8-7-2012

An Analysis of Geography Project Data to Determine HIV and Behavioral Risk for High Risk Zip Codes and Low Risk Zip Codes in Fulton County, GA

Jamaal B. Marshall
Georgia State University

Follow this and additional works at: http://scholarworks.gsu.edu/iph_theses

An Analysis of Geography Project Data to Determine HIV and Behavioral Risk for High Risk Zip Codes and Low Risk Zip Codes in Fulton County, GA

Jamaal B. Marshall
jmarshall5@student.gsu.edu

ABSTRACT
Jamaal B. Marshall

An Analysis of Geography Project Data to Determine HIV and Behavioral Risk for High Risk
Zip Codes and Low Risk Zip Codes in Fulton County, GA
(Under the direction of Richard Rothenberg, MPH, MD)

INTRODUCTION: The HIV epidemic continues to face new challenges as antiretroviral
therapy contributes to the increased prevalence of HIV. HIV disease in the Atlanta, GA area is
thought to be clustered in specific areas of the metropolitan area, rather than evenly distributed.
A study to show a significantly higher HIV risk in certain geographical areas would be beneficial
to the many agencies of the area that allocate significant resources based on zip codes and other
geographic factors.

AIM: The purpose of this study is to describe the demographics of the study population, describe
the demographics of those participants that tested HIV-positive, and perform univariate and
multivariate logistic regression analysis to determine the associations between zip code of
residence, HIV infection, and risky behavior

METHODS: Data were collected by Georgia State University's Center of Excellence for Health
Disparities Research for *The Geography Project*. HIV disease was determined for each case
using data from preliminary and confirmatory tests. Statistical analysis was performed using
SPSS. A univariate and multivariate binary logistic regression analysis was performed on select
variables. A p-value of < 0.05 and a 95% confidence interval (CI) were used to determine
significance.

RESULTS: Participants in high risk zip codes were roughly 6.7 times more likely to have been
given an HIV-positive result prior to interview when compared to participants in low risk zip
codes (OR=6.717, CI=1.989-22.683, p=.000). Furthermore, these same participants were about
4.4 times more likely to be infected with HIV at the time of interview (OR=4.402, CI=2.109-
9.187, p=.000), and 1.4 times more likely to have more than 3 sex contacts in the 6 months prior
to the interview (OR=1.425, CI=1.075-1.890, p=.014). Participants in high risk zip codes were
less likely to have experienced incarceration when compared to participants in low risk zip codes
(OR=.551, CI=.390-.778, p=.001). The association between HIV and persons that identify as
transgender was extremely significant (OR= 28.335, CI=8.305-96.678, p=.000). There was also
a significant association between HIV and the high risk zip code group (OR=2.875, CI=1.330-
6.217, p=.007).

DISCUSSION: The results indicated that participants in the high risk zip codes group were at a
higher risk for HIV infection and having 3 or more sex contacts in the 6 months prior to the
interview. Further analysis is suggested to determine if there is a significant association between
geographic distance and partner selection.

INDEX WORDS: HIV, high risk zip codes group, low risk zip codes group, spatial distribution

An Analysis of Geography Project Data to Determine HIV and Behavioral Risk for High Risk
Zip Codes and Low Risk Zip Codes in Fulton County, GA

by

Jamaal B. Marshall

B.A., Georgia State University

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the
Requirements for the Degree

MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA
2012

An Analysis of Geography Project Data to Determine HIV and Behavioral Risk for High Risk

Zip Codes and Low Risk Zip Codes in Fulton County, GA

by

JAMAAL B. MARSHALL

ACKNOWLEDGMENTS

In presenting this thesis as a partial fulfillment of the requirements for an advanced degree from Georgia State University, I agree that the Library of the University shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to quote from, to copy from, or to publish this thesis may be granted by the author or, in his/her absence, by the professor under whose direction it was written, or in his/her absence, by the Associate Dean, College of Health and Human Sciences. Such quoting, copying, or publishing must be solely for scholarly purposes and will not involve potential financial gain. It is understood that any copying from or publication of this dissertation which involves potential financial gain will not be allowed without written permission of the author.

Jamaal Marshall
Signature of Author

Notice to Borrowers

All theses deposited in the Georgia State University Library must be used in accordance with the stipulations prescribed by the author in the preceding statement.

The author of this thesis is:

Jamaal Marshall
621 N. Highland Ave. #9
Atlanta, GA 30306

The Chair of the committee for this thesis is:

Richard Rothenberg
Institute of Public Health
Health and Human Services
Georgia State University
P.O. Box 3995
Atlanta, Georgia 30302-3995

Users of this thesis who are not regularly enrolled as students at Georgia State University are required to attest acceptance of the preceding stipulation by signing below. Libraries borrowing this thesis for the use of their patrons are required to see that each user records here the information requested.

NAME OF USER	ADDRESS	DATE	TYPE OF USE (EXAMINATION ONLY OR COPYING)

Jamaal Marshall
621 N. Highland Ave #9
Atlanta, GA 30306
404-561-1546
jmarshall5@student.gsu.edu

Education
Georgia State University, Atlanta, GA
Master of Public Health, Prevention Sciences – Summer 2012

Georgia State University, Atlanta, GA
Bachelors of Arts, Journalism - Fall 2009

Work Experience
Georgia State University, Institute of Public Health, Atlanta, GA January 2011 - Present
Center of Excellence for Health Disparities Research; Graduate Research Assistant

Fulton County Department of Health, Atlanta, GA June 2006 – January 2011
Communicable Disease Prevention Branch; Disease Investigator

Skills
SPSS, SAS, Microsoft Excel, Microsoft Word, Microsoft PowerPoint, Public
Speaking, Phlebotomy, Spanish Language (Medium Proficiency), STD Surveillance, Qualitative
Interviews

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AIDS – Acquired Immune Deficiency Syndrome

BBI – Blood Borne Infection

CBG – Census Block Group

CD4 – Cluster of Differentiation 4

CDC – U.S. Centers for Disease Control and Prevention

CMC – Centers for Medicare and Medicaid Services

CoEx – Center of Excellence for Health Disparities Research

CDC – Centers for Disease Control and Prevention

GIS – Geographic Information Systems

HAART – Highly Active Antiretroviral Therapy

HIV – Human Immunodeficiency Virus

HIV-ELISA – Human Immunodeficiency Virus – Enzyme Linked Immunosorbent Assay

MSM – Men that Have Sex with Men

PCP – Pneumocystis Carinii Pneumonia

SES – Socioeconomic Status

STD – Sexually Transmitted Disease

STI – Sexually Transmitted Infection

TB – Tuberculosis

USPS – United States Postal Service

ZCTA – Zip code tabulation area

ZIP codes – Zone Improvement Plan Codes

CHAPTER I - INTRODUCTION

1.1 Background

The number of persons living with HIV in the United States continues to increase annually. The U.S. Centers for Disease Control and Prevention (CDC) estimated that there was a 4% increase (30,000-40,000 cases) in HIV prevalence per year from 1996 until 2006 (Hall et al., 2010). A major cause for this continuous rise in HIV prevalence was the introduction and continued use of highly active antiretroviral therapy (HAART), and a relatively stable HIV incidence (Hall et al., 2007; Hall et al., 2010; Campsmith et al., 2010). Adherence to HAART decreases viral load, which also decreases the infectiousness of an HIV-positive person (Li et al., 1998). However, increases in risky behavior by HIV-positive persons may counteract the benefits of HAART (Hall et al., 2007). Because risky behavior is often geographically associated with neighborhoods housing persons below the poverty line, persons of low socioeconomic status are often at higher risk for HIV infection. Although African-Americans are often reported as the group most burdened by HIV in the U.S., Hixson et al. (2010) found that HIV was more associated with poverty than race. One recent study resulted in HIV being detected in about 2.4% of the persons living below the federal poverty level (Hixson et al., 2010). Hixson et al. (2010) also states that "residents in impoverished areas may have a greater chance of encountering others who participate in illegal drug use, engage in prostitution, or have other experiences which put them at higher risk for HIV acquisition." Indeed, Atlanta, GA, a city with a poverty rate of about 21%, reports a large amount of new HIV infections every year (Kalichman et al., 2010). In 2006, the state of Georgia was ranked eighth in the U.S. for its numbers of AIDS cases. The metropolitan Atlanta area, which reported 21,354 cases of HIV in 2007, accounted for 64% of all cases in the state (Hixson et al., 2010). Regarding distribution, a large percentage of the HIV infections are thought to be grouped into one large cluster that spans parts of Fulton

and Dekalb counties in the Atlanta metropolitan area (Hixson et al., 2010). Clusters may be described as "defined geographic areas in which the prevalence of disease is disproportionately higher compared to neighboring areas (Hixson et al., 2010)." Gaining a clear understanding of the spatial distribution of HIV in Atlanta is very important. With a heightened awareness of where high prevalence clusters of HIV are located, it is possible that resources and services may be allocated in a more efficient way to enhance HIV-prevention efforts (Hixson et al. 2010).

1.2 Purpose of the Study

Due to the relatively high prevalence of HIV in Atlanta, GA, as well as the high percentage of persons in the metropolitan Atlanta area living below the poverty line, an association between high risk zip code groups and risk of HIV infection would be significant. If high risk zip codes are determined as a risk factor, more resources could be allocated toward specific areas in hopes of increasing prevention for those most at risk. This study will focus on factors that may influence HIV risk, such as area of residence and frequency of sex and drug contacts, among a population of participants interviewed in the Atlanta, GA from 2007 until 2010.

The purpose of this study is to:

1) describe the demographics of the study population

2) describe the demographics of those participants that tested HIV-positive

3) perform logistic analysis to determine if area of residence is associated with HIV infection and/or risky behavior

1.3 Hypotheses

It is hypothesized that:

1) Participants in a high risk zip codes group were more likely to test positive for HIV disease at the time of the survey than participants in a low risk zip codes group

2) Participants in a high risk zip codes group were more likely to have been given an HIV-positive result prior to the survey than participants in a low risk zip codes group

3) Participants in a high risk zip codes group will be more likely to have had 3 or more sex partners in the 6 months prior to the interview than participants in a low risk zip codes group

CHAPTER II - REVIEW OF THE LITERATURE

2.1 STD/HIV Prevalence in the U.S.

The introduction of highly active antiretroviral therapy (HAART) was largely responsible for the decline in new HIV infections and HIV-related deaths during the 1990's (Hall, Byers, Ling, & Espinoza, 2007). This may be in part because HAART decreases the infectivity of HIV-infected persons, thereby decreasing the chance that they will infect others (Hall et al., 2007). However, adherence to HAART has been demonstrated as difficult for those of low socioeconomic status, who also tend to be at higher risk for infection. A study of 188 HIV-positive persons performed by Kalichman and Grebler (2010) showed that half of the participants took less than 75% of their prescribed HAART. Not surprisingly, lack of adherence by the participants was determined to be strongly associated with food insecurity and poverty-related occurrences (Kalichman & Grebler, 2010).

Although great strides have been made in educating the public on how the HIV virus is transmitted, there has been less success with informing people on how it is not, and so HIV/AIDS stigma continues to exist (Herek, Capitanio, & Widaman, 2002). Data from one survey shows that proportions of respondents "overestimating the risks posed by some forms of casual social contact were higher in 1997 and 1999 than in 1991 (Herek et al., 2002)." And so Herek et al. (2002) consequently conclude that promoting how HIV is transmitted may be just as important to stigma eradication as promoting how it is not.

Although marketing the effectiveness of abstinence and condom use is significant for HIV-prevention campaigns, it is also imperative to encourage the alternatives of having one partner at a time, or the use of condoms with additional partners (Morris, Kurth, Hamilton, Moody, and Wakefield, 2010). These interventions may be thought of as less effective than abstinence or complete condom use

in the prevention of HIV, but their effects were demonstrated in a campaign launched in Uganda in the 1990's.

The campaign's intent was to convince Ugandan men that concurrent partnerships were the primary cause of the country's HIV epidemic. Following the campaign, the percentage of Ugandan men reporting three or more non-marital partners decreased from 15% in 1989 to 3% in 1995, and the HIV prevalence rate in Uganda fell from 15% in 1991 to 5% in 2001 (Morris et al., 2010). Morris et al. (2010) conclude that because connectivity is low, the spread of infection is reduced in groups where serial monogamy is the norm; however, in groups with certain levels of concurrency, spread of infection rises due to increased connectivity.

Although behavior certainly plays a large role in STD transmission on an individual level, socioeconomic factors are of great importance as community-level risk factors. Walker & Sweet (2011) state that history of incarceration and education levels are highly associated with risk of STD infection. Though it would seem obvious than those with less education were linked to higher STD infection rates, Walker & Sweet (2011) state that this association is only present when comparing members of the same race, as Black women who are college-educated have exhibited higher infection rates of STDs that White women who did not finish high school (Walker & Sweet, 2011). Morris et al. (2010) believes that assortative mixing, defined as forming partnerships between members of the same socioeconomic or racial groups, rather than between members of different socioeconomic or racial groups may explain the consistently high prevalence (relatively speaking) of STDs and HIV among African-Americans and those of low socioeconomic status. Assortative mixing may also help explain the high incidence of HIV infections in men who have sex with men (MSM).

The percentage of HIV prevalence in MSM has shifted the brunt of the epidemic toward males, as they constituted an estimated 74.8% of the HIV prevalence in the U.S. in 2006 (Campsmith, Rhodes, Hall, & Green, 2010). In one study of convenience samples of MSM in 5 U.S. cities, 48% of the MSM that tested HIV-positive were not previously aware of their status (Hall et al., 2007). In fact, Campsmith et al. (2010) estimated that at the end of the year 2006, 21% of the 1,106,400 adults living with HIV in the U.S. were undiagnosed. A late diagnosis of HIV is undesirable, as it may lead to initiation of treatment during later stages of HIV infection. This, in turn, may reduce the effectiveness of HAART (highly active anti-retroviral therapy) (Hall et al., 2007). The study by Hall et al. (2007) demonstrated that the percentage of unrecognized HIV infections differ greatly across the racial spectrum. In the study, only 18% of HIV-positive White MSM were previously unaware of infection, compared to 48% for Hispanics and 67% for Blacks. Consequently in a study performed by Hall et al. (2007) which examines HIV progression in MSM, the percentage of Black MSM that did not convert from HIV to AIDS in three years is 66.8%, compared to 68.1% for Hispanic MSM and 74.7% for White MSM. Hall et al. (2007) also reports that 3 years after an AIDS diagnosis, 80.6% of Black MSM were still alive, compared to 85.2% of Hispanic MSM and 84.5% of White MSM.

Hall et al. (2007) suggests that "integrating HIV screening into routine medical care would serve to detect HIV in the large number of MSM who are unaware of their HIV status and to detect HIV infection early for timely intervention to slow disease progression." According to another study, over half of new HIV infections from 2003 to 2006 occurred in MSM (Hall et al., 2008). This study, which examined incidence rates for HIV in the U.S., also noted that "incidence estimates continue to demonstrate the disproportionate distribution of HIV infection among blacks (incidence rate, 83.7/100 000) and Hispanics (29.3/100 000) compared with whites (11.5/100 000) (Hall et al., 2008)."

Regarding syphilis prevalence in the U.S., it is estimated to be .71% in 18 to 49 year olds, which would mean a relatively low prevalence of syphilis in the U.S. population (Gottlieb et al., 2010). While Gottlieb et al. (2010) reports Non-Hispanic blacks as having the highest seroprevalence of all groups (4.3%), they also state as a possibility that "Blacks may be more likely to attend public clinics where case reporting is thought to be most complete, and may be overrepresented at the limited sites where screening occurs (Gottlieb et al., 2010)." However, Gottlieb et al. (2010) also counters that case reporting would not be a likely explanation for the differences in prevalence among races. Gottlieb et al. (2010) also states that an indicator of risk for infection was the age that participants first experienced sex.

Gottlieb et al. (2010) found syphilis seroprevalence to be higher among people who experienced intercourse before the age of 15 (1.5% vs. 0.45%, P = 0.006). However, Gottlieb et al. (2010) notes that the degree of the difference in syphilis seroprevalence between Non-Hispanic Blacks and Non-Hispanic Whites has decreased dramatically. According to 1992 surveillance data, the ratio of Non-Hispanic Blacks to Non-Hispanic Whites with current syphilis was 62:1, while 2005 surveillance data shows that the ratio had decreased to 5.4:1 (Gottlieb et al., 2010). While the differences in racial disparities regarding syphilis in the U.S. have been reduced to a large extent, MSM have become the group that disproportionately experiences a higher prevalence than other groups. It is estimated that more than 60% of new syphilis infections occur in MSM (Gottlieb et al., 2010).

However, Tao et al. (2012) states that because the nationwide prevalence for gonorrhea is low, the practice of dual screening should be re-evaluated so that resources for healthcare may be used more in a more cost-effective manner. "Centers for Medicare and Medicaid Services (CMS) reimburse $102 for dual chlamydia and gonorrhea nucleic acid amplification testing, compared to $51 for chlamydia testing alone (Tao, Hoover, & Kent, 2012)." Furthermore, Walker and Sweet (2011) suggest

that because women who are infected with gonorrhea are frequently co-infected with chlamydia, treatments that eradicate both infections should be given to infected persons.

Gonorrhea is the second-highest reported STD in the United States and it results from infection with *Neisseria gonorrhoeae* (Walker & Sweet, 2011). The CDC estimates that there are 700,000 new cases of gonorrhea every year in the U.S (Walker & Sweet, 2011). However, this is a far cry from historical rates as gonorrhea rates have reportedly fallen 74% between 1975 and 1997 in response to a program aimed at gonorrhea control in the United States (Walker & Sweet, 2011).

Regarding demographic factors and geographic distribution of gonorrhea in the U.S., adolescent black women in urban areas in the South are at the highest risk for infection (Walker & Sweet, 2011). "In 2009, gonorrhea rates per 100,000 population by state ranged from 7.2 in Utah to 246.4 in Mississippi (Walker & Sweet, 2011)." Walker and Sweet (2011) also state that the 50 most populous metropolitan areas reported 60% of all U.S. gonorrhea cases to the CDC in 2009. It is also worth noting that in 2009, the rate of gonorrhea in Black women was 17 times higher than in White women (Walker & Sweet, 2011).

2.2 STD/HIV Prevalence in the Georgia and Fulton County, Georgia

The bulk of sexual transmitted disease has been detected most frequently in inner-city populations in the United States ever since the U.S. population migrated into large metropolitan areas during the industrial age. As of July 2008, the Atlanta-metropolitan area was "comprised of 31 counties with an estimated population of 5,376,285 persons (Hixson et al., 2011)." The city of Atlanta's population is relatively small in comparison, with a population of 437,105 persons in 2010 according to the U.S. Census Bureau. Also, 55.8% of this population consists of African Americans (Hixson et al., 2011). In 2006, the state of Georgia ranked eighth in the U.S. in the rate of AIDS cases (Hixson, Omer,

del Rio, & Frew, 2011). Kalichman and Grebler (2010) stated in their study that "Atlanta has over 23,000 reported cases of AIDS and an HIV/AIDS case rate of 23 per 100,000 population, exceeding the average rate of 15 per 100,000 population in other major US cities."

The Ponce de Leon Center located in Atlanta, GA serves over 4,000 HIV-infected patients, and is one of the largest HIV-care centers in the U.S. (Hixson et al., 2011). "The Georgia Department of Human Resources estimates that over 70% of HIV-infected patients who live in Atlanta reside within 2 miles of the clinic (Hixson et al., 2011)." Hixson et al. (2011) discuss that community-level variables are important to consider when determining risk factors for HIV infection. These community-level variables hold such influence because residents in impoverished areas may have a greater chance of encountering persons that participate in high risk HIV activities such as illegal drug use and prostitution (Hixson et al., 2011). Hixson et al. (2011) also states that there may be an association to race and ethnicity as African-Americans and Hispanic people are more likely to live in impoverished areas than their White counterparts.

In a similar study, Kalichman et al. (2010) examine food-related issues amongst 344 participants infected with HIV/AIDS in Atlanta, GA. Comparably, half of the participants "lacked sufficient food, and food insufficiency was associated with multiple indicators of poor health, including higher HIV viral loads, lower CD4 cell counts, and poorer treatment adherence (Kalichman et al., 2010)." The Atlanta-based study also demonstrated that a lack of sufficient food was more predictive of HAART non-adherence than education, employment, housing and income (Kalichman et al., 2010). About 25% of the participants indicated that they have had to decide between paying for HAART and purchasing food in the past year, results that were consistent with Kalichman and Grebler's 2010 study. Atlanta has a poverty rate of about 21% according to Kalichman et al. (2010) and Hixson et al. (2011). It is important

to state that food can impede HIV wasting, and is necessary for the proper absorption of some HAART medications (Kalichman et al., 2010).

2.3 The Impact of Socioeconomic Status on HIV/STD Transmission

Although it is important to establish poverty's strong association with STDs, it is important to examine the mechanisms responsible for this association as well (Fichtenberg, Jennings, Glass, & Ellen, 2010). Fichtenberg et al. (2010) attempts this by performing a study which examines the association between living in a lower poverty census block group (CBG) and the level of risk based on having multiple partners or having a partner with multiple partners. Those that were considered low risk individuals in this study were participants that were in conformed dyads (monogamous pairs). Medium risk individuals were defined as persons with a single partner that had multiple sex partners, or persons with a single partner whose partner was not interviewed, and therefore may or may not have had multiple partners. High risk individuals were those who have multiple sex partners. The study determined that "living in a higher poverty CBG was associated with increased likelihood of being in a non-dyadic sexual network component, controlling for age and sex (Fichtenberg et al., 2010)."

Comparably, another study using data from *The 1992 Youth Risk Behavior Survey/Supplement* shows that for adolescents, living in a 2 parent family was independently associated with never having been sexually active (Santelli, Lowry, & Brener, 2000).

Sullivan et al. (2011) states that STDs have a tendency to cluster in geographically definable areas with residents of low socioeconomic status (SES). While prevalence of HIV/STDs can be influenced by several factors, prevalence has a direct impact on new infections because "as STI prevalence increases, the likelihood of finding a sexual partner that has an STI also increases (Sullivan et al., 2010)." In their study of community-level factors that may be associated with the prevalence of gonorrhea,

Sullivan et al. (2010) state that the amount of single mothers in neighborhoods and the amount of African-Americans were strongly correlated, suggesting that neighborhoods with a large amount of single, African-American mothers may be responsible for a large amount of the disease burden. They also reached the conclusion that "census tracts with more women than men were associated with increased gonorrhea rates (Sullivan et al., 2010)." This finding is consistent with the results of a study performed by Rothenberg (1983) examining the gonorrhea occurrence in New York State. Furthermore, Sullivan et al. (2010) suggested that low SES may be a barrier to treatment for infected persons due to an inability to acquire a means of transportation.

2.4 The Impact of Geography on STD/HIV Transmission

Jennings et al. (2011) state that "geographic areas may have a higher incidence of infection because they have a greater percentage of residents who are demographically and/or behaviorally at higher risk for STIs. For example, a high STI area may contain a greater proportion of adolescent girls or a greater proportion of people who do not use condoms. This would suggest that neighborhood of residence is just a proxy for individual characteristics of the residents and not in of itself an independent risk factor."

However, Jennings et al.'s (2011) Baltimore-based study aims to determine if the prevalence of STDs/HIV in the available pool of partners in a neighborhood is an independent individual-level risk factor for STD/HIV infection. They also note that local sex networks, while defined as consisting of people close in proximity, may include both residents and non-residents of an area. The study did indeed determine that individuals who tested positive for chlamydia and gonorrhea were more likely to be connected to pools of people with high STD prevalence.

In another study based in Baltimore involving attendees at an STD clinic, Grindi et al. (2011)

similarly conclude that the clinic patients were likely to seek partners that lived nearby, as geography

and proximity of partner are very important factors in partner selection.

In a study examining the difference between demographic and geospatial risk factors for

chlamydia, gonorrhea, genital herpes, and genital warts in Leeds, England, the researchers concluded

that "31% of all disease occurred in the four inner city census wards, representing 15% of the population

(Monteiro, Lacey, and Merrick, 2005)."

Rothenberg (1983) also discusses demographic risk factors in his New York based-study

regarding core groups and the distribution of gonorrhea transmission. The study shows that gonorrhea

is "neither randomly nor uniformly distributed in Upstate New York (Rothenberg, 1983)" and that it is

actually "a tightly clustered illness, producing high rates of infection in small definable, geographic areas

(Rothenberg, 1983)."

2.5 Spatial Distribution of Disease

As Krieger et al. (2003) demonstrated, determining the distribution of disease in order to link

causes to geographic associations can be very helpful when determining the etiology of disease. Fede,

Stewart, Hardin, Mayfield-Smith, & Sudduth (2011) state that "information about the spatial distribution

of disease rates and rate disparities can be useful in targeting at-risk populations, allocating resources

for HIV prevention, and allocating resources for HIV/AIDS care and service delivery." Bernstein et al.

(2004) attempted using spatial data to identify likely areas in Baltimore, Maryland with high risk sexual

activity and transmission. Bernstein et al. (2004) describes STD transmission in communities "as a

function of three components: the efficiency of transmission of disease between individuals, the rate of

sexual partner exchange in a population, and duration of infectivity." Bernstein et al. (2004) goes on to

define core groups as "individuals who are consistently infectious and able to transmit disease to large numbers of sexual partners", and states that the presence of such individuals in a community ensures the continued reproduction of STDs. Per Bernstein et al. (2004), these individuals remain infectious by going untreated for extended periods or constantly experiencing reinfection. In the analysis of the 9,910 gonorrhea cases reported to Baltimore City Health Department in 2001 and 2002, 15.3% of the cases were persons with repeat infections (Bernstein et al., 2004). Bernstein et al. (2004) also stated that Rothenberg (1983), in a previous study, provided an operational definition for core, defining it as census tracts that account for more than 50% of the morbidity in a major urban area.

An important matter mentioned by Decker, Sharpe, and Dillon (1997) in regards to showing spatial distribution of disease is the maintenance of confidentiality. Because the six-digit postal code in their Toronto-based study defines a more specific area, the authors make mention of the possibility of being able to identify individuals represented by the data. However, the authors conclude that "confidentiality would not have been compromised because six-digit codes are only locational estimates centered on one side of a street of a city block (Decker et al., 1997)." The authors also cite Peter Gould, who models disease spread, as stating that "in all studies of mathematical modeling *[sic]*, geographers have never identified any one person, have no need to do so and would not know what to do with the information if they had it (Decker et al., 1997)."

Fede et al. (2011) also look at the distribution of syphilis, gonorrhea, chlamydia, and HIV rates in South Carolina.   The analysis reveals large disparities in race and gender regarding HIV. Law, Serre, Christakos, Leone, and Miller (2004) examine the spatial distribution of chlamydia, gonorrhea, syphilis, and HIV in Wake County, North Carolina to decide risk of infection in certain areas. They determined that the core areas of transmission should be targeting with STD prevention strategies, rather than dividing effort uniformly throughout Wake County. Law et al. (2004) also makes the observation that

healthcare providers tend to be located outside of the core areas where population density is high, but STD infection rate is relatively low. Consequently, Law et al. (2004) concludes that the availability of STD services should be increased in core areas.

2.6 Using Zip Codes as Predictors of Risk

Grubesic and Matisziw (2006) state that Zone Improvement Plan (zip) codes "originated as a way of classifying street segments, address ranges and delivery points to expedite the delivery of mail." Krieger et al. (2003) also state that zip codes are established by the U.S. Postal Service for efficient mail delivery. The size of zip codes can range from "large areas cutting across states to a single building or company with a high volume of mail (Krieger et al., 2003)." However, zip codes are typically designated for areas that people inhabit, meaning that desolate areas such as parts of Arizona's Sonora desert would not be represented by a zip code (Grubesic & Matisziw, 2006). It is also important to note that zip codes can be altered, expanded, or discontinued every few months to meet the needs of the U.S. Postal Service, making evaluations difficult for researchers performing zip-code based analyses (Grubesic & Matisziw, 2006; Krieger et al., 2003). However, the treatment of zip codes as units of analysis has increased substantially in the field of epidemiology in the past few years (Grubesic, 2008). Using zip codes may be beneficial comparable to county-level analysis as it would provide greater detail. Also, using zip codes rather than smaller units of analysis may be advantageous as zip code analysis increases the likelihood that confidentiality of participants would be maintained.

In order to monitor socioeconomic characteristics in relation to STD infection, Sullivan et al. (2010) believes that the census tract is the best geographic unit of measurement for this task. Krieger, Waterman, Chen, Soobader, & Subramanian (2003) perform a study to determine whether census tract, zip code, or census block group is the most appropriate unit of measure for socioeconomic position.

According to Krieger et al. (2003), zip codes usually contain about 30,000 individuals on average. By contrast, census tracts typically contain about 4,000 individuals on average, while census block groups contain about 1,000 individuals, and are the smallest unit of measure for which data is collected (Krieger et al., 2003). Krieger et al. (2003) determine that census tract measures and census block groups are both adequate units of measure when assessing socioeconomic characteristics of population groups. They also find that using zip codes as a measure of socioeconomic inequality may be inadequate considering that different geographical sections within the zip code may exhibit different socioeconomic characteristics.

Grubesic and Matisziw (2006) also discuss another alternative to zip codes for looking at disease risk. This alternative is referred to as Zip code tabulation area (ZCTA). ZCTAs "were developed as spatial units by the U.S. Census Bureau for the 2000 decennial census (Grubesic & Matisziw, 2006)," are not manipulated by the U.S. Postal Service (USPS), and thus have more defined boundaries that zip codes. The U.S. Census Bureau defines ZCTAs as "generalized area representations of U.S. Postal Service (USPS) ZIP Code service areas (http://www.census.gov/geo/ZCTA/zcta.html)" and states that ZCTAs represent the five-digit ZIP Code most often found in a given area.

Grubesic and Matisziw (2006) go on to list the numerous differences between zip codes and ZCTAs. Major differences include the assignment of ZCTAs to large undeveloped areas while zip codes are usually not assigned to such an area with no need for mail delivery. Also, zip codes are usually contiguous (sharing at least two borders), while ZCTAs consist of two or more discontiguous areas. The study concludes that both ZCTAs and zip codes should be analyzed with caution. It goes on to say that the inability to definitively establish borders for zip codes may create errors in data analysis, whereas topographical features such as rivers and lakes, which would be included in ZCTA analysis, may create representation errors during data analysis.

In a zip-code based analysis, Acevedo-Garcia (2001) examines the association between zip code-level risk factors and high tuberculosis rates amongst different ethnicities. Acevedo-Garcia (2001) concluded that zip code-level risk factors such as high exposure to poverty, high contact with immigrants, and high exposure to dilapidation have a strong association with high rates of TB infection.

A study performed in San Francisco examining Pneumocystis carinii pneumonia (PCP) in HIV-infected persons, the conclusion was reached that persons living in the 94103 zip code had a much lower risk of developing PCP than participants living in the other five zip codes used for examination (odds ratio = 0.2, 95% confidence interval 0.1-0.6, $p < 0.01$) (Morris, Swanson, Ha HuAn, & Huang, 2000). It is also worth noting that the effect was present despite controlling for prophylaxis use, antiretroviral therapy, CD4 cell count, and HIV RNA level. A comparison of the socioeconomic status in the different zip codes warrants an examination, and a look at the median annual household income for 94103 was $18,411, the lowest of the six zip codes. The average median annual household income of the other 5 zip codes was $29,094 (Morris et al., 2000). However, the authors state that P. carinii DNA has been discovered in water and air samples, and that patients with a history of PCP were more likely to be involved in activities that increase the likelihood of soil exposure (Morris et al., 2000). Such activities included gardening or hiking/camping (OR 5.38, 95% CI 1.39–20.8 for gardening; OR 7.68, 95% CI 1.34–44.1 for hiking/camping) (Morris et al., 2000)". Morris et al. (2010) go on to conclude that living in 94103, the poorest of the six zip codes, may have been a protective factor due to the limited access of residents to camping, gardening, and similar activities, adding weight to the argument that zip codes may have an association with disease incidence and prevalence.

CHAPTER III - METHODS

3.1 Data Source

Secondary data was obtained from the Center of Excellence for Health Disparities Research (CoEx) located in the Institute of Public Health at Georgia State University. The primary objective of the CoEx is conducting research that investigates health disparities in communities burdened by disease in Atlanta, GA. In 2005, the CoEx initiated a research undertaking called *The Geography Project.* This research project was based on the idea that continuous transmission of HIV, STDs, and BBIs (Blood-Borne infections) requires several exposures experienced through multiple avenues, a network structure that expedites infectious disease transmission, and geographic proximity that increases the likelihood of partner selection from a pool of high-risk persons. A chain-link study design was used for this research, and all interviews took place between 2007 and 2010 in the metropolitan Atlanta, GA area. The CoEx agreed to allow use of their encoded dataset for the purpose of this thesis. Based on the distribution of HIV and STDs in Atlanta, five urban zip codes in the metropolitan area of Atlanta were identified as having a low burden of HIV/STD, while five other metro Atlanta zip codes were identified as having a high HIV/STD burden. Research participants were selected from these 10 zip codes. Each participant received a standard questionnaire which included questions about sociodemographic, behavioral, geographic, and medical questions. Participants also received examinations for seven STDs and BBIs, including HIV, Herpes Simplex Virus-2, Hepatitis C, Syphilis, Gonorrhea, Chlamydia, and Trichomoniasis (only women received testing for Trichomoniasis). Each participant was assigned an individual identifying number, and identifying information was removed in order to ensure patient confidentiality.

3.2 Inclusion/Exclusion Criteria

Original Geography Project Dataset Inclusion Criteria -- The dataset used for these analyses represents information collected from participants in the metropolitan Atlanta area. Initially, 30 participants were selected as seeds. Participants selected as seeds for the study were men and women who were at least 18 years of age, and reported risky drug use and/or sexual activity. Also, seeds were required to be residents of one of the following metropolitan Atlanta area zip codes: 30308, 30310, 30311, 30314, 30315, 30318, 30331, 30337, 30344, and 30349. Other participants were men and women of at least 18 years of age who were either named by a seed or one of the seeds' contacts. Participants were to be interviewed 3 times over a 3 year period. The total N for the dataset was 927 before inclusion/exclusion parameters were applied.

Residence – Cases in which data for the current living situation, mailing address, or center of activities did not place the participant in one of ten metropolitan Atlanta area zip codes (30308, 30310, 30311, 30314, 30315, 30318, 30331, 30337,303441 and 30349) and did not link the participant to a seed residing in one of those zip codes were excluded. Participants listed for 30308, 30310, 30314, 30315, and 30318 were assigned to a high risk zip codes group. Participants listed for 30311, 30331, 30337, 30344, and 30349 were assigned to a low risk zip codes group

Age— All participants were listed in the dataset as 18 years of age or older. No maximum age was assigned for this study, and so no cases were excluded based on age.

3.3 HIV Assessment

Overall HIV assessment was determined by a preliminary HIV-ELISA examination and/or a HIV Western Blot examination.

Participants were indicated as HIV-negative in the dataset if preliminary HIV-ELISA tests reported negative, if preliminary HIV-ELISA tests reported positive and confirmatory HIV Western Blot tests reported negative, or if preliminary HIV-ELISA tests reported inconclusive and confirmatory HIV Western Blot tests reported negative.

Participants were indicated as HIV-inconclusive in the data set if preliminary HIV-ELISA tests reported positive and confirmatory HIV-Western Blot tests reported inconclusive, if preliminary HIV-ELISA tests reported positive and participant did not receive a confirmatory HIV Western Blot test, or if preliminary HIV-ELISA tests reported inconclusive and confirmatory HIV Western Blot tests reported inconclusive.

Participants were indicated as HIV-positive if preliminary HIV-ELISA tests reported positive and confirmatory HIV Western Blot tests reported positive, or if preliminary HIV-ELISA tests reported inconclusive and confirmatory HIV Western Blot tests reported positive.

3.4 Definitions

Gender: Gender as reported by participant during interview and indicated in dataset

Highly active antiretroviral therapy (HAART): Therapy administered to HIV-positive persons to improve the immune system and decrease the HIV viral load

HIV Incidence: Refers to the amount of new HIV infections in a given timespan

HIV Prevalence: Refers to the total amount of existing HIV cases in a given population

HIV Viral Load: Used to measure and refer to the severity of HIV infection in a single person

Race: Race as indicated by interviewer and listed in dataset

Risky behavior: Indicated by multiple sex partners and/or multiple drug use partners.

Socioeconomic status (SES): Used to refer to a person's social and economic standing relative to any give population of which that person is a part of.

Spatial distribution: How a population is geographically dispersed and how that dispersion impacts health

3.5 Analysis

Statistical analysis was performed in SPSS. Univariate and multivariate binary logistic regression analysis was performed for select variables. A p-value of <0.05 and a 95% confidence interval (CI) were used to determine significance.

CHAPTER IV – RESULTS

4.1 Demographics

The *N* for The Geography Project data after applying inclusion/exclusion criteria was

897. Zip codes were determined to have low or high risk based on previous reports of HIV

cases in Fulton County, GA. Seeds and their contacts from 30308, 30310, 30314, 30315, and

30318 were placed in a high risk zip codes group. Seeds and their contacts from 30311, 30331,

30337, 30344, and 30349 were placed in a low risk zip codes group.

Table 4.1 shows that the sample is well distributed among age and gender (with the

expected exception of persons identifying as transgender), but almost completely consists of

participants that identify as Black (97.3%). The table also shows that 30314 (4.4%) and 30337

(2.2%) may have been underrepresented in the sample, although this is likely affected by a zip

code for one or more of the seeds not being indicated in the dataset, thus leading to omission

of the seed(s) and any of their contacts lacking indication of residence or activity in one of the

high or low risk zip codes of focus.

**Table 4.1 Frequency and Percent of Qualified Participants by Demographic Category,
Metropolitan Atlanta, GA**

Categories	Frequency	Percent
Age		
18-24	223	26.0
25-34	188	21.0
35-44	182	20.3
45-54	224	25.0
55-64	59	6.6
65+	11	1.2
Race		
Black	873	97.3

White	9	1.0
Hispanic	6	0.7
Asian/ Pacific Islander	1	.1
Other	8	.9
Gender		
Male	465	51.8
Female	417	46.5
Transgender	15	1.7
Zip Code		
30308	82	9.1
30310	91	10.1
30311	92	10.3
30314	47	5.2
30315	77	8.6
30318	169	18.8
30331	63	7.0
30337	20	2.2
30344	192	21.4
30349	64	7.1
Total		**N=897**

Source: The Geography Project

Figure 4.1 displays the zip codes of interests, with the high risk zip codes group being indicated

by hash lines, while the low risk zip codes of interest are indicated by the lack of hash lines.

Figure 4.1 Map of High Risk and Low Risk Zip Codes
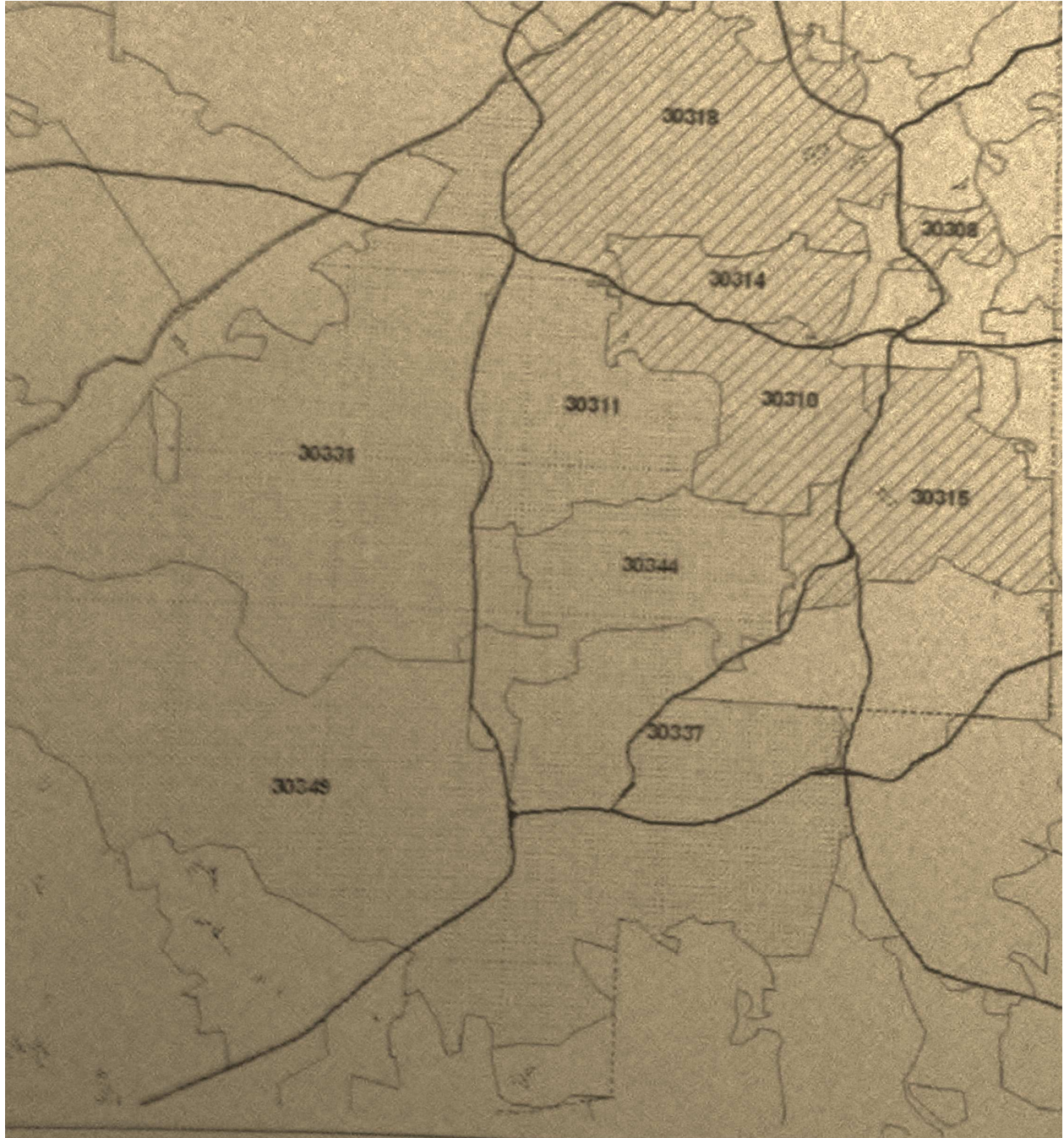
*High risk zip codes are distinguished by hash lines.

**Obtained from the "*The Geography Project*"

Table 4.2 shows that over a one-third of the sample population for low risk zip codes were between the ages of 18 and 24. The table similarly shows that almost one-third of the sample population in high risk zip codes were between the ages of 45 and 54. Also noteworthy is that 14 of the 15 transgendered persons in the study were listed in the high risk zip codes group.

Table 4.2 Frequency and Percent of Demographic Variables by Zip Code Risk Group, Metropolitan Atlanta, GA

| Categories	High Risk Zip Codes		Low Risk Zip Codes	
	Frequency	Percent	Frequency	Percent
Age				
18-24	84	18.0	149	34.6
25-34	82	17.6	106	24.6
35-44	116	24.9	66	15.3
45-54	135	30.0	89	20.6
55-64	42	6.6	17	3.9
65+	7	0.9	4	.9
Total	466	100%	431	100%
Race				
Black	447	95.9	426	98.8
White	8	1.7	1	.2
Hispanic	6	1.3	0	.0
Asian/ Pacific Islander	1	.2	0	.0
Other	4	.9	4	1.0
Total	466	100%	431	100%
Gender				
Male	231	49.6	234	54.3
Female	221	47.4	196	45.5
Transgender	14	3.0	1	0.2
Total	466	100%	431	100%
Total		N=897		

Participants indicated their number of drug and alcohol contacts in the 6 months prior to the survey. **Table 4.3** shows that high risk zip codes have a larger mean (15.25), median (8.0), and standard deviation (33.94) compared to the mean (11.86), median (6.0), and standard deviation (21.46) for low risk zip codes. **Figure 4.2** and **Figure 4.3** show the distributions in low risk zip codes and high risk zip codes, respectively, for the number of drug contacts in the six months prior to the survey.

Participants also indicated their number of sex contacts that they had in the 6 months prior to the survey. **Table 4.4** shows that high risk zip codes have a much larger mean (8.09) and standard deviation (33.28) than the mean (2.76) and standard deviation (5.95) for low risk zip codes. However, high risk and low risk zip codes do have the same median (2.0). **Figure 4.4** and **Figure 4.5** show these distributions in low risk zip codes and high risk zip codes, respectively.

Table 4.3 Mean, Median, and Std. Deviation of Participants' Drug Contacts in Last 6 Months by Zip Code Risk Group, Metropolitan Atlanta, GA

Categories	Mean	Median	Std. Deviation	N
Zip Code Risk Group				
Low Risk Zip Codes	11.86	6.0	21.46	408
High Risk Zip Codes	15.25	8.0	33.94	464
			Total	872
			25 Missing	

Figure 4.2

Low Risk Zip Code Group, Number of Drug Contacts in 6 Months
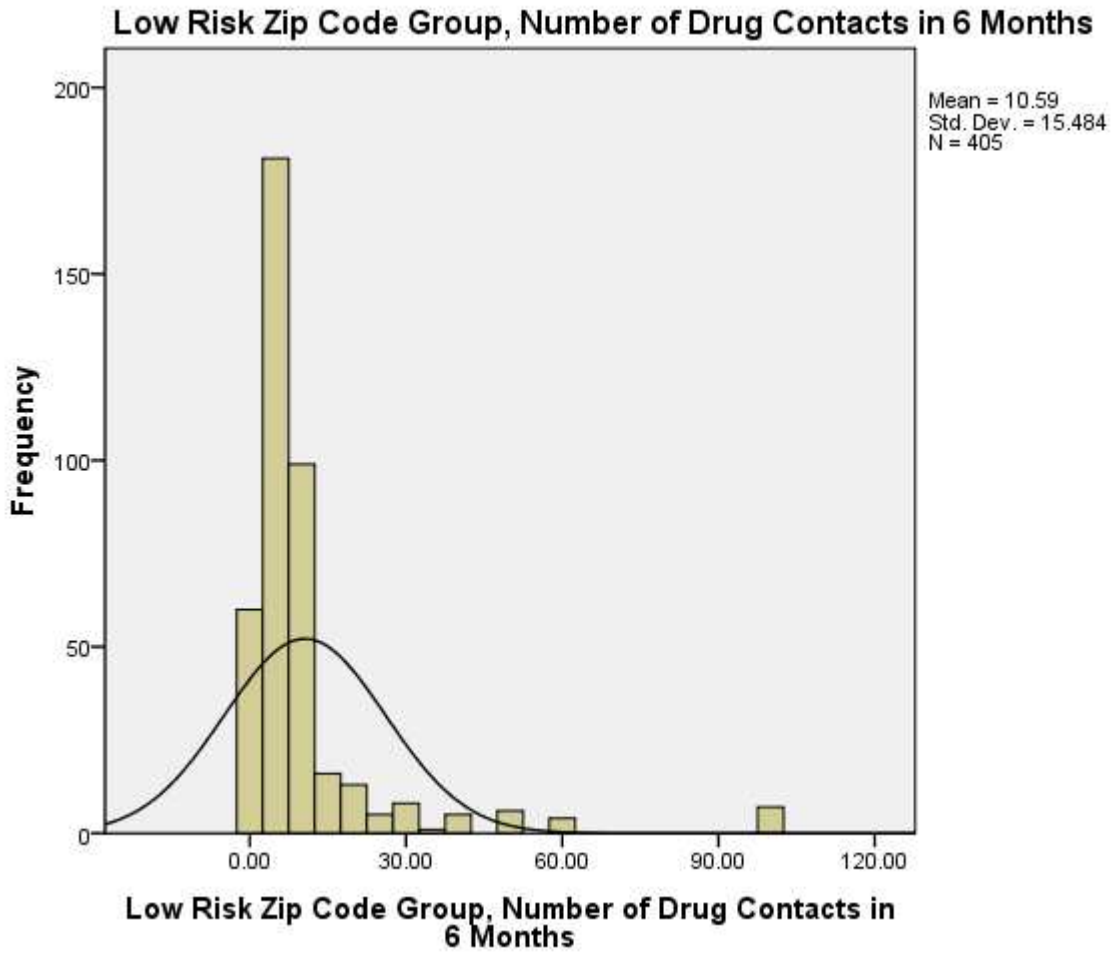
*Cases in which participants indicated values greater than 100 were removed during graphing of this distribution. Mean, median, and standard deviation for this graph were affected as a result.

Figure 4.3

Figure 4.3
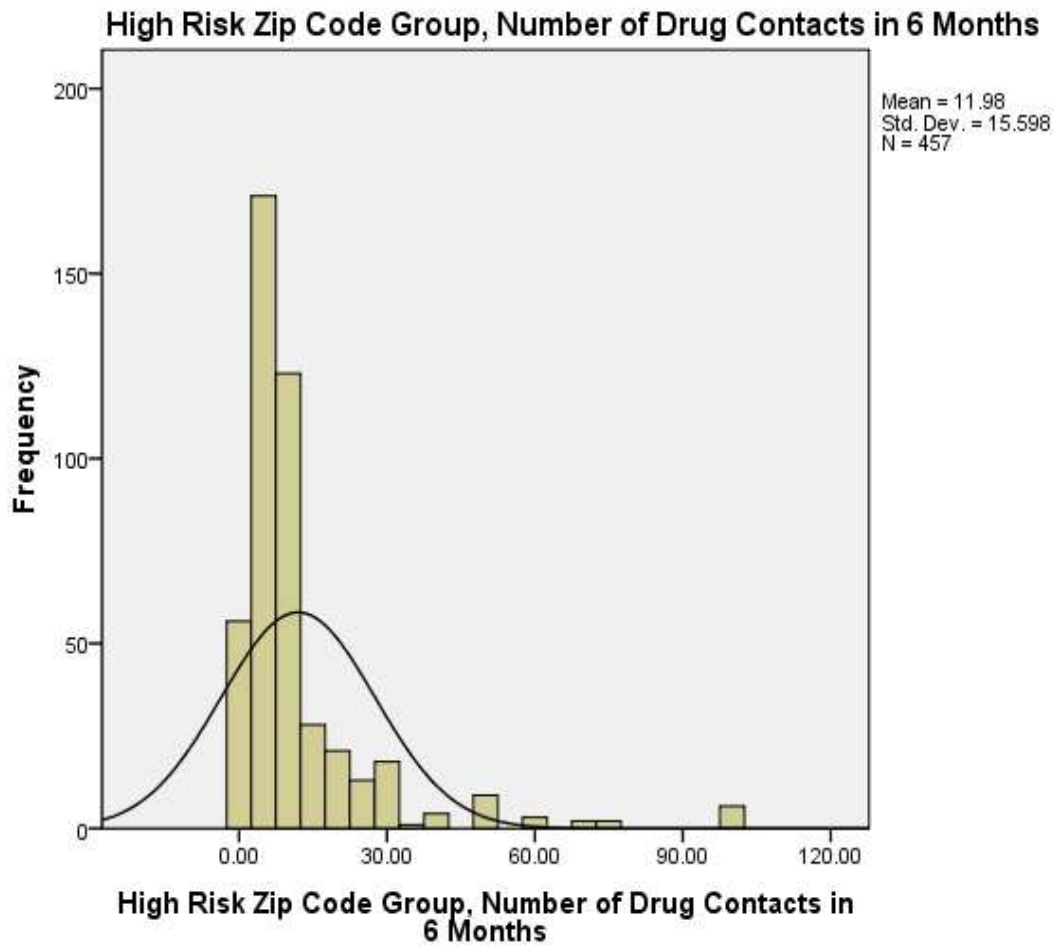
Table 4.4 Mean, Median, and Std. Deviation of Participants' Sex Contacts in Last 6 Months by Zip Code Risk Group, Metropolitan Atlanta, GA

Categories	Mean	Median	Std. Deviation	N
Zip Code Risk Group				
Low Risk Zip Codes	2.76	2.0	5.95	408
High Risk Zip Codes	8.09	2.0	33.28	464
			Total	872
				25 Missing

27

Figure 4.4

Low Risk Zip Code Group, Number of Sex Contacts in 6 Months

*Values indicated by participants to be greater than 100 were removed during graphing of this distribution. Mean, median, and standard deviation for this graph were affected as a result.

Figure 4.5

High Risk Zip Code Group, Number of Sex Contacts in 6 Months

Mean = 5.57
Std. Dev. = 13.951
N = 460

Frequency

High Risk Zip Code Group, Number of Sex Contacts in 6 Months

*Values indicated by participants to be greater than 100 were removed during graphing of this distribution. Mean, median, and standard deviation for this graph were affected as a result
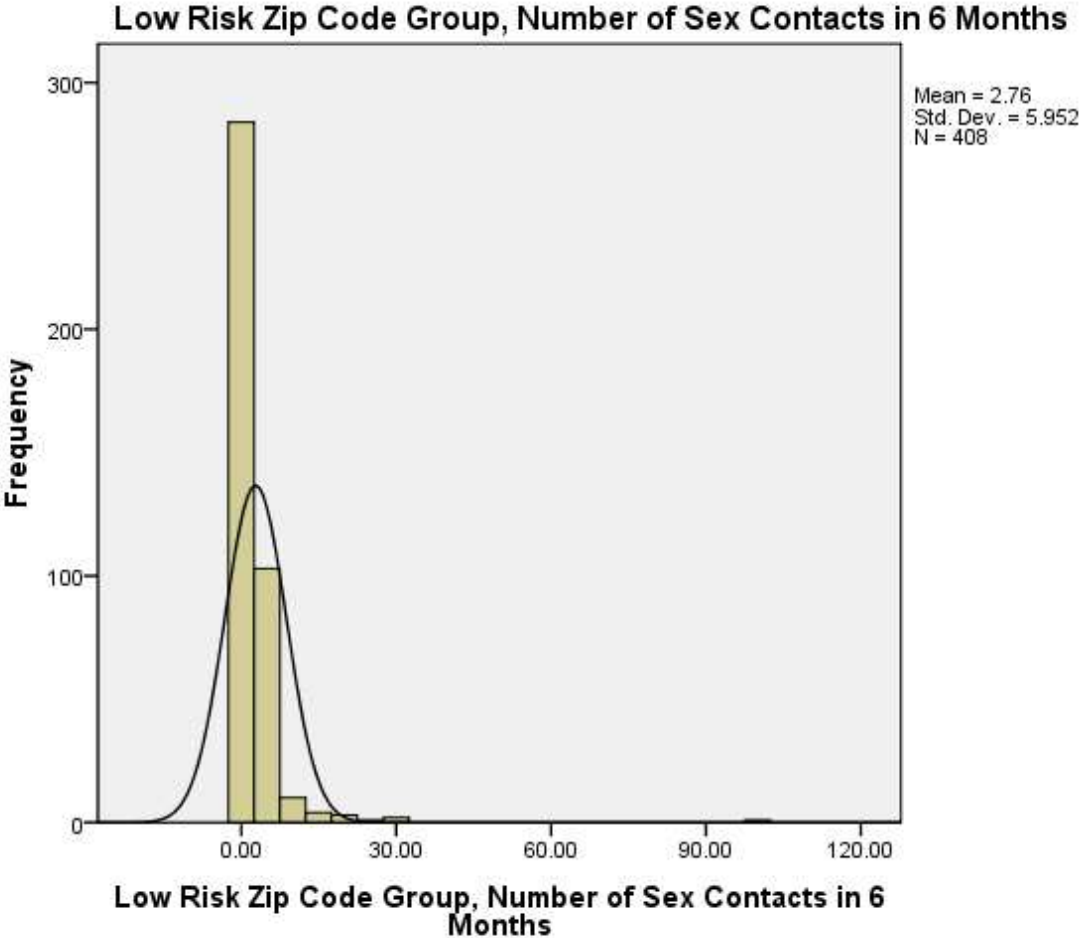
Table 4.5 displays the odds ratios for which participants were most likely to have 3 or more drug and alcohol contacts, and 3 or more sex contacts. Less than 3 and greater than or equal to 3 were used as indicators of risk based on previous literature in which the same measures were used to determine risk (Morris et al., 2010).

4.2 Univariate and Multivariate Analyses

Table 4.5 Univariate Analysis of the Association between Selected Independent Variables and Zip Code Risk Group for Geography Project Participants, Metropolitan Atlanta, GA

	Odds Ratio	95% CI		p-value
Categories		Low	High	
Infected w/ HIV at Time of Interview				
High Risk Zip Codes vs. Low Risk Zip Codes	4.402	2.109	9.187	.000
Infected w/ HIV Prior to Interview				
High Risk Zip Codes vs. Low Risk Zip Codes	6.717	1.989	22.683	.000
Infected w/ Chlamydia				
High Risk Zip Codes vs. Low Risk Zip Codes	.708	.427	1.173	.178
Infected w/ Gonorrhea				
High Risk Zip Codes vs. Low Risk Zip Codes	1.476 .	.668	3.665	.333
More than 3 Drug Contacts in 6 Mos. Prior to Interview				
High Risk Zip Codes vs. Low Risk Zip Codes	1.256	.849	1.858	.253
More than 3 Sex Contacts in 6 Mos. Prior to Interview				
High Risk Zip Codes vs. Low Risk Zip Codes	1.425	1.075	1.890	.014

Ever Incarcerated or Detained

High Risk Zip Codes vs. Low Risk Zip Codes	.551	.390	.778	.001

Table 4.6 Multivariate Analysis of the Association between Selected Independent Variables and HIV for Geography Project Participants, Metropolitan Atlanta, GA

	Odds Ratio	95% CI		p-value
Categories		Low	High	
Gender				
Male	Reference			
Female	1.611	.829	3.131	.160
Transgender	28.335	8.305	96.678	.000
Age	1.018	.992	1.045	.176
No. of Drug Contacts in 6 Mos. Prior to Interview	1.000	.990	1.010	.997
No. of Sex Contacts in 6 Mos. Prior to Interview	1.001	.992	1.011	.813
Ever Incarcerated or Detained	.			
No	Reference			
Yes	1.860	.618	5.595	.270
Zip Code Risk Group				
Low	Reference			
High	2.875	1.330	6.217	.007

CHAPTER V - DISCUSSION

5.1 Discussion of Results

It was hypothesized that participants in high risk zip codes would have a higher average number of drug and alcohol contacts as well as a larger dispersion. **Table 4.3** shows that high risk zip codes have a larger mean (15.25), median (8.0), and standard deviation (33.94) compared to the mean (11.86), median (6.0), and standard deviation (21.46) for low risk zip codes. It was similarly hypothesized that participants in high risk zip codes would have a higher average number of sex contacts as well as a larger dispersion. **Table 4.4** shows that high risk zip codes have a much larger mean (8.09) and standard deviation (33.28) than the mean (2.76) and standard deviation (5.95) for low risk zip codes. However, high risk and low risk zip codes do share a median (2.0), which likely means that the values for the number of sex contacts in six months prior to the interview are not normally distributed for high risk zip codes. This also may be indicative of some of the participants from high risk zip codes indicating extremely high values when asked about their number of sex partners in the past 6 months.

Analysis indicated that participants in high risk zip codes were roughly 6.7 times more likely to have been given an HIV-positive result prior to interview when compared to participants in low risk zip codes (OR=6.717, CI=1.989-22.683, p=.000). Furthermore, these same participants were about 4.4 times more likely to be infected with HIV at the time of

interview (OR=4.402, CI=2.109-9.187, p=.000), and 1.4 times more likely to have more than 3

sex contacts in the 6 months prior to the interview (OR=1.425, CI=1.075-1.890, p=.014). These

results are expected considering that the high risk zip codes group is host to the bulk of

Atlanta's MSM population. 14 of the 15 transgendered participants in this study were listed in

high risk zip code groups. Although it was assumed that the majority, if not all of the persons

that identified as transgender were male-to-female, there is no indication in the dataset if this

is entirely true. This high risk zip code group also hosts Grady Hospital's Ponce Clinic, one of the

largest HIV care clinics in the U.S. (Hixson et al., 2010). "The Georgia Department of Human

Resources estimates that over 70% of HIV-infected patients who live in Atlanta reside within 2

miles of the clinic (Hixson et al., 2011)." Unexpectedly, participants in high risk zip codes were

less likely to have experienced incarceration when compared to participants in low risk zip

codes (OR=.551, CI=.390-.778, p=.001). **Table 4.6** shows that the association between HIV and

persons that identify as transgender was extremely significant (OR= 28.335, CI=8.305-96.678,

p=.000). There was also a significant association between HIV and the high risk zip code group

(OR=2.875, CI=1.330-6.217, p=.007).

The high risk zip codes seem to have been selected on the basis that persons at higher

risk tend to have residence and/or a high level of activity there. Likewise, low risk zip codes

were selected on the basis that persons with a comparably lower risk tend to have residence

and/or a high level of activity there. Analysis of the data confirms the selection of zip codes

indicated as high risk, and displays several key differences between high and low risk groups.

This study supports the idea that the HIV spread has focal tendencies and that neighborhood contacts may play a vital role in HIV risk.

5.2 Limitations

There are several limitations to this study. First, as with many studies based on secondary data, the nature of the data collection presents challenges, as a chain link study design coupled with seeking seeds with risky behavior make the likelihood of participants having risky behavior higher than it would be in a random sample. 97.3% of the study population identified as Black, which may affect the study's generalizability. Also, there were seeds in the dataset for which no zip code was indicated, and this led to the omission of 30 cases. Furthermore, the age distribution was uneven in both low and high risk zip codes. Roughly one-third of the sample population in the high risk zip codes group were between the ages of 35 and 44, while about one-third of the sample population for low risk zip codes were between the ages of 18 and 24.

5.3 Recommendations

To assess if there is a correlation between sex and drug partnerships, future analyses should include consideration of network configurations and geographic distances between partners. These analyses would help to determine if there is a significant association between geographic distance and partner selection. More specifically, these analyses would help to

establish if those in high risk areas select partners closer to their residences and/or center of activities and determine whether high or low risk groups have a higher prevalence of risk taking.

5.4 Public Health Significance

HIV prevalence continues to increase each year in the United States, aided by a continued rise in HIV incidence and HAART, which has helped considerably to increase the survival rate of HIV-infected persons since the 1990's. Consequently, the health care system's workforce may feel a strain as it struggles to care for the ever-increasing number of HIV-infected individuals. HIV investigation and prevention efforts of the Fulton County Health Department in Atlanta, GA typically use zip codes as a determination of how to allocate personnel and resources. If a more effective means of resource allocation can be discovered through research, this would be a major accomplishment in the fight against HIV and other STDs. Health services made accessible to the public and positioned in specific areas with higher HIV prevalence around the country may very well contribute to the decline of annual HIV incidence rates.

5.5 Conclusion

The rate of HIV-prevalence in Atlanta, GA is one of the highest of all U.S. major cities. It is likely that this rate is contributed to by a large MSM population, over half of the population

being African-American (Hixson et al., 2010), and a poverty rate of 21% (Kalichman et al., 2010).

Predictably, MSM and those who live below the poverty line tend to have most of their activity

in high risk zip codes. Those in high risk zip codes were more likely to test positive for HIV

during the survey, be infected with HIV prior to the survey, and have more than 3 sex contacts

in the 6 months prior to the survey. Persons identifying as transgender had an extremely

significant association with HIV, and all but one of these persons were listed in the high risk zip

codes group. Further research is needed to determine the significance of geographic location to

an individual's overall health.

REFERENCE LIST

Acevedo-Garcia, D. (2001). Zip code-level risk factors for tuberculosis: Neighborhood
environment and residential segregation in new jersey, 1985-1992. *American Journal of
Public Health 91*(5), 734-741.

Bernstein, K.T., Curriero, F.C., Jennings, J.M., Olthoff, G., Erbelding, E.J. & Zenilman, J. (2004).
Defining core gonorrhea transmission utilizing spatial data. *American Journal of
Epidemiology 160*(1), 51-58.

Campsmith, M.L., Rhodes, P.H., Hall, H.I., & Green, T.A. (2010). Undiagnosed hiv prevalence
among adults and adolescents in the us at the end of 2006. *Journal of Acquired Immune
Deficiency Syndromes 53*(5), 619-624.

Decker, J.F., Sharpe, B., & Dillon, J.R. (1997). Mapping antibiotic-resistant neisseria gonorrhoeae
isolates in metropolitan toronto: Issues of scale, positional accuracy and confidentiality.
The Canadian Journal of Infectious Diseases 8(5), 273-278.

Elliot, P. & Wartenburg, D. (2004). Spatial epidemiology: Current approaches and future
challenges. *Environmental Health Perspectives 112*(9), 998-1006.

Fede, A.L., Stewart, J.E., Hardin, J.W., Mayfield-Smith, K., & Sudduth, D. (2011). Spatial
visualization of multivariate datasets: an analysis of std and hiv/aids diagnosis rates and
socioeconomic context using ring maps. *Public Health Reports 126*, 115-126.

Fichtenberg,C.M., Jennings, J.M., Glass, T.A., & Ellen, J.M. (2010). Neighborhood socioeconomic
environment and sexual network position. *Journal of Urban Health (87)*2, 225-235.

Gottlieb, S. L., Pope, V., Sternberg, M. R., McQuillan, G. M., Beltrami, J. F., Berman, S. M., &
Markowitz, L. E. (2008). Prevalence of syphilis seroreactivity in the united states: data

from the national health and nutrition examination surveys (NHANES) 2001-2004. *Journal of the American Sexually Transmitted Diseases Association 35*(5), 507-511.

Grindi, R.M., Sifakis, F., Sherman, S.G., Towe, V.L., Flynn, C., & Zenilman, J. (2011). The geography of heterosexual partnerships in Baltimore city adults. *Sexually Transmitted Disease (38)*4, 260-266.

Grubesic, T.H. & Matisziw, T.C. (2006). On the use of ZIP codes and ZIP code tabulation areas (ZCTAs) for the spatial analysis of epidemiological data. *International Journal of Health Geographics 5*, 58-72.

Hall, H.I., Byers, R.H., Ling, Q., and Espinoza, L. (2007). Racial/ethnic and age disparities in hiv prevalence and disease progression among men who have sex with men in the united states. *American Journal of Public Health 97*(6), 1060-1066.

Hall, H.I., Green, T.A., Wolitski, R.J., Holtgrave, D.R., Rhodes, P., Lehman, J.S., Durden,T., Fenton, K.A., & Mermin, J.H. (2010). Estimated future hiv prevalence, incidence, and potential infections averted in the united states: A multiple scenario analysis. *Journal of Acquired Immune Deficiency Symdromes(55)*2, 271-276.

Hall, H. I., Song, R., Rhodes, P., Prejean, J., An, Q., Lee, L. M., Karon, J., Brookmeyer, R., Kaplan E.H., McKenna, M.T. & Janssen, R. S. (2008). Estimation of hiv incidence in the united states. *The Journal of the American Medical Association 300*(5), 520-529.

Herek, G. M., Capitanio, J. P., & Widaman, K. F. (2002). HIV-related stigma and knowledge in the united states: Prevalence and trends, 1991–1999. *American Journal of Public Health 92*(3), 371-377.

Hixson, B.A., Omer, S.B., del Rio, C., & Frew, P.M. (2011). Spatial clustering of HIV prevalence in Atlanta, Georgia and population characteristics associated with case concentrations. *Journal of Urban Health 88*(1), 129-141.

Jennings, J.M., Taylor, R., Iannacchione, V.G., Rogers, S.M., Chung, S., Huettner, S., & Ellen, J.M. (2010). The available pool of sex partners and risk for a current sexually transmitted infection. *Annals of Epidemiology 20*(7), 532-538.

Kalichman, S.C., Cherry, C., Amaral, C., White, D., Kalichman, M.O., Pope, H., Swetsze, C., Jones, M., & Macy, R. (2010). Health and treatment implications of food insufficiency among people living with hiv/aids, atlanta, georgia. *Journal of Urban Health 87*(4), 631-641.

Krieger, N., Waterman, P.D., Chen, J.T., Soobader, M., & Subramanian, S.V. (2003). Monitoring socioeconomic inequalities in sexually transmitted infections, tuberculosis, and violence: Geocoding and choice of area-based socioeconomic measures. *Public Health Reports 118,* 240-258.

Law, D., Serre, M., Christakos, G., Leone, P., & Miller, W. (2004). Spatial analysis and mapping of sexually transmitted diseases to optimise intervention and prevention strategies. *Sexually Transmitted Infections (80)*4, 294-299.

Monteiro, E., Lacey, C., & Merrick, D. (2005). The interrelation of demographic and geospatial risk factors between four common sexually transmitted diseases. *Sexually Transmitted Infections 81*(1), 41-46.

Morris, A.M., Swanson, M., Ha HuAn, & Huang, L. (2000). Geographic distribution of human immunodeficiency virus-associated pneumocystis carinii pneumonia in san francisco. *American Journal of Respiratory and Critical Care Medicine 162*(5), 1622-1626.

Morris, M., Kurth, A.E., Hamilton, D.T., Moody, J., & Wakefield, S. (2009). Concurrent partnerships and hiv prevalence disparities by race: Linking science and public health practice. *American Journal of Public Health 99*(6), 1023-1031.

Rothenberg, R. (1983). The geography of gonorrhea: Empirical demonstration of core group transmission. *American Journal of Epidemiology 117*(6), 688-694.

Santelli, J.S., Lowry, R., Brener, N.D., & Robin, L. (2000). The association of sexual behaviors with socioeconomic status, family structure, and race/ethnicity among us adolescents. *American Journal of Public Health 90*(10), 1582-1588.

Sullivan, A.B., Gesink, D.C., Brown, P., Zhou, L., Kaufman, J.S., Fitch, M., Serre, M.L. & Miller, W.C. (2011). Are neighborhood sociocultural factors influencing the spatial pattern of gonorrhea in north carolina? *Annals of Epidemiology 21*(4), 245-252.

Tao, G., Hoover, K. W., & Kent, C. K. (2012). Chlamydia testing patterns for commercially insured women, 2008. *American Journal of Preventive Medicine 42*(4), 337-341.

Walker, C. K. & Sweet, R. L. (2011). Gonorrhea infection in women: prevalence, effects, screening, and management. *International Journal of Women's Health 3,* 197-206.

Xu, F., Sternberg, M. R., & Markowitz, L. E. (2010). Women who have sex with women in the united states: Prevalence, sexual behavior and prevalence of herpes simplex virus type 2

infection-results from national health and nutrition examination survey 2001-2006. *Journal of the American Sexually Transmitted Diseases Association 37*(7), 407-413.