.

Marks, G., Crepaz, N. & Janssen, R.S. (2006). Estimating sexual transmission of HIV from persons aware and unaware that they are infected with the virus in the USA. *AIDS.* 20(10): 1447-1450.

McDavid-Harrison, K., Ling,Q., Song, R. & Hall, H.I. (2008). County-level socioeconomic status and survival after HIV diagnosis, United States. *Annals of Epidemiology.* 18: 919-927.

McFarland, W., Chen, S., Hsu, L., Schwarcz, S. & Katz, M. (2003). Low socioeconomic status is associated with a higher rate of death in the era of Highly Active Antiretroviral Therapy, San Francisco. *Journal of Acquired Immune Deficiency Syndromes.* 33: 96-103.

McMahon, J., Wanke, C., Terrin, N., Skinner, S. & Knox, T. (2010). Poverty, hunger, education and residential status impact survival in HIV. *AIDS and Behavior.* Doi 10.1007/s10461-010-9759-z.

Mishra, V., Bignami-Van Assche, S., Greener, R., Vaessen, M., Hong, R., Ghys, P.D., Boerma, J. T., Assche, A.V., Khan, S. & Rutstein, S. (2007). HIV infection does not disproportionately affect the poorer in sub-Saharan Africa. *AIDS.* 21(S7): S17-S28.

Molitor, F, Truax, S.R., Ruiz, J.D. & Sun, R.K. (1998). Association of methamphetamine use during sex with risky sexual behaviors and HIV infection among non-injection drug users. *West J Med*. 168(2):93-7.

Morris, M. & Kretzschmar, M. (1995). Concurrent partnerships and transmission dynamics in networks. *Social Networks.* 17:299-318.

Morris, M. & Kretzschmar, M. (1997). Concurrent partnerships and the spread of HIV. *AIDS.* 11:641-648.

Msisha, W.M., Kapiga, S.H., Earls, F. & Subramanian, S.V. (2008). Socioeconomic status and HIV seroprevalence in Tanzania: a counterintuitive relationship. *International Journal of Epidemiology.* 37:1297-1303.

Natrass, N. (2009). Poverty, sex and HIV. *AIDS and Behavior.* DOI 10.1007/s10461-009-9563-9.

NIDA Research Report Series: Methamphetamine Abuse and Addiction, *NIH Publication Number 02-4210,* Printed April 1998, Reprinted January 2002. Available at *http://www.ehd.org/health_meth_17.php*. Accessed October 23, 2011.

O'Campo, P., Xue, X., Wang, M.C. & O'Brian-Caughy, M. (1997). Neighborhood risk factors for low birthweight in Baltimore: A multilevel analysis. *American Journal of Public Health.* 87(7):1113-1118.

Pappas, G., Queen, S., Hadden W. & Fisher, G. (1993). The increasing disparity in mortality between socioeconomic groups in the United States, 1960 and 1986. *New England Journal of Medicine*. 329:103-109.

Peterman, T.A., Lindsey, C.A. & Selik, R.M. (2005). This place is killing me: A comparison of counties where the incidence rates of AIDS increased the most and the least. *The Journal of Infectious Diseases.* 191(S1):S123-S126.

Planke,y M.W., Ostrow. D.G., Stall, R., Cox, C., Li, X., Peck, J.A. & Jacobson, L.P. (2007). The relationship between methamphetamine and popper use and risk of HIV seroconversion in the multicenter AIDS cohort study. *J Acquir Immune Defic Syndr.* 45(1):85-92.

Poundstone, K.E., Strathdee, S.A. & Celentano, D.D. (2004). The social epidemiology of human immunodeficiency virus/acquired immunodeficiency syndrome. *Epidemiologic Reviews.* 26: 22-35.

Pinkerton, S.D., Galletly, C.L., McAuliffe, T.L, DiFranceisco, W., Raymond, H.F. & Chesson, H.W. (2010). Aggregate Versus Individual-Level Sexual Behavior Assessment: How Much Detail Is Needed to Accurately Estimate HIV/STI Risk? *Evaluation Review.* 34(1):19-34.

Rapues, J., Packer, T., Wilson, E., Colfax, G.N. & Raymond, H.F. (2011). Correlates of HIV infection among transfemales: San Francisco, 2010.Abstract 1491. 2011 National HIV Prevention Conference. Atlanta, Georgia. August 2011. Available at http://www.2011nhpc.org/archivepdf/2011%20NHPC%20Final%20Abstract%20Book.pdf. Accessed October 24, 2011.

Raymond, H.F. & McFarland, W. (2009). Racial mixing among men who have sex with men. *AIDS and Behavior.* 13(4):671-6.

Reijneveld, S.A. (1998). The impact of individual and area level characteristics on urban socioeconomic differences in health and smoking. *International Journal of Epidemiology.* 27:33-40.

Riley, E.D., Moss, A.R., Clark, R.A., Monk, S.L. & Bangsberg, D.R. (2005). Cash benefits are associated with lower risk behavior among the homeless and marginally housed in San Francisco. *Journal of Urban Health.* 82(1):142-150.

San Francisco Department of Public Health. (2001). Atlas of HIV/AIDS in San Francisco. Available at http://www.sfdph.org/dph/files/reports/default.asp. Accessed February 23, 2011.

San Francisco HIV Prevention Planning Council. (2010). San Francisco 2010 HIV Prevention Plan. Available at http://www.sfhiv.org/community.php. Accessed February 23, 2011.

Schechter, M.T., Hogg, R.S., Aylward, B., Craib, K.J.P., Le, T.N. & Montaner, J.S.G. (1994). Higher socioeconomic status is associated with slower progression of HIV infection independent of access to health care. *Journal of Clinical Epidemiology.* 47(1): 59-67.

Schwarcz, S., Scheer, S., McFarland, W., Katz, M., Valleroy, L., Chen, S. & Catania, J. (2007). Prevalence of HIV infection and predictors of high-transmission sexual risk behaviors among men who have sex with men. Am J Public Health. 97(6):1067-75.

Shavers, V.L. (2007). Measurement of socioeconomic status in health disparities research. *Journal of the National Medical Association.* 99(9): 1013-1023.

Shaw, A., Egan, J. & Gillespie, M. (2007). Drugs and poverty: A literature review. Available at http://www.sdf.org.uk/sdf/files/Drugs%20and%20Poverty%20Literature%20Review%2006.03.07.pdf. Accessed October 23, 2010

Shelton, J. D., Cassell, M.M. & Adetunji, J. (2005). Is poverty or wealth at the root of HIV? *Lancet*. 366: 1057-1058.

Sherman, S.G., German, D., Cheng, Y., Marks, M. & Bailey-Kloche, M. (2006). The evaluation of the JEWEL project: An innovative economic enhancement and HIV prevention intervention study targeting drug using women involved in prostitution. *AIDS Care.* 18(1):1-11.

Shubert, V. & Bernstine, N. (2007). Moving from fact to policy: Housing is HIV prevention and health care. *AIDS and Behavior.* 11:S172-S181.

Sloggett, A. & Joshi, H. (1997). Deprivation indicators as predictors of life events 1981-1992 based on the UK ONS longitudinal study. *Journal of Epidemiology and Community Health.* 52:228-233.

Snowden, J., Raymond, H.F. & McFarland, W. (2009). Prevalence of seroadaptive behaviors of men who have sex with men: San Francisco, 2004. *Sexually Transmitted Infections.* 13(4):677-81.

Stratford, D., Mizuno, Y., Williams, K., Courtenay-Quirk, C. & O'Leary, A. (2008). Addressing poverty as risk for disease: Recommendations from CDC's consultation on microenterprise as HIV prevention. *Public Health Reports.* 123: 9-20.

Sumartojo, E. (2000). Structural factors in HIV prevention: concepts, examples and implications for research. *AIDS.* 14 (Suppl. 1): S3-S10.

Sumartojo, E., Doll, L., Holtgrave, D., Gayles, H. & Merson, M. (2000). Enriching the mix: incorporating structural factors into HIV prevention. *AIDS.* 14 (Suppl. 1): S1-S2.

Thomas, J.C. & Thomas, K.K. (1999). Things aren't what they ought to be: social forces underlying racial disparities in rate of sexually transmitted diseases in a rural North Carolina county. *Social Science and Medicine.* 49: 1075-1084.

Transgender Law Center. (2009). The state of transgender California report: Results from the 2008 California transgender economic health survey. Available at http://transgenderlawcenter.org/cms/ Accessed October 1, 2010.

US Census Bureau. (2008). Aug. 2008 supplement to the Current Population Survey. Available at www.ucensus.gov Accessed April 24, 2010.

Vaudrey, J., Raymond, H.F., Chen, S., Hecht, J., Ahrens, K. & McFarland, W. (2007). Indicators of use of methamphetamine and others substances among men who have sex with men, San Francisco 2003-2006. *Drug and Alcohol Dependence*, 90(1): 97-100.

Vittinghoff, E. Douglas, J., Judson, F., McKirnan, D., MacQueen, K. & Buchbinder, S. (1999). Per-contact risk of human immunodeficiency virus transmission between male sexual partners. *American Journal of Epidemiology.* 150 (3): 306-311.

Waitzman, N.J. & Smith, K.R. (1998). Phantom of the Area: Poverty-area residence and mortality in the United States. *American Journal of Public Health.* 88(6):973-976.

Wohlfeiler, D. (2000). Structural and environmental HIV prevention for gay and bisexual men. *AIDS.* 14 (Suppl. 1): S52-S56.

Appendices: Data for maps

Table A1. Residential distribution of study participants

		Residence Zip (n)		
Neighborhood	ZIP	BMT	White MSM	Teach
General Delivery	94100	0	0	2
Hayes Valley / Tenderloin	94102	43	9	51
South of Market	94103	23	21	24
Financial Dist. I	94104	0	0	1
Embarcadero	94105	0	0	1
Potrero Hill	94107	7	5	4
Chinatown	94108	1	1	1
Polk/ Russian Hill	94109	21	10	35
Inner Mission	94110	7	17	18
Financial Dist. II	94111	2	0	1
Ingelside	94112	2	5	4
Castro / Noe	94114	1	49	3
Western Addition	94115	5	6	2
Parkside / Forest Hill	94116	1	3	2
Haight Ashbury	94117	37	20	6
Inner Richmond	94118	1	2	0
Embarcadero	94119	0	1	0
Outer Richmond	94121	1	5	0
Sunset	94122	1	9	1
Marina	94123	0	0	0
Bayview – Hunters Point	94124	6	0	6
St Francis Wood / West Portal	94127	1	2	1
Presidio	94129	0	0	0
Treasure Island	94130	0	1	0
Twin Peaks	94131	0	17	3
Lake Merced	94132	2	2	1
North Beach	94133	1	2	0
Visitacion Valley / Sunnydale	94134	2	1	3

Table A2. Neighborhood level data, San Francisco, CA

		Indicator						
		Per Capita Income (1999 dollars)	HIV/AIDS Cases (n)	Population 18+ (n)	HIV Prevalence (%)	HIV Health Services (n)	HIV Prevention Services (n)	Community Viral Load (mean)
		Source						
Neighborhood	ZIP	ACS 2000	SFDPH	ACS 2000	SFDPH Cases/Population		SFHIV.org	SFDPH
General Delivery	94100	-	1014	-	-	-	-	24066.72
Hayes Valley / TL	94102	19822	1446	25901	0.056	32	6	10907.85
SOMA	94103	21034	1099	20405	0.054	37	7	12472.05
Financial Dist. I	94104	13885	38	333	0.114	1	0	13936.3
Embarcadero	94105	88829	80	2015	0.040	4	0	13692.44
Potrero Hill	94107	53646	441	15464	0.029	5	1	19689.08
Chinatown	94108	31945	163	12451	0.013	0	0	10675.08
Polk/ Russian Hill	94109	43527	1154	52458	0.022	8	3	25481.75
Inner Mission	94110	24609	1398	61486	0.023	20	3	6644.93
Financial Dist. II	94111	75344	39	3191	0.012	0	0	1861.73
Ingelside	94112	19645	448	57863	0.008	1	0	63740.03
Castro / Noe	94114	56892	2648	28384	0.093	6	3	21626.96
Western Addition	94115	51919	566	29456	0.019	8	0	9595.29
Parkside / Forest Hill	94116	29059	155	35462	0.004	1	0	2673.05
Haight Ashbury	94117	40986	1181	35960	0.033	16	1	9934.97
Inner Richmond	94118	43825	171	33583	0.005	1	0	4282.79
Embarcadero	94119	-	17	-	-	0	0	6057.7
Outer Richmond	94121	32881	167	36217	0.005	2	0	9674.35
Sunset	94122	29456	249	47432	0.005	0	0	7066.03
Marina	94123	81044	69	21369	0.003	0	0	5377.51
Bayview – Hunter's Point	94124	14200	332	23128	0.014	1	0	16092.58

Table A2 (continued)

St Francis Wood / West Portal	94127	44914	146	16961	0.009	0	0	2597.19
Presidio	94129	36243	15	1873	0.008	0	0	2645.5
Treasure Island	94130	30173	40	1314	0.030	3	0	6683.8
Twin Peaks	94131	51067	872	24509	0.036	0	0	8681.78
Lake Merced	94132	27903	125	22197	0.006	0	0	13437.01
North Beach	94133	36965	108	23908	0.005	1	0	10233.2
Visitacion Valley / Sunnydale	94134	17070	218	30611	0.007	2	0	14693.79