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# THE ASSOCIATION BETWEEN MOBILITY AND HIV RISK: AN ANALYSIS OF TEN HIGH PREVALENCE ZIP CODES OF ATLANTA, GEORGIA

by

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B.A., FURMAN UNIVERSITY
J.D., UNIVERSITY OF FLORIDA

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
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THE ASSOCIATION BETWEEN MOBILITY AND HIV RISK: AN ANALYSIS OF TEN HIGH PREVALENCE ZIP CODES OF ATLANTA, GEORGIA

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**ABSTRACT**

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THE ASSOCIATION BETWEEN MOBILITY AND HIV RISK: AN ANALYSIS OF TEN HIGH PREVALENCE ZIP CODES OF ATLANTA, GEORGIA

(Under the direction of Richard Rothenberg, M.D.)

Studies from developing countries disagree on whether mobility is a risk factor or a protective factor for HIV risk. The difference is often determined by gender. Few studies exist, however, examining the relationship among high risk populations in developed nations. This study seeks to examine that relationship in 10 high risk ZIP codes of Atlanta, Georgia using data gathered from the Geography Project by Rothenberg and colleagues. Logistic regression was used to examine the relationship between HIV risk and five independent variables of mobility. Results were stratified by gender. After controlling for demographic and behavioral variables, use of public transportation by men was significantly protective of HIV risk. Significant associations were also observed with ever injection drug use and recent condom use, indicating that high risk behaviors may be the real driver of the epidemic in these neighborhoods.

KEYWORDS: Mobility, Transportation, HIV Risk, Social Networks, Geographic Concentration

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GRAs and others who worked on the Geography Project

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# Chapter I
# Introduction

Epidemiological studies have shown that sexually transmitted diseases (STDs), such as HIV, tend to concentrate in core geographic areas of inner cities which act as reservoirs of disease for their larger communities (Potterat, et al., 1985; R Rothenberg, Muth, Malone, Potterat, & Woodhouse, 2005; R. B. Rothenberg, 1983). These inner city neighborhoods are characterized by poverty; a high prevalence of HIV-risk behaviors, such as unprotected sex and injection drug use (IDU); and high partner assortativity (associating with persons of similar circumstances) (R. B. Rothenberg, 1983). The concentration of these characteristics in geographic cores helps maintain the endemicity of HIV and increases the risk of infection for those who live in or associate with these core communities, even if they are not involved in high-risk behaviors (Potterat, et al., 1985; R. B. Rothenberg, 1983). These findings have been observed in several cities, including Atlanta, Georgia (Hixson, Omer, del Rio, & Frew, 2011).

Another characteristic of these inner city areas is limited mobility. Many people do not own their own car and must rely on public transportation or friends for travel and moving around (Gindi, et al., 2011; Potterat, et al., 1985; R Rothenberg, 2007; Zenilman, Bonner, Sharp, Rabb, & Alexander, 1988). Some studies in developing countries have shown increased mobility to be an independent risk factor for HIV (Boerma, Urassa, Senkoro, Klokke, & Ng'weshemi, 1999; Lagarde, et al., 2003). However, other studies have shown increased mobility to be protective, especially for women in groups with high HIV prevalence (Haibo, et al., 2010; Strathdee, et al., 2008; Watts, et al., 2010). Due to a lack of an operational definition of mobility (Deane, Parkhurst, & Johnston, 2010) and a scarcity of studies in developed countries, it is not clear if such findings would be observed in geographic regions of high HIV prevalence located in a

developed country, such as the United States.

Therefore, the present study addressed the question: "How does mobility affect HIV risk in inner city areas with high HIV prevalence located in the United States?" Based on the available literature and the data available, I proposed the following affirmative hypothesis: "increased mobility has a protective effect on HIV risk among persons living in inner city communities of Atlanta, Georgia with high HIV prevalence, but the effect varies by gender." The corresponding null hypothesis was: "mobility has no effect on HIV risk among persons living in inner city communities with high HIV prevalence, regardless of gender." For the purposes of this paper, the research question was examined in terms of the affirmative hypothesis.

The question posed was important, because knowing the effects of mobility in these communities would further contribute to the growing evidence base on the influence of social networks in HIV transmission. Much research has been done already on the characteristics of these networks in inner city communities with high HIV prevalence. Multiple contacts and high partner assortativity have been shown to increase HIV risk in these core geographic areas (R Rothenberg, et al., 2005). Because mobility is one way that persons form contacts with others, those who are highly mobile would presumably have more contacts and a larger social network than those who are less mobile. Nevertheless, those who are highly mobile could also leave those high risk neighborhoods more often and be less exposed to high-risk behaviors and HIV. Thus, it was heretofore unclear how mobility would affect HIV risk in these communities.

Knowing how mobility influences HIV risk in these communities could help formulate more effective HIV prevention programs. For example, if increased mobility were shown to be a protective factor for women, public health authorities would want to focus more prevention

efforts on women in these communities who are geographically isolated. Likewise, if increased mobility were shown to be a risk factor for men, campaigns could be developed that address men who travel frequently. The transmission of HIV is influenced by a variety of factors and more knowledge of those factors could lead to more effective interventions targeted to those at greatest risk. Therefore, the present study was undertaken to examine how mobility might affect HIV risk in these core geographic areas of the inner city.

Before analyzing the research question, the current literature on geographic concentrations of STDs and HIV, the influence of social networks on HIV transmission in these core areas, and the effects of mobility on HIV risk in high prevalence populations was thoroughly examined. Data from the Geography Project by Rothenberg and colleagues was used to perform statistical analyses of the effects of mobility on HIV risk in 10 ZIP codes of Atlanta, Georgia with high HIV prevalence. Variables from that data set were re-coded to form five independent variables of mobility: furthest distance away from one's center of activity (COA) within in the Atlanta area in the past six months, travel out of the Atlanta area in the past six months, driving one's own car, use of any car, and use of public transportation. The dependent variable was HIV status, determined by the results of an HIV antibody test.

The five independent variables of mobility were compared in univariate analyses to the dependent variable of HIV status. Further univariate analyses were used to determine significant associations between each independent variable of mobility and various demographic and behavioral factors. Those factors were also compared to HIV status. Any factor shown to be significantly associated with a mobility variable or HIV status was included in the final multivariate analysis. A logistic regression model was used to analyze the relationship between the mobility variables and HIV status, controlling for those possible confounders, with results

stratified by gender. Subsequent to the analyses, the results were interpreted in light of the current literature and the need for HIV prevention programs, leading to recommendations for further research.

## Chapter II
## Review of the Literature

Nearly 30 years ago, Rothenberg (1983) found that gonorrhea cases in upstate New York were concentrated in a small number of census tracts representing only nine percent of the population. He also observed a gradient of clustering with the highest concentrations located in these core tracts and a gradual dispersion of cases moving out from the core into adjacent and peripheral areas. Furthermore, Rothenberg (1983) found that these core census tracts corresponded to inner city poverty areas of high population density where persons frequently had sexual contact only with others from the same area; thus, the gonorrhea epidemic was maintained in and largely confined to these small geographic clusters.

Potterat and colleagues (1985) confirmed these findings in a similar study of gonorrhea in Colorado Springs, Colorado. There they found that 51 percent of cases came from only four census tracts representing 5.9 percent of the city's population with a similar proportion of contacts from the same area. They also observed that 30 percent of cases came from adjacent census tracts and the remainder came from the rest of the city (the periphery). This core area of the inner city served as a reservoir of gonorrhea for the rest of the city: Sex usually happened between core cases and contacts and between peripheral cases and contacts, but adjacent cases were more likely to have sex with core contacts than with adjacent cases. Interestingly, the population of this core area was rather stable with half of cases not having moved in the previous six months and 38 percent not having moved in the previous year.

Geographic concentrations have also been observed with other sexually transmitted diseases (STD), such as syphilis and Chlamydia (Alvarez-Dardet, Marquez, & Perea, 1985), as well as Penicillinase-Producing Neisseria Gonorrhea (PPNG) (Zenilman, et al., 1988).

In addition, Bernstein and colleagues (2004) found that high risk behaviors tended to further concentrate in small areas within the geographic core of an STD epidemic.

Furthermore, Kerani and colleagues (2005) demonstrated a gradient of concentrations based on the type of STD. For example, they found that STDs transmitted less efficiently and for a shorter duration, such as syphilis, would only persist in populations with high levels of sexual mixing and therefore be more concentrated in small core areas. In contrast, STDs transmitted efficiently and for longer periods, such as herpes, would be more broadly distributed in a population. This observation was confirmed in a study by Zenilman and colleagues (2002) who found that 53 per cent of gonorrhea cases at Fort Bragg were concentrated in three morbidity areas whereas the distribution of Chlamydia, which has a longer duration due to its more frequent asymptomatic nature, was much more widespread.

Geographic concentrations of infection have also been observed with HIV. Rothenberg and colleagues (2005) found that HIV cases were concentrated in the downtown area of Colorado Springs and that the majority of social connections between cases and contacts were in this same area. They found that geographic concentrations promoted higher mixing of persons at risk than would be observed in the general population, even for those not connected socially. This tendency to associate with others with similar characteristics, such as HIV risk, is known as assortative mixing and is another feature of core areas that helps maintain the epidemic. Such a concentration of HIV infection has been observed in Atlanta, Georgia: Hixson and colleagues (2011) found that 60 per cent of HIV cases in metro Atlanta were contained in a large cluster centered on the downtown area with an HIV prevalence of 1.34 percent as compared to 0.32 percent in the general population.

STD epidemics tend to concentrate in core areas of inner cities for several reasons.

Characteristics of inner city neighborhoods contribute to their being reservoirs for disease. Inner city neighborhoods are characterized by poverty and its various sequelae (Hixson, et al., 2011; R. B. Rothenberg, 1983); high population density (Hixson, et al., 2011; R. B. Rothenberg, 1983; Zenilman, et al., 2002); a greater frequency of high risks behaviors, such as injection drug use (IDU) and prostitution; and men who have sex with men (MSM) (R. B. Rothenberg, et al., 2000; Zenilman, et al., 2002). Although many inner city neighborhoods are predominantly African American, the literature shows that racial identity is not as important a factor in STD prevalence as is poverty (Hixson, et al., 2011; Jennings, Curriero, Celentano, & Ellen, 2005) and socio-economic status (SES) (Zenilman, et al., 2002).

The characteristics of the social networks within these geographic areas also influence the transmission of HIV and other STDs. Most importantly, these networks are highly assortative: People generally associate with others in their same network. When these associations involve sexual relations, the chance of pairing with an infected partner is high and thus, the disease remains epidemic in the community (Bernstein, et al., 2004; Doherty, Padian, Marlow, & Aral, 2005; Gindi, et al., 2011; Kerani, et al., 2005; Potterat, et al., 1985; R Rothenberg, et al., 2005; R. B. Rothenberg, 1983; Zenilman, Ellish, Fresia, & Glass, 1999). Conversely, disassortative mixing (associating with people of different characteristics) creates a bridge for transmission to areas outside of the core network (Doherty, et al., 2011). Core social networks also have a high incidence of STDs that are widespread among the various nodes in the network (Jennings, et al., 2010; R. Rothenberg, Baldwin, Trotter, & Muth, 2001; R. B. Rothenberg, et al., 1998; Woodhouse, et al., 1994). Furthermore, greater social cohesion—more connected components than in the general population—leads to an increase in disease transmission over time (Potterat, Rothenberg, & Muth, 1999).

One possible reason for greater assortativity and social cohesion is that people in these inner city core areas are generally less mobile than people in the general population. People reside in these areas for long periods of time (Potterat, et al., 1985; R Rothenberg, 2007; Zenilman, et al., 1988) and have less access to transportation (Gindi, et al., 2011). However, two articles identified mobility as an independent risk factor for HIV in high prevalence areas of Africa. Lagarde and colleagues (2003) found that short-term mobility (defined as having been away from one's village for at least one day and one night in the previous four weeks) was a risk factor for HIV in men (OR=2.06) but not for women in a community in West Africa where the prevalence rate was 10.5 percent. Similarly, Boerma and colleagues (1999) found greater population mobility in a trading center in rural Tanzania where the HIV prevalence was twice that of surrounding areas.

The studies by Lagarde and colleagues (2003) and Boerma and colleagues (1999) were both conducted in Africa and may not be generalizable to high prevalence areas in the United States or other developed countries. So whether mobility is a risk factor for HIV in the high prevalence areas heretofore described is not clear. Like the two previously cited studies, most of the literature on mobility and HIV risk focuses on migrants in developing countries who travel from rural to urban areas either seasonally or frequently for work (Xiaoming, et al., 2004). Unfortunately, there are virtually no studies of this topic in developed nations.

The numerous studies that do exist from developing countries, however, observe that increased mobility is associated with high-risk behaviors, such as casual, extramarital, or concurrent partnerships (Deren, Kang, Colon, & Robles, 2007; El-Bassel, et al., 2011; Feldacker, Emch, & Ennett, 2010; Gupta, Vaidehi, & Majumder, 2010; Khan, et al., 2008; Vissers, et al., 2008; Xiaoming, et al., 2004; Yang & Xia, 2006; Zuma, Gouws, Williams, & Lurie, 2003),

higher rates of commercial sex, both for female sex workers (FSW) (Bo, et al., 2007; Khan, et al., 2008; Nguyen Anh, et al., 2007; Sopheab, Fylkesnes, Vun, & O'Farrell, 2006; Yang & Xia, 2006) and their male clients (Bo, et al., 2007; Feldacker, et al., 2010; Gupta, et al., 2010; Sopheab, et al., 2006), and higher rates of IDU (Deren, et al., 2007; Rachlis, et al., 2007). Studies have also found that HIV risk increases with one's mobility (Lippman, et al., 2007; Lydié, et al., 2004). Finally, even though some safer sex behaviors have been observed among mobile persons, such as increased condom use (El-Bassel, et al., 2011; Goldenberg, Strathdee, Perez-Rosales, & Sued, 2012; Haibo, et al., 2010), most people in these communities perceive mobile persons to be more likely to engage in high-risk behaviors (Ezekiel, Talle, Mnyika, & Klepp, 2010).

Despite the agreement that an association exists between mobility and high-risk behavior, there is no consensus in the literature as to whether mobility is a risk factor for HIV. Many studies identify it as a risk factor (Bloom, Urassa, Isingo, Ng'weshemi, & Boerma, 2002; El-Bassel, et al., 2011; Kishamawe, et al., 2006; Nguyen Anh, et al., 2007; Sopheab, et al., 2006; Vissers, et al., 2008; Zuma, et al., 2003), but several studies are inconclusive as to the effect of mobility on HIV risk (Coffee, et al., 2005; Haibo, et al., 2010; Mundandi, Vissers, Voeten, Habbema, & Gregson, 2006; Watts, et al., 2010; Yan, Xiaoming, Hongmei, Xiaoyi, & Ran, 2009). In addition, some studies found different results based on gender as to the influence of mobility on both high-risk behaviors and HIV risk with no agreement as to whether mobility was a greater risk for men (Lurie, et al., 2003) or for women (Bo, et al., 2007; Camlin, et al., 2010; Khan, et al., 2008). Hirsch and colleagues (2007) found that men have different patterns of movement that lead to greater opportunities for high-risk sexual behaviors. However, Feldacker and colleagues (2010) found that women who lived close to major roads and cities were at

greater risk and that isolated women were protected from HIV. Moreover, they found that that men's heightened status in society may be a protective factor despite their greater mobility. Therefore, whether and how gender plays a role in determining the sexual risks associated with mobility is not clear.

There are several factors that may explain the disparate results observed in the literature as to whether mobility is a risk factor for HIV. The most obvious explanation is that there is no agreement on an operational definition for mobility; thus, mobility has been conceptualized in different ways and subsequently measured differently. Results then depend on which definition is used. The concept of mobility is broad and can include seasonal and circular migration, rural to urban migration, commuting, internal displacement, and international refugee migration with different results depending on what one is actually studying (Deane, et al., 2010). For example, three studies from the same study cohort in Tanzania used three completely different definitions but referred to their results simply in terms of "mobility". Boerma and colleagues (1999) defined mobility as having moved between the years 1994 and 1995 or having moved into one's current household in the previous five years (either condition qualified one as mobile). Using that definition, they found that HIV positive persons were more mobile than HIV negative persons. Kishamawe and colleagues (2006) used the terms long-term mobile and short-term mobile to differentiate whether one had been living elsewhere (long-term) or briefly staying elsewhere (short-term) the night before on at least one of the survey's five rounds of demographic interviews. Using those definitions, they found increased risk for short-term mobile men and long-term mobile women. Finally, Vissers and colleagues (2008) defined couples as co-resident or living apart and further defined individuals as non-mobile or mobile (based on whether or not one had slept outside the home more than 10 times in the previous year) to create four mobility

categories: co-resident mobile, co-resident non-mobile, living apart mobile, and living apart non-mobile. Using this criteria, they found that mobile co-resident men were more likely to have extramarital sex than non-mobile co-resident men and that women living apart who saw their partner infrequently were at greater risk than non-mobile co-resident women. While each study purported to be analyzing mobility, they were clearly talking about three different ideas and arriving at different conclusions based on these arbitrary definitions. Therefore, results cannot be compared across studies.

The various and nuanced characteristics of migration may also be a factor in whether mobility increases or decreases HIV risk (Goldenberg, et al., 2012). Migration is a type of mobility characterized by large scale movement of people from one location to another, often for work or food. It is usually associated with negative characteristics, such as societal marginalization that may reduce access to social and health services (Goldenberg, et al., 2012; Xiaoming, et al., 2004; Yang & Xia, 2006), greater opportunities for high risk behaviors, particularly in transit centers (Goldenberg, et al., 2012; Rachlis, et al., 2007), and a disproportionate number of persons, particularly women, employed in the service and entertainment industries (Yang & Xia, 2006). However, there are sometimes positive aspects to migration, such as moving into an area with better access to social and health services, especially HIV resources, and better attitudes toward women (Goldenberg, et al., 2012). Therefore, whether mobility is a risk factor for HIV may also depend on the characteristics of the community into which one is moving or travelling and community variations may be wide spread even within a small geographic area.

Finally, even though most of the studies cited were performed in developing countries, there is still much heterogeneity in these areas. Obviously, China, Africa, and Latin America are

different places, but even within those large regions, there are numerous peoples, traditions, and customs that could affect the outcome of these studies (Mundandi, et al., 2006). One study performed in a country of West Africa may not be generalizable to an area in East Africa or even to an adjacent country. Therefore, the results of these studies may be confounded by unidentified variables unique to the study locations that have little to do with mobility.

Although there are no studies directly examining the association between mobility and HIV risk in geographic areas with high HIV prevalence in the developed world, there are several studies examining this relationship in other high risk populations, not necessarily defined by geography. Even so, these studies may be provide some insight for the present analysis and thus deserve further examination. Khan and colleagues (2008) compared HIV-related sexual behavior among mobile and non-mobile populations by gender in two districts of Burkina Faso with high HIV prevalence (1.4 and 2.3%). Defining mobility as travelers and recent migrants of less than one year, they found that mobile women were more likely to report new sexual partners (OR=2.07; 95% CI: 1.19, 3.50) and commercial sex (OR=2.3; 95% CI: 1.55, 3.42) in the previous month as compared to their non-mobile counterparts. However, no significant associations were observed among men.

In a study examining the relationship between mobility, sexual behavior, and HIV infection, Lydié and colleagues (2004) studied an urban population (n=2,089) in Yaoundé, Cameroon with a 2000 HIV prevalence of 5.5%. Mobility was determined by the number of trips for more than one night outside of the city and the time spent away from their residence in the previous 12 months. They found that HIV prevalence among men increased with time away from home, after controlling for age, SES, and sexual behavior. More specifically, they found that men who reported no absence in the prior year were less likely to be infected than those who

had been away for more than 31 days (OR=0.23; 95% CI: 0.07, 0.82). However, the difference for women was not significant.

In another study of a high risk population, Strathdee and colleagues (2008) compared correlates of HIV infection among male and female IDUs in Tijuana, Mexico. In their study, males (n=896) and females (n=157) had an HIV prevalence of 3.5% and 10.2%, respectively, both rates being much higher than the general population. Adjusting for age, injection drug use, active syphilis infection, deportations from the United States, and arrests, the authors found that having lived in Tijuana for a longer period of time was associated with greater HIV infection in women (Adj.OR=1.81 per 10 years; 95% CI: 1.12, 2.94), but that the opposite was true for males (Adj.OR=0.65 per 10 years; 95% CI: 0.46, 0.93). Therefore, in this population with high HIV prevalence, mobility was found to be a risk factor for HIV among men, but a protective factor among women.

Furthermore, two recent studies on female sex workers (FSW) and their mobility implied that increased mobility was a protective factor for this high risk population. Watts and colleagues (2010) analyzed information from developing countries on the duration that women sell and men buy sex and used modeling to simulate transmission between FSW and their male partners. By comparing relative numbers of sexual partners, the authors found that non-mobile sex workers were at greater risk of HIV infection. Similar results were observed in a cohort study of Chinese FSW by Haibo and colleagues (2010) who found that the FSW at highest risk were less mobile than those at lower risk.

Whether any of the previously described results would be observed among the high risk population (as defined by geography) of an inner city in the United States is not clear but merits further examination. Therefore, the present analysis focused on the association between mobility

and HIV risk for the populations of ten high-risk ZIP codes in the inner city of Atlanta, Georgia. As this study did not involve a developing country or a migrant population and because the available data on mobility were limited, mobility was based on how often people left their zone of residence, how far they traveled when they did, and their access to transportation. As previously reported, high risk areas in developed countries have been described as stable; therefore, I hypothesized that greater mobility would be a protective factor for those residing in these areas because of the ability to remove oneself from the concentration of risk behaviors, but that the results would vary by gender. Univariate analysis was used to compare various mobility variables to HIV risk and multivariate logistic regression was used to control for possible confounders, such as age, race, SES, sexual behavior, and drug use. Results were stratified by gender.

# Chapter III
# Methods and Procedures

## Background

The data used in this analysis were gathered as part of the Geography Project conducted by Rothenberg and colleagues from 2005 to 2011 in Atlanta, Georgia. That project sought to examine the role of geography, networks, and risk in the transmission of HIV and other sexually transmitted diseases (STDs) in inner city neighborhoods of Atlanta. Prior research had led to the establishment of a theory that network structures and risk configuration were generated by local choices. The research for the Geography Project sought to further illustrate that theory in an inner city framework where local choices result in multiple paths of exposure from multiple sources, a network that aids in transmission, and assortative mixing which encourages contact primarily with those in the same network (whether or not persons are actually known to one another).

The aims of the Geography Project were to determine the behavioral, social, and geographic characteristics of those at risk due to drug use and sexual activity in high- and low-burden HIV prevalence areas, as well as to evaluate the combined influence of those factors and their dynamics on the prevalence and incidence of seven STDs, including HIV. Rothenberg and colleagues expected to observe a strong association between social and geographic distance, a high prevalence of compound risk, structural features of small networks that aid in transmission, and data confirming the greater importance of these factors in high risk areas. The research was funded by a grant from the National Institute on Drug Abuse to Dr. Rothenberg.

## Data Collection

Participants for the study were selected from five ZIP codes of Atlanta, Georgia with

high prevalence rates for HIV (30318, 30314, 30310, 30315, and 30308), representing 30% of reported AIDS cases in Fulton County, Georgia between 1998 and 2003; and five ZIP codes with intermediate rates (30349, 30331, 30337, 30344, and 30311) adjacent to the five high prevalence ZIP codes. An initial six month period of ethnographic investigation was used to determine three seed persons from each ZIP code who represented the characteristics of persons at risk due to their sexual activity or drug use and not known to each other. Each seed was interviewed and asked to name 10-12 contacts and to nominate one of them to be another seed in the chain. The process was repeated until three chains of three persons each and their contacts were formed in each ZIP code. Some contacts, but none of the seeds, may have overlapped. The study was designed with 80% power to detect an attributable risk as low as 15% when assuming an HIV prevalence of 10%.

Seed persons in each chain and some, but not all, of their named contacts (respondents) were interviewed using a standard questionnaire that included questions about sociodemographic, behavioral, medical, sexual, and drug-using factors; as well as information about their named contacts, such as geographic location, the nature of their relationship, and any shared sexual or drug using experiences. In addition, respondents were offered testing and appropriate counseling for seven STDs, including HIV; those testing positive were referred to the local health department for treatment. Interviews were repeated at annual intervals over a three year period from 2008 to 2011. Respondents were paid $20 for each interview. The data used in the present analysis were obtained from the final interviews.

**Variables Used**

Among the sociodemographic questions asked, those relating to gender, race/ethnicity, education, sexual orientation, and age were used in the present analysis. For gender, respondents

chose Male, Female, or other; those who responded "other" were treated as missing. For race/ethnicity, respondents were asked "what race or ethnic group do you mainly think of yourself as?" Possible answers were Black (African-American), Black (Caribbean), White, Hispanic (Black), Hispanic (White), Native American Indian/Alaskan Native, Asian/Pacific Islander, Mixed (Black/White), and other. Responses were re-coded into four categories: White, Black (African American and Caribbean), Hispanic (Black and White), and other (all other categories).

Regarding education, respondents were asked "what is the last grade you finished in school?" Possible answers were none, elementary school (K-8), some high school (9-11), GED, high school graduate, some college or technical training, college graduate, and graduate work. Responses were re-coded into three categories: less than high school diploma, high school diploma or equivalent, and some college or more. Respondents were also asked to identify their sexual orientation from a list of possible answers: homosexual, heterosexual (straight), bisexual, gay, lesbian, transgendered, transsexual, and other. Responses were re-coded into three categories: heterosexual, gay/lesbian/bisexual (including homosexual), and other (including transgendered and transsexual). Age at interview was categorized roughly into the four quartiles observed: 18-24, 25-36, 37-47, and 48 or over.

The dependent variable in this analysis, HIV status, was initially determined by the results of a saliva evaluation (Orasure®) administered during the interview. Positive results were then confirmed using the STAHRS assay (Serologic Testing Algorithm for Determining Recent HIV Seroconversion) and PCR testing. For the present analysis, those who were not tested or who had an indeterminate result were coded as HIV negative.

The independent variables in this analysis were those related to mobility. Respondents

were asked to give the furthest distance within the Atlanta area that they had travelled away from their center of activity (COA) during the six months prior to interview. Responses were given in miles and ranged from 1 to 16. Responses were re-coded into three categories: 4 miles or less, 5-8 miles, and 9 miles or more. Respondents were also asked if they had travelled outside the Atlanta area to other parts of Georgia in the six months prior to their interview with response options of yes or no.

Additional questions were asked about respondents' use of various transportation modes: whether they drove themselves, rode with others, paid other for rides, used public trains, used public buses, or used taxis. Responses were yes, no, or N/A. All responses of N/A were treated as missing. "Drove themselves" was examined by itself and also combined with "rode with others" and "paid others for rides" to create a variable representing general use of any car. "Used public trains", "used public buses", or "used taxis" were combined into one variable representing general use of public transportation.

Several variables related to HIV risk behaviors were included in the present analysis as possible confounders. Ever injection drug use was measured by the response to the question "have you ever injected any drug?" Commercial sex was measured by the responses to the questions "have you paid a woman to have sex with you in the past six months?" and "have you paid a man to have sex with you in the past six months?" Finally, safer sexual practices were measured by the response to the question "the last time you had sex, did you or the person you were with use a condom?" Responses options for all of these items were yes or no. Answers of "don't know" or "refuse to answer" were treated as missing.

**Statistical Analyses**

Statistical analyses were performed using SAS version 9.2 (SAS Institute, Inc.).

Univariate analysis was used to compare each independent variable of mobility (travel from COA in past six months, travel outside of Atlanta in past six months, drives oneself, use of any car, and use of public transportation) with the outcome variable, HIV status. Associations were measured using odds ratios and significance was determined by 95% confidence intervals. These analyses were also stratified by gender.

Further univariate analyses were used to compare each demographic variable (gender, race, education, sexual orientation, and age) and each potential confounder (ever injection drug use, paying a woman for sex, paying a man for sex, and recent condom use) with both the outcome variable and each independent variable. Those demographic and possible confounder variables found to have a significant association, based on 95% confidence intervals for odds ratios, with the outcome variable or any independent variable were included in the final multivariate analysis.

Multivariate analyses were performed using logistic regression to control for the variables shown to have significant associations in the univariate analysis. Because no strong correlations were observed between any of the five independent variables of mobility (travel from COA in past six months, travel outside of Atlanta in past six months, drives oneself, use of any car, and use of public transportation), they were included in one logistic model along with gender, age, education, sexual orientation, ever injection drug use, and recent condom use to predict HIV status. A gender stratified analysis was also performed with gender removed as an independent variable. Paying a woman for sex in the past six months was excluded from the analysis for the total sample and the stratified analysis for females, because including it had the effect of excluding most women from those analyses; it was, however, included in the stratified analysis for males. Associations were determined by odds ratios and significance by 95%

confidence intervals.

**Informed Consent**

Informed consent was obtained in writing from all study respondents. The informed consent form was approved by the Institutional Review Board of Georgia State University and the research protocol was approved by the Institutional Review Boards of both Emory University and Georgia State University. Possible vulnerable populations identified were pregnant women and recent parolees. Pregnant women were informed of treatment risks for the conditions being tested and extra precautions were taken to ensure that parolees knew they could leave the study at any time and that the study was not related to their parole status.

# Chapter IV
# Results

## Basic Characteristics

A total of 927 adults were included in the present analysis. As shown in Table 1, excluding missing values, 479 (52.5%) were male and 433 (47.5%) were female. Regarding race, there were nine non-Hispanic whites (0.97%), 903 non-Hispanic blacks (97.41%), six Hispanics (0.65%), and nine of other racial backgrounds (0.97%). The mean age of participants was 36.2 with a standard deviation of 12.9. The sample was almost evenly distributed in four age group quartiles: 252 (27.2%) between ages 18 and 24, 217 (23.4%) between ages 25 and 36, 244 (26.3%) between ages 37 and 47, and 214 (23.1%) at age 48 or over. Heterosexuals numbered 799 (86.3%); those identifying as gay, lesbian, or bisexual numbered 110 (11.9%); and transgendered, transsexual, and others numbered 17 (1.8%). Finally, 427 (46.0%) had less than a high school diploma, 363 (39.2%) had a high school diploma or its equivalent, and 137 (14.8%) reported some college or more. 49 respondents (5.3%) were HIV positive and 878 (94.7%) were HIV negative.

Regarding the five independent variables of mobility, 549 (59.2%) had traveled four miles or less within the Atlanta area away from their center of activity (COA) in the six months prior to interview. 354 (38.2%) had traveled a distance of five to eight miles, and 24 (2.6%) had travelled a distance of nine miles or more. Slightly more than half of the sample (500; 54.4%) had travelled outside of the Atlanta area to other parts of Georgia in the six months prior to interview. Only 142 (15.4%) respondents reported that they generally drove themselves. However, 682 (74.0%) reported having used a car, whether driving themselves or riding with someone else. Finally, most of the sample (725; 78.7%) had used public transportation.

**Univariate Analyses**

Univariate analyses of each independent variable with HIV status revealed few significant associations (Table 2). No significant association between travel within the Atlanta area outside of one's COA in the past six months and HIV status was observed (OR=1.132; 95% CI: 0.675, 1.898). Those who had travelled outside of the Atlanta area to other parts of Georgia in the six months prior to interview were 1.1515 times as likely to be HIV positive as those who had not travelled outside of the metro area but the association was not significant (95% CI: 0.6475, 2.0480). Those who drove themselves were almost two thirds less likely to be HIV positive than those who did not drive themselves, but that association was also not significant (OR=0.3444; 95% CI: 0.1056, 1.1229). However, those who used any car were significantly less likely to be HIV positive than those who did not use a car (OR=0.4885; 95% CI: 0.2708, 0.8811). Finally, those who used public transportation were 1.0574 times as likely to be HIV positive as those without such access, but this association was not significant (95% CI: 0.5181, 2.1581). Stratification by gender only revealed one significant association: Females who used any car were significantly less likely to be HIV positive than those who did not use any car (OR=0.3846; 95% CI: 0.1591, 0.9296).

**Univariate Analyses for Possible Confounders**

Stratification of the demographic variables by HIV status (Table 3) further revealed the nature of HIV prevalence in the sample and some significant associations. In regards to gender, 3.8% of males and 5.1% of females were HIV positive, but this difference was not significant (OR=1.371; 95% CI: 0.725, 2.592). Non-Hispanic blacks were the only racial/ethnic group to have any HIV cases with 5.4% of them being positive, but that distribution was also not significant (OR=.684; 95% CI: 0.155, 3.025). The 25-36 and 37-47 year age groups had the

highest percentages of HIV positive status with 7.8% each. In contrast, 0.8% of the 18-24 year age group and 5.1% of the 48 or over age group were HIV positive. The association between age group and HIV status was significant (OR=1.342; 95% CI: 1.030, 1.748). Sexual orientation was also significantly associated with HIV status (OR=4.488; 95% CI: 2.864, 7.033): 3.6% of heterosexuals; 10.0% of gay, lesbian, or bisexual participants; and 52.9% of transgendered, transsexual, or other participants were HIV positive. However, education was not significantly associated with HIV status (OR=1.399; 95% CI: 0.950, 2.059): 4.0% of those with less than a high school diploma, 6.1% of those with a high school diploma or its equivalent, and 7.3% of those with some college or more were HIV positive.

When stratifying the possible confounder variables by HIV status (Table 3), only ever injection drug use and recent condom use were shown to be significant. 11.6% of those who had ever injected any drug and 4.8% of those who had never injected any drug were HIV positive (OR=2.574; 95% CI: 1.268, 5.225). Of those who used a condom the last time they had sex, 9.4% were HIV positive, while only 1.7% of those who did not use a condom were HIV positive (OR=6.189; 95% CI: 2.868, 13.356).

In comparing demographic and possible confounder variables with each independent variable (Table 4), education was significantly associated with travel outside of Atlanta in the past six months (OR=1.379; 95% CI: 1.149, 1.655). Significant associations were also observed between those who drove themselves and age (OR=0.802; 95% CI: 0.682, 0.943), education (OR=1.799; 95% CI: 1.410, 2.295), paying a woman for sex in past six months (OR=0.294; 95% CI: 0.115, 0.750), and recent condom use (OR=0.564; 95% CI: 0.388, 0.818). Significant associations were also observed between use of any car and gender (1.145; 95% CI: 1.046, 1.914), age (OR=0.670; 95% CI: 0.585, 0.769)), sexual orientation (OR=0.673; 95% CI: 0.482,

0.941), ever injection drug use (OR=0.504; 95% CI: 0.324, 0.785), and paying a woman for sex in past six months (OR=0.531; 95% CI: 0.322, 0.875). Finally, gender (OR=0.627; 95% CI: 0.455, 0.863) and sexual orientation (OR=0.671; 95% CI: 0.472, 0.953) were both significantly associated with use of public transportation.

**Multivariate Analyses**

A logistic regression analysis (Table 5) composed of each independent variable of mobility, as well as the demographic and confounder variables shown to be significant in univariate analyses (gender, age, education, sexual orientation, ever injection drug use, and condom use in past six months, but not paying a woman for sex in the past six months), did not reveal any significant associations between the independent variables of mobility and HIV status. HIV status was, however, significantly associated with sexual orientation and recent condom use. When controlling for all other variables, those who were gay, lesbian, or bisexual were 2.805 times as likely as heterosexuals to be HIV positive, and those who were transgendered, transsexual, or other were 2.805 times as likely to be HIV positive than those who were gay, lesbian, or bisexual (95% CI: 1.326, 5.935). Finally, those who used a condom the last time they had sex were 4.536 times as likely to be HIV positive as those who had not used a condom (95% CI: 2.027, 10.154).

When the model was stratified by gender, no significant observations were observed among females between the independent variables of mobility and HIV status. However, age was significantly associated with HIV status for women. With each increase in age quartile, women were 1.647 times as likely to be HIV positive (95% CI: 1.024, 2.650). In the stratified model for males, which also included the variable “paid woman for sex in the past six months,” men who used public transportation were much less likely to be HIV positive than men who did

not use public transportation, and this association was shown to be significant (adj. OR=0.121; 95% CI: 0.019, 0.768). No other independent variables of mobility were shown to be significantly associated with HIV status among men. Nevertheless, large significant associations were observed between HIV status among men and sexual orientation. When controlling for all other variables, men who were gay, lesbian, or bisexual were 25.675 times as likely as heterosexual men to be HIV positive, and men who were transgendered, transsexual, or other were 25.675 times as likely as gay, lesbian, or bisexual men to be HIV positive (95% CI: 1.707, 386.100). Significant associations for men were also observed between HIV status and ever injection drug use (adj. OR=13.835; 95% CI: 2.759, 69.373) and recent condom use (adj. OR=31.665; 95% CI: 2.585, 387.900).

# Chapter V
# Discussion and Conclusions

This study analyzed the relationship between mobility and HIV risk in ten ZIP codes of Atlanta, Georgia with high HIV prevalence. I hypothesized that increased mobility would be a protective factor for persons residing in these geographic areas but that results would vary by gender. The results of the logistic regression analysis comparing the five independent variables of mobility with HIV risk, controlling for demographic and behavioral variables, show that, with one exception, no significant relationship existed between those variables and HIV risk. Therefore, the hypothesis of this study is rejected, except to the extent that use of public transportation appears to be a protective factor for men, but not women, in this population.

## Interpretation of Findings

Univariate analysis revealed that those who used any car were less likely to be HIV positive than those who did not. However, multivariate analysis did not support this finding. In fact, no significant associations were found in the total sample population between any of the independent variables of mobility and HIV risk. Prior studies analyzing this relationship were primarily conducted among migrant populations in developing countries. Most of those studies found mobility to be an independent risk factor for HIV, but some also showed it to be protective. However, it would appear from the present study that those results are not applicable to inner city populations in the southeastern region of the United States. There are several possible reasons for this disparity in findings.

The most obvious explanation is that the mobility analyzed in the present study is different than the types of mobility examined in prior research. This study is unique in looking at mobility and its relationship to HIV risk in an inner city population of a developed country. In

this study, mobility was measured by variables that essentially related to being able to move around on a regular basis—recent movement outside of one's center of activity (COA) and access to transportation. Therefore, this study was really about the effects of short term, or even daily, mobility on HIV risk. The studies conducted in developing countries, however, focused primarily on long-term migration or other forms of mobility which are necessary for survival. The motivation for the mobility observed in the present sample is unknown, but presumably many people are moving around by choice, or at least not for the same types of basic survival needs that motivate migrants in developing countries.

The results also indicate that mobility in these inner city neighborhoods cannot be separated from the demographic and behavioral characteristics which define the population. Rather, it is part of a cluster of several factors that occur together. The basic characteristics observed in this study are consistent with previous findings that core areas of STD transmission are characterized by poverty and its various sequelae (Hixson, et al., 2011; R. B. Rothenberg, 1983). Almost half of study participants had less than a high school diploma and only 15% drove their own car, implying that this population is composed mainly of person of low socio-economic status. In addition, the risk behaviors observed in this sample are consistent with prior studies showing a concentration of high risk sexual behaviors in these core areas (Bernstein, et al., 2004). Twelve percent of the sample had ever injected any drug and more than half did not use a condom the last time they had sex. The results of the present study imply that all of these factors, including mobility, contributed to the observed high HIV prevalence of 5.29% in the sample population and that most of these factors cannot be analyzed separately.

I also hypothesized that study results would vary by gender and the results indicate that this was partially true. A gender-stratified univariate analysis found that women who used any

car were significantly less likely to be HIV positive than women who did not use any car. No other variables in the univariate analyses were found to have a significant association for either women or men. Multivariate analysis did not confirm this finding but instead showed that men who used public transportation were significantly less likely to be HIV positive than men who did not use public transportation. No other significant associations were found in the stratified logistic regression model.

These findings have several possible interpretations. I based much of my hypothesis that mobility results would vary by gender on several studies which observed a protective factor for mobile women in various high-prevalence groups in developing countries (Haibo, et al., 2010; Khan, et al., 2008; Lydié, et al., 2004; Strathdee, et al., 2008; Watts, et al., 2010). Those studies were of populations with different demographic compositions and motivations for mobility than those in the present sample. In addition, the condition of women in those studies was quite different from the women in the present study. For example, two studies were of female sex workers (Haibo, et al., 2010; Watts, et al., 2010) and two studies were of more long-term migrant populations (Khan, et al., 2008; Lydié, et al., 2004). The gender differences observed in those studies, therefore, do not appear to be applicable to an inner city population in the United States with a high HIV prevalence.

The observation that men who used public transportation were significantly less likely to be HIV positive than men who did not use public transportation is interesting. Several studies found mobility to be a risk factor among men because there are more opportunities for risk behaviors when men are away from their homes (Bo, et al., 2007; Rachlis, et al., 2007). As only 15% of the sample drove their own car, it is likely that, for most, public transportation was their primary means of transit. Men who use public transportation would most likely not be traveling

as far as those who drive a car, because public transportation options and distances are limited. Therefore, they may be protected by being closer to home. More research is needed as to the effects of public transportation use on HIV risk to see if this relationship is observed elsewhere.

Although few significant associations were found between HIV risk and the independent variables of mobility, significant associations were observed with sexual orientation, ever injection drug use, and recent condom use. Sexual orientation was shown to be a significant risk factor in the entire study population; however, when the logistic model was stratified by gender, it was only significant for men. This is consistent with findings that men who have sex with men are still at increased risk for HIV and are concentrated in inner city neighborhoods (R. B. Rothenberg, et al., 2000; Zenilman, et al., 2002). Additionally, that half of those who identified as transgendered, transsexual, or other were HIV positive is alarming and indicates that more research is needed as to why that population might have such a high rate of HIV and whether certain high-risk behaviors are more prevalent in this group.

Ever injection drug use was also shown to be a significant risk factor for HIV: Those who had ever injected any drug were almost three times as likely to be HIV positive as those who had never injected. This finding is consistent with studies showing injection drug users to be at high risk for HIV and to be concentrated in geographic core areas (R. B. Rothenberg, et al., 2000; Zenilman, et al., 2002). Surprisingly, recent condom use was shown to be a significant risk factor for HIV in the study population. Those who reported using a condom the last time they had sex were more than four times as likely to be HIV positive as those who had not used a condom. It is possible that condom use served as a marker for those who engage in frequent sexual activity with multiple partners and are, therefore, at greater risk. However, it may also be that those who knew they were HIV positive were more likely to use condoms to protect their

partners. The significance of these two behavioral variables suggest that high-risk behaviors are the main drivers of the HIV epidemic in these core areas, despite whatever other common factors may exist.

**Strengths and Limitations**

The present study has several strengths which add reliability to its findings. The sample size was large at 927 adults and was generally representative of the population in the ten ZIP codes from which participants were recruited. The ethnographic portion of the study design involved six months of preliminary research, consisting of focus groups and small surveys, in order to establish a better relationship with the community involved. This approach improved follow up and aided in the design of the final questionnaire. In addition, the three seeds in each ZIP code, who would eventually form several chains of contacts, were carefully chosen to be representative of and active in their communities. Great care was taken, however, to make sure that the seeds were not known to each other, ensuring that more contacts could be named and thereby increasing sample size.

This study also has its limitations. It was not possible to determine the motivations for participants' mobility. Much of mobility's influence on HIV risk may depend on why one is travelling or moving about. For example, commuting for work would presumably have a different effect on HIV risk than travelling to meet a sexual contact or to use drugs. Therefore, it is possible that significant associations might have been observed if the mobility variables could have been further defined by purpose. Furthermore, the mobility variables that were examined were not mutually exclusive; someone could, for example, be classified as both a user of public transportation and a user of any car, preventing a comparison of risk between those two groups. Future studies should include one mobility variable with several mutually exclusive choices.

The results of this study may not be generalizable to other populations. It was not possible to control for racial differences in this sample, because almost all participants identified as black (of either African or Caribbean origin). It is unclear what results might have been observed in a geographic area of high HIV prevalence with a more racially diverse population. In addition, the cross-sectional nature of the sample prevents conclusions as to the effects of mobility on HIV incidence. The mobility variables referred to current or recent behavior, whereas HIV status was not related to a time interval. A positive test result could only measure prevalence and did not indicate when a participant actually seroconverted. Thus, it is possible that at the time one became HIV positive their mobility or access to transportation was different than it was at the time of interview, but that relationship could not be examined.

Finally, the hypothesis formulated and the definitions of mobility used were limited by the lack of studies on this topic in the developed world and by disagreement on an operational definition for mobility. I formulated my hypothesis largely based on what had been observed in developing countries and how that might be applied to the present study. Other hypotheses would also be possible. Additionally, with no clear guidance on an operational definition of mobility, the one used was largely based on the available data.

**Implications**

Despite the lack of significant associations, the results of this study confirm the findings of Rothenberg (1983), and others, that cases of sexually transmitted diseases, such as HIV, are concentrated in geographically defined areas of the inner city where poverty, risk behaviors, and social network characteristics combine to create a reservoir for disease transmission. Even though most of the independent variables of mobility were not found to have a significant association with HIV risk, the results suggest that a lack of mobility options is a further

characteristic of these neighborhoods that may act in concert with other factors to influence HIV risk. In addition, men's use of public transportation was shown to be a significant protective factor for HIV risk. Further studies are needed to confirm this association. Despite few significant findings, the results of this study indicate that mobility options of a target population should at least be considered along with other factors when examining HIV risk and formulating prevention programs. Further analyses from the Geography Project will focus on the pattern of geographic space in areas of higher and lower prevalence.

**Conclusions**

The association between mobility and HIV risk was examined using results from a large study of ten ZIP codes of Atlanta, Georgia gathered by Rothenberg and colleagues between 2005 and 2011. Mobility was based on how often participants left their center of activity and their access to transportation. It was classified by five independent variables: furthest distance away from COA within the Atlanta area in the past six months, travel out of the Atlanta area in the past six months, driving one's own car, use of any car, and use of public transportation. Only use of public transportation was shown to have a significant association with HIV risk and only as a protective factor for men. Future studies on this issue in developed countries are needed to establish an operational definition of mobility based on the types of and reasons for mobility observed in geographic areas with high HIV prevalence. Once such a definition has been established, additional studies should examine mobility's effects on HIV risk and whether corresponding prevention programs would be worthwhile.

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# Appendix
# Summary Statistical Tables

**Table 1**
**Demographic, Dependent, and Independent Variables**
(Showing frequencies and percentages; missing responses excluded)

| | | |
|---|---|---|
| **DEMOGRAPHIC VARIABLES** | | |
| **Gender** | *Male* | 479 (52.5%) |
| | *Female* | 433 (47.5%) |
| **Race/Ethnicity** | *Non-Hisp. White* | 9 (0.97%) |
| | *Non-Hisp. Black* | 903 (97.41%) |
| | *Hispanic* | 6 (0.65%) |
| | *Other* | 9 (0.97%) |
| **Age (Mean and Quartiles)** | *Mean* | 36.2 (SD=12.9) |
| | *18-24* | 252 (27.2%) |
| | *25-36* | 217 (23.4%) |
| | *37-47* | 244 (26.3%) |
| | *48 and over* | 214 (23.1) |
| **Sexual Orientation** | *Heterosexual* | 799 (86.3%) |
| | *Gay/Lesbian/Bi* | 110 (11.9%) |
| | *Trans/other* | 17 (1.8%) |
| **Education** | *Less than HS Diploma* | 427 (46.0%) |
| | *HS Diploma, GED, or equivalent* | 363 (39.2%) |
| | *Some college or more* | 137 (14.8%) |
| **DEPENDENT VARIABLE** | | |
| **HIV Status** | *HIV Negative* | 878 (94.7%) |
| | *HIV Positive* | 49 (5.3%) |
| **INDEPENDENT VARIABLES** | | |
| **6 mos. furthest distance from Center of Activity (COA)** | *4 miles or less* | 549 (59.2%) |
| | *5-8 miles* | 354 (38.2%) |
| | *9 miles or more* | 24 (2.6%) |
| **Travel outside of Atlanta in past 6 mos.** | *No* | 500 (54.4%) |
| | *Yes* | 420 (45.6%) |
| **Drives self, generally** | *No* | 780 (84.6%) |
| | *Yes* | 142 (15.4%) |
| **Use of any car** | *No* | 240 (26.0%) |
| | *Yes* | 682 (74.0%) |
| **Use of public transportation** | *No* | 196 (21.3%) |
| | *Yes* | 725 (78.7%) |

**Table 2**
**Results of univariate analysis of independent variables with HIV status, stratified by gender**
(Numbers shown are crude odds ratios and 95% confidence intervals)

| INDEPENDENT VARIABLES | Males | Females | Total Sample |
|---|---|---|---|
| **6 mos. furthest distance from COA*** | 1.324<br>(0.602, 2.912) | 1.679<br>(0.769, 3.664) | 1.132<br>(0.675, 1.898) |
| **Travel outside of Atlanta in past 6 mos.** | 1.7525<br>(0.6675, 4.6007) | 1.0782<br>(0.4554, 2.5525) | 1.1515<br>(0.6475, 2.0480) |
| **Respondent drives self, generally** | 0.3621<br>(0.0474, 2.7684) | 0.4453<br>(0.1019, 1.9465) | 0.3444<br>(0.1056, 1.1229) |
| **Use of any car** | 1.0416<br>(0.3641, 2.9798) | 0.3846<br>(0.1591, 0.9296) | 0.4885<br>(0.2708, 0.8811) |
| **Use of Public transportation** | 1.0771<br>(0.3047, 3.8073) | 1.1743<br>(0.4228, 3.2616) | 1.0574<br>(0.5181, 2.1581) |

**Table 3**
**Distribution and univariate analysis of demographic and possible confounding variables by HIV status** (excluding missing responses)

| | | HIV Positive | HIV Negative | Crude Odds Ratio |
|---|---|---|---|---|
| **DEMOGRAPHIC VARIABLES** | | | | |
| **Gender** | *Male* | 18 (3.8%) | 461 (96.2%) | 1.371 |
| | *Female* | 22 (5.1%) | 411 (94.9%) | (0.725, 2.592) |
| **Race/Ethnicity** | *Non-Hisp. White* | 0 | 9 (100%) | 0.684* |
| | *Non-Hisp. Black* | 49 (5.4%) | 854 (94.6%) | (0.155, 3.025) |
| | *Hispanic* | 0 | 6 (100%) | |
| | *Other* | 0 | 9 (100%) | |
| **Age Quartiles** | *18-24* | 2 (0.8%) | 250 (99.2%) | 1.342* |
| | *25-36* | 17 (7.8%) | 200 (92.2%) | (1.030, 1.748) |
| | *37-47* | 19 (7.8%) | 225 (92.2%) | |
| | *48 and over* | 11 (5.1%) | 203 (94.9%) | |
| **Sexual Orientation** | *Heterosexual* | 29 (3.6%) | 770 (96.4%) | 4.488* |
| | *Gay/Lesbian/Bi* | 11 (10.0%) | 99 (90.0%) | (2.864, 7.033) |
| | *Trans/Other* | 9 (52.9%) | 8 (47.1%) | |
| **Education** | *Less than HS Diploma* | 17 (4.0%) | 410 (96.0%) | 1.399* (0.950, 2.059) |
| | *HS Diploma, GED, or equivalent* | 22 (6.1%) | 341 (93.9%) | |
| | *Some college or more* | 10 (7.3%) | 127 (92.7%) | |
| **POSSIBLE CONFOUNDERS** | | | | |
| **Ever injected any drug** | *No* | 38 (4.8%) | 747 (95.2%) | 2.574 |
| | *Yes* | 11 (11.6%) | 84 (88.4%) | (1.268, 5.225) |
| **Paid woman for sex in past 6 mos.** | *No* | 10 (2.4%) | 408 (97.6%) | 1.549 |
| | *Yes* | 3 (3.7%) | 79 (96.3%) | (0.417, 5.757) |
| **Paid man for sex in past 6 mos.** | *No* | 29 (6.8%) | 395 (93.2%) | Not Calculable |
| | *Yes* | 0 | 11 (100%) | |
| **Used condom last time had sex** | *No* | 8 (1.7%) | 477 (98.3%) | 6.189 |
| | *Yes* | 41 (9.4%) | 395 (90.6%) | (2.868, 13.356) |

**Table 4**
**Univariate analysis of demographic and possible confounding variables with independent variables**
(Numbers shown are crude odds ratios and 95% confidence intervals unless otherwise noted)

| INDEPENDENT VARIABLES | 6 mos. furthest distance from COA | Travel outside of Atlanta in prior 6 mos. | Respondent drives self, generally | Use of any car | Use of public transportation |
|---|---|---|---|---|---|
| **DEMOGRAPHIC VARIABLES** | | | | | |
| **Gender** (Male is ref.) | $\chi^2$=5.4339 (df=2; p=.07) | 0.847 (0.652, 1.101) | 1.375 (0.960, 1.970) | 1.145 (1.046, 1.914) | 0.627 (0.455, 0.863) |
| **Race / Ethnicity**** | $\chi^2$=14.4416 (df=6; p=0.03)* | 1.186 (0.682, 2.063) | 1.336 (0.660, 2.705) | 0.763 (0.413, 1.408) | 1.280 (0.593, 2.765) |
| **Age**** | $\chi^2$=5.3304 (df=6; p=0.50) | 0.907 (0.807, 1.019) | 0.802 (0.682, 0.943) | 0.670 (0.585, 0.769) | 1.006 (0.874, 1.158) |
| **Sexual Orientation**** | $\chi^2$=25.3859 (df=4; p<0.01)* | 0.918 (0.668, 1.261) | 0.587 (0.338, 1.019) | 0.673 (0.482, 0.941) | 0.671 (0.472, 0.953) |
| **Education**** | $\chi^2$=1.9592 (df=4; p=0.74) | 1.379 (1.149, 1.655) | 1.799 (1.410, 2.295) | 0.962 (0.784, 1.182) | 0.978 (0.785, 1.219) |
| **POSSIBLE CONFOUNDERS** | | | | | |
| **Ever injected any drug** | $\chi^2$=1.3598 (df=2; p=0.51) | 1.107 (0.723, 1.695) | 0.500 (0.236, 1.057) | 0.504 (0.324, 0.785) | 1.215 (0.690, 2.138) |
| **Paid woman for sex, 6 mos.** | $\chi^2$=3.0760 (df=2; p=0.21) | 0.698 (0.432, 1.128) | 0.294 (0.115, 0.750) | 0.531 (0.322, 0.875) | 0.841 (0.472, 1.498) |
| **Paid man for sex, 6 mos.** | $\chi^2$=0.3908 (df=2; p=0.82)* | 0.477 (0.125, 1.822) | 0.483 (0.061, 3.835) | 0.561 (0.161, 1.955) | 0.422 (0.126, 1.410) |
| **Condom use last time had sex** | $\chi^2$=4.0178 (df=2; p=0.13) | 1.087 (0.838, 1.411) | 0.564 (0.388, 0.818) | 0.813 (0.605, 1.092) | 1.074 (0.781, 1.476) |

**Table 5**
**Logistic Regression Analysis, stratified by gender, predicting odds of positive HIV status**
(Numbers shown are adjusted odds ratios and 95% confidence intervals)

| **INDEPENDENT VARIABLES** | **Males** (n=408) | **Females** (n=407) | **Total Sample** (n=857) |
|---|---|---|---|
| **6 mos. furthest travel from COA** | 0.964 (0.277, 3.353) | 1.949 (0.811, 4.685) | 1.524 (0.821, 2.830) |
| **Travel outside Atlanta In past 6 mos.** | 0.994 (0.235, 4.200) | 1.167 (0.466, 2.920) | 1.317 (0.665, 2.609) |
| **Respondent drives self, generally** | 0.197 (0.013, 3.005) | 0.920 (0.175, 4.842) | 0.641 (0.171, 2.406) |
| **Use of any car** | 7.939 (0.755, 83.458) | 0.467 (0.172, 1.264) | 0.736 (0.349, 1.553) |
| **Use of public transportation** | 0.121 (0.019, 0.768) | 1.322 (0.432, 4.046) | 1.033 (0.427, 2.497) |
| **Gender** | | | 1.512 (0.748, 3.055) |
| **Age** | 1.202 (0.548, 2.636) | 1.647 (1.024, 2.650) | 1.295 (0.914, 1.834) |
| **Education** | 1.254 (0.509, 3.090) | 0.996 (0.528, 1.877) | 1.153 (0.730, 1.822) |
| **Sexual Orientation** | 25.675 (1.707, 386.100) | 1.635 (0.573, 4.670) | 2.805 (1.326, 5.935) |
| **Ever injected any drug** | 13.835 (2.759, 69.373) | 1.061 (0.258, 4.362) | 2.381 (0.996, 5.691) |
| **Paid woman for sex in past 6 mos.** | 0.768 (0.149, 3.947) | * | * |
| **Used condom last time had sex** | 31.665 (2.585, 387.900) | 2.327 (0.898, 6.030) | 4.536 (2.027, 10.154) |