Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

Emily F. Dauria Date

Male Incarceration, the Health Care Service Environment and Sexual Health

By

Emily F. Dauria
Doctor of Philosophy

Behavioral Sciences and Health Education

_____

Dr. Hannah L.F. Cooper
Advisor

_____

Dr. Kimberly Jacob Arriola
Committee Member

_____

Dr. Kirk Elifson
Committee Member

_____

Dr. Gina Wingood
Committee Member

Accepted:

_____

Lisa A. Tedesco, Ph.D.

Dean of the James T. Laney School of Graduate Studies

_____

Date

Male Incarceration, the Health Care Service Environment and Sexual Health

By

Emily F. Dauria

M.P.H., Emory University, 2009

An abstract of

a dissertation submitted to the Faculty of the

James T. Laney School of Graduate Studies of Emory University

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in Behavioral Science and Health Education

2014

Abstract

Male Incarceration, the Health Care Service Environment and Sexual Health

By
Emily F. Dauria

Compared to areas with low rates of incarceration, areas with higher rates of incarceration have higher and increasing rates of sexually transmitted infections (STIs). Few studies have examined this relationship and even fewer studies have explored the pathways through which higher incarceration rates may shape HIV/STI-risk. For this dissertation, qualitative and quantitative methods were used to examine rates of male incarceration, health care service accessibility and the prevalence of newly-diagnosed STIs. The qualitative phase involved in-depth interviews with 33 heterosexual Black women living in two neighborhoods: one with a high rate of male incarceration and low sex ratio and one with lower rate of male incarceration and a more equitable sex ratio. The quantitative phase used decennial data, STI surveillance data, incarceration data and an inventory of health care service locations.

The first paper examined how local male incarceration rates and sex ratios influenced perceptions of partner availability and the nature of partnerships for heterosexual Black women. High rates of male incarceration and low sex ratios: 1) reduced the number of available, desirable male partners, 2) impacted the structure and purpose of partnerships and 3) influenced the risk characteristics of male sexual partners.

The second paper explored the longitudinal relationship between the local rate of male incarceration and the prevalence of newly-diagnosed STIs. Census tracts with higher baseline rates and faster increasing rates of male incarceration had a prevalence of newly-diagnosed STIs that was higher at baseline and increased more rapidly over time. Census tracts with higher baseline rates of male incarceration did not have a faster increase in their prevalence of newly-diagnosed STIs.

The third paper examined the relationship between rates of male incarceration and of STIs, and whether spatial access to health care moderated this relationship. As spatial access to sexual health services worsened, the magnitude of the relationship between rate of male incarceration and prevalence of newly-diagnosed STIs *decreased*.

This dissertation study strengthens the evidence that rates of male incarceration have negative consequences on sexual health outcomes and advances current understandings of the pathways through which incarceration and sex ratios may contribute to a vulnerability to STIs.

Male Incarceration, the Health Care Service Environment and Sexual Health

By

Emily F. Dauria

M.P.H., Emory University, 2009

Advisor: Hannah L.F. Cooper, ScD

A dissertation submitted to the Faculty of the

James T. Laney School of Graduate Studies of Emory University

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in Behavioral Science and Health Education

2014

Acknowledgements

I would like to acknowledge and extend my sincere appreciation to the following people who were essential to the development and completion of my dissertation.

To my dissertation chair, Hannah L.F. Cooper, ScD, I am immensely grateful for the opportunity to have worked with you since beginning my graduate student career at Emory University in 2007. From you I have learned so much about how to conduct thoughtful and meaningful research. Your feedback and guidance challenged me to be a better and more careful writer and researcher.

Many thanks to the members of my committee, Kirk Elifson, PhD, Kimberly Jacob Arriola, PhD, MPH, and Gina Wingood, PhD. I am grateful for your time, mentorship, thoughtful critique and encouraging words as I wrote my dissertation.

To my participants, thank you for sharing your time, personal histories and experiences with me.

Thank you to the Georgia Department for Community Health for sharing data on sexually transmitted infections and the Georgia Department of Corrections for sharing male incarceration date used in this dissertation study. Thank you also to Kathleen Adams, PhD for sharing Title X health location service data, without which this dissertation would not have been possible.

I am incredibly grateful for the many resources available for students at Emory University. The Center for Digital Scholarship, especially Michael Page, provided instruction and guidance that helped to shape my dissertation and informed my methodological approach.

I also would like to recognize my colleagues for sharing their enthusiasm for and comments on my work. Thanks to the wonderful Lisa Oakley, Robin McGee and Liz Walker for your endless support, encouragement and insights.

A number of fellowships, grants and awards supported the successful completion of this dissertation. First I would like to thank the National Institutes of Health for providing support via the National Research Service Award. Thank you also to the Laney Graduate School and the Department of Behavioral Sciences and Health Education. These funding streams ensured that I had protected time to conduct this dissertation research and funding for my professional development.

Finally, unlimited thanks to my friends and family, with a special acknowledgement of the support and encouragement provided by Ken and Donna Dauria, Anu Rajasingham, Monique Martin and Jordan Wright.

Table of Contents

Table of Tables

Table of Figures

Chapter 1: Introductory Literature Review

Introduction

Compared to areas with low rates of incarceration, areas with higher rates of incarceration have higher and increasing rates of sexually transmitted infections (hereafter STIs) (Thomas 2005, Thomas 2006, Thomas 2007). One study also found a statistically significant association between rates of male incarceration and rates of Human Immunodeficiency Virus (HIV) (Thomas 2006). As this is an emerging area of research, few studies have examined these relationships and even fewer studies have been conducted to explore the pathways through which higher incarceration rates may lead to higher HIV/STI prevalences. Further, nearly all of the past work on the association between incarceration rates and HIV and other STI rates has been cross-sectional (Thomas 2005, Thomas 2006).

Because Black adults are imprisoned at a higher rate than members of other racial/ethnic groups, male incarceration may help explain national racial/ethnic disparities in STIs (Carson 2012). In 2011, Black adults represented roughly 13% of the national population (Rastogi 2011), however, they accounted for approximately 38% of prisoners under state and federal jurisdiction (Carson 2012). Black men and women have the highest rates of STIs of all racial/ethnic groups in the U.S. In 2012, the prevalence of gonorrhea among Black adults was 14.9 times that of White adults, the prevalence of Chlamydia was 6.8 times that of White adults, and the prevalence of primary and secondary syphilis was 6.1 times that of Whites (Centers for Disease Control and Prevention 2014).

Recently, public health researchers have focused on the impact of factors operating within neighborhoods and other geographic areas to understand disparities in STIs, HIV and other health outcomes (Culhane J.F. & Elo 2005, Gary 2008). Further,

the National HIV/AIDS Strategy for the United States outlines the need to address the impact of high rates of male incarceration on community health, including its effect on rates of HIV and other STIs (The White House Office of National AIDS Policy 2010). Aspects of the social environment (e.g. low male to female sex ratios) are a hypothesized mediator of the relationship between rates of male incarceration and the transmission of HIV and other STIs (Adimora 2006, Thomas 2006, Adimora 2007, Pouget 2010). Given that health care availability may be associated with poorer health outcomes (Agency for Healthcare Research and Quality 2008, Richardson 2010), we also hypothesize that the health care service environment (e.g. availability) may act as a moderator of this relationship.

The purpose of this dissertation was to use mixed methods to explore the relationship among rates of male incarceration, the health care service environment and the prevalence of newly-diagnosed STIs and to explore possible pathways through which male incarceration may help explain racial disparities in sexual health outcomes. The theoretical framework guiding this research was based on the social ecological model (SEM) and Social Cognitive Theory (SCT). The SEM emphasizes that the health of the individual is influenced by community and social structures in addition to individual attitudes and behaviors (Stokols 1992, Stokols 1996). SCT states that human behaviors are the result of the interaction between personal factors, behavior and the environment (Bandura 1984). Both SEM and SCT allow researchers to address the factors that the PI believes put individuals living in communities with higher rates of male incarceration at increased risk for STIs and HIV (Stokols 1992).

This research provides an important step towards advancing understanding the social factors that contribute to geographic variations and racial/ethnic disparities in HIV and other STIs. The long-term objective of this study was to gain a greater understanding of how male incarceration rates and the health care service environment

influence sexual health outcomes. Results from this dissertation can be used to inform the development of programs and policies aimed at mitigating the adverse impact of rates of male incarceration on the transmission of HIV and other STIs.

HIV/AIDS and other STIs

The southern region of the United States (US) consistently has the highest burden of sexually transmitted infections (STIs) in the nation (Centers for Disease Control and Prevention 2013, Centers for Disease Control and Prevention 2014, Centers for Disease Control and Prevention 2014, Centers for Disease Control and Prevention 2014). In 2012, there were 496.9 cases of gonorrhea per 100,000 people and 131.9 cases of Chlamydia per 100,000 people. Southern states also accounted for 43.5% of primary and secondary syphilis cases. In 2008 (the most recent year of available data), states in the South and Northeast reported the highest rates of HIV in the country (Centers for Disease Control and Prevention 2013). By year's end in 2010 the South accounted for 45% of the estimated 33,015 new AIDS diagnoses in the US (Centers for Disease Control and Prevention 2013).

In 2012, the southern state of Georgia ranked first in the US in prevalence of primary and secondary syphilis (9.5 case per 100,000), fifth in gonorrhea prevalence (156.1 cases per 100,000), and eighth in Chlamydia prevalence (534 cases per 100,000) (Centers for Disease Control and Prevention 2013). In 2011, the rate of diagnosis of HIV infection among adults (aged 18 to 64) in the state of Georgia was 31.4 per 100,000 people and the rate of adults and adolescents living with diagnosed HIV infection in Georgia was 428.8 per 100,000 people; both of which were higher than the national rate of HIV diagnosis (19.1 per 100,000) and the national rate of adults and adolescents living with diagnosed HIV (342.2 per 100,000) (Centers for Disease Control and Prevention 2013).

Black men and women have the highest rates of STIs of all racial/ethnic groups in the US. In 2012, the prevalence of gonorrhea among Black adults was 14.9 times that of White adults, the prevalence of Chlamydia was 6.8 times that of White adults, and the prevalence of primary and secondary syphilis was 6.1 times that of Whites (Centers for Disease Control and Prevention 2014). In 2010, Black adults accounted for roughly 44% of all new HIV infections among individuals aged 13 years or older (Centers for Disease Control and Prevention 2014).

National trends in racial disparities in rates of HIV/STIs are also evident in the state of Georgia. Although Black adults represent roughly 30% of Georgia's population, they account for a higher proportion of HIV/AIDS cases and cases of other STIs compared with other races and ethnicities. Of the newly diagnosed HIV cases in Georgia in 2012, 55% were among African Americans (Georgia Department of Human Resources 2008). In 2012, Black adults in Georgia had a higher rate of Chlamydia (794.4 versus 110.9 per 100,000), gonorrhea (309.4 versus 18.8 per 100,000) and primary (3.8 versus 0.5 per 100,000) and secondary syphilis (20.2 versus 1.9 per 100,000) than White adults (Georgia Division of Public Health 2011).

Social and Contextual Determinants of Health

While important, individual-level behaviors alone (e.g. number of partners, practices and condom use) are typically unable to explain complex health outcomes like HIV and other STIs (Division of STD Prevention 2007, Hallfors, Iritani et al. 2007, Aral, Adimora et al. 2008). These and other behaviors should be examined with the understanding that they occur within a larger social and environmental context (Aral 1996, Rhodes 1998, Koopman 1999, Diez Roux 2007, Richardson 2010). Researchers have examined how social and contextual determinants are associated with several health outcomes including infant birth weight (Collins 1998, Masi 2007, Auger 2008), breast cancer mortality (Dean 1988, Jenks 1994, Auschengrau 1996) and of particular

interest, sexual initiation(Cubbin 2005) and risk of STIs (Ellen 2004, Adimora 2007), even after controlling for individual-level factors. One of these determinants, incarceration rates, has emerged as a potentially powerful contextual determinant of the prevalence of newly-diagnosed STIs in the general population (Thomas 2006, Thomas 2007, Pouget 2010).

Male Incarceration

The US incarcerates more individuals than any other country in the world. In 2012, there were over 1.5 million individuals incarcerated in our nation's jails and prisons (The Sentencing Project 2014). Geographic variations evident in rates of HIV and other STIs are also visible in rates of male incarceration. Rates of male incarceration are highest in southern region of the US (The Sentencing Project 2008). In Georgia, there are roughly 542 (per 100,000) individuals incarcerated in prisons and 496 (per 100,000) incarcerated in jails. Both of which are higher than the national average (480 per 100,000 and 235 per 100,000 respectively). Men are incarcerated at a higher rate than women: of those incarcerated in Georgia nearly 94% are male (Georgia Department of Corrections 2010).

Racial disparities in incarceration rates are evident in rates of incarceration nationally and in the state of Georgia. In 2011, while Black adults represented roughly 13% of the national population (Rastogi 2011), they accounted for approximately 38% of prisoners under state and federal jurisdiction (Carson 2012). Although African Americans represent roughly 30% of Georgia's population, they represent over 62% of the individuals who are incarcerated (Georgia Department of Corrections 2010).

Research Linking Incarceration and the Transmission of HIV and other STIs

Initial studies examining the relationship between rates of incarceration and rates of STIs found a positive correlation between incarceration rates and STI prevalence in the general population (Thomas 2005, Thomas 2006, Thomas 2007).

In the first study, Thomas et al. (Thomas 2005) examined the relationship between incarceration rates and rates of STIs (gonorrhea, Chlamydia, AIDS and syphilis) in North Carolina in 1999. The investigators calculated county-level Pearson correlation coefficients to identify the association between rate of incarceration and the rate of each STI. The investigators found that a higher rate of incarceration for a given North Carolina county was associated with a higher rate of gonorrhea, Chlamydia and AIDS but not syphilis. Findings from this study support the relationship between male incarceration rates and rates of STIs.

In the second study, Thomas et al. (2007) used mixed methods to examine the relationship between incarceration and STIs. Quantitative methods were used to explore this relationship at the census tract level in Durham County, North Carolina for the years 2001 and 2002. In addition, semi-structured ethnographic interviews with male ex-offenders and the sexual partners of prisoners or ex-offenders in Durham, North Carolina were conducted to identify the mechanisms by which incarceration affected the transmission of STIs. The investigators found that tract-level incarceration rate was associated with Gonorrhea rate in the subsequent year, independently of the effects of age, race and poverty. Their ethnographic interviews helped to illuminate some of the mechanisms by which a high incarceration rate could lead to high STI rates. Specifically, their findings revealed that imprisonment often led both members of a former sexual partnership into a relationship with a new partner. The partner who was not incarcerated would often become engaged in a new partnership due to the need to remain financially secure after losing a breadwinning partner to prison. Imprisoned

partners also developed new relationships while in prison or upon their release from prison. Lastly, recently released ex-offenders felt they needed to have multiple sex partners in order to satisfy pent-up desires.

In the third study, Thomas et al.(Thomas 2006) calculated age-adjusted Pearson correlation coefficients between rates of incarceration and reportable STIs in the 100 counties of North Carolina for each year from 1995 to 2002. To approximate a temporal casual sequence, the investigators calculated age-adjusted correlations for the incarceration rate in a given year and health outcomes 1 and 2 years later. Results suggest that rates of Chlamydia and gonorrhea in North Carolina increased with increasing incarceration rates, when adjusted for age, race and poverty distributions.

Lastly, Pouget et al. (2010) examined the associations of "male shortage" and high incarceration rates with the number of opposite sex partners using cross-sectional population level data linked to survey data. They found that sex ratios and incarceration rates varied greatly by race and ethnicity. Non-Hispanic Black men in counties with a shortage of non-Hispanic Black men and a high non-Hispanic Black male incarceration rate were more likely to have more than one opposite-sex partner than those in counties with more balanced sex ratios. Further, participants living in two low sex ratio categories and one high incarceration rate category had significantly greater odds of having five or more partners. The findings from this study support the hypothesis that male shortage and incarceration rates are associated with having a larger number of sexual partners, increasing an individual's risk of HIV/STIs.

These studies were the only ones found in the current literature that 1) establish an association between rates of incarceration and rates of STIs and 2) investigate the relationship between incarceration and STI risk by examining the influence of available partners and partner concurrency. More research needs to be done to determine the

longitudinal relationship between rates of incarceration and to understand the mechanisms through which male incarceration affects HIV/STI risk for.

Mechanisms of STIs and HIV Transmission: Sexual Networks, Relationship Dynamics and Male Incarceration

Sexual network dynamics play a significant role in understanding the transmission of STIs (Garnett, Hughes et al. 1996, Rothenberg and Narramore 1996, Ghani 1997, Ghani, Swinton et al. 1997, Aral 1999, Laumann and Youm 1999). Sexual networks, or a group of people who are linked either directly or indirectly through sexual contact (Klovdahl 1994, Flom 2001), are often formed among people with similar attributes including age, race or ethnicity, educational background, religion and often develop through social networks, activities and the neighborhoods where individuals live (Aral 1999, Adimora 2005, Adimora 2006). Sexual networks are thought to influence individual behavior through multiple pathways including via: 1) social support, 2) social influence, 3) social engagement and attachment and 4) access to resources and material goods (Berkman 2000). High incarceration rates in geographic areas can have devastating consequences on communities by altering the size and composition of sexual networks in ways that accelerate the spread of STIs.

To begin, high rates of male incarceration can lead to a decrease in the number of available sexual and relationship partners for women (Adimora, Schoenbach et al. 2001, Adimora 2005, Harawa 2008, Friedman 2009). Sex ratios are a key determinant of the structure of sexual networks, marital patterns and family stability (Guttenburg 1983). Low male to female sex ratios may influence partner selection, duration and stability and can lead to concurrent partnerships (Aral 1999, Adimora 2005, Adimora 2006, National Alliance of State and Territorial AIDS Directors 2008).

Concurrent partnerships are defined by the United Nations Working Group on Concurrent Partnerships as "overlapping sexual partnerships where intercourse with one partner occurs between two acts of intercourse with another partner"(UNAIDS Reference Group on Estimates 2009, pg. 621). Sexual partnership concurrency has been associated with increasing the size of HIV and STI epidemics and with increasing speed at which they are spread (Morris 1995, Ghani 1997, Doherty 2006). Specifically, mathematical modeling and empirical research suggest that concurrent sexual partnerships permit a more rapid spread of disease then sequential monogamous relationships because an individual infected by one partner already has additional sexual partners to infect (Watts 1992, Adimora 2002). Furthermore, because sexual partnerships overlap, early partners are no more protected from infections than partners acquired later; a concept known as *connectivity* (Morris 1995). Partnerships that overlap for longer periods of time may be associated with greater HIV/STI transmission risk than concurrent partnership episodes of short duration (Khan 2009). Concurrent partnerships are particularly important regarding the spread of HIV, given that, individuals who are newly infected with HIV experience higher infectivity levels (Pilcher, Tien et al. 2004).

A growing body of research has examined the pathways through which individual-level experiences of incarceration are associated with partner concurrency (Gorbach 2002, Adimora, Schoenbach et al. 2003, Nunn, Dickman et al. 2011, Senn, Scott-Sheldon et al. 2011). Periods of incarceration can disrupt existing romantic partnerships and female partners left behind may engage in concurrent partnerships to fulfill unmet material, sexual or emotional needs (Nunn, Dickman et al. 2011, Senn, Scott-Sheldon et al. 2011, Davey-Rothwell 2013). Findings from these suggest that women and men have similar reasons for engaging in sexual partner concurrency (Gorbach 2002, Senn, Scott-Sheldon et al. 2011). Recently released men also report

engaging in concurrent partnerships following their reentry in order to fulfill multiple needs (Nunn, Dickman et al. 2011). For recently released men, however, identifying partners may be relatively easy given imbalanced sex ratios among Black adults (Adimora 2005, Harawa 2008, Friedman 2009). These studies, while important for understand the impact of incarceration on sexual risk, largely focus on the experiences of formerly incarcerated men and/or their sexual partners. We were unable to identify any studies that empirically examined the pathways through which high male incarceration rates influence the nature of sexual partnerships among Black women.

In addition to influencing the number and structure of partnerships (e.g. partner concurrency) sexual network characteristics are believed to influence sexual decision-making within partnerships. It has been posited that imbalanced sex ratio can disrupt relationship power in ways that contribute to a woman's difficulty in discussing and negotiating condom use with male sexual partners (Adimora 2002, Adimora and Schoenbach 2002, Logan, Cole et al. 2002, Adimora 2005, Adimora 2006, Adimora 2007, Harawa 2008, National Alliance of State and Territorial AIDS Directors 2008, Khan 2009). Specifically, lower levels of interpersonal power can interfere with a woman's ability to initiate discussions about condom use due to concerns that discussing the topic will lead to conflict, violence or threaten the future of the relationship (Fullilove 1990, Wingood 1997, Logan, Cole et al. 2002).

While it has been frequently hypothesized that imbalanced sex ratios (due in part to male incarceration) can influence sexual relationship power and sexual decision-making within partnerships, especially among Black adults (Adimora, Schoenbach et al. 2001, Logan, Cole et al. 2002, National Alliance of State and Territorial AIDS Directors 2008) we were unable to identify any studies specifically examining this relationship. Further research into the role that imbalanced sex ratios have on sexual relationships is needed to better understand racial disparities in rates of HIV and other STIs.

The Service Environment: Spatial Access to Health Care Services

At the most basic level, access to health care depends on the individual characteristics of an individual and community characteristics, like features of the environment where they live (Andersen 2002). Decreased access to healthcare services among African Americans has been identified as a contributing factor to health disparities across various health outcomes (Mayberry 2000, Smedley 2003). Research suggests that spatial or geographic factors such as increased distance and travel time to health care providers may be associated with poorer health outcomes (Mercer, Sutcliffe et al. 2007, Agency for Healthcare Research and Quality 2008, Goldenberg 2008, Richardson 2010). For example, convenience of access to health care services has been associated with patient decisions regarding cancer screenings (Richardson 1990, Zimmerman 1997, Friedman 2001, Baron 2008), breast cancer care (Onega 2008), vaccinations for children (Fu 2009), asthma care visits (Teach 2006) and general health care utilization (Acury 2005).

Health care visits are important opportunities for testing for HIV and other STIs (Dorell, Sutton et al. 2011). Delayed detection of HIV and other STIs can lead to increased morbidity and even mortality (Mosen, Wenger et al. 1998), and delayed treatment may increase the likelihood that the infections will spread to other individuals in a sexual network (Aral, Adimora et al. 2008). Spatial access to health care shapes utilization and is an important determinant of treatment seeking behavior (Fortney 2000, Mays 2000). Reduced spatial access to health care services may affect HIV and other STI rates by delaying testing and treatment (Fulcher 2005, Division of STD Prevention 2007, Mercer, Sutcliffe et al. 2007, Tyler-Hill 2007, Hogben 2008). There is conflicting evidence, however, regarding the relationship between access to health care services and delay in diagnosis and treatment of STIs (Mercer, Sutcliffe et al. 2007,

Goldenberg 2008, Monnet, Ramee et al. 2008, Olonilua, Ross et al. 2008, Bonney 2011). Some empirical evidence suggests that when health care is convenient to access STI care seeking delays are shorter (Mercer, Sutcliffe et al. 2007, Goldenberg 2008). Other studies have failed to find a connection between travel time and STI diagnosis or care (Olonilua, Ross et al. 2008), decreased STI diagnosis (Olonilua, Ross et al. 2008) or have found curvilinear relationships between travel time and STI status (Bonney 2011).

To our knowledge there have been no studies that have considered the service environment, specifically spatial access to health care, as a potential moderator of the relationship between incarceration rates and rates of HIV and other STIs. More research is needed to better understand whether a relationship exists between spatial access to health care, male incarceration rates and rates of HIV and other STIs

Gaps in the Literature

There are several limitations evident in the literature presented above that warrant attention. These limitations are presented below.

Sexual Networks, Relationship Dynamics and Male Incarceration. Although several studies have identified incarceration as an important factor contributing to an individual's engagement in partner concurrency, none of the studies provided an in-depth exploration of how incarceration impacts partner concurrency. A few studies have explored attitudes and practices of partner concurrency among African Americans (Carey 2010, Dolwick Grieb 2011, Nunn, Dickman et al. 2011, Senn, Scott-Sheldon et al. 2011) and even fewer have considered the attitudes and practices of African American women (Gorbach 2002, Senn, Scott-Sheldon et al. 2011). To our knowledge no studies have examined the attitudes and practices of partner concurrency explicitly among African American women. Further, of those studies that did include African American

women, the qualitative methods used (e.g. focus groups) may not be the best suited for exploring a topic that is perceived as sensitive or stigmatized (Kaplowitz 2000).

Research Linking Incarceration and the Transmission of HIV and other STIs. To our knowledge only three studies have established a positive correlation between rates of incarceration and rates of STIs (Thomas 2005, Thomas 2006, Thomas 2007). The bulk of this work however, has been cross-sectional (Thomas 2005, Thomas 2006), and are therefore unable to establish a causal relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs. Researchers have utilized different administrative units (i.e. zip codes, census tracts and counties) to understand the influence of neighborhood-level characteristics on health outcomes (O'Campo 2003, Osypuk 2007). Thus far associations have been identified at the county-level (Thomas 2005, Thomas 2006), and rates of male incarceration and the prevalence of newly-diagnosed STIs may vary too much within counties to best understand the nature of their association (O'Campo 2003). Given that individuals tend to select romantic and sexual partners from the neighborhoods in which they live (Aral 1999, Adimora 2006, Adimora, Schoenbach et al. 2007), a smaller geographic unit (e.g. census tracts) may be better suited to examine this relationship over time (Osypuk 2007, Gindi 2011). Lastly, because these studies examined incarceration rates among men and women combined (Thomas 2005, Thomas 2006, Thomas 2007). Further research is needed to examine the relationship between *male* incarceration rates of rates of STIs and longitudinal research is needed to better understand the possible causal relationships between male incarceration and rates of STIs.

We identified two studies that empirically examined whether sexual network characteristics, the number of available sexual partners and partner concurrency help explain the relationship between high rates of male incarceration and the transmission of HIV and other STIs (Thomas 2007, Pouget 2010). In the Pouget et al. (2010) study, no

information on partnership formation and maintenance was obtained. In the mixed methods Thomas et al. study (2007), interviews were limited to ex-offenders and the partners of ex-offenders and did not include men and women living in communities that were affected by high rates of male incarceration (Thomas 2007). Moreover, only ten female partners of ex-offenders were included in the study. While the findings from these studies shed light on sexual networks and partnership formation and maintenance in communities with high rates of male incarceration and among previously incarcerated men, there is much more to be learned about the impact of an individual's social environment on partnership and sexual decision-making.

Spatial Access to Health Care Services. Empirical evidence suggests that spatial access to health care shapes utilization and is an important determinant of treatment seeking behavior (Fortney 2000, Mays 2000). To our knowledge there have been no studies that have considered the service environment, specifically spatial access to health care, as a potential moderator of the relationship between male incarceration rates and rates of STIs. Further research is needed to understand whether and how spatial access to health care impacts the relationship between male incarceration and rates of STIs.

Conceptual Model and Theoretical Framework

The conceptual model used in the proposed study is based on the Social Ecological Model (SEM) (Stokols 1996, Centers for Disease Control and Prevention 2009) and Social Cognitive Theory (SCT) (Bandura 1984). The SEM emphasizes that the health of the individual is influenced by community and social structures in addition to individual attitudes and behaviors (Stokols 1992, Stokols 1996). SCT states that human behaviors are the result of the interaction between personal factors, behavior and the environment (Bandura 1984). SEM and SCT allow researchers to address the factors that

the PI believes put individuals living in communities with higher rates of male incarceration at increased risk for STIs and HIV (Stokols 1992).

Figure 1.1 depicts the possible mechanisms through which rates of male incarceration and the health care service environment may influence rates of STIs and HIV. This model provided the theoretical underpinnings for the present research. The figure includes both individual, interpersonal, community and societal characteristics. First, individual-level factors include personal characteristics and histories (e.g. age, education, income, or history of substance abuse) that may increase an individual's likelihood of contracting an HIV or another STI (Centers for Disease Control and Prevention 2009).Interpersonal factors are represented in the model by the characteristics of the sexual partnership (e.g. partnership formation and maintenance) which can greatly impact an individuals' risk of STIs and HIV (Koumans 2001, Fals-Stewart 2002, Drumright 2004).

SCT highlights the importance of "reciprocal determinism" where behaviors, personal factors and environmental factors (including social and physical) interact with and influence each other (Bandura 1984). The community-level factors depicted in the model include aspects of an individual's neighborhood or community that are thought to influence individual health (Macintyre 1993, Jones 1995, Kaplan 1996, Diez Roux 2001, Cohen 2003, Gee 2004, Zenk 2004, Diez Roux 2007, Richardson 2010). Community factors are those that do not directly involve an individual but that may impact his/her behavior. Measures at the community-level focus on geographic and social features that can influence outcomes of interest, in this case rates of HIV and other STIs (Gregson 2001). Health care availability and imbalanced male to female sex ratios are two aspects of the environment that are thought to influence STI and HIV risk.

Finally, both SCT and SEM describe the link between societal factors and the health behaviors of individuals within the community (Bandura 1984). The broadest

level of influence, the societal level, includes local, state and federal policies or conditions that regulate or impact society (Gregson 2001, Hosek 2008). Community and societal factors differ in that societal factors are those that do not directly impact the outcomes of individuals, but society as a whole. For example, high rates of male incarceration may lead to imbalanced sex ratios in some communities. Women living in these communities may feel that they are less able to negotiate monogamous relationships or safer sex practices because of the reduced number of available male partners and the availability of other female partners (Adimora 2006, Thomas 2006). In this study, qualitative methods were used to examine and compare the processes through which male to female sex ratios influence sexual networks and partnership formation and maintenance among heterosexual African-American women living in two types of census tracts: one that has a higher male incarceration rate and a low male to female sex ratio, and the other that has a lower male incarceration rate and a male to female sex ratio close to 1.00. Quantitative methodologies explored: 1) how male incarceration rates contribute to rates of STIs in census tracts in the Atlanta over time and 2) health care service availability as a moderator of the relationship between rates of male incarceration and rates of STIs.

Significance of the Research

Emerging research suggests that people living in communities with high rates of incarceration are at a higher risk of having HIV or other STIs (Thomas 2005, Thomas 2006, Thomas 2007). Understanding how an individual's social environment can influence their selection of sexual partners may help us to better target HIV and other STI programs for communities that are disproportionately affected by male incarceration. To our knowledge, only three studies examined the factors contributing to increased rates of STIs and HIV in communities with high rates of male incarceration (Thomas 2007, Pouget 2010). These studies provided new information on the social

environment including: (1) non-Hispanic Black men in counties with imbalanced sex ratios are likely to have more opposite-sex partners than those in counties with more balanced sex ratios, and (2) incarceration interrupts existing partnerships and can lead ex-offenders to have concurrent partnerships. No new information was provided about the processes through which imbalanced sex ratios impact women's partnership and sexual network formation (i.e., no mechanisms were proposed or tested). Furthermore, none of the studies in the reviewed literature examined availability to health care services within these communities and nearly all of the past work on the association between incarceration rates and HIV and other STI rates was cross-sectional and conducted in one setting (e.g. North Carolina) (Thomas 2005, Thomas 2006).

There have been calls in the literature and from the White House's National HIV/AIDS Strategy for the United States report for future studies to examine how incarceration in Black communities affects HIV/STI-risk behaviors among the sexual partners and sexual networks of those left behind and in the community at large (Latkin and Knowlton 2005, Adimora 2006, Hallfors, Iritani et al. 2007, Harawa 2008, Wyatt 2008, The White House Office of National AIDS Policy 2010). Furthermore, the CDC highlights the importance of health care and sexual networks in understanding STI and HIV health disparities (Primm 2007). This study will advance our understanding of how male incarceration may lead to higher rates of HIV and other STIs. Employing a combination of both small scale qualitative and large scale quantitative methodologies is a promising approach to investigate the relationship between neighborhood factors and individual health (Diez Roux 2001). This study addresses specific gaps in the literature by:

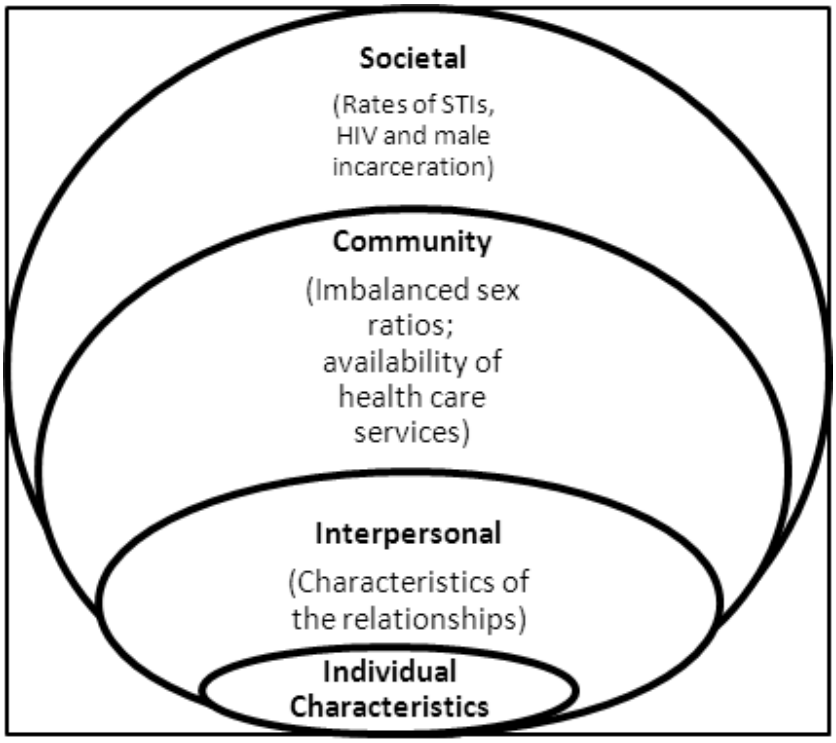
1. Providing an in-depth examination of the sexual relationship norms and processes through which imbalanced male to female sex ratios influence sexual

networks and partnership characteristics in communities with varying rates of male incarceration and sex ratios from the perspectives of Black women;

2. Developing and testing a conceptual model for understanding how rates of male incarceration and spatial access to health care impact rates of STIs over time.

The results from the research are organized into the three chapters. The first paper uses qualitative methods (Chapter 2) and the final two papers use quantitative methods (Chapters 3 and 4). In Chapter 2 we explored and compared the processes through which local rates of male incarceration and imbalanced male to female sex ratios influence sexual networks, partner availability, and the nature and structure of partnerships from the perspectives of heterosexual Black women. Chapter 3 examines the longitudinal relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs in the Atlanta Metropolitan Statistical Area (MSA). In Chapter 4, spatial access to health care is tested as an effect modifier of the relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs in the Atlanta MSA. Lastly, we discuss the implications for future research and practice, which are presented in the concluding chapter (Chapter 5).

Figure 1.1 Possible mechanisms linking rates of male incarceration, the health care service environment and sexual health



References

Acury, T. A., Gesler, W.M., Presisser, J.S., Sherman, J., Spencer, J., Perin, J. (2005). The effect of geography and spatial behavior on health care utilization among the residents of a rural region. *Health Services Research, 40*(1), 135-156.

Adimora, A. (2007). *Social Determinants of STDs*. Paper presented at the Consultation to Address STD Disparities in African American Communities, Atlanta, GA. http://www.cdc.gov/std/general/STDHealthDisparitiesConsultationJune2007.pdf

Adimora, A. A., & Schoenbach, V. J. (2002). Contextual factors and the black-white disparity in heterosexual HIV transmission. *Epidemiology, 13*(6), 707-712. doi: 10.1097/01.EDE.0000024139.60291.08

Adimora, A. A., Schoenbach, V. J., & Doherty, I. A. (2007). Concurrent sexual partnerships among men in the United States. *Am J Public Health, 97*(12), 2230-2237. doi: 10.2105/AJPH.2006.099069

Adimora, A. A., Schoenbach, V. J., Martinson, F., Donaldson, K. H., Stancil, T. R., & Fullilove, R. E. (2004). Concurrent sexual partnerships among African Americans in the rural south. *Ann Epidemiol, 14*(3), 155-160. doi: 10.1016/S1047-2797(03)00129-7

Adimora, A. A., Schoenbach, V. J., Martinson, F. E., Coyne-Beasley, T., Doherty, I., Stancil, T. R., & Fullilove, R. E. (2006). Heterosexually transmitted HIV infection among African Americans in North Carolina. *J Acquir Immune Defic Syndr, 41*(5), 616-623. doi: 10.1097/01.qai.0000191382.62070.a5

Adimora, A. A., Schoenbach, V. J., Martinson, F. E., Donaldson, K. H., Fullilove, R. E., & Aral, S. O. (2001). Social context of sexual relationships among rural African Americans. *Sex Transm Dis, 28*(2), 69-76.

Adimora, A. A., Schoenbach, V. J., Martinson, F. E., Donaldson, K. H., Stancil, T. R., & Fullilove, R. E. (2003). Concurrent partnerships among rural African Americans with recently reported heterosexually transmitted HIV infection. *J Acquir Immune Defic Syndr, 34*(4), 423-429.

Adimora, A. A., Schoenbach, V. J., Taylor, E. M., Khan, M. R., & Schwartz, R. J. (2011). Concurrent partnerships, nonmonogamous partners, and substance use among women in the United States. *Am J Public Health, 101*(1), 128-136. doi: 10.2105/AJPH.2009.174292

Adimora, A. A., Schoenbach, V.J. (2002). Contextual factors and the black-white disparity in heterosexual HIV transmission. *Epidemiology, 13*, 707-712.

Adimora, A. A., SChoenbach, V.J. . (2005). Social context, sexual networks and racial disparities in rates of sexually transmitted infections. *Journal of Infectious Disease, 291*, S115-S122.

Adimora, A. A., Schoenbach, V.J., Bonas, D.M. (2002). Concurrent sexual partnerships among women in the United States. *Epidemiology, 13*, 320-327.

Adimora, A. A., Schoenbach, V.J., Doherty, I.A. (2006). HIV and African Americans in the southern United States: sexual networks and social context. *Sexually Transmitted Diseases, 33*(7 Suppl), S39-45.

Agency for Healthcare Research and Quality. (2008). *2007 National Healthcare Disparities Report*. Rockville, MD: AHRQ

Amaro, H. (1995). Love, sex, and power. Considering women's realities in HIV prevention. *Am Psychol, 50*(6), 437-447.

Andersen, R. M., Yu, H., Wyn, R. (2002). Access to medical care for low-income persons: how do communities make a difference? *Med. Res Rev., 59*, 384-411.

Aral, S. O. (1999a). Sexual mixing patterns as determinants of STD rates: paradigm shift in the behavioral epidemiology of STDs made visible. *Sexually Transmitted Diseases, 26*, 262-264.

Aral, S. O. (1999b). Sexual patterns as determinants of STD rates: paradigm shift in the behavioral epidemiology of STDs made visible. *Sexually Transmitted Diseases, 26*, 262-264.

Aral, S. O., Adimora, A. A., & Fenton, K. A. (2008). Understanding and responding to disparities in HIV and other sexually transmitted infections in African Americans. *Lancet, 372*(9635), 337-340. doi: 10.1016/S0140-6736(08)61118-6

Aral, S. O., Holmes, K.K., Padian, N.S., Cates, W. . (1996). Overview: individual and population approaches to the epidemiology and prevention of sexually transmitted diseases and human immunodeficiency virus infection. *Journal of Infectious Disease, 174*(2), S127-S133.

Auger, N., Daniel, M., Platt, R.W., Wu, Y., Luo, Z.C., Choiniere, R. (2008). Association between perceived security of the neighborhood and small-for-gestational-age birth. *Pediatric Perinatal Epidemiology, 22*(5), 467-477.

Auschengrau, A., Ozonoff, D., Coogan, P., Vezina, R., Heeren, T., Zhang, Y.,. (1996). Cancer risk and residential proximity to cranberry cultivation in Massachusettes. *American Journal of Public Health, 86*(1289-1296).

Bandura, A. (1984). Recycling misconceptions of perceived self-efficacy. *Cognitive Therapy and Research, 8*, 231-255.

Baron, R. C., Rimer, B.K., Breslow, R.A., et al. . (2008). Client-directed interventions to increase community demand for breast, cervical, and colorectal cancer screening: a systematic review. *AMerican Journal of Preventive Medicine, 35*, 34-55.

Berkman, L. F., Glass, T. (2000). Social integration, social networks, social support and health. In L. F. Berkman, Kawachi, I. (Ed.), *Social Epidemiology* (pp. 137-173). New York: Oxford University Press.

Bonney, L. E., Cooper, H.L.F., Caliendo, A.M., del Rio, C., Hunter-Jones, J., Swan, D.F., Rothenberg, R., Druss, B. (2011). Access to Health Services and Sexually Transmitted Infections in a Cohort of Relocating African American Public Housing Residents: An Association Between Travel Time and Infection. *Sexually Transmitted Diseases, 38*(12), 1-6.

Campbell, C. A. (1995). Male gender roles and sexuality: implications for women's AIDS risk and prevention. *Soc Sci Med, 41*(2), 197-210.

Carey, M. P., Senn, T.E., Seward, D.X., Vanable, P.A. (2010). Urban African-American Men Speak Out on Sexual Partner Concurrency: Findings from a Qualitative Study. *AIDS Behaivor, 14*, 38-47.

Carson, E. A., Sabol, W.J. (2012). *Prisoners in 2011*. (NCJ 239808). Retrieved from http://www.doc.wa.gov/aboutdoc/measuresstatistics/docs/BJSReport.Prisonersin2011.pdf.

Centers for Disease Control and Prevention. (2006). Questions and Answers: HIV Prevention. Retrieved December 28,, 2011, from http://www.cdc.gov/hiv/resources/qa/prevention.htm

Centers for Disease Control and Prevention. (2009). Violence Prevention- The Social-Ecological Model: A Framework for Prevention. Retrieved March 20, 2010, from http://www.cdc.gov/ViolencePrevention/overview/social-ecologicalmodel.html

Centers for Disease Control and Prevention. (2013a). HIV and AIDS in the United States by Geographic Distribution. Retrieved May 30, 2014, from http://www.cdc.gov/hiv/statistics/basics/geographicdistribution.html

Centers for Disease Control and Prevention. (2013b). HIV in the United States: At a Glance. Retrieved May 29, 2014, from http://www.cdc.gov/hiv/statistics/basics/ataglance.html

Centers for Disease Control and Prevention. (2013c). *Sexually Transmitted Surveillance 2012*. Atlanta, GA.

Centers for Disease Control and Prevention. (2014a). 2012 Sexually Transmitted Diseases Surveillance. Retrieved April 22,, 2014, from http://www.cdc.gov/std/stats12/minorities.htm

Centers for Disease Control and Prevention. (2014b). 2012 Sexually Transmitted Diseases Surveillance: Syphilis. Retrieved April 28, , 2014, from http://www.cdc.gov/std/stats12/syphilis.htm

Centers for Disease Control and Prevention. (2014c). 2012 Sexually Transmitted Diseases Surveillance: Chlamydia. Retrieved April 28, , 2014, from http://www.cdc.gov/std/stats12/chlamydia.htm

Centers for Disease Control and Prevention. (2014d). 2012 Sexually Transmitted Diseases Surveillance: Gonorrhea. Retrieved April 28, , 2014, from http://www.cdc.gov/std/stats12/gonorrhea.htm

Centers for Disease Control and Prevention. (2014e). HIV Among African Americans. Retrieved March 20, , 2014, from http://www.cdc.gov/hiv/risk/racialethnic/aa/facts/

Cohen, D., Mason, K., Bedimo, A., Scribner, R., Basolo, V., Farley, T.A. . (2003). Neighborhood Service Conditions and Health. *American Journal of Public Health, 93*(3), 467-471.

Coleman, L., & Ingham, R. (1999). Contrasting strategies used by young people to ensure condom use: some findings from a qualitative research project. *AIDS Care, 11*(4), 473-479. doi: 10.1080/09540129947866

Collins, J. W., David, R.J., Symons, R., Handler, A., Wall, S., Andes, S. (1998). African-American mothers' perception of their residential environment, stressful life events, and very low birth weight. *Epidemiology, 9*(3), 286-289.

Cubbin, C., Santelli, J., Brindis, C.D., Braveman, P. (2005). Neighborhood context and sexual behaviors among adolescents: Findings from the National Longitudinal Study of Adolescent Health. *Perspectives on Sexual and Reproductive Health, 37*(3), 125-134.

Culhane J.F. & Elo, I. T. (2005). Neighborhood context and reproductive health. *American Journal of Obstetrics and Gynecology, 192*, SS22-29.

Davey-Rothwell, M., Villarroel, M.A., Grieb, S.D., Latkin, C.A. (2013). Norms, attitudes, and sex behaviors among women with incarcerated main partners. *Journal of Urban Health, 90*(6), 1151-1165.

Dean, A. G., Imrey, H.H., Dusich, K., Hall, W.N. (1988). Adjusting morbidity ratios in two communities using risk factor prevalence in cases. *American Journal of Epidemiology, 127*, 654-662.

Diez Roux, A. V. (2001). Investigating neighborhood and area effects on health. *American Journal of Public Health, 91*(11), 1783-1789.

Diez Roux, A. V. (2007). Neighborhoods and health: where are we and where do we go from here? . *Rev Epidemiol Sante Publique, 55*(1), 13-21.

Division of STD Prevention. (2007). *Consultation to Address STD Disparities in African American Communities*. Atlanta, GA: BullsEye Resources Retrieved from http://www.cdc.gov/std/general/STDHealthDisparitiesConsultationJune2007.pdf.

Doherty, I. A., Shiboski, S., Ellen, J.M., ADimora, A.A., Padian, N.S. (2006). Sexually bridging socially and over time: A simulation model exploring the relative effects

of mixing and concurrencfy on viral sexually transmitted infection transmission. *Sexually Transmitted Diseases, 33*, 368-373.

Dolwick Grieb, S. M., Davey-Rothwell, M., Latkin, C.A. (2011). Social and Sexual Network Characteristics and Concurrent Sexual Partnerships Among Urban African American High-risk Women with Main Sex Partners. *AIDS Behav*.

Dorell, C. G., Sutton, M. Y., Oster, A. M., Hardnett, F., Thomas, P. E., Gaul, Z. J., . . . Heffelfinger, J. D. (2011). Missed opportunities for HIV testing in health care settings among young African American men who have sex with men: implications for the HIV epidemic. *AIDS Patient Care STDS, 25*(11), 657-664. doi: 10.1089/apc.2011.0203

Drumright, L. N., Gorbach, P.M., Holmes, K.K. (2004). Do people really know their sex partners? Concurrency, knowledge of partner behavior, and sexually transmitted infections within partnerships. *Sexually Transmitted Diseases, 31*, 437-442.

Drumwright, L. N., Gorbach, P.M., Holmes, K.K. . (2004). Do people really know their sex partners? Concurrency, knowledge of partner behavior and sexually transmitted infections with partnerships. . *Sexually Transmitted Diseases, 31*(7), 437-442.

Ellen, J. M., Jennings, J.M., Meyers, T., Chung, S., Taylor, R. (2004). Perceived social cohesion and prevalence of sexually transmitted diseases. *Sexually Transmitted Diseases, 31*(2), 117-122.

Fals-Stewart, W., Birchler, G.R., Hoebbel, C., Kashdan, T.B., Golden, J., Parks, K. (2002). An examination of indirect risk of exposure to HIV among wives of substance-abusing men. *Drug and Alcohol Dependence, 70*, 65-76.

Flom, P. L., Friedman, S.R., Kottiri, B.J. et. al. (2001). Stigmatized drug use, sexual partner concurrency, and other sex risk network and behavior characteristics of

18- to 24-year-old youth in a high-risk neighborhood. *Sexually Transmitted Diseases, 28*, 598-607.

Fortney, J., Rost, K., Warren, J. (2000). Comparing alternative methods of measuring geographic access to health services. *Health Services and Outcomes Research Methodology, 1*(2), 173-184.

Friedman, S. R., Cooper, H.L.F., Osborne, A.H. (2009). Structural and Social Contexts of HIV Risk Among African Americans. *AMerican Journal of American Public Health, 99*, 1002-1008.

Friedman, S. R. A., S. . (2001). Social networks, risk-potential networks, health and disease. *Journal of Urban Health, 78*(3), 411-418.

Fu, L. Y., Cowan, N., McLaren, R., Engstrom R., Teach, S.J. ((2009). Spatial accessibility to providers and vaccination compliance among children with Medicaid. *Pediatrics, 124*(6), 1579-1586.

Fulcher, C., Kaukinen, C. (2005). Mapping and visualizing the location of HIV service providers: An exploratory spatial analysis of Toronto neighborhoods. *AIDS Care, 17*(3), 386-396.

Fullilove, M. T., Fullilove, R., Bowser, B.P., Haynes, K., Gross, S.A. (1990). Black women and AIDS: Gender rules. *Journal of Sex Res, 27*, 47-64.

Garnett, G. P., Hughes, J. P., Anderson, R. M., Stoner, B. P., Aral, S. O., Whittington, W. L., . . . Holmes, K. K. (1996). Sexual mixing patterns of patients attending sexually transmitted diseases clinics. *Sex Transm Dis, 23*(3), 248-257.

Gary, T. L., Safford, M.M., Gerzoff, R.B., Ettner, S.L., Karter, A.J., Beckles, G.L., Brown, A.F. (2008). Perceptions of neighborhood problems, health behaviors and diabetes outcomes among adults with diabetes in managed care: The Translating Research into Action for Diabets (TRIAD). *Diabetes Care, 31*(2), 272-278.

Gee, G. C. P.-S. (2004). Environmental Health Disparities: A Framework integrating psychosocial and environmental concepts. *Environmental Health Perspective, 112*(17), 1546-1653.

Georgia Department of Corrections. (2010). Georgia Department of Corrections Offender Statistics. Retrieved March 20, 2010, from <http://www.dcor.state.ga.us/GDC/OffenderStatistics/jsp/OffStatsSelect.jsp>

Georgia Department of Human Resources, D. o. P. H. (2008). 2008 Georgia Data Summary: HIV/AIDS Surveillance. Retrieved March 20, 2010, from <http://health.state.ga.us/pdfs/epi/hivstd/HIV Data Summary 10_16_08.pdf>

Georgia Division of Public Health. (2011). *HIV/AIDS Surveillance Fact Sheet*. Retrieved from http://health.state.ga.us/pdfs/epi/hivstd/HIV-AIDS Surveillance Fact Sheet 2009-05-17-11.pdf.

Ghani, A., Swinton, J., Garnett, G.P. (1997). The role of sexual partnership networks in the epidemiology of gonorrhea. *Sexually Transmitted Diseases, 24*, 45-56.

Ghani, A. C., Swinton, J., & Garnett, G. P. (1997). The role of sexual partnership networks in the epidemiology of gonorrhea. *Sex Transm Dis, 24*(1), 45-56.

Goldenberg, S. M., Shoveller, J.A., Ostry, A.C. (2008). Sexually transmitted infection (STI) testing among young oil and gas workers: The need for innovative, place-based approaches to STI-control. *Canadian Journal of Public Health, 99*, 350-354.

Gorbach, P. M., Stoner, B.P., Aral, S.O., Whittington, W.L.H., Holmes, K.K. (2002). "It takes a village": Understanding concurrent sexual partnerships in Seattle, Washington. *Sexually Transmitted Diseases, 29*(453-462).

Gregson, J., Foerster, S.B., Orr, R., Jones, L., Benedict, J., Clarke, B., Hersey, J., Lewis, J., Zotz, K. (2001). System, Environmental, and Policy Changes: Using the Social-Ecological Model as a Framework for Evaluating Nutrition Education and Social

Marketing Programs with Low-Income Audiences. *Society for Nutrition Education, 33*, S4-S15.

Grieb, S. M., Davey-Rothwell, M., & Latkin, C. A. (2011). Social and Sexual Network Characteristics and Concurrent Sexual Partnerships Among Urban African American High-risk Women with Main Sex Partners. *AIDS Behav*. doi: 10.1007/s10461-011-0030-z

Guttenburg, M. (1983). *Too many women: the sex ratio question*. Beverly Hills: Sage.

Hallfors, D. D., Iritani, B. J., Miller, W. C., & Bauer, D. J. (2007). Sexual and drug behavior patterns and HIV and STD racial disparities: the need for new directions. *Am J Public Health, 97*(1), 125-132. doi: 10.2105/AJPH.2005.075747

Harawa, N. A., A. (2008). Incarceration, African Americans and HIV: advancing a research agenda. *Journal of the National Medical Association, 100*(1), 57-62.

Harvey, S. M., Bird, S. T., Galavotti, C., Duncan, E. A., & Greenberg, D. (2002). Relationship power, sexual decision making and condom use among women at risk for HIV/STDS. *Women Health, 36*(4), 69-84. doi: 10.1300/J013v36n04_06

Hodder, S. L., Justman, J., Haley, D. F., Adimora, A. A., Fogel, C. I., Golin, C. E., . . . El-Sadr, W. M. (2010). Challenges of a hidden epidemic: HIV prevention among women in the United States. *J Acquir Immune Defic Syndr, 55 Suppl 2*, S69-73. doi: 10.1097/QAI.0b013e3181fbbdf9

Hogben, M., Leichliter, J.S. (2008). Social Determinants and Sexually Transmitted Disease Disparities. *Sexually Transmitted Diseases, 35*(12), S13-S18.

Hosek, S. G., Harper, G.W., Lemos, D., Martinez, J. (2008). An ecological model of stressors experienced by youth newly diagnosed with HIV. *Journal of HIV/AIDS Prevention in Children and Youth, 9*(2), 192-218.

Jenks, S. (1994). Researchers to comb Long Island for potential cancer factors. *Journal of the National Cancer Institute, 86*, 88-89.

Jones, K., Duncan C. . (1995). Individuals and their ecologies: analyzing the geography of chronic illness within a multi-level modeling framework. *Health and Place, 1*, 27-40.

Kaplan, G. (1996). People and places: Contrasting perspectives on the association between social class and health. *International of Journal of Health Service, 26*, 507-519.

Kaplowitz, M. D. (2000). Statistical analysis of sensitive topics in group and individual interviews. *Quality and Quantity, 34*, 419-431.

Khan, M. R., Doherty, I.A., Schoenbach, V.J., Taylor, E.M., Epperson, M.W., Adimora, A.A. (2009). Incarceration and high-risk sex partnerships among men in the United States. *Journal of Urban Health, 86*(4), 584-601.

Klovdahl, A. S., Potterat, J.J., Woodhouse, D.E., Muth, J.B., Muth, S.Q., Darrow, W.W. (1994). Social networks and infectious disease: the Colorado Springs Study. *Social Science and Medicine, 38*, 79-88.

Koopman, J. S., Lynch, J.W. (1999). Individual causal models and population system models in epidemiology. *American Journal of Public Health, 89*, 1170-1174.

Koumans, E. H., Gibson, J.J., Langley, C. (2001). Characteristics of persons with syphilis in areas of persisting syphilis in the United States: Sustained tranmission associated with concurrent partnerships. *Sexually Transmitted Diseases, 28*, 497-503.

Kraut-Becher, J. R., Aral, S.O. (2003). Gap length: an important factor in sexually transmitted disease transmission. *Sexually Transmitted Diseases, 30*(3), 221-225.

Lane, M. A., McCright, J., Garrett, K. (1999). Features of sexually transmitted disease services important to African American adolescents. *Archives of Pediatric and Adolescent Medicine, 153*(829-833).

Latkin, C. A., & Knowlton, A. R. (2005). Micro-social structural approaches to HIV prevention: a social ecological perspective. *AIDS Care, 17 Suppl 1*, S102-113. doi: 10.1080/09540120500121185

Laumann, E. O., & Youm, Y. (1999). Racial/ethnic group differences in the prevalence of sexually transmitted diseases in the United States: a network explanation. *Sex Transm Dis, 26*(5), 250-261.

Logan, T. K., Cole, J., & Leukefeld, C. (2002). Women, sex, and HIV: social and contextual factors, meta-analysis of published interventions, and implications for practice and research. *Psychol Bull, 128*(6), 851-885.

Macintyre, S., Maciver, S., Sooman A. . (1993). Area, class, and health: should we be focusing on places or people? *Journal of Social Policy, 22*, 213-234.

Masi, C. M., Hawkley, L.C., Piotrowski, Z.H., Picket, K.E. (2007). Neighborhood economic disadvantage, violent crime, group density and pregnancy outcomes in a diverse, urban population. *Social Science and Medicine, 65,* 2440-2457.

Mayberry, R. M., Mili, F., Ofili, E. (2000). Racial and ethnic differences in access to medical care. *Medical Care Research, 57*(suppl 1), 108-145.

Mays, V., Cochran, S., Sullivan, J. (2000). Health Care for African AMerican and Hispanic Women: Report on Perceived Health Status, Access to Care, and Utilization Patterns. In C. Hogue, Hargraves, M., Scott Collins, K. (Ed.), *Minority Health in America: Findings and Policy Implications from the Commonwealth Fund Minority Health Survey*. Baltimore: The Johns Hopkins University Press.

McNair, L. D., Prather, C.M. (2004). African American women and AIDS: Factors influencing risk and reaction to HIV disease. *Journal of Black Psychology, 30*, 106-123.

Mercer, C. H., Sutcliffe, L., Johnson, A. M., White, P. J., Brook, G., Ross, J. D., . . . Cassell, J. A. (2007). How much do delayed healthcare seeking, delayed care

provision, and diversion from primary care contribute to the transmission of STIs? *Sex Transm Infect, 83*(5), 400-405. doi: 10.1136/sti.2006.024554

Monnet, E., Ramee, C., Minello, A., Jooste, V., Carel, D., & Di Martino, V. (2008). Socioeconomic context, distance to primary care and detection of hepatitis C: a French population-based study. *Soc Sci Med, 66*(5), 1046-1056. doi: 10.1016/j.socscimed.2007.11.044

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

Mosen, D. M., Wenger, N. S., Shapiro, M. F., Andersen, R. M., & Cunningham, W. E. (1998). Is access to medical care associated with receipt of HIV testing and counselling? *AIDS Care, 10*(5), 617-628. doi: 10.1080/09540129848479

National Alliance of State and Territorial AIDS Directors. (2008). The Landscape of HIV/AIDS among African American Women in the United States *African American Women* (Vol. No.1).

Nunn, A., Dickman, S., Cornwall, A., Rosengard, C., Kwakwa, H., Kim, D., . . . Mayer, K. H. (2011). Social, structural and behavioral drivers of concurrent partnerships among African American men in Philadelphia. *AIDS Care, 23*(11), 1392-1399. doi: 10.1080/09540121.2011.565030

Olonilua, O., Ross, J. D., Mercer, C., Keane, F., Brook, G., & Cassell, J. A. (2008). The limits of health-care seeking behaviour: how long will patients travel for STI care? Evidence from England's 'Patient Access and the Transmission of Sexually Transmitted Infections' ('PATSI') study. *Int J STD AIDS, 19*(12), 814-816. doi: 10.1258/ijsa.2008.008205

Onega, T., Duell, E.J., Shi,X., Wang,D., Demidenko,E., Goodman, D. . (2008). Geographic access to cancer care in the U.S. *Cancer, 112*(4), 909- 918.

Pilcher, C. D., Tien, H. C., Eron, J. J., Jr., Vernazza, P. L., Leu, S. Y., Stewart, P. W., . . . Cohen, M. S. (2004). Brief but efficient: acute HIV infection and the sexual transmission of HIV. *J Infect Dis, 189*(10), 1785-1792. doi: 10.1086/386333

Pouget, E. R., Kershaw, T.S., Niccolai, L.M., Ickovics, J.R., Blankenship, K.M. (2010a). Associations of Sex Ratios and Male Incarceration Rates with Multiple Opposite-Sex Partners: Potential Social Determinants of HIV/STI Transmission. *Public Health Reports, 125*(Supplement 4), 70-80.

Pouget, E. R., Kershaw, T.S., Niccolai, L.M., Ickovics, J.R., Blankenship, K.M. (2010b). Associations of sex ratios and male incarceration rates with multiple opposite-sex partners: potential social determinants of HIV/STI transmission. *Public Health Report, 125*(Suppl 4), 70-80.

Primm, B. J., Aral, S.O. (2007). *Framework for Understanding Disparities*. Paper presented at the Consultation to Address STD Disparities in African American Communities, Atlanta, GA. http://www.cdc.gov/std/general/STDHealthDisparitiesConsultationJune2007.pdf

Pulerwitz, J., Amaro, H., De Jong, W., Gortmaker, S. L., & Rudd, R. (2002). Relationship power, condom use and HIV risk among women in the USA. *AIDS Care, 14*(6), 789-800. doi: 10.1080/0954012021000031868

Rastogi, S., Johnson, T.D., Hoeffel, E.M., Drewery, M.P. (2011). *The Black Population: 2010*. (C2010BR-06). Retrieved from http://www.census.gov/prod/cen2010/briefs/c2010br-06.pdf.

Rhodes, T., Quirk, A. (1998). Drug users' sexual relationships and the social organisation of risk: the sexual relationship as the site of risk management. *Social Science and Medicine, 46*, 157-169.

Richardson, A. (1990). Factors likley to affect participation in mammographic screening. *N Z Med J, 103*, 155-156.

Richardson, L. D. N., M. (2010). Access to Health and Health Care: How Race and Ethnicity Matter. *Mount Sinai Journal of Medicine, 77*, 166-177.

Rothenberg, R., & Narramore, J. (1996). The relevance of social network concepts to sexually transmitted disease control. *Sex Transm Dis, 23*(1), 24-29.

Senn, T. E., Scott-Sheldon, L. A., Seward, D. X., Wright, E. M., & Carey, M. P. (2011). Sexual partner concurrency of urban male and female STD clinic patients: a qualitative study. *Arch Sex Behav, 40*(4), 775-784. doi: 10.1007/s10508-010-9688-y

Smedley, B. D., Stith, A.Y., Nelson, A.R. (Ed.). (2003). *Unequal treatment: Confronting racial and ethnic disparities in health care* Washington D.C.: National Academies Press.

Stokols, D. (1992). Establishing and Maintaining Healthy Environments: Toward a Social Ecology of Health Promotion. *American Pyschologist, 47*(1), 6-22.

Stokols, D. (1996). Translating social ecological theory into guidelines for community health promotion. . *American Journal of Public Health, 10*(4), 282-298.

Teach, S. J., Guagliardo, M.F., Crain, E.F., McCarter, R.J., Quint, D.M., Shao, C., Joseph, J.G. . (2006). Spatial accessibility of primary care pediatric services in an urban environment: association with asthma management and outcome. *Pediatrics, 117*(4), S78-85.

The Sentencing Project. (2008). Incarceration Trends in Georgia 1988-2008. Retrieved March 20, 2010, from <http://www.communityvoices.org/Uploads/Incarceration_Trends_in_Georgia_1988-2008_00108_00232.pdf>

The Sentencing Project. (2014). Incarceration. Retrieved June 1, 2014, from http://www.sentencingproject.org/template/page.cfm?id=107

The White House Office of National AIDS Policy. (2010). National HIV/AIDS Strategy for the United States. Retrieved December 1,, 2010, from http://www.whitehouse.gov/sites/default/files/uploads/NHAS.pdf

Thomas, J. C., Levandowski, B.A., Isler, M.R., Torrone, E., Wilson, G. (2007). Incarceration and Sexually Transmitted Infections: A Neighborhood Perspective. *Journal of Urban Health, 85*(1), 90-99.

Thomas, J. C., Sampson, L.A. . (2005). High rates of incarceration as a social force associated with community rates of sexually transmitted infection. *Journal of Infectious Disease, 191*(Suppl 1), S55-60.

Thomas, J. C., Torrone, E. . (2006). Incarceration as forced migration: Effects on selected community health outcomes. *American Journal of Public Health, 96*(10), 1762-1765.

Tilson, E. C., Sanchez, V., Ford, C.L. (2004). Barriers to asymptomatic screening and other STD services for adolescents and young adults: Focus group discussions. *BMC Public Health, 4*(21).

Tyler-Hill, Y. (2007). *Reducing Health Disparities: Influences and Opportunities in Health Care Financing and Delivery*. Paper presented at the Consultation to Address STD Disparities in African American Communities, Atlanta, GA. http://www.cdc.gov/std/general/STDHealthDisparitiesConsultationJune2007.pdf

UNAIDS Reference Group on Estimates, M. a. P. (2009). *Consultation on concurrent partnerships*. Nairobi, Kenya.

Watts, C. H., May, R.M. (1992). The influence of concurrent partnerships on the dynamics of HIV/AIDS. *Mathematical Biosciences, 108*, 89-104.

Wingood, G. M., DiClemente, R.J. (1995). Understanding the role of gender relations in HIV prevention research. *American Journal of Public Health, 85*, 592.

Wingood, G. M., DiClemente, R.J. (1997). Consequences of having a physically abusive partner on the condom use and sexual negotiation practices of young adult African American women. *American Journal of Public Health, 87*, 1016-1018.

Wingood, G. M., DiClemente, R.J. (1998a). Partner Influences and Gender-Related Factors Associated with Noncondom Use Among Young Adult African American Women. *American Journal of Community Psychology, 26*(1), 29-51.

Wingood, G. M., DiClemente, R.J. (1998b). Relationship characteristics associated with noncondom use among young adult African American women. *American Journal of Community Psychology, 26*, 29-53.

Wingood, G. M., DiClemente, R.J. (2000). Application of the Theory of Gender and Power to Examine HIV-Related Exposures, Risk Factors, and Effective Interventions for Women. *Health Education and Behavior, 27*(5), 539-565.

Wyatt, G. E., Williams, J.K., Myers, H.F. (2008). African-American Sexuality and HIV/AIDS: Recommendations for Future Research. *Journal of the National Medical Association, 100*(1), 44-51.

Zenk, S. N., Shultz, A.J., Israel, B.A., James, S.A., Bao, S., Wilson, M.L. (2004). Neighborhood Racial Composition, Neighborhood Poverty, and the Spatial Accessibility of Supermarkets in Metropolitan Detroit. *American Journal of Public Health, 95*(4), 660-667.

Zimmerman, S. (1997). Factors influencing Hispanic participation in prostate cancer screening. *Oncology Nursing Forum, 24*, 499-504.

Chapter 2:

Collateral Consequences: The Implications of male incarceration rates, imbalanced sex ratios and partner availability among heterosexual Black women

Abstract

While several studies have found correlations between male incarceration rates and HIV/STI rates, few have explored the *mechanisms* linking these phenomena. This qualitative study examines how local male incarceration rates and sex ratios influence perceptions of partner availability and the nature of partnerships for heterosexual Black women. Semi-structured interviews were conducted with 33 Black women living in two neighborhoods: one with a higher incarceration rate and an imbalanced sex ratio (Allentown) and one with a lower incarceration rate and a more balanced sex ratio (Blackrock). Data were analyzed using grounded theory. In Allentown, women believed that incarceration reduced the number of available men and participants largely viewed men available for partnerships as undesirable for long-term relationships. Imbalanced sex ratios and the undesirable qualities of available men impacted the structure and purpose of partnerships such that they were characterized as shorter, focused on sexual activity and may be with higher risk sexual partners. In Blackrock, local marriage rates contributed to the shortage of desirable male partners. In the absence of being able to identify one male partner to suit all of their needs, women in Blackrock engaged in multiple concurrent partnerships. This study advances current understandings of how incarceration and sex ratios contribute to vulnerability to HIV/STIs.

Introduction

Compared to women of other races/ethnicities in the United States (U.S.), Black women are disproportionately affected by HIV and other sexually transmitted infections (STIs) (Centers for Disease Control and Prevention 2014). In 2010, Black women accounted for roughly 66% of all new HIV infections among women, a population rate that is 20 times that of White women (Centers for Disease Control and Prevention 2010). Black women also have higher rates of gonorrhea, Chlamydia and syphilis than White women (Centers for Disease Control and Prevention 2010). In 2010, the rate of gonorrhea among Black women was 16.2 times the rate among White women; the rate of Chlamydia was over 7 times the rate for White women; and the rate of primary and secondary syphilis was 21 times the rate for White women (Centers for Disease Control and Prevention 2010).

Racial disparities evident in HIV and STI trends are mirrored in national trends in incarceration. The U.S. incarcerates more adults per capita than any other country in the world (The Sentencing Project 2010). The burden of this high rate of incarceration falls disproportionately on Black men. In 2011, Black men were imprisoned at a rate that was more than six times higher than that of their White counterparts (3,023/100,000 vs. 478/100,000) (Carson 2012). Notably, Black men have substantially higher incarceration rates than Black women: in 2011, there were roughly 21 incarcerated Black men for every incarcerated Black woman (Carson 2012). Such gender differences in incarceration rates contribute to the sex ratio imbalance that already exist among Black adults: in 2011 there were roughly 91 Black males living in the community

(i.e., not behind bars) for every 100 Black women living in the community (United States Census Bureau 2007-2011).

Several quantitative studies have found that geographic areas with higher rates of incarceration have higher and increasing rates of STIs (Thomas 2005, Thomas 2006, Thomas 2007), including higher rates of HIV (Thomas 2006). A growing body of research has explored the pathways through which incarceration influences the transmission of HIV and other STIs (Thomas 2007, Khan, Wohl et al. 2008, Khan 2009, Pouget 2010, Green 2012, Davey-Rothwell 2013, Knittel 2013), however, these studies largely focus on the experiences of formerly incarcerated men and/or their sexual partners. We were unable to identify any studies that empirically examined the pathways through which high male incarceration rates and the subsequent low sex ratio (where there are more women than men) influence the nature and type of sexual partnerships among Black women, though research has investigated how low sex ratios (also referred to as "male shortage") impact HIV and STI risk among Black women (Adimora, Schoenbach et al. 2001, Ferguson 2007, Adimora 2013). Most existing studies examine male shortage in a variety of contexts (e.g. college campuses (Ferguson 2007)) rather than focusing on low sex ratios that have been produced by incarceration. These studies suggest that low sex ratios are directly related to men having multiple and concurrent sex partners (Adimora, Schoenbach et al. 2001, Ferguson 2007, Adimora 2013). Qualitative findings suggest that low sex ratios can lead to concurrent sex partners and increased sexual risk by increasing the number of available female sexual partners, and by undermining women's ability to negotiate monogamous relationships with their partners (Adimora,

Schoenbach et al. 2001, Ferguson 2007). While these studies inform current understandings of the pathways through which imbalanced sex ratios impact romantic partnerships, the unique mechanisms through which high male incarceration rates and male shortage together influence the nature and type of partnerships among Black women warrants further attention.

The majority of empirical studies exploring rates of male incarceration and sexual health outcomes have used quantitative designs and have therefore been unable to explore subjective experiences of the various ways that sex ratios and incarceration rates can, and do, impact heterosexual Black women's sexual partnerships. The purpose of this qualitative paper is to examine and compare the unique processes through which local rates of male incarceration and imbalanced male to female sex ratios influence partner availability and the nature and structure of partnerships from the perspectives of heterosexual Black women. To our knowledge, this is the first study to explore the pathways through which community-level male incarceration influence heterosexual women's individual partnerships and sexual behavior.

Methods

Sampling. This study sampled two units of analysis: census tracts within the Atlanta metropolitan statistical area (MSA) and women living in these census tracts.

Sampling Census Tracts. We sought to study women living in two types of census tracts in the Atlanta MSA: a tract that had a high male incarceration rate and low male: female sex ratio and a tract that had a relatively low male incarceration rate and more balanced sex ratios. 2009 incarceration rates were

calculated by dividing the number of incarcerated men by the tract's adult male population [18-64 years] annually; data on the number of incarcerated men in Atlanta tracts were obtained from Georgia's Department of Correction (GA DOC). Sex ratios were calculated using data from 2007-2011 American Community Survey (United States Census Bureau 2005-2009). First we identified census tracts that had either low sex ratios (less than .70) or equitable sex ratios (approximately 1.0). To help ensure that the low sex ratios were likely produced by high male incarceration rates, we next examined the rates of male incarceration in these two groups of census tracts. Lastly, because our focus was on Black adults, census tracts were examined to ensure that those that were selected had a high proportion of Black residents (>75% of the population). While all attempts were made to identify two census tracts in Atlanta's urban core, it was impossible to locate a predominately Black census tract in the city of Atlanta that had a low incarceration rate and equitable sex ratio. As a result, the tract with low incarceration rates and balanced equitable sex ratios, called "*Blackrock,"* was located in the suburbs. The other tract, *Allentown*, was located in the urban core.

The boundaries of *Blackrock* were expanded during the recruitment period to include women who lived just outside the census tract's borders but whose "activity space", or the local areas where people move or travel to during their daily activities(Golledge 1987, Albert 2000), may have fallen within the census tract's boundaries. The first author (ED) used a grounded knowledge of *Blackrock* and the locations of local businesses, places of worship, schools, government services, and parks to expand the census tract's boundaries.

Sampling Study Participants within Census Tracts

Eligibility. Women from *Allentown* and *Blackrock* were eligible if they self-identified as Black or African American; were heterosexual; were unmarried; between the ages of 18 and 39; had had sex with a man in the past 90-days; resided in their census tract (or within the expanded tract boundaries, in the case of *Blackrock*) for at least three years prior to the screening; and were able to speak English fluently enough to understand the screening and consent process. In line with theoretical sampling methods (Marshall 1996), we sought to create a sample of women that varied with regard to characteristics that might be salient to the relationships among sex ratios and the nature and structure of partnerships including: age and whether the participant cared for a child. After recruitment began, we added transactional sex and whether the participant had a partner who was incarcerated at some point during their relationship as sampling criteria. This sampling process helped to test, elaborate, and refine categories identified in initial analyses. Eligibility was assessed through a brief screening process.

Recruitment. Women were recruited using passive and snowball recruitment methods (Crosby 2006). Flyers describing the study were posted at various community-based organizations, local businesses, and places of worship in each census tract. Additional participants were recruited using snowball sampling methods (Crosby 2006), in which a community recruiter or study participant (a "seed") was asked to invite individuals from her social network to be screened for eligibility for the study. Community recruiters were identified during the recruitment period and were selected because of their knowledge of

the neighborhood and its residents. Referral chains, originating either from seeds or community recruiters, were limited to three study participants in order to prevent a large proportion of participants from being from one social network. Individuals interested in participating in the study contacted the first author (ED) for an initial screening. Seeds and community recruiters were given $5 for each eligible person they referred who participated in the study.

Data Collection Procedures. Data were collected from each participant via a one-on-one semi-structured interview and a short questionnaire. The semi-structured interviews lasted between 60 and 90 minutes and were conducted in organizations located in the neighborhood of interest, in rooms that allowed for private conversations. Interview guides explored participants' perceptions of neighborhood rates of male incarceration, sex ratios, and partner availability and the nature and structure of sexual partnerships in the context of local male incarceration rates and sex ratios. Neighborhoods were defined subjectively: participants were asked to describe the boundaries of their neighborhood or the geographic area around the place where they live, including local places where the participants ate, shopped, and spent their free time. Participants from *Allentown* described neighborhood boundaries that largely aligned with administratively defined boundaries. Neighborhood boundaries described by *Blackrock* participants varied; some participants perceived their neighborhood to be limited to the immediate area around their street or subdivision while others described an area larger than the administratively defined boundaries. A Sexual Partner Chart, which asked participants to list sexual partners (within the past 90 days) and answer questions about their partner's incarceration history and their

sexual activities with each of the partners, was used to facilitate discussions about sexual partnerships during the semi-structured interview. Interviews were audio-recorded with the participant's permission and were transcribed verbatim.

Upon completing of the interview a short interviewer-administered questionnaire was used to assess sociodemographic characteristics of the study sample (e.g. age, marital status, income). Each participant received $30 and an Atlanta-specific resource guide for her contribution to the study.

Because sociodemographic data were unavailable for the participants' subjectively defined neighborhoods, we used data from the 2007-2011 American Community Survey (United States Census Bureau 2007-2011, United States Census Bureau 2007-2011, United States Census Bureau 2007-2011) to assess several characteristics of the two census tracts. These sociodemographic characteristics were: percent of residents living in poverty, median household income, and the median age of residents.

Data Analysis. Qualitative data were analyzed using grounded theory methods (Strauss 1998). Grounded theory consists of three main processes: 1) open coding, in which data are examined, compared, and categorized, 2) axial coding, in which categories are further developed by examining and refining causal conditions, and 3) selective coding, in which main categories are developed and all other categories are related to the main category/ies by examining intersections (Strauss 1998, Patton 2002). An initial codebook, consisting of 25 codes, was developed based on the semi-structured interview guide and the content of interview transcripts. To improve inter-rater reliability, two initial interviews were open coded by the first author and one of the

coauthors (LO). In order to improve reliability and to ensure adequate intercoder agreement, coding patterns were compared and the codebook was refined until consensus was reached between the coders (which occurred after coding the first seven interviews). In order to code for themes unique to participants in *Blackrock*, the codebook was revisited and revised when coding the first three interviews from that census tract. The remaining interviews were double-coded in a similar fashion and the codebook was reviewed and revised throughout the analysis process. Changes to codebook included creating codes specific to participants' experiences in sexual relationships with older men and merging codes related to participants' experiences exchanging sex for material goods and money. The first author generated memos to develop categories and highlight connections between categories and subcategories. Quotations from participants were compiled to illustrate concepts and relationships pertinent to core categories. During the axial and selective coding process, findings from each census tract were compared to identify similarities and differences in the mechanisms through which local male incarceration rates and a low sex ratio influence partner availability and the nature and structure of partnerships among women in *Allentown* and *Blackrock*. Member checks were conducted with two participants from each tract to enhance the findings' interpretive validity. In these checks, results were presented and feedback was solicited from these four participants (Maxwell 1996, Kelly 2007). Member check participants were selected based on their interest in participating and their perceptions of male incarceration rates and local partner availability. MAXQDA, a qualitative management software package, was used to facilitate qualitative analysis (VERBI

Software 2013). Descriptive statistics were generated for quantitative data using SAS version 9.3 (Cary, N.C.).

Ethics

The study was approved by Emory University's Institutional Review Board. In order to provide additional protection for the participants, oral rather than written consent was obtained.

Results

Sociodemographic Characteristics of the Census Tracts. In *Allentown,* 12 of every 100 adult men were incarcerated, and there were 70 men for every 100 women (Table 1). In *Blackrock*, less than one (0.89) man of every 100 was incarcerated, and there were 96 men for every 100 women. Notably, residents in *Allentown* were more impoverished (37.2% versus 7.6% lived below the poverty line, older (median age: 45 years versus 31 years), and had a lower median household income ($19,529 versus $69,387) than residents living in *Blackrock*. Nearly all residents in *Allentown* or *Blackrock* were Black (99% and 96% respectively) (U.S. Census Bureau 2005-2009).

Sociodemographic and Sexual Risk Characteristics of the Participants, by Census Tract. Thirty-three women took part in the study; 20 were from *Allentown* and 13 were from *Blackrock*. Fewer participants were interviewed from *Blackrock* because saturation of themes was reached earlier in the data collection process. The median age of participants in both census tracts was approximately 30 (Table 2). Consistent with the economic differences between the tracts where they lived, participants from *Allentown* were more impoverished and less educated than participants from *Blackrock:* nearly 79% of *Allentown*

participants had an annual household income under $10,000 compared to only 7% of *Blackrock* participants. *Allentown* women were also more likely to be mothers: 80% of *Allentown* participants reported having children as opposed to only 46.15% of participants from *Blackrock*.

Participants in both census tracts reported having at least one primary sexual partner in the past three months; "primary sex partners" were defined as male partners with whom the participant has an emotional bond with, and with whom they have regular sex (Table 2). A higher percentage of participants from *Allentown* than *Blackrock* reported having a male partner who paid them for sex in the past three months (20% versus 7.69% respectively). In the main, participants from *Allentown* reported having riskier sexual partners (e.g. higher number of sexual partners with a history of incarceration, sexual partners who paid for sex) than participants from *Blackrock,* however, a higher percentage of women from *Blackrock* reported having sex with one partner while in a sexual relationship with someone else (i.e., concurrent partnerships) (Table 2).

Overview of Findings. We identified three major pathways through which male incarceration rates and sex ratios contribute to HIV and STI risk: from women's perspectives, high incarceration rates and low sex ratios 1) reduced the number of available, desirable male partners, 2) impacted the structure and purpose of partnerships, and 3) influenced the risk characteristics of male sexual partners (Figure 1). We also identified another aspect of the social environment that contributed to low local sex ratios and sexual risk: local marriage rates. Each of these pathways will be described in detail below. We first characterize participants' perceptions of male incarceration rates and local sex ratios, partner

desirability, and the availability of desirable male partners. Next, we present findings about the processes through which male incarceration rates and low sex ratios impact the nature and structure of partnerships and contribute to sexual risk.

Characterizing Male Incarceration. Consistent with data from the GA DOC, all 20 *Allentown* participants reported that a large number of local men were incarcerated. One *Allentown* resident said:

> *I mean, they lock 'em [men in the neighborhood] up, every day, all day over here. (Allentown resident aged 38 years)*

Allentown participants' understanding of high local rates of male incarceration was complex. They recognized the influences of individual-level (e.g. criminal activity), community-level (e.g. pervasive police presence), and societal-level factors (e.g. lack of economic opportunities) in shaping these rates. Participants first recognized the high prevalence of drug-related crimes and of violent crimes occurring in their neighborhood.

> *There's a lot of men getting locked up from around here for killing somebody or whatever that's the only reason I can think of. Killing somebody or robbing somebody, or beating somebody or anything. In this neighborhood anyway. (Allentown resident aged 38 years)*

Although the participants widely recognized that the neighborhood was crime-ridden, participants in *Allentown* believed that due to the constant police presence it was easy for men in the neighborhood to be detained or arrested for any illegal activity. A quote from one participant describes the link between the constant police presence and the ease with which men were arrested:

The police are out here 24/7. So it's easy to get caught doing anything wrong in this neighborhood. (Allentown resident aged 19 years)

Additionally, police frequently detained individuals for engaging in their daily activities (e.g. standing on the corner, walking down a street):

Just by you being in this neighborhood, sometimes you don't have to do things-police can just mess with you just for walking down the street sometimes and it's like, "Why you walking down on my street?" It's like, "Because I live in this neighborhood." I mean, I can't take a walk down here or take a walk down there? (Allentown resident aged 37 years)

Lastly, nearly all participants described the lack of economic opportunities as a factor leading men in the neighborhood to commit crimes. The lack of job opportunities was believed to be a consequence of both the economic downturn and employment restrictions against individuals with a criminal background. Many men were believed to commit crimes to augment income earned from low-wage positions. Other men were believed to intentionally commit crimes in order to be incarcerated and have direct access to basic necessities including food and shelter. As one participant said about this scenario:

You know and then some of them don't have nowhere to go so they are getting locked up just to eat or you know have somewhere to sleep. (*Allentown* resident aged 39 years)

Participants stated that in addition to having large numbers of men in the neighborhood behind bars at any given time, men were also likely to be incarcerated repeatedly. Having a history of incarceration limited men from finding legal employment

opportunities, and instead they would continue engaging in activities that led to their initial incarceration. *Allentown* is located in an urban area within walking distance to a local jail, a factor that contributed to the number of men in the neighborhood with a criminal record. Recently released men who had nowhere to go, or who lacked the financial resources to return to their own neighborhoods, could walk very easily to this neighborhood. As a result, many of these men ended up getting "stuck" and either temporarily or permanently residing in the neighborhood. Many formerly incarcerated men were thought to resume the criminal activities that originally led to their incarceration. Recidivating was believed to be such a common occurrence that one participant reported that men in the neighborhood sometimes referred to their periods of incarceration as "vacation."

Despite having lower rates of incarceration, roughly half of the participants from *Blackrock* felt that a large number of men from their neighborhood were incarcerated. Similar to *Allentown,* participants in *Blackrock* perceived local rates of male incarceration to be the result of overly-aggressive law enforcement practices and crimes being committed due to a lack of economic opportunity. Unlike *Allentown*, however, the types of crimes committed in *Blackrock* were largely described as non-violent. The remaining *Blackrock* participants believed that few men were incarcerated in their neighborhood. These women described men in their neighborhood as hardworking men who were gainfully employed or who would seek out legal employment opportunities. Said one participant:

> *Most of the men over here are working men, so far that I see, a class of working men. They're not like street thugs or anything like that. So most of them that I do see are men that work. They get up and try to have,*

any, even if they don't have a job they make a job. I notice that they cut grass, they find things to do. (Blackrock resident age 38 years)

There were subtle differences between Blackrock participants who believed there to be lower rates of male incarceration and Blackrock participants who believed their local rates of male incarceration to be high. Some of the women who believed that incarceration rates were low had lived in the neighborhood for several years and felt that local male incarceration rates had dropped significantly over the past few years. One participant describes the differences in local male incarceration in the neighborhood over time by stating:

Back in the 90's and early 2000's it was a lot of guys getting locked up because it was a lot of drugs going on, you know. But it's piped down. It's not as, it's not bad like it used to be. (Blackrock resident aged 31 years).

The majority of women who believed incarceration rates to be lower, however, moved to the area from a neighborhood where crime and incarceration rates were higher than in the neighborhood where they currently lived.

Perceptions of local sex ratios. The majority of women from *Allentown* believed that there were more women than men living in the neighborhood. Incarceration and death were two central factors described as contributing to low sex ratios. Participants almost exclusively linked the lack of men in the neighborhood to these two factors. One participant explained local sex ratios in the following way:

A lot of men are in jail or dead, so, you know, it's definitely a lot, a lot of women and not enough men. (Allentown resident aged 31 years)

A small minority of women, however, felt that men were physically available in their neighborhood, though rates of local male incarceration were high. These participants felt that men constantly cycled in and out of their neighborhood from jail or prison, resulting in a constant, albeit variable, source of available male partners. One participant noted that:

> *I mean it's like some go in and some get out [of jail]. So it is like always a balance (Allentown resident age 24 years).*

The majority of women from *Blackrock* described the sex ratio in their neighborhood as either being equitable or as having more women than men. Women who perceived their neighborhoods to have more women then men, however, seemed to largely base their perception of local sex ratios on their understanding or knowledge of sex ratios within Atlanta and Georgia more broadly, instead of their perception of the sex ratio in their neighborhood. Women in this subset identified more mechanisms through which they identified potential male partners, including looking outside of their neighborhood, than women who perceived sex ratios to be equitable or to have more men than women. Even participants who believed there to be a more equitable sex ratio often reflected on city and state level sex ratios when asked about sex ratios within their neighborhood.

> *I've always heard that. That's the old saying that the ratio of women to men is greater [in Georgia]. It's more women than there is men. But if I just do a, you know, a scan of just a parking lot or, you know, a store in the mall, it seems to balance out to me. (Blackrock resident aged 30 years)*

With the exception of one participant, participants from *Blackrock* who perceived there to be a low local sex ratio were similar to those from *Allentown;* they cited male incarceration as one of the biggest contributing factors to low local sex ratios. Only one additional factor was described by *Blackrock* participants as contributing to the local sex ratio: the presence of publicly-subsidized housing, which participants believed increased the number of women living in the neighborhood.

Perceptions of "desirability" and the availability of desirable male partners. Regardless of their perception of the local sex ratio, women in *Allentown* largely agreed that available men were undesirable. Participants defined undesirable men as men who were unemployed or unmotivated to work, immature, not interested in a committed romantic relationship, or who were physically, verbally, or sexually abusive. Describing her perception of local sex ratios and the desirability of available men one participant commented:

> *You don't see a lot of men, and the ones you do is not that good of a man. (Allentown resident aged 26 years)*

Notably, one characteristic that was not viewed as a deterrent for women in *Allentown* was having a history of incarceration. Many participants felt that because so many men had criminal histories (a "record") that if they wanted any type of romantic or sexual relationship that they could not exclude men with a history of incarceration. Furthermore, because of the high prevalence of local male incarceration, some women automatically assumed that men (living in and outside of the neighborhood) would have a record. A participant highlighted this sentiment:

> *Cuz 95% of mens have been to jail, you know, once or twice. They say they haven't, I know they lying… I think most men in general have been either to jail or prison.(Allentown resident aged 32 years)*

Women in *Allentown,* however, did perceive low local male to female sex ratios to have a greater impact on the availability of certain groups of men. Specifically, women described a paucity of *desirable* available men *in their age range*. Overwhelmingly women felt that available men in the neighborhood were too young (18 to 22 years old) or too old (45 years or older).

> *I don't see a lot of women finding a man like in my age range around here really. Like I said, it might be one out of fifty or something. (Allentown resident aged 37 years)*

Younger men were generally perceived as being undesirable because they were involved in criminal and violent behavior. In addition, younger men were not desirable as romantic or sexual partners because they were perceived to be selfish: they were more likely to look out for their own interests instead of the interests of their partner or the partnership more generally. Due to this perception, many women sought out older romantic and sexual partners. There were many reasons that women gave for seeking out older sexual partners, including the fact that older men had "no drama, no none of that." Specifically, these men were viewed as being financially stable, interested in a monogamous romantic partnership, and more understanding. One participant described her

own and other local women's interest in dating an older man as opposed to a younger man when noting:

> *Older dudes they understand women, young boys they don't…Sexually, moneywise, you know business wise, talking to it, like feelings and all they know how to treat a woman. A young person they wouldn't know what to do with a woman because they don't have that much experience with a woman. (Allentown resident aged 19 years)*

While older men were generally sought out as romantic partners some women believed that they were not as readily available as younger men. Specifically women believed that older men lived on the periphery of the neighborhood (as defined by the participant); where they were thought to have moved to avoid interaction and conflict with younger men. One participant said,

> *I mean, but you do find some older men, but like I said, they're like on the outskirts of [Street Name]…Because some older people like that don't like to be around young kids…[they] distance theyself away from some of the young boys that live out here, because, you know, sometimes [the young boys are] ignorant, you can say something or you cannot go along with something that they don't want you to go along with, they get mad, they get a attitude, they want to curse you. (Allentown resident aged 37 years)*

Although most Allentown participants described older men as living in the periphery of the neighborhood, a participant's age influenced her perception of whether older men were available for romantic partnerships with them. Older men were perceived to only make themselves readily available as romantic partners to younger

women living in the neighborhood. Partnerships between older men and younger women were viewed as fulfilling a specific purpose for both partners. For young women, the older men provided financial stability and material support; for older men, young women provided sexual activity. Current and recent partnerships among many of the older participants reflected this trend. Over half reported being in a current or recent relationship with an older (by 10 or more years) male partner that they began while in their early 20s or teenage years.

There were three additional factors frequently cited by women in *Allentown* as contributing to a reduction in the number of desirable available male partners: local rates of HIV and other STIs, men engaging in concurrent and multiple partnerships, and men engaging in same-sex sexual behavior. Women in *Allentown* believed that there was a high prevalence of HIV and other STIs locally. Due to this perception, many women would actively seek partners out who did not live in the neighborhood:

> *…I would not dare [date someone from the neighborhood]. Uh-uh…not trying to catch no disease. (Allentown resident aged 19 years)*

Many participants believed that the high neighborhood rates of HIV and other STIs were in part caused by men engaging in multiple and concurrent (or overlapping) sexual partnerships, another factor contributing to a reduction in the number of desirable available male partners. Participants from *Allentown* described an environment where men frequently engaged in multiple concurrent partnerships:

> *There is a lot going on out here. I'd rather be safe than sorry. STDs you know with men not being able to be faithful and want to sleep with more than one woman. (Allentown resident aged 37 years)*

Finally, many women in *Allentown* discussed the occurrence of men engaging in same-sex relationships that they felt contributed to a reduced number of desirable available male partners. In some cases participants felt that some younger men engaged in transactional same-sex relationships with older men living in the neighborhood for the same reasons that older male partners were desirable to women: they were thought to be in a stable financial position and have more disposable income. A small group of women described previous sexual partners engaging in same-sex relationships during their relationship. One of these participants believed her partner's same sex behavior began during a period of incarceration and continued when he returned to the neighborhood. Due to these experiences, women were hesitant to engage in sexual relationships with men from the neighborhood. One participant said,

> *[Men engaging in same-sex relationships] is just a common thing in this area. Like the younger guys are getting caught up in it because the homosexual is usually the one that has the money and they are willing a lot of the younger guys in like a couple of my friends not telling people but we know what's going on. It is common and happening in the neighborhood." (Allentown resident aged 22 years)*

Regardless of their perception of local sex ratios, women in *Blackrock* were similar to women in *Allentown* in their perception of the availability of *desirable* men for sexual or romantic partnerships. Women in this census tract described men who were available for partnerships locally as being of a lower quality than they were interested in. The characteristics that made men undesirable to women in *Allentown* were echoed by women in *Blackrock*:

> *I think that, this area is kind of, is kind of really limited to, I guess you could say a quality type guys. They just don't live in this area. You really have to go outwards to find somebody. They just aren't in this area. (Blackrock resident aged 30 years)*

Women in *Blackrock* differed from women in *Allentown,* however, with regards to their perception of the factors that reduced the number of *desirable* available male sexual partners. Regardless of their view of local sex ratios, all women in *Blackrock* referenced the number of married men living in their neighborhood as reducing the number of single and desirable men available for romantic or sexual partnerships. One woman's comments summarized common perceptions of local marriage rates:

> *Well for me, just looking around, a lot of guys in this area who… are already married and so of course, that's out…The kind of guy that I think that I would like…you know they kind of already married. (Blackrock resident aged 30 years)*

Outside of local marriage rates, there were a myriad of factors cited by women in *Blackrock* as contributing to reducing the number of *desirable* available male partners, however, there was little consensus about the main issues. Much like participants from *Allentown*, some participants in *Blackrock* believed that there were men in the neighborhood engaging in same-sex sexual behavior, a behavior that women perceived to have begun during periods of incarceration. An additional factor, unique to women living in *Blackrock*, was the perception that the racial/ethnic segregation of the neighborhood reduced the number of desirable available male partners. Some women believed that because

the residents of their neighborhood were predominantly Black and that other racial ethnic groups tended to "stay in their separated area" that they had limited access to desirable available men of other racial/ethnic backgrounds, limiting their overall pool of male partners. Some of the remaining factors that women highlighted included: the number of incarcerated men and the lack of places in the neighborhood to interact with men.

Perceptions of partnership characteristics. In *Allentown,* male incarceration and the availability of desirable male partners influenced the structure and type of romantic and sexual partnerships that participants sought out, experienced, and witnessed. While a history of incarceration was not exactly considered to be undesirable it seemed to influence the type of relationship that women were interested in with that partner. For example, one participant would not rule out dating a man with a record, but would not pursue a serious relationship with such a man. This participant went on to state that if she were looking for a stable partnership it would not be with anyone with a record, due to a fear that he may still be involved in activities that lead to his initial incarceration. She describes this by stating:

> *[His incarceration history] was what kept me from getting serious with him because he tends to have patterns to where he makes dumb decisions to end right back up prison. So I can handle jail maybe, but when you keep going in and out of prison for long periods of time, I'm not too big on that.(Allentown resident aged 19 years)*

For the most part, relationships with men with a criminal background seemed to be characterized as short, based primarily on sexual activity, and often overlapped with other sexual partnerships that the man might be engaged in. These relationships, however, occurred in an environment where individuals engaging in multiple or overlapping relationships was a regular occurrence. Women described sexual relationships in the neighborhood as a "spider web," or a network of interrelated and overlapping sexual connections. Local rates of male incarceration were believed to influence concurrency by destabilizing existing sexual partnerships, referred to as "foundation relationships." In a partner's absence women were thought to seek out additional sexual or romantic partners.

> *[Women] don't necessarily want to stick to one man or be faithful to one man, so if you [a male partner] go to jail you're going to move on to the next one. (Allentown resident aged 26 years)*

The exceptions to this were women whose partners were incarcerated briefly for minor violations (e.g., driving without a license). The burden that this period of incarceration placed on the relationship was chiefly financial (e.g., paying bail) and did not contribute to a substantial disruption in the nature or structure of the relationship. Longer periods of incarceration, however, were frequently cited as a contributing factor to a male partner's interest in engaging in multiple sexual partnerships upon his release. Said one participant of her relationship with a man who recently served four years:

> *[His incarceration] kind of had an impact on why our relationship didn't last long. Because he had just spent the last four years in prison so now he has his freedom to do what he wants to do [sexually]. (Allentown resident aged 26 years)*

Participants believed that it was common for women in *Allentown* to engage in transactional sex relationships (or to exchange sex for financial or material support) when their romantic partners were incarcerated. These relationships were thought to provide much-needed financial and material support when a primary male partner was absent. Money earned from these exchanges was sometimes used to defray the costs associated with a partner's incarceration. Summarizing these costs one 21-year old participant revealed "Yeah, it [incarceration] costs me money. Lawyers, bonds, books, phones." Transactional sex exchanges were also viewed as a mechanism through which women could obtain "fast" cash, allowing them to provide largely uninterrupted care for their children without incurring the additional childcare expense. Describing the relationship between local male incarceration rates and women engaging in transactional sex relationships one participant stated:

> *Well, the man in jail, that's why the womens out here are prostituting. All this and that. Cuz the man in jail, they can't do nothing…And they have so many children, they don't have no money to pay no babysitter so they got to make some money to better provide for them (Allentown resident aged 32 years)*

There were other scenarios where women reported engaging in transactional sex relationships. For women with partners with a criminal record but who are not currently incarcerated, income from transactional sex relationships was necessary to help provide financial stability for their household. A lack of employment opportunities for women and the employment restrictions against individuals with a criminal background (their male partners) contributed to a situation where women felt that if they "can't get no job, I might as well use what I got."

Participants viewed transactional sex relationships as a mechanism through which women in their neighborhood met future romantic partners. For example, when participants were asked how women in their neighborhood met new romantic partners several participants responded by stating women were "tricking off." After engaging in transactional sex relationships with men, these relationships often transitioned into primary romantic relationships. One of the consequences of the seemingly high prevalence of women engaging in transactional sex relationships in *Allentown* was the perception that this contributed to the high neighborhood prevalence of STIs and HIV (described above).

> *Some men have the diseases…Because some men will go out there and pay for it [sex], which is most definitely why diseases will come back. (Allentown resident aged 21 years)*

In *Blackrock,* the structure and type of romantic and sexual partnerships that women sought out, experienced, and witnessed were also influenced by the local availability of desirable male partners. The one factor that all participants from *Blackrock* agreed influenced the number of available desirable male partners in the neighborhood was local marriage rates. While a man's marital status influence a participant's romantic interest (or lack thereof) in him, it did not seem to deter some married men from pursuing romantic relationships with women in their neighborhood. Moreover, participants felt that some married men did not try to hide their marital status from the women they pursued. Instead they would approach single women and offer to support them materially or financially in exchange for a romantic or sexual relationship. One woman described her experience being approached by a married man:

I've had married men approach me and it's disheartening, you know. If you decide to get married, obviously it doesn't mean anything anymore to be married and be faithful to that one person…Yeah, [when he approach me] he was up front with it…You know… "I'm married but I'll take care of you". What? What? I was like "No thank you." Yeah. That was someone that goes to church with me. (Blackrock resident aged 36 years)

For women living in *Blackrock* the major consequence of the paucity of desirable available male partners was that several women described engaging in multiple long-term concurrent relationships. For these women each long-term partner seemed to serve a specific purpose or fill a unique role (e.g. providing love, financial support, or sex) that a single male partner was unable to provide alone. *Blackrock* participants described vacillating between partners seemingly trying to identify which partner's "purpose" served her needs more.

I started cheating on him. I got me another boyfriend or another dude I was messing with. I was dating him, was dating both of them at the same time like [the] same day sometimes. It would be just, I was there with him because he's faithful but …I was seeking other options. (Blackrock resident aged 30)

Discussion

Emerging research suggests that people living in communities with high rates of incarceration are at a higher risk of having HIV or other STIs (Thomas 2005, Thomas 2006, Thomas 2007), but the exact pathways through which incarceration and sex ratios contribute to HIV and STI risk have not been fully

explored. This qualitative study explored how male incarceration rates and resulting sex ratio imbalances impacted the nature and structure of sexual relationships to create conditions that increase the risk of HIV/STI transmission. Our findings support and extend previous research on incarceration rates, sex ratios and heterosexual Black women's sexual risk for HIV and other STIs (Adimora, Schoenbach et al. 2001, Ferguson 2007, Thomas 2007, Khan, Wohl et al. 2008, Khan 2009, Adimora 2013).

Participants discussed the impact that male incarceration rates and male shortage had on the number and *desirability* of available male partners in their neighborhood. While past research has highlighted the impact that male incarceration has on the number of partners available for Black women and how male shortage shapes sexual risk (e.g. higher number of sex partners, (Pouget 2010, Green 2012, Knittel 2013) multiple and concurrent partnerships (Adimora, Schoenbach et al. 2001, Ferguson 2007, Adimora 2013)), the perceived desirability of available partners has been absent from this discussion. Specifically, participants highlighted the paucity of available, desirable men in their age range, resulting in many women reporting relationships with men ten or more years older than them. Sexual relationships with older male partners may place younger women at risk of HIV and STI infection because these partners are more likely to be infected themselves or because of resulting power imbalances which can impact sexual decision-making (Aral 1996, Adimora and Schoenbach 2002). Moreover, in the absence of men who were worthy of a long-term or committed partnership, women discussed seeking out less desirable men for short-term partnerships; these partnerships were focused on sexual activity and

were often with partners believed to have higher sexual risk (e.g. men engaged in multiple or overlapping partnerships).

Transactional sex relationships are associated with lower rates of condom use (Dunkle 2004, Luke 2006, Dunkle 2010) and an increased number of sexual partners (Dunkle 2010) which significantly contribute to a women's risk of acquiring HIV (Dunkle 2004, Luke 2006, Poulin 2007, Swindler 2007). Our findings illuminate two pathways through which incarceration influenced women's reliance on transactional sex relationships. First, male incarceration disrupted the economic stability of a household by removing a male partner who was providing material or financial support (Cooper 2013). Second, once released from incarceration having a criminal record served as a barrier to employment opportunities for many of the participants' partners. Women engaged in transactional sex relationships during periods where their partner was absent or during periods where their partner was un- or underemployed. Most studies exploring transactional sex relationships and sexual risk have been conducted in international settings (Dunkle 2004, Luke 2006, Poulin 2007, Swindler 2007) or nationally among substance-using women (McMahon 2006, Davey-Rothwell 2008), however, we identified one recent study examining the prevalence of transactional sex among women in the general population of the U.S. (Dunkle 2010). In this study, Dunkle et al. found that Black women were more likely than White women to report starting a relationship due to economic considerations and initiating transactional sex with someone who was not a regular partner (Dunkle 2010). Transactional sex with non-regular partners was associated with concurrent partnerships, substance use, and having high-risk sexual partners. To

better understand racial/ethnic disparities in rates of HIV and other STIs, future research should focus on economically motivated sexual relationships among Black women in the US, specifically among women living in communities disproportionately impacted by incarceration.

We also found that local marriage rates influenced the perceived desirability of available male partners in *Blackrock*, the tract with a low incarceration rate and equitable sex ratio. As a result, several participants in *Blackrock* reported engaging in multiple long-term concurrent partnerships due to their inability to identify one male partner to fulfill all of their needs. Our findings are echoed in previous research, which suggests that women may be motivated to participate in concurrent partnerships because different sexual partners fulfilled different roles (Carey 2010, Nunn, Dickman et al. 2011). Although the majority of research exploring the context and motivations for partner concurrency has focused on the experiences of heterosexual men (Carey 2010, Nunn, Dickman et al. 2011), we identified one study that explored partner concurrency among adults recruited from an urban STD clinic (Senn, Scott-Sheldon et al. 2011). The results suggest that there is some overlap in the reasons men and women give for engaging in concurrent partnerships, including the need for different partners to fulfill different needs. Situations where people seek out additional partners because of a perceived deficiency in one or more of their current partners has been termed by Gorbach et al. (2002) as “compensatory concurrency.” Our findings suggest that similar motivations for engaging in concurrent partnerships may exist for heterosexual Black women in areas where desirable men are believed to be less available.

Our finding that local marriage rates influenced the number of available male partners for women living in *Blackrock* is particularly important given how sex ratios are currently conceptualized and calculated. In research examining racial HIV/STI disparities, sex ratios (a proxy for the number of available male and female partners) are typically measured by dividing the size of the male population of a geographic level of interest (e.g. block group, tract) by the size of the corresponding female population (Senn, Carey et al. 2010, Green 2012, Adimora 2013). Recently, some empirical studies have altered their calculations to exclude incarcerated individuals from measures of the sex ratio (Pouget 2010, Cooper 2014). Our work advances previous research by suggesting that local marriage rates should be considered when assessing the number of available men to the number of available women.

One natural extension of this research that the present analysis was unable to explore was how male shortage influences gender-based relationship power and sexual decision-making among women living in communities disproportionately affected by incarceration. It has been posited that low sex ratios (created in part by incarceration) make it difficult for women to negotiate condom use with male sexual partners because they fear losing the partner to another woman (Adimora and Schoenbach 2002, Logan, Cole et al. 2002, Adimora 2005, Adimora 2006, Adimora, Schoenbach et al. 2007, Harawa 2008, Khan 2009). We were only able to identify one qualitative study confirming these hypotheses (Ferguson 2007), and this study was conducted in an environment where sex ratios were not shaped by local incarceration rates. Further research into the role that low sex ratios shaped by incarceration have on sexual

relationship power and decision-making is needed to better understand racial disparities in rates of HIV and other STIs. Future analyses published from our qualitative sample will explore this topic.

Limitations. Our findings should be understood in the context of several study limitations. First, the boundaries and scales of census tracts might not accurately reflect how people experience or perceive their neighborhood. Census tracts are used frequently in studies examining reproductive, sexual, and other health outcomes at the neighborhood level (Anderson 1996, O'Campo 1997, Culhane J.F. & Elo 2005, Apparicio 2008, Gindi 2011). Second, while every attempt was made to select two census tracts from the urban core, we were unable to identify a census tract in the urban core with a low male incarceration rate, a male: female sex ratio close to 1.00, and a high proportion of Black residents. The difficulty in identifying this type of census tract highlights the racialization of incarceration in the U.S.. As a result, *Blackrock* was located outside of the urban core. Our findings therefore could be a reflection of the different perceptions that women living within and those living outside of the urban core may have of sex ratios, partner availability, and romantic relationships instead of a product of their perceptions of local incarceration rates and sex ratios. Further, administratively-defined boundaries may be less relevant in suburban settings because living outside the urban core may be accompanied by greater mobility (e.g. access to transportation) outside of the neighborhood boundaries.

This study also had several strengths. A rigorous examination of negative cases helped to refine our interpretations and member checks were used to solicit

feedback about our study's findings. Further, we sought variation by tract-level rates of male incarceration and sex ratios, allowing for the contrast and comparison of research findings across census tracts. Finally, we were able to reach saturation of key analytic themes and our findings support previous research examining the consequences of incarceration and low sex ratios on sexual risk behavior.

Conclusions

To our knowledge, this is the first study to provide an in-depth examination of the processes through which low sex ratios and high male incarceration rates influence partner availability, and the nature and structure of partnerships from the perspective of heterosexual Black women. This study describes how male incarceration and sex ratios influence partner availability and the nature and structure of sexual relationships to favor the transmission of HIV and other STIs. HIV and STI prevention efforts focusing on heterosexual Black women should consider the role of local incarceration rates, marriage rates and resulting sex ratio imbalances.

Racial disparities exist in law enforcement, conviction and sentencing; Black men receive a disproportionate number of convictions and harsher sentences than their White counterparts. Efforts should be made to create and implement more equitable enforcement, conviction and sentencing practices. Such changes could have important implications on the composition of sexual networks and sexual behaviors that promote the transmission of HIV and other STIs. Additionally, creating a more stable economic environment could minimize

the number of economically motivated relationships in communities disproportionately impacted by incarceration.

Table 2.1. Sociodemographic characteristics of the two census tracts located in the Atlanta, GA Metropolitan Statistical Area (MSA) from which participants were sampled

	"Allentown"	"Blackrock"	Atlanta MSA
Characteristics			
Male:female sex ratio (for individuals 18 years and over)	0.70	0.96	0.92
Male Incarceration Rate (per 100 men 15 to 64 years old)	12	0.89	0.43
Percent of residents who are non-Hispanic Black/ African-American	99.3%	96.0%	33.2%
Median Age	45.0	30.7	34.7
Percent of residents living in poverty	37.2%	7.6%	13.5%
Median household income	$19,529	$69,387	$57,783

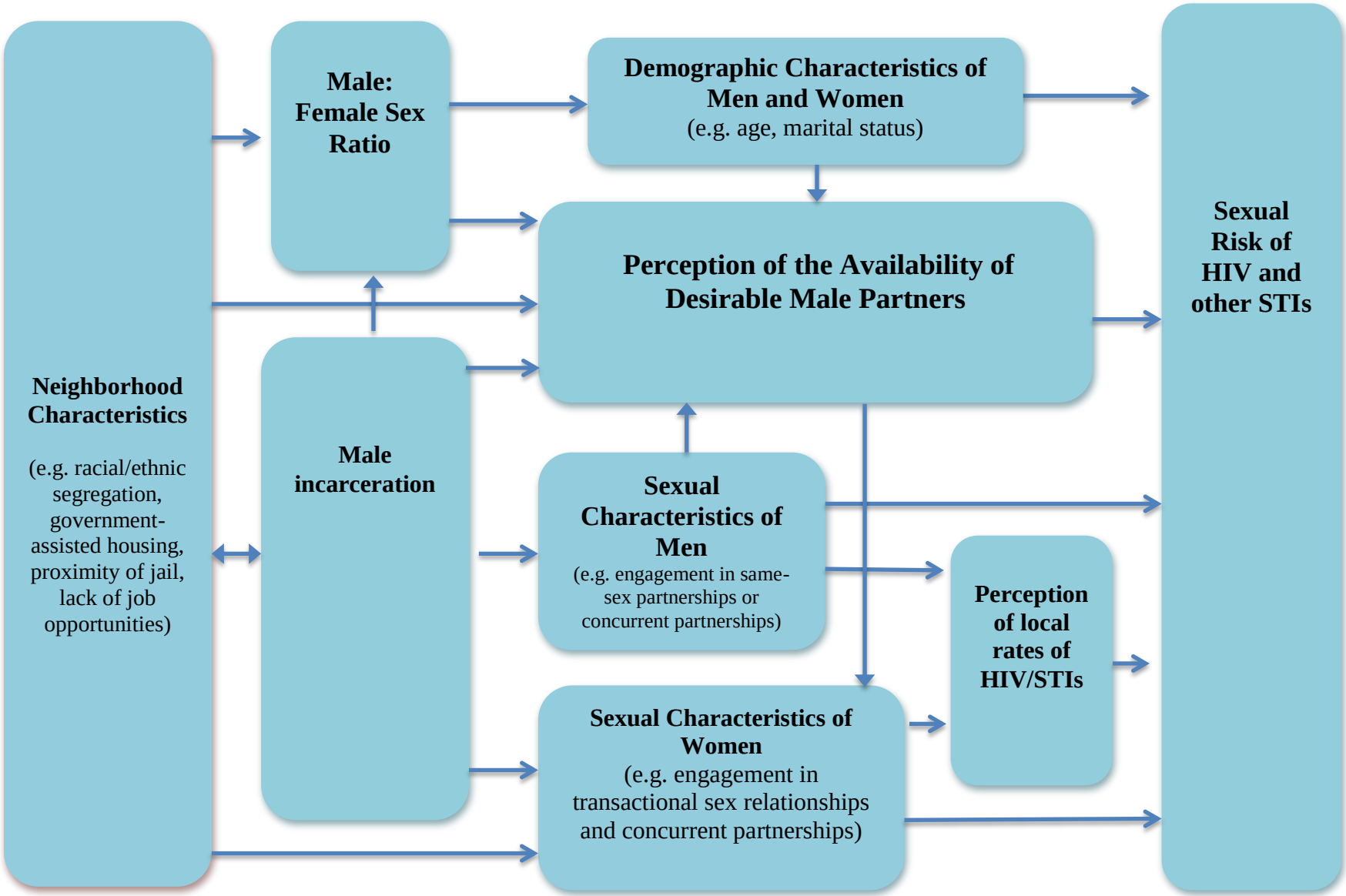
Source: U.S. Census Bureau, 2007-2011 American Community Survey; Georgia Department of Corrections, 2009.

Table 2.2. Sociodemographic and sexual risk characteristics of study participants sampled from two census tracts located in the Atlanta, GA Metropolitan Statistical Area (N=33)

	Allentown (n=20)	***Blackrock*** (n=13)
Characteristics	**Median (range) or n (%)**	
Median Age (years)	30.5 (19-39)	30 (18-39)
Education Level		
Less than high school	7 (35.00%)	---
High school diploma/ GED	8 (40.00%)	3 (23.08%)
Some college/Associate Degree/Trade School	4 (20.00%)	7 (53.85%)
Bachelor Degree/Any Graduate Education	1 (5.00%)	3 (23.08%)
Annual Household Income		
$0 to $9,999	15 (78.95%)*	1 (7.69%)
$10,000 to $19,999	1 (5.26%)*	6 (46.15%)
$20,000 to $29,999	3 (15.79%)*	3 (23.08%)
$30,000 or up	---	3 (23.08%)
Number of Children		
0	4 (20.00%)	7 (53.85%)
1-2	8 (40.00%)	3 (23.08%)
3-4	3 (15.00%)	2 (15.38%)
≥5	5 (25.00%)	1 (7.69%)
Percentage of respondents who reported having a sexual partner in the last three months, by partner type		
Primary	20 (100.00%)	13 (100.00%)
Casual	3 (15.00%)	4 (30.77%)
Paying	4 (20.00%)	1(7.69%)
Number of male sexual partners in the last twelve months	2 (1-10)	2 (1-3)
Partner concurrency		
Yes	4 (20.00%)	4 (30.77%)
Had a sex partner(s) in the last six months, who was ≥5 years older		
Yes	17 (89.47%)*	5 (38.46%)**
Sexual partner who was ever incarcerated		
Yes	16 (80.00%)	7 (53.85%)
Sexual partner who was incarcerated during their relationship		
Yes	11 (55.00%)	4 (30.77%)
Sexual partner who is currently incarcerated		
Yes	3 (15.00%)	2 (15.38%)

Note: *n=19; ** n=13.

Figure 2.1: Processes through which male incarceration and sex ratios influence sexual risk of heterosexual Black women in two Atlanta census tracts: one with high rates of male incarceration and an imbalanced sex ratio (*Allentown*) and one with a lower rate of male incarceration and a sex ratio close to 1.0 (*Blackrock*).



References

Adimora, A. A., & Schoenbach, V. J. (2002). Contextual factors and the black-white disparity in heterosexual HIV transmission. *Epidemiology, 13*(6), 707-712. doi: 10.1097/01.EDE.0000024139.60291.08

Adimora, A. A., Schoenbach, V. J., & Doherty, I. A. (2007). Concurrent sexual partnerships among men in the United States. *Am J Public Health, 97*(12), 2230-2237. doi: 10.2105/AJPH.2006.099069

Adimora, A. A., Schoenbach, V. J., Martinson, F. E., Donaldson, K. H., Fullilove, R. E., & Aral, S. O. (2001). Social context of sexual relationships among rural African Americans. *Sex Transm Dis, 28*(2), 69-76.

Adimora, A. A., SChoenbach, V.J. . (2005). Social context, sexual networks and racial disparities in rates of sexually transmitted infections. *Journal of Infectious Disease, 291*, S115-S122.

Adimora, A. A., Schoenbach, V.J., Doherty, I.A. (2006). HIV and African Americans in the southern United States: sexual networks and social context. *Sexually Transmitted Diseases, 33*(7 Suppl), S39-45.

Adimora, A. A., Schoenbach, V.J., Taylor, E.M., Khan, M.R., Schwartz, R.J., Miller, W.C. (2013). Sex ratio, poverty and concurrent partnerships among men and women in the United States: a multilevel analysis. *Annals of Epidemiology, 23*(11), 716-719.

Albert, D. P., Gesler, W.M., Levergood, B. (Ed.). (2000). *Spatial Analysis, GIS and Remote Sensing Applications in the Health Sciences*. Chelsea, MI: Ann Arbor Press.

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

Apparicio, P., Abdelmajid,M., Riva, M., Shearmur, R. (2008). Comparing alternative approaches to measuring the geographical accessibility of urban health services:

Distance types and aggregation-error issues. *International Journal of Health Geographics, 7*(7).

Aral, S. O. (1999). Sexual patterns as determinants of STD rates: paradigm shift in the behavioral epidemiology of STDs made visible. *Sexually Transmitted Diseases, 26*, 262-264.

Aral, S. O., Holmes, K.K., Padian, N.S., Cates, W. . (1996). Overview: individual and population approaches to the epidemiology and prevention of sexually transmitted diseases and human immunodeficiency virus infection. *Journal of Infectious Disease, 174*(2), S127-S133.

Carey, M. P., Senn, T.E., Seward, D.X., Vanable, P.A. (2010). Urban African-American Men Speak Out on Sexual Partner Concurrency: Findings from a Qualitative Study. *AIDS Behaivor, 14*, 38-47.

Carson, E. A., Sabol, W.J. (2012). *Prisoners in 2011*. (NCJ 239808). Retrieved from http://www.doc.wa.gov/aboutdoc/measuresstatistics/docs/BJSReport.Prisonersin2011.pdf.

Centers for Disease Control and Prevention. (2010a). Health Disparities in HIV/AIDS, Viral Hepatitis, STDs, and TB: African Americans/ Blacks. Retrieved December 1, 2010, from http://www.cdc.gov/nchhstp/healthdisparities/AfricanAmericans.html

Centers for Disease Control and Prevention. (2010b). HIV among African Americans. Retrieved December 1, 2010, from http://www.cdc.gov/hiv/topics/aa/index.htm

Centers for Disease Control and Prevention. (2010c). Sexually Transmitted Diseases and Health Disparities. Retrieved December 19,, 2010, from http://www.cdc.gov/std/health-disparities/race.htm

Centers for Disease Control and Prevention. (2014). HIV among Women. Retrieved March 31, 2014, from http://www.cdc.gov/hiv/risk/gender/women/facts/index.html

Cooper, H. L. F., Clark, C.D., Barham, T., Embry, V., Caruso, B., Comfort, M. (2013). "He Was the Story of My Drug Use Life" : A Longitudinal Qualitative Study of the Impact of Partner Incarceration on Substance Misuse Patterns Among African American Women. *Substance Use and Misuse, 49*(1-2), 176-188.

Cooper, H. L. F., Haley, D.F., Kelley, M.E., Karnes, C.C., Ross, Z., Hunter-Jones, J., Linton, S., Dauria, E.F., Adimora, A., Wingood, G., Rothenberg, R., Bonney, L.E. (2014). *Public Housing Relocations and Sexual Health: Do Changes in Neighborhood Characteristics Predict Sexual Risk Behaviors among Relocating Adults*.

Crosby, R. A., DiClemente, R.J., Salazar, L.F. (Ed.). (2006). *Research Methods in Health Promotion* (First ed.). San Francisco Jossey-Bass.

Culhane J.F. & Elo, I. T. (2005). Neighborhood context and reproductive health. *American Journal of Obstetrics and Gynecology, 192*, SS22-29.

Davey-Rothwell, M., Villarroel, M.A., Grieb, S.D., Latkin, C.A. (2013). Norms, attitudes, and sex behaviors among women with incarcerated main partners. *Journal of Urban Health, 90*(6), 1151-1165.

Davey-Rothwell, M. A., Latkin, C.A. (2008). An examination of perceived norms and exchanging sex for money or drugs among women injectors in Baltimore, MD, USA. *INternational Journal of STD and AIDS, 19*(1), 47-50.

Dunkle, K. L., Jewkes, R.K., Brown, H.C., Gray, G.E., McIntyre, J.A., Harlow, S.D. (2004). Transactional sex among women in Soweto, South Africa: prevalence, risk factors and association with HIV infection. *Social Science and Medicine, 59*, 1581-1592.

Dunkle, K. L., Wingood, G.M., Camp, C.M., DiClemente, R.J. (2010). Economically motivated relationships and transactional sex among unmarried African American and white women: results from a U.S. national telephone survey. *Public Health Reports, 125*(Suppl 4), 90-100.

Ferguson, Y. O., Quinn, S.C., Sandelowski, M. (2007). The gender ratio imbalance and its relationship to risk of HIV/AIDS among African American women at historically black colleges and universities. *AIDS Care, 18*(4), 323-331.

Gindi, R. M., Sifakis, F., Sherman, S.G., Towe, V.L., Flynn, C., Zenilman, J.M. (2011). The Geography of Heterosexual Partnerships in Baltimore City Adults. *Sexually Transmitted Diseases, 38*(4), 260-266.

Golledge, R. G., Stimson, R.J.,. (1987). *Analytical Behavioural Geography*. New York: Croom Helm.

Gorbach, P. M., Stoner, B.P., Aral, S.O., Whittington, W.L.H., Holmes, K.K. (2002). "It takes a village": Understanding concurrent sexual partnerships in Seattle, Washington. *Sexually Transmitted Diseases, 29*(453-462).

Green, T. C., Pouget, E.R., Harrington, M., Taxman, F.S., Rhodes, A.G., O'Connell, D., Martin, S.S., Prendergast, M., Friedmann, P.D. (2012). Limiting Options: Sex ratios, incarceration rates and sexual risk behavior among people on probation and parole. *Sexually Transmitted Diseases, 39*(6), 424-430.

Harawa, N. A., A. (2008). Incarceration, African Americans and HIV: advancing a research agenda. *Journal of the National Medical Association, 100*(1), 57-62.

Kelly, L. (2007). Lesbian Body Image Perceptions: The Context of Body Silence. *Qualitative Health Research, 17*, 873.

Khan, M. R., Doherty, I.A., Schoenbach, V.J., Taylor, E.M., Epperson, M.W., Adimora, A.A. (2009). Incarceration and high-risk sex partnerships among men in the United States. *Journal of Urban Health, 86*(4), 584-601.

Khan, M. R., Wohl, D. A., Weir, S. S., Adimora, A. A., Moseley, C., Norcott, K., . . . Miller, W. C. (2008). Incarceration and risky sexual partnerships in a southern US city. *J Urban Health, 85*(1), 100-113. doi: 10.1007/s11524-007-9237-8

Knittel, A. K., Snow, R.C., Griffith, D.M., Morenoff, J. (2013). Incarceration and sexual risk: Examining the relationship between men's involvement in the criminal justice system and risky sexual behavior. *AIDS Behavior, 17*, 2703-2714.

Logan, T. K., Cole, J., & Leukefeld, C. (2002). Women, sex, and HIV: social and contextual factors, meta-analysis of published interventions, and implications for practice and research. *Psychol Bull, 128*(6), 851-885.

Luke, N. (2006). Exchange and condom use in informal sexual relationships in urban Kenya. *Econ Dev Cult Change, 54*, 319-348.

Marshall, M. N. (1996). Sampling for qualitative research. *Family Practice, 13*(6), 522-525.

Maxwell, J. A. (1996). *Qualitative research design: an interactive approach*. Thousand Oaks: Sage Publications Inc.

McMahon, J. M., Tortu, S., Pouget, E.R., Hamid, R., Neaigus, A. (2006). Contextual determinants of condom use among female sex exchangers in East Harlem, NYC: an event analysis. *AIDS Behavior, 10*(6), 731-741.

Nunn, A., Dickman, S., Cornwall, A., Rosengard, C., Kwakwa, H., Kim, D., . . . Mayer, K. H. (2011). Social, structural and behavioral drivers of concurrent partnerships among African American men in Philadelphia. *AIDS Care, 23*(11), 1392-1399. doi: 10.1080/09540121.2011.565030

O'Campo, P., Xue, X., Wang, M-C., Caughy, M.O. (1997). Neighborhood risk factors for low birth weight in Baltimore: a multi-level analysis. *American Journal of Public Health, 87*, 1113-1118.

Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods* (Third Edition ed.). London: Sage Publications, Inc.

Pouget, E. R., Kershaw, T.S., Niccolai, L.M., Ickovics, J.R., Blankenship, K.M. (2010). Associations of sex ratios and male incarceration rates with multiple opposite-sex partners: potential social determinants of HIV/STI transmission. *Public Health Report, 125*(Suppl 4), 70-80.

Poulin, M. (2007). Sex, money, and premarital partnerships in southern Malawi. *Social Science and Medicine, 65*(11), 2383-2393.

Senn, T. E., Carey, M. P., Vanable, P. A., Urban, M. A., & Sliwinski, M. J. (2010). The male-to-female ratio and multiple sexual partners: multilevel analysis with patients from an STD clinic. *AIDS Behav, 14*(4), 942-948. doi: 10.1007/s10461-008-9405-1

Senn, T. E., Scott-Sheldon, L. A., Seward, D. X., Wright, E. M., & Carey, M. P. (2011). Sexual partner concurrency of urban male and female STD clinic patients: a qualitative study. *Arch Sex Behav, 40*(4), 775-784. doi: 10.1007/s10508-010-9688-y

Strauss, A., Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* (Second ed.). Thousand Oaks, CA: Sage.

Swindler, A., Watkins, S.C. (2007). Ties of dependence: AIDS and transactional sex in rural Malawi. *Studies in Family Planning, 38*(3), 147-162.

The Sentencing Project. (2010). Incarceration in the United States. Retrieved June 26, 2013, from http://www.sentencingproject.org/template/page.cfm?id=107

Thomas, J. C., Levandowski, B.A., Isler, M.R., Torrone, E., Wilson, G. (2007). Incarceration and Sexually Transmitted Infections: A Neighborhood Perspective. *Journal of Urban Health, 85*(1), 90-99.

Thomas, J. C., Sampson, L.A. . (2005). High rates of incarceration as a social force associated with community rates of sexually transmitted infection. *Journal of Infectious Disease, 191*(Suppl 1), S55-60.

Thomas, J. C., Torrone, E. . (2006). Incarceration as forced migration: Effects on selected community health outcomes. *American Journal of Public Health, 96*(10), 1762-1765.

U.S. Census Bureau. (2005-2009). American Community Survey, 5-Year Estimates. Retrieved December 10, 2010, from http://www.census.gov/acs/www/

United States Census Bureau. (2005-2009). American Community Survey, 5-Year Estimates. Retrieved December 10, 2010, from http://www.census.gov/acs/www/

United States Census Bureau. (2007-2011a). American Community Survey 5-Year Estimates: B01001B: Sex by Age (Black or African American Alone) Retrieved September 1, 2013, from http://factfinder2.census.gov

United States Census Bureau. (2007-2011b). American Community Survey 5-Year Estimates: DP03: Selected Economic Characteristics. Retrieved September 1, 2013, from http://factfinder2.census.gov

United States Census Bureau. (2007-2011c). American Community Survey 5-Year Estimates: S0101: Age and Sex. Retrieved September 1, 2013, from http://factfinder2.census.gov

United States Census Bureau. (2007-2011d). American Community Survey 5-Year Estimates: S1701: Poverty Status in the Past Months. Retrieved September 1, 2013, from http://factfinder2.census.gov

VERBI Software. (2013). MAXQDA, software for qualitative data analysis, 1989-2013. Berlin, Germany.

Chapter 3:

Male Incarceration Rates and the Prevalence of Sexually Transmitted Infections: Results from a Longitudinal Analysis in a South-Eastern City

Abstract

Introduction. In the United States (US), rates of certain sexually transmitted infections (STIs) are increasing. Social and contextual factors appear to play an important role in the shaping STI transmission dynamics. The goal of this study was to explore the longitudinal relationship between one contextual determinant of health, the local rate of male incarceration, and the prevalence of newly-diagnosed STIs at the census-tract level in the Atlanta Metropolitan Statistical Area (MSA).

Methods. The study sample consisted of all census tracts in Atlanta. We analyzed STI surveillance, male incarceration and decennial census data for the years 2005 through 2010. Multivariate growth models were used to examine the association between the rate of male incarceration and the prevalence of newly-diagnosed STIs, controlling for covariates.

Results. Census tracts with higher baseline rates of male incarceration had a higher baseline prevalence of newly-diagnosed STIs. Census tracts with increasing rates of male incarceration experienced a more rapid increase in their prevalence of newly-diagnosed STIs. Census tracts with higher baseline rates of male incarceration did not have a faster increase in their prevalence of newly-diagnosed STIs. Instead, census tracts with medium and high baseline rates of

male incarceration experienced a *decrease* in their prevalence of newly-diagnosed STIs over time.

Conclusions. The present study strengthens the evidence that rates of male incarceration have negative consequences on sexual health outcomes, however, the relationship may be more nuanced than originally thought. Future multilevel research should explore individual sexual risk behaviors in the context of high rates of male incarceration to better understand how male incarceration shapes rates of STIs.

Introduction

In the United States (US), rates of certain sexually transmitted infections (STIs) are increasing (Centers for Disease Control and Prevention 2014). From 1992 to 2012, national rates of Chlamydia increased from 182.3 to 456.7 cases per 100,000 population (Centers for Disease Control and Prevention 2014). From 2009 to 2012, after a period when rates of gonorrhea were the lowest in recorded history, rates began gradually increasing from 98.1 to 107.5 cases per 100,000 population (Centers for Disease Control and Prevention 2014). A similar trend was also evident for syphilis (Centers for Disease Control and Prevention 2014). While individual sexual behaviors (e.g. number of sexual partners, concurrent sexual partnerships) (Morris 1995, Ghani 1997, Doherty 2006) may be able to explain some of the variation in national rates of STIs, contextual factors (e.g. residential segregation, economic oppression) have received significant attention for their contribution in explaining variations in sexual health outcomes (Stokols 1992, Fullilove 2006, Division of STD Prevention 2007).

It has been hypothesized that the relationship between rates of male incarceration and rates of STIs is very important and emerging existing studies support this hypothesis (Blankenship 2005, Golembeski 2005, Fullilove 2011, Adimora 2013). High incarceration rates in geographic areas can have devastating consequences on sexual networks (Harawa 2008, Herman-Stahl 2008, Laurencin 2008, Wyatt 2008, Alexander 2010) by altering the size and composition of sexual networks in ways that accelerate the spread of STIs. First, by removing a large number of men from a neighborhood, high rates of incarceration can disrupt existing sexual partnerships (Hagan 1999, Thomas 2007, Khan 2011, Cooper 2013, Dauria 2014). Partners left behind may engage in high-risk sexual relationships (e.g. transactional sex partnerships, concurrent partnership) to fulfill financial, emotional or sexual needs.(Adimora, Schoenbach et al. 2003, Thomas 2007, Cooper 2013, Dauria 2014). Additionally, during

periods of incarceration men may engage in same-sex sexual behavior that increase their risk of STI transmission (i.e. unprotected anal sex) (Herman-Stahl 2008, Thomas 2008). Finally, recently-released men may resume old sexual partnerships while also forming new ones (Adimora, Schoenbach et al. 2003, Thomas 2008). Collectively, these factors may help explain mechanisms through which high rates of male incarceration may contribute to national rates of STIs.

Research examining the relationship between incarceration rates and STI prevalence and incidence remains a relatively new area of inquiry (Thomas 2005, Thomas 2006, Thomas 2007). Initial studies examining the relationship between rates of incarceration and rates of STIs found a positive correlation between incarceration rates and STI prevalence in the general population (Thomas 2005, Thomas 2006, Thomas 2007). Most of the studies on incarceration rates and STIs however, have been cross-sectional (Thomas 2005, Thomas 2006), and are therefore unable to establish a causal relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs. The studies also focused on county-level associations (Thomas 2005, Thomas 2006). Researchers have utilized different administrative units (i.e. zip codes, census tracts and counties) to understand the influence of neighborhood-level characteristics on health outcomes (O'Campo 2003, Osypuk 2007). Thus far associations have been identified at the county-level, and rates of male incarceration and the prevalence of newly-diagnosed STIs may vary too much within counties to best understand the nature of their association (O'Campo 2003). Given that individuals tend to select romantic and sexual partners from the neighborhoods in which they live (Aral 1999, Adimora 2006, Adimora, Schoenbach et al. 2007), a smaller

geographic unit (e.g. census tracts) may be better suited to examine this relationship over time (Osypuk 2007, Gindi 2011). Lastly, because these studies examined incarceration rates among men and women combined, they are unable to determine the true relationship between rates of male incarceration and sexual health outcomes (Thomas 2005, Thomas 2006, Thomas 2007).

The present longitudinal study aims to examine the relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs in census tracts in Atlanta, Georgia, over time. We hypothesize that 1) at baseline, census tracts with higher rates of male incarceration will have a higher prevalence of newly-diagnosed STIs, 2) the prevalence of newly-diagnosed STIs will increase at a faster rate over time in census tracts with higher baseline rates of male incarceration than census tracts with lower baseline rates of male incarceration and 3) census tracts where male incarceration rates are increasing at a faster rate will experience a more rapid increase in the prevalence of newly-diagnosed STIs.

Methods

This study's sample consists of the universe of census tracts in the 28-county Atlanta Metropolitan Statistical Area (MSA) (n=946). Census tracts have between 2,500 and 8,000 residents (Stokols 1996) and are used frequently in studies examining reproductive, sexual, and other health outcomes at the neighborhood level (Anderson 1996, O'Campo 1997, Culhane J.F. & Elo 2005, Apparicio 2008). All data were analyzed at the census tract level, for the years 2005 through 2010.

Measures.

Our primary dependent variable was the annual prevalence of newly-diagnosed cases of Chlamydia, gonorrhea, and primary stage syphilis in each census tract in the Atlanta MSA in 2005 through 2010. Annual STI surveillance data were obtained from

Georgia's Department of Community Health. Case counts of newly-diagnosed STIs were suppressed for census tracts with less than five cases. To reduce the number of tracts with suppressed data, tract-level counts of the three STIs of interest (Chlamydia, gonorrhea and primary-stage syphilis) were aggregated to create a single measure of newly-diagnosed STIs. To calculate an annual prevalence of newly-diagnoses cases of STIs, we divided the aggregate number of STI cases reported in each census tract by the adult population (aged 18-59) of the census tract, and multiplied by 1,000 (Thomas 2007). Annual rates were calculated for each year from 2005 to 2010.

The rate of male incarceration in each census tract was our independent variable of interest. We obtained records for each male entering prison in the Atlanta MSA for the years 2005 through 2010 (n=167,605) from the Georgia Department of Corrections (GA DOC). Information included the street address, county of residence, date of birth, race/ethnicity, and date of entry and date of release from prison. Addresses in the database were the "last known address" as reported by each inmate at the time of their admission. Each address was geocoded to a corresponding census tract in ArcGIS (ESRI 2013). Unmatched addresses were geocoded a second time using Google Earth Pro (Google Inc. 2013). Using ArcGIS and Google Earth Pro, 82.60% (n=138,443) of the addresses were matched with 70-100% accuracy; 17.40% (n=29,162) remained unmatched. Unmatched addresses were largely the result of blank or missing address information. Once assigned to a census tract, male incarceration rates for each year and tract were calculated by dividing the mean number of incarcerated men by the tract's adult male (aged 18-64) population, multiplied by 1,000 (Thomas 2007). Annual rates were calculated for each year from 2005 to 2010.

We considered the following variables for inclusion in adjusted models as possible confounders: tract-level percent of residents who identified as non-Hispanic Black/ African American, percent unemployed, percent of residents living in poverty (as

defined by the Census Bureau) (U.S. Census Bureau 2013), percent of residents who are married, and the percent of residents aged 26 or older who had a high school diploma as their highest educational attainment. Due to the changes in tract-level boundaries from 2000 to 2010 we used the Longitudinal Tract Data Base (LTDB) (Logan 2012), which provides a public-use database that creates estimates from 2010 tract-boundaries for tract-level data for 2000. From this database we used 2000 and 2010 decennial data and interpolated values for 2005 through 2009 assuming linear change over time.

Analysis

Univariate analyses were used to summarize the characteristics of the tracts. Hierarchical linear modeling was used to test our hypothesis that male incarceration rates were positively related to rates of newly-diagnosed STIs over time. First we fit an unconditional means model to describe how much census tracts vary in their mean prevalence of newly-diagnosed STIs. Based on the covariance estimates, we calculated the intraclass correlation (ICC). Next, we tested for heteroscedastic errors and used the likelihood ratio test to evaluate model fit. We fit an unconditional growth model (allowing for heteroscedastic error variances) to determine whether the prevalence of newly-diagnosed STIs changed systematically over time. We then added rate of male incarceration, a time varying predictor, into the model to predict change in the prevalence of newly-diagnosed STIs over time. Bivariate analyses were used to determine associations between covariates and the prevalence of newly-diagnosed STIs. The rate of male incarceration (and all other continuous predictor variables) was centered at its baseline value to facilitate interpretation. The next model introduced interaction terms between time and change in rate of male incarceration. Lastly, we built and tested a multivariate model to test the hypothesis that census tracts with a higher rate of male incarceration and a large increase from their baseline rate of incarceration have higher

and increasing prevalence of newly-diagnosed STIs, controlling for covariates identified as significant ($p < 0.05$) in bivariate analyses.

To examine whether census tracts with a high baseline rate of male incarceration and census tracts with a larger change from their baseline rate of male incarceration have a higher and faster increase in their prevalence of newly-diagnosed STIs than census tracts with a lower baseline rate of male incarceration and a smaller change from their baseline rate of male incarceration, we tested the regression of the prevalence of newly-diagnosed STIs on time at low, medium, and high values of baseline rate of male incarceration and change in the rate of male incarceration from baseline. We defined high/large, medium, and small/low as one standard deviation above the mean, at the mean and one standard deviation below the mean of the baseline rate of male incarceration and change in rate of male incarceration from baseline, respectively. Next, we conducted a sensitivity analysis to determine whether our results were robust across models where values for tract-level suppressed STI case counts were set to missing, and where suppressed values were set to the minimum and maximum possible values (0 and 4 respectively) (Pannell 1997). To address issues of multicollinearity, we examined variance inflation factors (VIFs) and removed variables with VIFs >4. We reran the model with and without these variables to ensure that the strength and direction of the main effects of rates of male incarceration and the prevalence of newly-diagnosed STIs did not change.. Finally, we conducted regression diagnostics to identify possible influential outliers, including visually examining diagnostic plots of residuals and studentized residuals. Models were run with and without outliers to ensure that associations identified in the full model remained. Estimation was done using maximum likelihood. Analyses were conducted in SAS version 9.3 (Cary, N.C.).

Ethics

Emory University's Institutional Review Board approved all study protocols and the Georgia Department of Community Health approved the use of STI data.

Results

Table 1 shows the sociodemographic characteristics of all census tracts in the Atlanta MSA (n=946). There was a lot of variation in the covariates at baseline, however, there was little change over time. For example, at baseline the average percent of residents who are non-Hispanic Black/ African was 32.26 and the standard deviation was 30.48 and the average percent of adults whose highest degree is a high school diploma or less was 40.88 (SD =18.57) but these means remained largely unchanged over time. At baseline, the average tract-level rate of male incarceration was 2.77 per 1,000 adult men. Rates of male incarceration varied throughout the study period, with the largest increase occurred between the years 2009 and 2010 (from 2.69 to 4.38 per 1,000 adult men). At baseline, average rates of newly-diagnosed STIs varied across census tracts (SD=11.36). Rates of newly-diagnosed STIs increased from their lowest point in 2005 (10.74 per 1,000 adults) until 2007 when they decreased (from 13.28 to 12.14 per 1,000 adults) until 2009 when they increased again slightly to 12.18 (per 1,000 adults).

Table 2 presents the results of fitting a taxonomy of multilevel models for change on the prevalence of newly-diagnosed STIs over time (*Models A-C)*. The unconditional means model (*Model A*) suggests that the average prevalence of newly-diagnosed STIs was 12.51 (per 1,000 adults) between the years 2005 and 2010; this value is statistically different from zero ($p < 0.0001$). The ICC implies

that 74.69% of the total variation observed in the prevalence of newly-diagnosed STI is due to between-tract differences.

Next, we fit an unconditional growth model to examine whether the prevalence of newly-diagnosed STIs changed systematically over time (*Model B*). The fixed effects indicate that there is a significant model implied initial value of newly-diagnosed prevalence of STIs of 13.31 per 1,000 adults and, taking the exponent of the log transformation of time, a significant mean curvilinear slope (γ_{01}=0.53).

Model C explores the unadjusted relationship of rates of male incarceration and the prevalence of newly-diagnosed STIs over time. Estimation of the parameter estimates show that rate of male incarceration at baseline, change from baseline in rate of male incarceration (also referred to as the change score [CS] from baseline), and both interaction terms are significant. Examining the main effects and interaction term for baseline rate of male incarceration suggest that at baseline, census tracts with higher rates of male incarceration have a higher prevalence of newly-diagnosed STIs (γ_{20}=0.53, p<0.001). The relationship between baseline rate of male incarceration and the prevalence of newly-diagnosed STIs decreased approximately 0.91 (p=0.04) each year. The main effects and interaction term for change from baseline rate of male incarceration reveal that census tracts that have increasing rates of incarceration have a lower prevalence of newly-diagnosed STIs at baseline (γ_{30}= -0.43, p=0.03) however, the magnitude of the inverse relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs attenuates over time.

Bivariate associations between covariates and the prevalence of newly-diagnosed STIs were explored (Table 3) and all statistically significant covariates were tested individually in *Model C* (*Models D* through *H*) (Table 4). Each of the potential confounders was statistically significant and included in the final model (*Model I)* (Table 5).

Table 5 presents the final adjusted model, *Model I*. Census tracts that have increasing rates of incarceration have a lower prevalence of newly-diagnosed STIs at baseline (γ_{30}= -0.74, p<0.0001). Unlike the unadjusted model (*Model C*, Table 2), there was no significant association identified between the interaction of baseline rate of male incarceration and log(time) (p= 0.17). In order to examine the nature of the interaction we tested the regression of the prevalence of newly-diagnosed STIs on time at low, medium, and high values of baseline rate of male incarceration (Figure 1A). The intercepts and slopes for the trajectories of the prevalence of newly-diagnosed STIs differ as a function of baseline rate of male incarceration. The intercepts and slopes for low baseline rate of male incarceration are not statistically significant (p=0.47) (data not shown). For medium baseline rates of male incarceration, the slope has a significant but negative value, such that the prevalence of newly-diagnosed STIs significantly decreased by 0.79 (per 1,000 adults) each year from 2005 to 2010 (p=0.0019). For high baseline rates of male incarceration, the slope has a significant but negative value such that in census tracts with high baseline rates of male incarceration, the prevalence of newly-diagnosed STIs significantly decreases by 0.94 (per 1,000 adults) each year from 2005 to 2010 (p=0.0005).

In *Model I*, the significant interaction between change from baseline rate of male incarceration and log(time) suggests that over time, for every one-unit increase in change from baseline rates of male incarceration the prevalence of newly-diagnosed STIs increased approximately 0.53, when adjusting for covariates ($p < 0.0001$) (Table 5). The parameter estimate for the main effect of baseline rate of male incarceration decreased but remained significant ($\gamma_{20}=0.53$, $p<0.001$). Figure 1b explores the nature of the interaction between change from baseline rate of male incarceration and the prevalence of newly-diagnosed STIs. Notably, the slope of the trajectory of census-tracts with a slight change from baseline rate is significant ($p=0.0002$)(data not shown). Census tracts that experience a small change from baseline in their rate of male incarceration had a model-implied baseline prevalence of 2.70 newly-diagnosed STIs per 1,000 adults (*n.s.*) that decreased 1.46 each year from 2005 to 2010. The slope of the trajectory in census-tracts with a medium change from baseline in rate of male incarceration is significant ($p=0.05$) however, the slope of the trajectory is not significantly different in tracts that experience a large change in rate of male incarceration from baseline ($p=0.5449$).

The final moderation model (adjusted for covariates) was rerun with values imputed for the minimum and maximum possible values (0 and 4 respectively) for census tracts with suppressed data on the prevalence of newly-diagnosed STIs. Final results from the sensitivity analysis reveal that imputing both minimum and maximum values for the prevalence of newly-diagnosed STIs for census tracts with suppressed data had no significant effect on the final model (data not shown).

Discussion

The goal of this study was to explore the longitudinal relationship between one contextual determinant of health, the local rate of male incarceration, and the prevalence of newly-diagnosed STIs at the census-tract level in the Atlanta MSA. Findings from the adjusted model support our hypotheses that census tracts with higher baseline rates of male incarceration had a higher prevalence of newly-diagnosed STIs and that census tracts with increasing rates of male incarceration will experiences a more rapid increase in the prevalence of newly-diagnosed STIs. Census tracts with a less rapid change from their baseline rate of male incarceration have a prevalence of newly-diagnosed STIs that decreased over time. Finally, our analyses do not support our hypothesis that census tracts with a higher baseline rate of incarceration will experience a faster increase in the prevalence of newly-diagnosed STIs than census tracts with lower baseline rates of male incarceration. In fact, our findings suggest that census tracts with medium and high baseline rates of male incarceration experience a *decrease* in their prevalence of newly-diagnosed STIs over time.

Our findings support and extend previous research on incarceration rates and STIs (Thomas 2005, Thomas 2007, Thomas 2008). To our knowledge, only one previous study has examined the longitudinal relationship of incarceration rates with STIs. Thomas et al. (Thomas 2006) calculated age-adjusted correlation coefficients between county-level rates of incarceration in a given-year and STIs one and two years later. The investigators found that rates of Chlamydia and gonorrhea consistently increased with increasing incarceration rates. The present study extends this line of research by establishing a longitudinal relationship

between tract-level rates of male incarceration and the prevalence of newly-diagnosed STIs. Recent studies have illuminated possible mechanisms through which high rates of male incarceration influences rates of STIs (Thomas 2008, Pouget 2010, Dauria 2014). These studies suggest that high incarceration rates and the resulting shortage of males are associated with having a larger number of sexual partners (Pouget 2010, Green 2012, Knittel 2013), overlapping (or concurrent) partnerships (Thomas 2007, Khan, Wohl et al. 2008, Khan 2009), engaging in transactional sex relationships (Dauria 2014) and a greater risk of having unprotected sex with a risky partner (Khan 2009, Green 2012).

In the present study, census tracts with medium and high baseline rates of male incarceration experienced a decrease in their prevalence of newly-diagnosed STIs over time. One possible explanation for this result is that in having a high rate of male incarceration a large number of high-risk male partners are being forcibly removed from their neighborhood's sexual network. Compared to individuals who have not been incarcerated, incarcerated individuals have more risk factors associated with acquiring and transmitting STIs including commercial sex work and injection drug use and other drug use (Epperson 2008, Khan 2009, Farel 2013, centers for Disease Control and Prevention 2014). Further, rates of STIs and HIV are much more prevalent among correctional inmates than in the total US population (Hammett 2002, National Commission on Correctional Health Care 2002). It follows then, that the removal of high-risk or infectious men from a neighborhood might lessen transmission in that census tract.

Due to the amount of suppressed STI surveillance data, we were unable to examine racial/ethnic differences in the association between rates of male incarceration and the prevalence of newly-diagnosed STIs. Given that Black adults are imprisoned at a higher rate than members of other racial/ethnic groups, male incarceration may help explain national racial/ethnic disparities in STIs (Carson 2012). In 2011, Black adults represented roughly 13% of the national population (Rastogi 2011), however, they accounted for approximately 38% of prisoners under state and federal jurisdiction (Carson 2012). Black men and women have the highest rates of STIs of all racial/ethnic groups in the U.S. In 2012, the prevalence of gonorrhea among Black adults was 14.9 times that of White adults, the prevalence of Chlamydia was 6.8 times that of White adults, and the prevalence of primary and secondary syphilis was 6.1 times that of Whites (Centers for Disease Control and Prevention 2014). Future research should focus on the longitudinal relationship between rates of male incarceration on the prevalence of newly-diagnosed STIs among Black adults specifically to better understand racial disparities in sexual health outcomes.

This study has several limitations. First, there has been some debate about the use of census tracts to estimate the scale and boundaries of neighborhoods (Sampson 2002, O'Campo 2003), however, census tracts are used frequently in studies examining reproductive, sexual, and other health outcomes at the neighborhood level (Anderson 1996, O'Campo 1997, Culhane J.F. & Elo 2005, Apparicio 2008). Second, our findings are based on addresses provided by inmates and may not be an accurate representation of where an offender actually lived at the time of his incarceration. This problem is amplified by conducting

analyses at the census-tract level because even small errors in an address can lead to tract-level misclassification. There is no reason however, to suspect that any misclassifications would be the result of nonrandom error. Finally, given that the present study has an ecologic design, we were unable to explore how individual-level factors influence our study outcomes.

Despite these limitations, the present study strengthens the evidence that rates of male incarceration have negative consequences on sexual health outcomes, however, the relationship may be more nuanced than originally thought. Future multilevel research should explore individual sexual risk behaviors in the context of high rates of male incarceration to better understand the processes through which male incarceration shapes rates of STIs. Findings from these studies could be used to help identify geographic areas where prevention programs and interventions may be most needed.

Table 3.1. Distributions of census tract level characteristics in the Atlanta Metropolitan Statistical Area (MSA), 2005 - 2010 (N=946).

	2005	2006	2007	2008	2009	2010
Characteristics of census tracts	**Mean (SD)**					
% residents who are non-Hispanic Black/ African American	32.26 (30.48)	32.73 (30.43)	33.17 (30.42)	33.59 (30.43)	33.98 (30.46)	34.23 (30.45)
% living in poverty	12.35 (10.63)	12.73 (10.86)	13.12 (11.13)	13.51 (11.45)	13.90 (11.81)	14.29 (12.21)
% unemployed	7.69 (5.38)	8.07 (5.22)	8.44 (5.12)	8.79 (5.12)	9.12 (5.24)	9.45 (5.52)
% of adults (≥ 25 years) whose highest degree is a high school diploma or less	40.88 (18.57)	40.62 (18.50)	40.38 (18.47)	40.15 (18.48)	39.92 (18.54)	39.70 (18.66)
% Married	50.91 (15.68)	50.43 (15.75)	49.95 (15.86)	49.47 (16.01)	49.00 (16.20)	48.52 (16.43)
Rate of Male Incarceration (per 1,000 men 18 to 64 years old)	2.77 (5.11)	2.69 (5.07)	2.78 (5.02)	2.41 (4.64)	2.69 (4.99)	4.38 (5.22)
Rate of newly-diagnosed STIs* (per 1,000 adults 18 to 64 years old)	10.74 (11.36)	13.21 (17.84)	13.28 (14.84)	12.38 (14.39)	12.14 (13.80)	12.18 (12.97)

**Note: Suppressed data were set to missing.*

Table 3.2. A taxonomy of hierarchical linear models examining the association between tract-level rate of male incarceration and the tract-level prevalence of newly-diagnosed STIs, Atlanta MSA, 2005 – 2010.

	Model A		Model B		Model C	
	Estimate	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
Intercept	12.51	1.12***	13.31	1.02***	8.15	1.10***
Main effects						
Log (Time)	---	---	-0.63	0.23**	-0.39	0.29
BL rate of male incarceration	---	---	---	---	1.83	0.19***
Rate of male incarceration CS	---	---	---	---	-0.44	0.20*
Interactions						
Log(Time) x BL rate of male incarceration	---	---	---	---	-0.09	0.04*
Log(Time) x Rate of male incarceration CS	---	---	---	---	0.30	0.14*

*$p < 0.05$, **$p < 0.01$, ***p< 0.001 . *Note:* BL= Baseline and CS= Change score from baseline.

Table 3.3. Pearson correlations between select covariates and the prevalence of newly-diagnosed STIs, by census tract, Atlanta MSA, 2005-2010.

	Prevalence of newly-diagnosed STIs (per 1,000 adults 18 to 64)	
2005	**N**	**r**
% of residents who are NH-Black	740	0.75***
% of adults (> 25 years) whose highest level of educational attainment is high school	740	0.40***
% Unemployed	740	0.64***
% Married	740	-0.67***
% living below poverty	740	0.70***
2006		
% of residents who are NH-Black	783	0.64***
% of adults (> 25 years) whose highest level of educational attainment is high school	783	0.35***
% Unemployed	783	0.55***
% Married	783	-0.59***
% living below poverty	783	0.63***
2007		
% of residents who are NH-Black	783	0.75***
% of adults (> 25 years) whose highest level of educational attainment is high school	783	0.39***
% Unemployed	783	0.62***
% Married	783	-0.66***
% living below poverty	783	0.65***
2008		
% of residents who are NH-Black	783	0.74***
% of adults (> 25 years) whose highest level of educational attainment is high school	783	0.38***
% Unemployed	783	0.62***
% Married	783	-0.66***
% living below poverty	783	0.66***
2009		
% of residents who are NH-Black	780	0.74***
% of adults (> 25 years) whose highest level of educational attainment is high school	780	0.35***
% Unemployed	780	0.61***
% Married	780	-0. 64***
% living below poverty	780	0.61***

2010		
% of residents who are NH-Black	783	0.81***
% of adults (> 25 years) whose highest level of educational attainment is high school	783	0.37***
% Unemployed	783	0.61***
% Married	783	-0.69***
% living below poverty	783	0.63***

*p < 0.05 , **p < 0.01 , ***p< 0.001 .

Table 3.4. Tract-level predictors of trajectories of the tract-level prevalence of newly-diagnosed STIs in multiple hierarchical linear regressions, Atlanta MSA, 2005 – 2010.

	Model D		Model E		Model F		Model G		Model H	
	Estimate	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
Intercept	2.03	0.56**	-0.18	1.38	28.43	1.14***	3.19	2.41	1.72	1.67
Main effects										
Log (Time)	-0.54	0.27*	-1.00	0.31**	-0.84	0.27**	-0.34	0.29	-0.53	0.30
BL rate of male incarceration	1.25	0.09***	0.62	0.22**	1.33	0.08***	1.62	0.20***	1.27	0.21***
Rate of male incarceration CS	-0.57	0.18**	-0.42	0.20*	-0.59	0.18**	-0.48	0.20*	-0.45	0.20*
Log(Time) x BL rate of male incarceration	0.11	0.04**	-0.04	0.05	-0.10	0.04*	-0.04	0.05	-0.09	0.04*
Log(Time) x Rate of male incarceration CS	0.42	0.13**	0.30	0.14*	0.45	0.12**	0.35	0.14*	0.31	0.14*
BL % living in poverty	0.55	0.03***		---	---	---	---	---	---	---
% living in poverty CS	0.08	0.07	---	---	---	---	---	---	---	---
BL % NH-Black	---	---	0.34	0.04***	---	---	---	---	---	---
% NH-Black CS	---	---	0.39	0.08***	---	---	---	---	---	---
BL % Married	---	---	---	---	-0.40	0.02***	---	---	---	---
% Married CS	---	---	---	---	-0.23	0.06***	---	---	---	---
BL % of adults (>25 years) whose highest level of educational attainment is high school	---	---	---	---	---	---	0.14	0.06*	---	---
% of adults (>25 years) whose highest level of educational attainment is high school CS	---	---	---	---	---	---	0.35	0.08***	---	---
BL % unemployed	---	---	---	---	---	---	---	---	1.01	0.20***
% Unemployed CS	---	---	---	---	---	---	---	---	0.17	0.08*

*$p < 0.05$, **$p < 0.01$, ***p< 0.001 . *Note:* BL= Baseline and CS= Change score from baseline.

Table 3.5. Adjusted hierarchical linear model examining the association between tract-level rate of male incarceration and the tract-level prevalence of newly-diagnosed STIs, Atlanta MSA, 2005 – 2010.

	Model I	
	Estimate	**SE**
Intercept	-1.31	1.62
Main effects		
Log (Time)	-0.18	0.35
BL rate of male incarceration	0.60	0.07***
Rate of male incarceration CS	-0.74	0.18***
BL % living in poverty	0.52	0.04***
% living in poverty CS	-0.52	0.09***
BL % NH-Black	0.21	0.01***
% NH-Black CS	0.19	0.07**
BL % Married	0.001	0.03
% Married CS	-0.01	0.09
BL % of adults (>25 years) whose highest level of educational attainment is high school	-0.05	0.02**
% of adults (>25 years) whose highest level of educational attainment is high school CS	0.13	0.07
BL % unemployed	0.03	0.06
% Unemployed CS	0.13	0.08
Interactions		
Log(Time) x BL rate of male incarceration	-0.07	0.05
Log(Time) x Rate of male incarceration CS	0.53	0.13***

*$p < 0.05$, **$p < 0.01$, ***p< 0.001 . *Note:* BL= Baseline and CS= Change score from baseline.

Figure 3.1. Line graphs examining the interaction between baseline rate of male incarceration and log(time) on the prevalence of newly-diagnosed STIs and the interaction between change from baseline rate of male incarceration and log (time) on prevalence of newly diagnosed STIs in the Atlanta MSA, 2005-2010.

Figure 3.1A. Line graph examining the interaction between baseline in rate of male incarceration and log (time) on the prevalence of newly-diagnosed STIs.

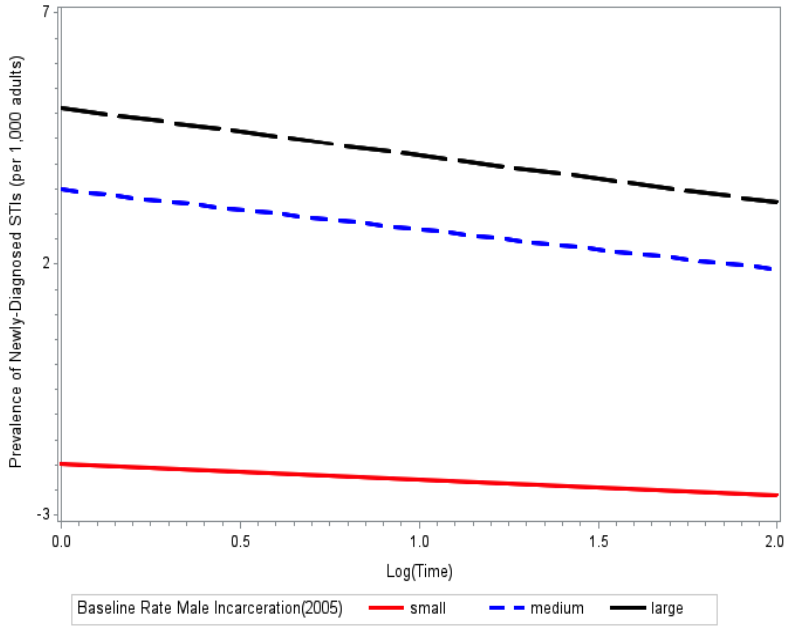
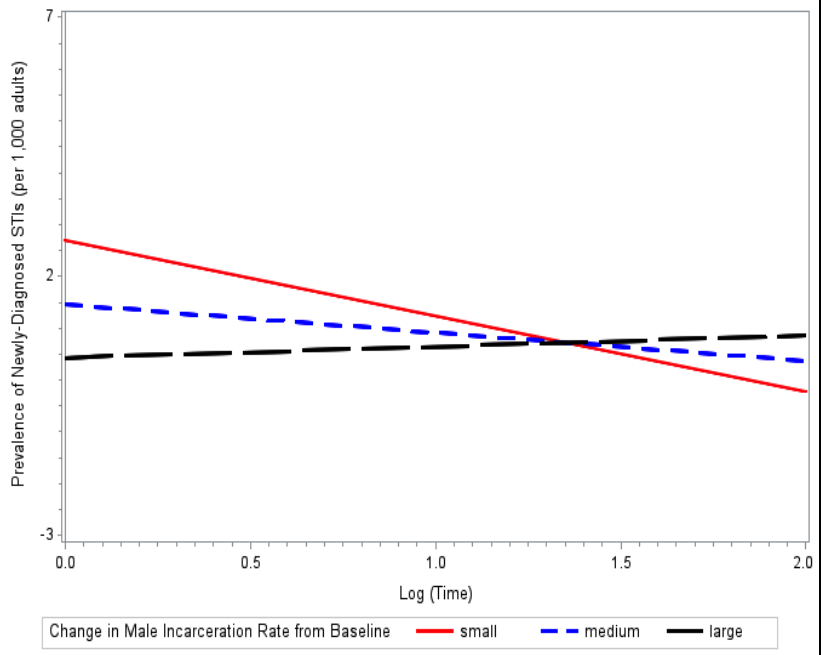


Figure 3.1B. Line graph examining the interaction between change in baseline rate of male incarceration and log (time) on the prevalence of newly-diagnosed STIs.



References

Adimora, A. A., Schoenbach, V. J., & Doherty, I. A. (2007). Concurrent sexual partnerships among men in the United States. *Am J Public Health, 97*(12), 2230-2237. doi: 10.2105/AJPH.2006.099069

Adimora, A. A., Schoenbach, V. J., Martinson, F. E., Donaldson, K. H., Stancil, T. R., & Fullilove, R. E. (2003). Concurrent partnerships among rural African Americans with recently reported heterosexually transmitted HIV infection. *J Acquir Immune Defic Syndr, 34*(4), 423-429.

Adimora, A. A., SChoenbach, V.J. . (2005). Social context, sexual networks and racial disparities in rates of sexually transmitted infections. *Journal of Infectious Disease, 291*, S115-S122.

Adimora, A. A., Schoenbach, V.J., Doherty, I.A. (2006). HIV and African Americans in the southern United States: sexual networks and social context. *Sexually Transmitted Diseases, 33*(7 Suppl), S39-45.

Adimora, A. A., Schoenbach, V.J., Taylor, E.M., Khan, M.R., Schwartz, R.J., Miller, W.C. (2013). Sex ratio, poverty and concurrent partnerships among men and women in the United States: a multilevel analysis. *Annals of Epidemiology, 23*(11), 716-719.

Alexander, M. (2010). *The New Jim Crow: Mass Incarceration*. New York: The New Press.

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

Apparicio, P., Abdelmajid,M., Riva, M., Shearmur, R. (2008). Comparing alternative approaches to measuring the geographical accessibility of urban health services: Distance types and aggregation-error issues. *International Journal of Health Geographics, 7*(7).

Aral, S. O. (1999). Sexual patterns as determinants of STD rates: paradigm shift in the behavioral epidemiology of STDs made visible. *Sexually Transmitted Diseases, 26*, 262-264.

Blankenship, K. M., Smoyer, A.B., Bray, S.J., Mattocks, K. (2005). Black-White Disparities in HIV/AIDS: The Role of Drug Policy and the Corrections System. *Journal of Health Care for the Poor and Underserved, 16*(4 Suppl B), 140-156.

Carson, E. A., Sabol, W.J. (2012). *Prisoners in 2011*. (NCJ 239808). Retrieved from http://www.doc.wa.gov/aboutdoc/measuresstatistics/docs/BJSReport.Prisonersin2011.pdf.

Centers for Disease Control and Prevention. (2014a). 2012 Sexually Transmitted Diseases Surveillance. Retrieved April 22,, 2014, from http://www.cdc.gov/std/stats12/minorities.htm

centers for Disease Control and Prevention. (2014b). HIV in Correctional Settings. Retrieved May 22, 2014, from http://www.cdc.gov/hiv/risk/other/correctional.html

Centers for Disease Control and Prevention. (2014c). *Sexually Transmitted Disease Surveillance 2012*. Atlanta, GA: Retrieved from http://www.cdc.gov/sTD/stats12/Surv2012.pdf.

Cooper, H. L. F., Clark, C.D., Barham, T., Embry, V., Caruso, B., Comfort, M. (2013). "He Was the Story of My Drug Use Life" : A Longitudinal Qualitative Study of the Impact of Partner Incarceration on Substance Misuse Patterns Among African American Women. *Substance Use and Misuse, 49*(1-2), 176-188.

Culhane J.F. & Elo, I. T. (2005). Neighborhood context and reproductive health. *American Journal of Obstetrics and Gynecology, 192*, SS22-29.

Dauria, E., Oakley, L., Arriola, K.J., Elifson, K., Cooper, H.L.F. (2014). Collateral Consequences: The implications of male incarceration rates. imbalanced sex ratios and partner availability among heterosexual Black women.

Division of STD Prevention. (2007). *Consultation to Address STD Disparities in African American Communities: Meeting Report*. Paper presented at the Consultation to Address STD Disparities in African American Communities:, Atlanta, GA.

Doherty, I. A., Shiboski, S., Ellen, J.M., ADimora, A.A., Padian, N.S. (2006). Sexually bridging socially and over time: A simulation model exploring the relative effects of mixing and concurrencfy on viral sexually transmitted infection transmission. *Sex Transm Dis, 33*, 368-373.

Epperson, M., El-Bassel, N., Gilbert, L., Orellana, E.R., Chang, M. (2008). Increased HIV risk associated with criminal justice involvement among men on methadone. *AIDS and Behavior, 12*, 51-57.

ESRI. (2013). ArcGIS Desktop: Release 10.1. Redlands, CA: Environmental Systems Research Institute,.

Farel, C. E., Parker, S.D., Muessig, K.E., Grodensky, C.A., Jones, C., Golin, C.E., Fogel, C.I., Wohl, D.A. (2013). Sexuality, sexual practices, and HIV risk among incarcerated African-American women in North Carolina. *Womens Health Issue, 23*(6), e357-364.

Fullilove, R. E. (2006). Health Disparities and HIV/AIDS: Recommendations for Confronting the Epidemic in Black America. Washington, D.C. : National Minority AIDS Council.

Fullilove, R. E. (2011). Mass Incaraceration in the United States and HIV/AIDS. *Ohio State Journal of Criminal Law, 9*(1), 353-361.

Ghani, A., Swinton, J., Garnett, G.P. (1997). The role of sexual partnership networks in the epidemiology of gonorrhea. *Sex Transm Dis, 24*, 45-56.

Gindi, R. M., Sifakis, F., Sherman, S.G., Towe, V.L., Flynn, C., Zenilman, J.M. (2011). The Geography of Heterosexual Partnerships in Baltimore City Adults. *Sexually Transmitted Diseases, 38*(4), 260-266.

Golembeski, C., Fullilove, R. (2005). Criminal (In)Justice in the City and Its Associated Health Consequences. *American Journal of Public Health, 95*, 1701-1706.

Google Inc. (2013). Google Earth Pro, Version 7.1.2.2041. Mountain View, CA: Google.

Green, T. C., Pouget, E.R., Harrington, M., Taxman, F.S., Rhodes, A.G., O'Connell, D., Martin, S.S., Prendergast, M., Friedmann, P.D. (2012). Limiting Options: Sex ratios, incarceration rates and sexual risk behavior among people on probation and parole. *Sexually Transmitted Diseases, 39*(6), 424-430.

Hagan, J., Dinovitzer, R. (1999). Collateral consequences of imprisonment for children, communities, and prisoners. In M. Tonry, Petersilia, J. (Ed.), *Prisons* (Vol. 26). Chicago: University of Chicago Press.

Hammett, T. M., Harmon, M.P., Rhodes, W. (2002). The burden of infectious disease among inmates of and releases from US correctional facilities, 1997. *American Journal of Public Health, 92*, 1789-1794.

Harawa, N. A., A. (2008). Incarceration, African Americans and HIV: advancing a research agenda. *Journal of the National Medical Association, 100*(1), 57-62.

Herman-Stahl, M., Kan, M., McKay, T. (2008). Incarceration and the Family: A review of research and promising approaches for serving fathers and families. Research Triangle Park RTI International

Khan, M. R., Behrend, L., Adimora, A.A., Weir, S.S., White, B.L., Wohl, D.A. (2011). Dissolution of primary intimate relationships during incarceration and implications for post-release HIV transmission. *Journal of Urban Health, 88*(2), 365-275.

Khan, M. R., Doherty, I.A., Schoenbach, V.J., Taylor, E. M., Epperson, M.W., Adimora, A.A. (2009). Incarceration and High-Risk Sex Partnerships Among Men in the United States. *Journal of Urban Health, 86*(4), 584-601.

Khan, M. R., Wohl, D. A., Weir, S. S., Adimora, A. A., Moseley, C., Norcott, K., . . . Miller, W. C. (2008). Incarceration and risky sexual partnerships in a southern US city. *J Urban Health, 85*(1), 100-113. doi: 10.1007/s11524-007-9237-8

Knittel, A. K., Snow, R.C., Griffith, D.M., Morenoff, J. (2013). Incarceration and sexual risk: Examining the relationship between men's involvement in the criminal justice system and risky sexual behavior. *AIDS Behavior, 17*, 2703-2714.

Laurencin, C. T., Christensen, D.M., Taylor, E.D. (2008). HIV/AIDS and the African-American Community: A State of Emergency. *Journal of the National Medical Association, 100*(1), 35-43.

Logan, J. R., Xu,Z., Stults, B. (2012). Interpolating US Decennial Census Tract Data from as Eart as 1970 to 2010: A Longitudinal Tract Database. *Professional Geographer forthcoming*.

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

National Commission on Correctional Health Care. (2002). The Health Status of Soon-to-Be-Released Inmates. A Report to Congress. Chicago: National Commission on Correctional Health Care,.

O'Campo, P. (2003). Invited Commentary: Advancing theory and methods for multilevel models of residential neighborhoods and health. *American Journal of Epidemiology, 157*(1), 9-13.

O'Campo, P., Xue, X., Wang, M-C., Caughy, M.O. (1997). Neighborhood risk factors for low birth weight in Baltimore: a multi-level analysis. *American Journal of Public Health, 87*, 1113-1118.

Osypuk, T. L., Galea, S. (2007). What level macro? Choosing appropriate level to assess how place influences population health. In G. S. (Ed.), *Macrosocial determinants of population health* (pp. 399-438). New York: Springer.

Pannell, D. J. (1997). Sensitivity analysis of normative economic models: Theoretical framework and practical strategies. *Agricultural Economics 16*(139-152).

Pouget, E. R., Kershaw, T.S., Niccolai, L.M., Ickovics, J.R., Blankenship, K.M. (2010). Associations of sex ratios and male incarceration rates with multiple opposite-sex partners: potential social determinants of HIV/STI transmission. *Public Health Report, 125*(Suppl 4), 70-80.

Rastogi, S., Johnson, T.D., Hoeffel, E.M., Drewery, M.P. (2011). *The Black Population: 2010*. (C2010BR-06). Retrieved from http://www.census.gov/prod/cen2010/briefs/c2010br-06.pdf.

Sampson, R. J., Morenoff, J.D., Gannon-Rowley, T. (2002). Assessing 'Neighborhood Effects': Social Process and New Direction in Research. *Annual Review of Sociology, 28*, 443-478.

Stokols, D. (1992). Establishing and Maintaining Healthy Environments: Toward a Social Ecology of Health Promotion. *American Pyschologist, 47*(1), 6-22.

Stokols, D. (1996). Translating social ecological theory into guidelines for community health promotion. . *American Journal of Public Health, 10*(4), 282-298.

Thomas, J. C., Levandowski, B.A., Isler, M.R., Torrone, E., Wilson, G. (2007). Incarceration and Sexually Transmitted Infections: A Neighborhood Perspective. *Journal of Urban Health, 85*(1), 90-99.

Thomas, J. C., Levandowski, B.A., Isler, M.R., Torrone, E., Wilson, G. (2008). Incarceration and Sexually Transmitted Infections: A Neighborhood Perspective. *Journal of Urban Health, 85*(1), 90-99.

Thomas, J. C., Sampson, L.A. . (2005). High rates of incarceration as a social force associated with community rates of sexually transmitted infection. *Journal of Infectious Disease, 191*(Suppl 1), S55-60.

Thomas, J. C., Torrone, E. . (2006). Incarceration as forced migration: Effects on selected community health outcomes. *American Journal of Public Health, 96*(10), 1762-1765.

U.S. Census Bureau. (2013). How the Census Bureau Measures Poverty. Retrieved May 29, 2014, from http://www.census.gov/hhes/www/poverty/about/overview/measure.html

Wyatt, G. E., Williams, J.K., Myers, H.F. (2008). African-American Sexuality and HIV/AIDS: Recommendations for Future Research. *Journal of the National Medical Association, 100*(1), 44-51.

Chapter 4

Male incarceration rates, spatial access to sexual health care and sexually transmitted infections: A moderation analysis

Abstract

This cross-sectional analysis examines the relationship between rates of male incarceration and of sexually transmitted infections (STIs) in census tracts in the Atlanta Metropolitan Statistical Area (MSA), and whether spatial access to health care (SPAHC) moderates this relationship. We measured SPAHC by straight-line distance from the population-weighted centroid of each census tract to the nearest health care facility. Regression models and moderation analyses were used to test associations. In multivariate models, SPAHC had a moderating effect such that as spatial access to sexual health services worsened, the magnitude of the relationship between rate of male incarceration and prevalence of newly-diagnosed STIs *decreased*. Health care consumers might consider additional "costs" associated with accessing sexual health services that may serve as better determinants of health care utilization.

Introduction

The southern region of the United States (US) consistently has the highest burden of sexually transmitted infections (STIs) in the nation (Centers for Disease Control and Prevention 2013, Centers for Disease Control and Prevention 2014, Centers for Disease Control and Prevention 2014, Centers for Disease Control and Prevention 2014). In 2012, the southern state of Georgia ranked first in the US in prevalence of primary and secondary syphilis (9.5 case per 100,000), fifth in gonorrhea prevalence (156.1 cases per 100,000), and eighth in Chlamydia prevalence (534 cases per 100,000) (Centers for Disease Control and Prevention 2013). Social and contextual factors (e.g. economic oppression, housing instability, healthcare access) appear to play an important role in shaping STI transmission dynamics (Adimora and Schoenbach 2002, Hogben 2008, Marshall 2008) and STI prevalence (Moran 1989, Fullilove 2006, Geisler 2006, Song 2011).

Incarceration rates have emerged as a potentially powerful contextual determinant of the prevalence of newly-diagnosed STIs in the general population (Thomas 2006, Thomas 2007, Pouget 2010). Thomas et al., for example, found that an increase of the percentage of census tract-person time spent in prison from 2.0% to 2.5% corresponded to a gonorrhea rate increase of 7.1 cases per 100,000 person-years (Thomas 2007). Several mechanisms may link incarceration rates to STIs. High rates of incarceration in geographic areas can alter the local composition of social and sexual networks in ways that facilitate the transmission of STIs (Thomas 2007). By removing a large number of individuals from a neighborhood, high rates of incarceration can disrupt existing sexual partnerships (Hagan 1999, Thomas 2007, Cooper 2013, Dauria 2014). Partners left behind may engage in high-risk sexual relationships (e.g. transactional sex partnerships, concurrent partnership) to fulfill financial, emotional or sexual needs (Adimora, Schoenbach et al. 2003, Thomas 2007, Cooper 2013, Dauria 2014). High rates

of male incarceration have a unique impact on STI transmission by helping to create a shortage of available male sexual partners (i.e. imbalanced sex ratios). When there are more women than men, women may have difficulty discussing and negotiating condom use with male sexual partners because they fear losing their romantic partner to one of the many other available women (Adimora and Schoenbach 2002, Logan, Cole et al. 2002, Adimora 2005, Adimora 2006, Adimora 2007, Harawa 2008, Khan 2009). Additionally, the sexual behaviors of men during and after periods of incarceration can also increase their risk of STI transmission, including engaging in same-sex sexual behavior (i.e. unprotected anal sex)(Herman-Stahl 2008, Thomas 2008) while incarcerated and engaging in multiple and overlapping sexual partnerships after they have been released (Adimora, Schoenbach et al. 2003, Thomas 2008).

Geographic variation in the prevalence of newly-diagnosed STIs may be the result of multiple, intersecting factors (Stokols 1992, Fullilove 2006, Adimora 2007, Division of STD Prevention 2007, Division of STD Prevention 2007). As such, it is important to explore how factors work together to influence the prevalence of newly-diagnosed STIs. At issue in the present paper is whether the relationship between incarceration rates and newly-diagnosed STI prevalence in geographic areas is moderated by spatial access to health care facilities that offer STI treatment and prevention services. Research suggests that reduced spatial access to health care, such as increased distance and travel time to health care providers, may be associated with poorer health outcomes (Teach 2006, Mercer, Sutcliffe et al. 2007, Agency for Healthcare Research and Quality 2008, Goldenberg 2008, Richardson 2010). Health care visits present critical opportunities for the testing and treatment of STIs (Dorell, Sutton et al. 2011). Research examining the relationship between spatial access to sexual health services and sexual health outcomes is limited, however, and the findings are inconclusive (Monnet, Ramee et al. 2008, Olonilua, Ross et al. 2008, Astell-Burt 2011, Bonney 2011). The goal of this study is to

explore the extent to which the relationship between male incarceration rates and the prevalence of newly-diagnosed STIs depends on spatial access to sexual health care services. Findings from this study have important implications for identifying areas where publicly funded sexual health facilities may be needed.

Exploring whether spatial access to health care moderates the relationship between rates of incarceration and the prevalence of newly-diagnosed STIs may be especially important for understanding patterns of STIs among Black adults. In 2012, the prevalence of gonorrhea among Black adults was 14.9 times that for White adults; the prevalence of Chlamydia was 6.8 times that for White adults; and the prevalence of primary and secondary syphilis was 6.1 times that for Whites (Centers for Disease Control and Prevention 2014). Because Black adults are imprisoned at a higher rate than members of other racial/ethnic group in the US (Carson 2012), the detrimental impact of high incarceration rates may be particularly pronounced in predominantly Black neighborhoods. In 2011, Black adults represented roughly 13% of the national population (Rastogi 2011), however, they accounted for approximately 38% of prisoners under state and federal jurisdiction (Carson 2012). In addition, predominantly Black neighborhoods may have decreased access to health care services (Mayberry 2000, Smedley 2003). Consequently, analyses focused on whether spatial access to health care services moderates the relationship between male incarceration rates and the prevalence of newly-diagnosed STI may be useful for public health departments aiming to reduce rates of newly-diagnosed STIs among Black adults.

To our knowledge there have been no studies that have considered the health care service environment, specifically spatial access to health care, as a potential moderator of the relationship between male incarceration rates and rates of newly-diagnosed STIs. The present tests the hypothesis that the magnitude of the relationship

between male incarceration rates and the prevalence of newly-diagnosed STI will be attenuated in census tracts that have better spatial access to sexual health services.

Methods

The geospatial units of analysis in this study are the 946 census tracts in the Atlanta Metropolitan Statistical Area (MSA). In 2010, the median census tract population size in the Atlanta MSA was 5,108 (range: 0 to 20,655). All analyses were conducted at the census tract level for the year 2010.

Measures.Our primary dependent variable was the prevalence of newly-diagnosed STIs in each census tract in 2010. Surveillance data on newly-diagnosed Chlamydia, gonorrhea, and primary stage syphilis were obtained from Georgia's Department of Community Health. Case counts of newly-diagnosed STIs were suppressed for census tracts with less than five newly-diagnosed STI cases. In order to reduce the amount of suppressed data, census-level counts of the three newly-diagnosed STIs of interest were aggregated to create a single STI measure. To calculate an annual estimate of the prevalence of newly-diagnosed STIs, we divided the aggregate number of newly-diagnosed STI cases reported in each census tract by the adult population (18-64) of the census tract, and multiplied by 1,000 (Thomas 2007) .

The rate of male incarceration in each census tract was one of our independent variables of interest. We obtained records for each male entering prison in the Atlanta MSA in 2010 (n=29,106) from the Georgia Department of Corrections. Information included the street address, county of residence, date of birth, race/ethnicity, and date of entry and date of release from prison. Addresses in the database were the "last known address" as reported by each inmate at the time of his admission. Each address was geocoded to its census tract using ArcGIS version 10.1 software (ESRI 2013). Unmatched addresses were geocoded a second time using Google Earth Pro (Google Inc. 2013).

Using ArcGIS and Google Earth Pro 89.20% (n=25,962) of the addresses were matched with 70-100% accuracy and 10.80% (n=3,144) remained unmatched. Unmatched addresses were largely the result of blank or missing address information. Once assigned to a census tract, the number of men incarcerated for each quarter was computed. Male incarceration rates were calculated by dividing the mean number of incarcerated men across quarters by the tract's adult male (aged 18-64) population, and multiplied by 1,000(Thomas 2007).

Sexual health service locations were defined as any health care service facility that provided STI testing, treatment, and/or vaccination services (Hall 2012). Health care service organizations were included in this study regardless of whether they provided the services at a specialized sexual health clinic or as part of a larger medical clinic. An inventory of sexual health care service facilities in 2010 in the Atlanta MSA was created using four methods: (1) through a comprehensive internet search for sexual health clinics in the area, (2) surveying local health care providers, (3) consulting the American Congress of Obstetricians and Gynecologists (ACOG) inventory of physicians(The American Congress of Obstetricians and Gynecologists 2012) and (4) surveying health care locations that received Title X funding from the Department of Health and Human Services' Office of Population Affairs, for providing cost effect family planning and related services for low-income men and women (Office of Population Affairs 2013). Once an inventory was created, the first author (ED) contacted all health care service locations to verify that each was open during the year 2010 and to confirm their address. Next, we geocoded the addresses of all sexual health service locations to their longitude/latitude using ArcGIS (Environmental Systems Research Institute, Redlands, CA, USA)(ESRI 2013).

We defined "spatial access to sexual health care" as local *potential access*. *Potential* access refers to reasonable possible use whereas *revealed* access refers to

actual service use.(Khan 1992) We assessed potential spatial access to sexual health service locations using the minimum distance approach, also referred to as the equity index (Talen 1998). This measure of spatial access has been used previously to examine spatial access to health care service providers (Fulcher 2005, Wang 2008). A Euclidean distance, or a straight-line distance, was used to examine the distance (in miles) from the population-weighted centroids of each census tract to the nearest sexual health care service provider. Population-weighted centroids (based on census block-level population data) were used instead of geographic centroids because they offer a better estimation of areas where residents of census tracts live (Henry 2008). Higher values on the equity index indicate a further distance to sexual health services, and reflect poorer spatial access.

Lastly, we considered the following variables for inclusion in the model as possible confounders: tract-level percent of residents who identified as non-Hispanic Black/African American, percent unemployed, percent of residents in the armed forces, percent of residents living in poverty, median age, percent of residents who are married, and the percent of residents aged 26 or older who had a high school diploma as their highest educational attainment (Thomas 2006, Khan 2009, Pouget 2010). Demographic data were obtained from 2010 decennial census data and the 5-year American Community Survey.

Analysis. Univariate analyses were used to summarize the characteristics of the tracts. Bivariate analyses were used to determine associations between covariates and the prevalence of newly-diagnosed STIs. First, we explored the relationships between: 1) rates of male incarceration and the prevalence of newly-diagnosed STIs, and 2) spatial access to sexual health and the prevalence of newly-diagnosed STIs. Next, we explored the possibility that the relationship between the rate of male incarceration and STI prevalence was moderated by spatial access to sexual health care (Baron 1986). We used

Baron and Kenny methods to investigate our hypothesis that greater spatial access to sexual health care decreases the strength of the relationship between tract-level male incarceration rate and the prevalence of newly-diagnosed STIs (Baron 1986). The multivariate model controlled for covariates identified as significant ($p < 0.05$) in bivariate analyses.

When we found evidence of moderation, we conducted two stratified moderation analyses to investigate the nature of the interaction. First, the data was stratified into four groups based on the quartiles of spatial access to sexual health services, and regression analyses were conducted to examine the nature of the association between rate of male incarceration and prevalence of newly-diagnosed STIs in each group. Finally, we conducted a sensitivity analysis to determine whether our results were robust across models where values for tract-level suppressed STI case counts were set to missing, and where suppressed values were set to the minimum and maximum possible values (0 and 4 respectively) (Pannell 1997). All statistical analyses were conducted using SAS version 9.3 (Cary, NC).

Ethics. Emory University's Institutional Review Board approved all study protocols and the Georgia Department of Community Health approved the use of the STI data.

Results

In 2010, on average, 4 out of every 1,000 men were incarcerated (SD=5.25) in census tracts in the Atlanta MSA (Table 1). Notably at the tract level, there were, on average, over 11 reported cases of STIs for every 1,000 adults (SD=12). The average distance from the population-weighted centroid of each tract to the nearest sexual health service facility was 0.42 miles (SD=0.35). On average for census tracts in the Atlanta MSA, roughly 34% of residents were non-Hispanic Black/African American, nearly 59% of residents are aged 15 to 64 years old, approximately 49% of residents were married

and over one-quarter of adults' (25 years or older) highest education attainment was a high school diploma.

Figure 2 depicts potential spatial access to sexual health care, rates of male incarceration and the prevalence of newly-diagnosed STIs across census tracts in Atlanta. In 2010, census tracts with the shortest distance to the nearest sexual health facility were located in the central region of the Atlanta MSA, including tracts located in two of the most populated counties (e.g. Fulton and DeKalb).(U.S. Census Bureau 2010) High rates of male incarceration were evident throughout the Atlanta MSA, with concentrated areas in the central and southwestern regions. Census tracts with a high prevalence of STIs were concentrated in the central and southeastern regions of the Atlanta MSA. Visual examination of these maps suggests that census tracts with a high prevalence of newly-diagnosed STIs varied in their spatial access to sexual health care services. For example the central region of the Atlanta MSA appears to have greater spatial access to sexual health services, whereas tracts in the southeastern region of the Atlanta MSA appear to be more distant from the nearest sexual health care facility (indicating poorer spatial access).

In bivariate analyses, rates of male incarceration were positively and significantly associated with the prevalence of newly-diagnosed STIs (B =0.69, p<0.0001) and there was a negative significant association between distance to the nearest sexual health facility and prevalence of newly-diagnosed STIs (B =-0.35, p<0.0001) (Table 2). Next, incarceration rates and distance to the nearest sexual health facility were entered simultaneously into a regression model. The results of this regression model suggest that approximately 53% of the variation in the prevalence of newly diagnosed STIs is explained by rate of male incarceration and the distance to the nearest sexual health facility (R^2=0.53, F (2, 782) = 435.47, p< 0.0001) (Table 3). For every one-point increase in the rate of male incarceration, prevalence of newly-diagnosed STI increased by 1.43

cases per 1,000 ($p < 0.0001$), when controlling for the distance to the nearest sexual health facility. For every one-unit increase in the straight-line distance to the nearest sexual health facility, the prevalence of newly-diagnosed STIs decreased by 81.91 ($p<0.0001$), when controlling for rate of male incarceration (Table 2).

Next, the interaction between the rate of male incarceration and distance to the nearest sexual health facility was added to the regression model. The moderation model did not account for significantly more variance of the prevalence of newly-diagnosed STIs than the rate of male incarceration and distance to the nearest sexual health facility alone ($R^2=0.53$). Although rate of male incarceration ($p < 0.0001$) and distance to the nearest sexual health facility ($p < 0.0001$) were both significant predictors of the prevalence of newly-diagnosed STIs, the interaction effect was not significant ($B = 0.78$, $p=0.79$). Our findings at the bivariate do not suggest that distance to the nearest sexual health facility modified the effect of rate of male incarceration on the prevalence of newly-diagnosed STIs, when other variables were not controlled for (Table 3).

Next, all potential confounders were tested individually in the moderation model (*Models 1-7*, Table 4). Each of the following covariates were significantly related to the prevalence of newly-diagnosed STIs: percent of residents living in poverty ($B = 0.30$, $p<0.0001$), percent of residents who are Black ($B = 0.24$, $p<0.0001$), percent of residents who are unemployed ($B = 0.78$, $p<0.0001$), percent of residents in the armed forces ($B = 1.63$, $p<0.0001$), percent of residents aged ≥ 25 years whose highest level of educational attainment is high school ($B = 0.16$, $p<0.0001$), percent married ($B = -0.39$, $p<0.0058$), and median age ($B = -0.37$, $p<0.0001$). All significant covariates were added to the moderation model that contained the main effects of male incarceration rates, distance to the nearest sexual health facility, and the interaction of these two covariates.

The moderation analysis was statistically significant, once potential confounders were included in the model (Table 5). Notably, in the moderation model the strength of

the association between rate of male incarceration and the prevalence of newly-diagnosed STI was attenuated by the distance to the nearest sexual health facility and the prevalence of newly-diagnosed STI changed. The results of the adjusted regression model indicate that approximately 78% of the variation in the prevalence of newly-diagnosed STIs is explained by rate of male incarceration, distance to the nearest sexual health facility (R^2=0.78, F (10, 764) = 266.32, p< 0.0001) and other covariates.

To examine the nature of the interaction, we conducted a stratified regression analysis between rates of male incarceration and the prevalence of newly-diagnosed STIs based on the quartiles of distance to the nearest sexual health facility. The results indicate that in census tracts with the furthest distance to the nearest sexual health facility (those in the third and fourth quartiles), there was no significant association between rate of male incarceration and prevalence of newly-diagnosed STIs (p=0.30 and p=0.41 respectively), when controlling for covariates (Table 6). For census tracts with a medium distance to the nearest sexual health facility (25%-50% quartiles), every unit increase in the parameter estimate for rate of male incarceration predicted an increase of 0.32 (p=0.0035) in prevalence of newly-diagnosed STIs. For census tracts with the shortest distance to th nearest sexual health facility, every unit increase in the parameter estimate for rate of male incarceration predicted an increase of 0.49 (p<0.0001) in the prevalence of newly-diagnosed STI. Census tracts with the shortest distance to the nearest sexual health facility (less than 0.02 miles) had the highest average rates of male incarceration with 6.74 per 1,000 adult men (SD=1.98) (Table 6).

Finally, we conducted a sensitivity analysis to determine whether our results were robust across models where values for tract-level suppressed STI case counts were set to missing. The final moderation model (adjusted for covariates) was rerun with values imputed for the minimum and maximum possible values (0 and 4 respectively) for census tracts with suppressed data on the prevalence of newly-diagnosed STIs. Final

results from the sensitivity analysis reveal that imputing both minimum and maximum values for the prevalence of newly-diagnosed STIs for census tracts with suppressed data had no significant effect on the final model (data not shown). We examined variance inflation factors of each variable in the final model and determined that multicollinearity was not an issue (all VIFs < 4). Lastly, regression diagnostics were conducted to identify possible influential outliers. Models were run with and without outliers to ensure that associations identified in the full model remained. With the exception of changing the significance of one covariate (percent of residents in the armed forces) there were no significant changes to the magnitude, direction, or statistical significance of effect sizes when outliers were removed.

Discussion

While our findings suggest that spatial access to sexual health care is an effect modifier, the data did not support our hypothesis. As spatial access to sexual health services worsened, the magnitude of the relationship between rate of male incarceration and prevalence of newly-diagnosed STIs *decreased*.

One possible explanation for our finding that rates of male incarceration and the prevalence of newly-diagnosed STIs decreased as spatial access to sexual health services worsened (not improved as would be expected) could be connected to our measure of health care access. Spatial access to health care is only one of several important dimensions of access to health care. Penchansky and Thomas (1981) identified five dimensions of access: availability, accessibility, accommodation, affordability and acceptability, only two are which are defined in spatial terms (Penchansky 1981). Although distance to health care service locations generally deters utilization (Haynes 2003), it may not be the only important factor for understanding health care accessibility, especially in an urban environment like the Atlanta. In areas with sufficient spatial access to health care services, consumers may consider additional “costs”

associated with accessing health care services (Haynes 2003). These costs include the time required to realize health care access, which may be associated with arranging for transportation, time off from paid work, long wait times, and/or being able to secure and pay for childcare (Gibson 1985, Yang 2006). We found that areas with the best spatial access to health care services were also areas that had the highest rates of male incarceration. "Costs" like these may be especially relevant for understanding health care access and utilization among individuals living in neighborhoods with high rates of male incarceration. In neighborhoods with high rates of male incarceration, a large number of men are forcibly removed from neighborhoods, which can result in the disruption of familial bonds and can strain economic resources (Clear 2008); both of which may make it difficult to negotiate time off from work or make childcare arrangements (Dauria 2014). In this context, the costs associated with accessing health care may represent too high of a burden to overcome, regardless of their spatial location.

Our inventory of sexual health care locations included both public and private health care facilities, which has important implications on our study findings. Individuals living in tracts with higher rates of male incarceration and a high prevalence of newly-diagnosed STIs might have excellent spatial access to private and public clinics but may be preventing from utilizing health care services for other reasons. For example, crowded waiting rooms and longer wait times in public health clinics may prevent individuals from receiving health care (Haynes 2003). Excellent spatial access to private health clinics is irrelevant if an individual is uninsured or does not have the financial means to pay for services at private facilities. Unfortunately, given the limitations of our inventory of sexual health care service locations we were unable to distinguish between private and public health care facilities in our analysis. Future studies exploring these relationships should examine spatial access to various types of health care facilities when trying to understand sexual health outcomes.

In census tracts with the best spatial access to care, male incarceration rates predicted a slight positive increase in the prevalence of newly-diagnosed STIs. The findings from this subset of census tracts are consistent with an emerging body of literature documenting the association between high rates of male incarceration and high rates of STIs (Thomas 2006, Thomas 2008). There are several pathways through which male incarceration may shape the transmission risk and prevalence of STIs. Imbalances in local sex ratios (produced in part by male incarceration) are associated with sexual risk behaviors that contribute to a high prevalence of newly-diagnosed STIs, including having a larger number of sexual partners (Pouget 2010, Pouget 2010, Green 2012, Knittel 2013), overlapping (or concurrent) partnerships (Thomas 2007, Khan, Wohl et al. 2008, Khan 2009) and a greater risk of having unprotected sex with a risky partner (Khan 2009, Green 2012). High rates of male incarceration are thought to have particularly negative consequences on the sexual risk behaviors of heterosexual women. Qualitative findings suggest that imbalanced sex ratios can undermine women's ability to negotiate condom use and monogamous relationships with their partners (Adimora, Schoenbach et al. 2001, Ferguson 2007). Increased spatial access to care in this context may indeed be helpful in curtailing the transmission of STIs, however, by itself, it may not be sufficient enough to overcome the influence that factors of the social environment have on the spread of STIs.

Given that this was a cross-sectional study design, we could not examine the moderation effect of spatial access to sexual health care and rate of male incarceration on the prevalence of newly-diagnosed STIs over time. In order to better serve the needs of the community, public health clinics may be more likely to be located in areas with a high prevalence of newly-diagnosed STIs. This may help explain the positive cross-sectional relationship between spatial access to sexual health care and the prevalence of newly-diagnosed STIs found in the present study. Future research should employ

longitudinal designs to examine the moderation effect that health care access and rate of male incarceration have on the prevalence of newly-diagnosed STIs over time.

In this study we were unable to examine racial/ethnic variations in rates of male incarceration, spatial access to health care or the prevalence of newly-diagnosed STIs. Given that rates of male incarceration are highest among Black men (Carson 2012), that Black adults and individuals living in predominantly Black neighborhoods have poorer access to and utilization of health care services (Burgess 2008, Gaskin 2012, Guerro 2013), and that Black adults have the highest rates of newly-diagnosed STIs of all racial/ethnic groups in the US (Centers for Disease Control and Prevention 2014), examining the relationship between these factors among Black adults specifically may be a particularly important area of study. As noted, high rates of male incarceration can alter the nature and structure of social and sexual networks to create conditions that increase the risk of STI transmission (e.g. larger number of sexual partners, concurrent partnerships) (Herman-Stahl 2008, Thomas 2008, Pouget 2010, Green 2012, Knittel 2013). For these reasons, high rates of male incarceration may increase the sexual risk, health needs, and thus the demand for health care services. A recent study suggests that disparities in health care utilization are related to an individuals' race/ethnicity and the racial/ethnic composition of their neighborhood: African Americans and those residing in predominately African American neighborhoods have lower rates of health care use than their White counterparts or individuals living in predominately White neighborhoods (Gaskin 2012). Black adults' distrust in the healthcare system and concerns about discrimination from health care providers contribute to disparities in health care use(Washington 2006, Wiehe 2011). These barriers may be particularly relevant for understanding health care utilization related to the testing and treatment of STIs among Black adults given the stigma associated having a STI (Lichtenstein 2005, Barth 2010).

There are several limitations to the study that warrant attention. First, this study has an ecologic design and therefore is unable to explore how individual-level factors influence study outcomes. Our findings are based on addresses provided by inmates to the GA DOC and may not be an accurate representation of where an offender actually lived at the time of their incarceration. This problem is amplified when conducting analyses at the census-tract level because even small errors in an address can lead to census-tract misclassification. There is no reason, however, to suspect that any misclassifications would be the result of nonrandom error. Second, our measure of spatial access to sexual health care does not include several important features of access. Using the Euclidean distance to measure spatial access is not the best metric available to estimate travel patterns and travel potential because it fails to account for transportation routes and barriers to movement (Cromley 2012). Despite these limitations the Euclidean distance is frequently used in spatial analyses (Thornton 2012, Hattori 2013) and has been used to examine spatial access to health care (Fulcher 2005, Charreire 2009, Larson 2012, Johnson 2013). Some research suggests that straight line distance measures are highly correlated with other travel-distance measures including like travel time along a local road network (Phibbs 1995). Lastly, the creation of a retrospective inventory of sexual health care locations is fraught with challenges. Despite our best efforts to create a complete inventory of sexual health care service locations, there is no way to know that our inventory was comprehensive for 2010.

Notwithstanding these limitations, the present study represents an important step in improving our understanding of how different features of local social environments can intersect with one another to shape sexual health outcomes. These pathways are undoubtedly complex and warrant further research. One potential avenue for future research would be using qualitative methods to explore aspects of access to sexual health care that are particularly important for determining health care seeking

utilization among individuals living in neighborhoods disproportionately impacted by male incarceration. This research could direct the development and examination of more comprehensive measures of health care access and their relationship to sexual health.

Table 4.1. Distribution of census-tract level characteristics in the Atlanta Metropolitan Statistical Area (MSA), 2010 (N= 946).

Characteristics	**Mean (SD)**
Median Age	35.52 (5.52)
Percent of residents who are non-Hispanic Black/ African American	33.78% (30.78)
Percent of adults (≥25 years) whose highest degree is a high school diploma	25.87% (10.94)
Percent Unemployment (total population ≥16 years)	6.45% (3.52)
Percent of residents living below poverty	14.29% (12.21)
Percent of residents in the Armed Forces (total population ≥16 years)	0.17% (0.48)
Percent of residents who are married	48.52% (16.43)
Male Incarceration Rate (per 1,000 men 18 to 64 years old)	4.63 (5.25)
Euclidean distance (in miles) to nearest sexual health facility	0.42 (0.35)
Rate of newly-diagnosed STIs (rate per 1,000 adults 18-64 years)	11.30 (12.00)

Figure 4.2. Maps depicting the Euclidean distance to the nearest sexual health care facility, male incarceration rate (per 1,000 adults 18 – 64 years old) and prevalence of newly-diagnosed sexually transmitted infections (STI) at the census-tract level in the Atlanta MSA, 2010.

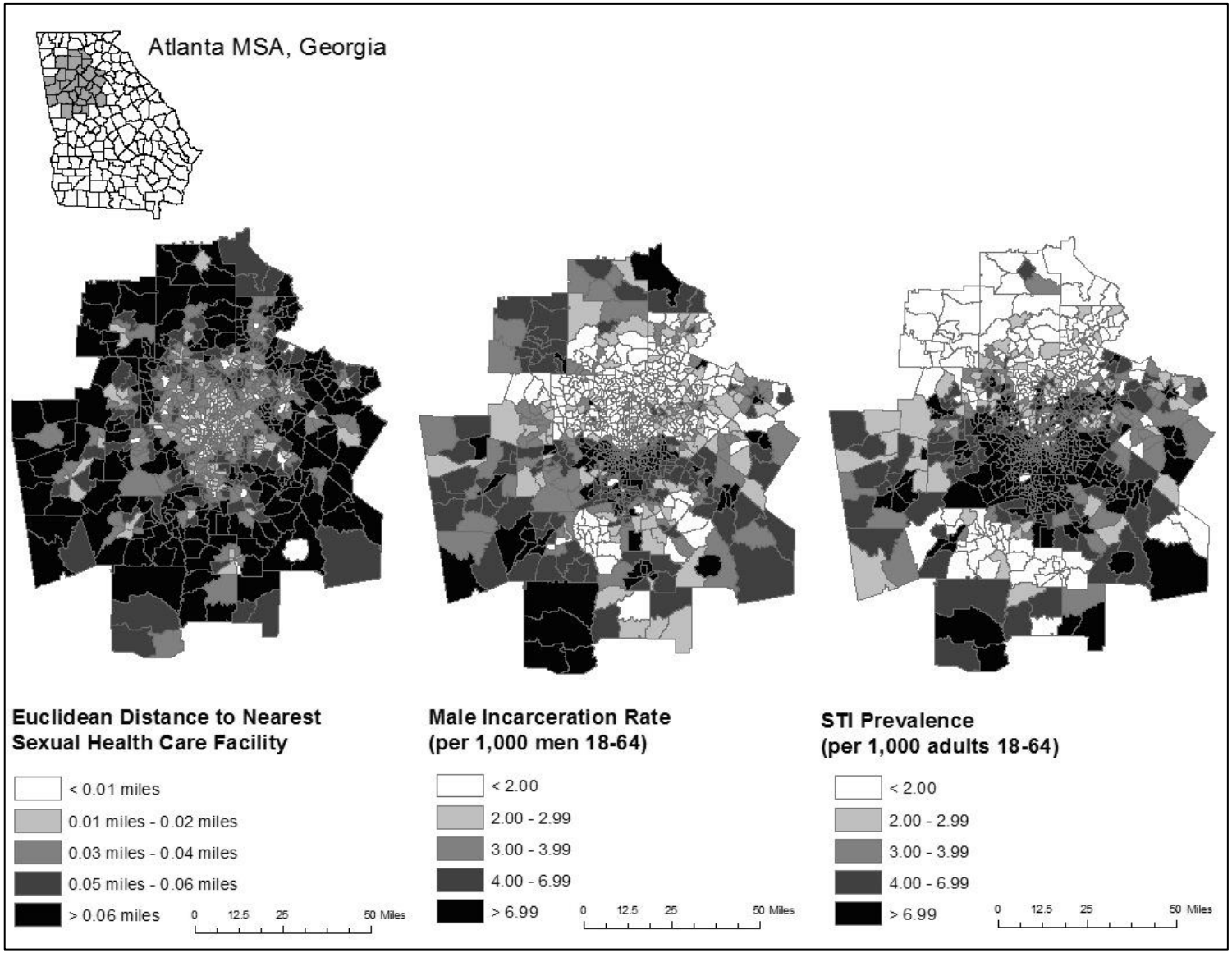


Table 4.2. Pearson correlations between select covariates and the prevalence of newly-diagnosed STIs, by census tract, Atlanta MSA, 2010 (N= 946).

Characteristics	**Prevalence of newly-diagnosed STIs** (per 1,000 adults 18 to 64) r
Median Age	-0.28***
Percent of residents who are non-Hispanic Black/ African American	0.81***
Percent of adults (≥25 years) whose highest degree is a high school diploma	0.32***
Percent unemployment (total population ≥16 years)	0.51***
Percent of residents living below poverty	0.64***
Percent of residents in the Armed Forces (total population ≥16 years)	0.05
Percent of residents who are married	-0.70***
Male Incarceration Rate (per 1,000 men 18 to 64 years old)	0.69***
Euclidean distance (in miles) to nearest sexual health facility	-0.35***

Note: $*p < 0.05$, $**p < 0.01$, ***p < 0.0001 .

Table 4.3. Unadjusted base model and moderation model examining the moderation effect of spatial access to sexual health care on tract-level rate of male incarceration and tract-level prevalence of newly-diagnosed STIs in the Atlanta MSA, 2010

	Base Model		*Moderation Model*	
	B	*SE B*	*B*	*SE B*
Rate of male incarceration (per 1,000 adult men)	1.44	0.06***	1.43	0.08***
Euclidean distance to closest sexual health care service (in miles)	-81.91	9.21***	-84.96	14.87***
Rate of male incarceration* Euclidean distance to closest sexual health care service (in miles)			0.78	2.96
R^2	0.53		0.53	
F	435.47**		289.99**	

Note: $^*p < 0.05$, $^{**}p < 0.01$, ***p < 0.0001 .

Table 4.4. Models examining the moderation effect of spatial access to sexual health care on tract-level rate of male incarceration and tract-level prevalence of newly-diagnosed STIs in the Atlanta MSA, adjusting for individual covariates, 2010.

	B	***SE B***	***R²***	***F***
Model 1			0.58	267.64***
Rate of male incarceration	1.12	0.08***		
Euclidean distance to closest sexual health care service	-49.51	14.50***		
Rate of male incarceration * Euclidean distance to closest sexual health service	-0.82	2.81		
% living in poverty	0.30	0.03***		
Model 2			0.74	548.70***
Rate of male incarceration	0.85	0.06***		
Euclidean distance to closest sexual health care service	-9.72	11.55		
Rate of male incarceration * Euclidean distance to closest sexual health service	-8.36	2.25***		
% Black/African American	0.24	0.01***		
Model 3			0.57	257.11***
Rate of male incarceration	1.24	0.08***		
Euclidean distance to closest sexual health care service	-71.49	14.29***		
Rate of male incarceration * Euclidean distance to closest sexual health service	-1.44	2.84		
% unemployed	0.78	0.09***		
Model 4			0.55	235.21***
Rate of male incarceration	1.43	0.08***		
Euclidean distance to closest sexual health care service	-66.80	14.89***		
Rate of male incarceration * Euclidean distance to closest sexual health service	-.08	2.91		
Median age	-0.37	0.06***		
Model 5			0.5408	229.63***
Rate of male incarceration	1.32	0.08***		
Euclidean distance to closest sexual health care service	-93.47	14.76***		
Rate of male incarceration * Euclidean distance to closest sexual health service	-1.49	2.96		
% of adults (≥25 years) whose highest degree is a high school diploma	0.16	0.03***		
Model 6			0.53	221.25***
Rate of male incarceration	1.43	0.08***		
Euclidean distance to closest sexual health care service	-85.67	14.81***		
Rate of male incarceration * Euclidean distance to closest sexual health service	0.97	2.95		
% in the armed forces	1.63	0.59**		
Model 7			0.66	385.12***
Rate of male incarceration	1.16	0.08***		
Euclidean distance to closest sexual health care service	38.76	14.81***		
Rate of male incarceration * Euclidean distance to closest sexual health service	-8.59	2.95		
% married	-0.39	0.59**		

Note: *$p < 0.05$, **$p < 0.01$, ***p< 0.001.

Table 4.5. Full model examining the moderation effect of spatial access to sexual health care on tract-level rate of male incarceration and tract-level prevalence of newly-diagnosed STIs in the Atlanta MSA, adjusting for significant covariates, 2010.

	B	*SE B*
Rate of male incarceration (per 1,000 adult men)	0.69	0.06***
Euclidean distance to closest sexual health care service	37.90	11.99**
Rate of male incarceration * Euclidean distance to closest sexual health service	-10.63	2.14***
% living in poverty	0.17	0.03***
% Black/African American	0.20	0.01***
Median Age	0.14	0.06*
% of adults (≥25 years) whose highest degree is a high school diploma	-0.01	0.03
% unemployed	-0.12	0.08
% in the armed forces	0.09	0.39
% married	-0.15	0.03***
R^2	0.78	
F	266.32***	

Note: *$p < 0.05$, **$p < 0.01$, ***p< 0.001

Table 4.6. Regression models exploring tract-level rate of male incarceration and tract-level prevalence of newly-diagnosed STIs in the Atlanta MSA, stratified by spatial access to sexual health care and adjusted for covariates, 2010.[+]

	Rate of Male Incarceration	**Distance to Nearest Sexual Health Facility (in miles)**	**Model Characteristics**			
	Mean (SD)	**Mean (SD)**	***B***	***SE B***	***R²***	***F***
25% Shortest Distance to Nearest Sexual Health Facility	6.74 (8.18)	0.01 (0.004)				
Rate of male incarceration			0.49	0.11***	0.73	65.01***
50% Distance to Nearest Sexual Health Facility	5.09 (4.81)	0.02 (0.004)				
Rate of male incarceration			0.32	0.11**	0.81	95.77***
75% Distance to Nearest Sexual Health Facility	3.77 (3.11)	0.04 (0.007)				
Rate of male incarceration			0.17	0.16	0.81	100.39***
> 75% Furthest Distance to Nearest Sexual Health Facility	3.15 (1.98)	0.09 (0.03)				
Rate of male incarceration			0.08	0.10	0.80	84.72***

Note: $*p < 0.05$, $**p < 0.01$, ***p< 0.001 . [+]All models control for the following covariates: percent in the armed forces, percent married, percent living below poverty, percent Black/African American, percent unemployed, percent whose highest educational attainment is high school and median age.

References

Adimora, A. (2007). *Social Determinants of STDs*. Paper presented at the Consultation to Address STD Disparities in African American Communities, Atlanta, GA. http://www.cdc.gov/std/general/STDHealthDisparitiesConsultationJune2007.pdf

Adimora, A. A., & Schoenbach, V. J. (2002). Contextual factors and the black-white disparity in heterosexual HIV transmission. *Epidemiology, 13*(6), 707-712. doi: 10.1097/01.EDE.0000024139.60291.08

Adimora, A. A., Schoenbach, V. J., Martinson, F. E., Donaldson, K. H., Fullilove, R. E., & Aral, S. O. (2001). Social context of sexual relationships among rural African Americans. *Sex Transm Dis, 28*(2), 69-76.

Adimora, A. A., Schoenbach, V. J., Martinson, F. E., Donaldson, K. H., Stancil, T. R., & Fullilove, R. E. (2003). Concurrent partnerships among rural African Americans with recently reported heterosexually transmitted HIV infection. *J Acquir Immune Defic Syndr, 34*(4), 423-429.

Adimora, A. A., SChoenbach, V.J. . (2005). Social context, sexual networks and racial disparities in rates of sexually transmitted infections. *Journal of Infectious Disease, 291*, S115-S122.

Adimora, A. A., Schoenbach, V.J., Doherty, I.A. (2006). HIV and African Americans in the southern United States: sexual networks and social context. *Sexually Transmitted Diseases, 33*(7 Suppl), S39-45.

Agency for Healthcare Research and Quality. (2008). *2007 National Healthcare Disparities Report*. Rockville, MD: AHRQ

Astell-Burt, T., Flowerdew, R., Boyle P. J., Dillon, J.F. (2011). Does geographic access to primary healthcare influence the detection of hepatitis C? *Social Science and Medicine, 72*(9), 1472-1481.

Baron, R. M., Kenny, D.A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Pers Soc Psychol, 51*, 1173-1182.

Barth, K. R., Cook, R.L., Downs, J.S., Switzer, G.E., Fischhoff, B. (2010). Social stigma and negative consequences: Factors that influence college students' decisions to seek testing for sexually transmitted infections. *Journal of American College Health, 50*(4), 153-159.

Bonney, L. E., Cooper, H.L.F., Caliendo, A.M., del Rio, C., Hunter-Jones, J., Swan, D.F., Rothenberg, R., Druss, B. (2011). Access to Health Services and Sexually Transmitted Infections in a Cohort of Relocating African American Public Housing Residents: An Association Between Travel Time and Infection. *Sexually Transmitted Diseases, 38*(12), 1-6.

Burgess, D. J., Ding, Y., Hargreaves, M., van Ryn, M., Phelan, S. (2008). The association between perceived discrimination and underutilization of needed medical and mental health care in a multi-ethnic community sample. *Journal of Health Care for the Poor and Underserved, 19*, 894-911.

Carson, E. A., Sabol, W.J. (2012). *Prisoners in 2011*. (NCJ 239808). Retrieved from http://www.doc.wa.gov/aboutdoc/measuresstatistics/docs/BJSReport.Prisoners in2011.pdf.

Centers for Disease Control and Prevention. (2013). *Sexually Transmitted Surveillance 2012*. Atlanta, GA.

Centers for Disease Control and Prevention. (2014a). 2012 Sexually Transmitted Diseases Surveillance. Retrieved April 22,, 2014, from http://www.cdc.gov/std/stats12/minorities.htm

Centers for Disease Control and Prevention. (2014b). 2012 Sexually Transmitted Diseases Surveillance: Syphilis. Retrieved April 28, , 2014, from http://www.cdc.gov/std/stats12/syphilis.htm

Centers for Disease Control and Prevention. (2014c). 2012 Sexually Transmitted Diseases Surveillance: Chlamydia. Retrieved April 28, , 2014, from http://www.cdc.gov/std/stats12/chlamydia.htm

Centers for Disease Control and Prevention. (2014d). 2012 Sexually Transmitted Diseases Surveillance: Gonorrhea. Retrieved April 28, , 2014, from http://www.cdc.gov/std/stats12/gonorrhea.htm

Charreire, H., Combier,E. (2009). Poor prenatal care in an urban area: A geographic analysis. *Health and Place, 15*(2), 412-419.

Clear, T. R. (2008). The effects of high imprisonment rates on communities. *Crime and Justice, 37*(1), 97-132.

Cooper, H. L. F., Clark, C.D., Barham, T., Embry, V., Caruso, B., Comfort, M. (2013). "He Was the Story of My Drug Use Life" : A Longitudinal Qualitative Study of the Impact of Partner Incarceration on Substance Misuse Patterns Among African American Women. *Substance Use and Misuse, 49*(1-2), 176-188.

Cromley, E. K., McLafferty, S.L. (2012). *GIS and Public Health* (Second Edition ed.). New York: The Guilford Press.

Dauria, E., Oakley, L., Arriola, K.J., Elifson, K., Cooper, H.L.F. (2014). Collateral Consequences: The implications of male incarceration rates, imbalanced sex ratios and partner availability among heterosexual Black women.

Division of STD Prevention. (2007a). *Consultation to Address STD Disparities in African American Communities*. Atlanta, GA: BullsEye Resources Retrieved from

http://www.cdc.gov/std/general/STDHealthDisparitiesConsultationJune2007.pdf.

Division of STD Prevention. (2007b). *Consultation to Address STD Disparities in African American Communities: Meeting Report*. Paper presented at the Consultation to Address STD Disparities in African American Communities:, Atlanta, GA.

Dorell, C. G., Sutton, M. Y., Oster, A. M., Hardnett, F., Thomas, P. E., Gaul, Z. J., . . . Heffelfinger, J. D. (2011). Missed opportunities for HIV testing in health care settings among young African American men who have sex with men: implications for the HIV epidemic. *AIDS Patient Care STDS, 25*(11), 657-664. doi: 10.1089/apc.2011.0203

ESRI. (2013). ArcGIS Desktop: Release 10.1. Redlands, CA: Environmental Systems Research Institute,.

Ferguson, Y. O., Quinn, S.C., Sandelowski, M. (2007). The gender ratio imbalance and its relationship to risk of HIV/AIDS among African American women at historically black colleges and universities. *AIDS Care, 18*(4), 323-331.

Fu, L. Y., Cowan, N., McLaren, R., Engstrom R., Teach, S.J. ((2009). Spatial accessibility to providers and vaccination compliance among children with Medicaid. *Pediatrics, 124*(6), 1579-1586.

Fulcher, C., Kaukinen, C. (2005). Mapping and visualizing the location of HIV service providers: An exploratory spatial analysis of Toronto neighborhoods. *AIDS Care, 17*(3), 386-396.

Fullilove, R. E. (2006). Health Disparities and HIV/AIDS: Recommendations for Confronting the Epidemic in Black America. Washington, D.C. : National Minority AIDS Council.

Gaskin, D. J., Dinwiddle, G.Y., Chan, K.S., McCleary, R. (2012). Residential segregation and disparities in health care service utilization. *Medical Care Research and Review, 69*(2), 158-175.

Geisler, W. M., Chyu, L., Kusonoki, Y. (2006). Health insurance coverage, health care-seeking behaviors, and genital chlamydial infection prevalence in sexually active young adults. *Sexually Transmitted Diseases, 33*, 389-396.

Gibson, D. M., Goodin, R.E., LeGrand, J. (1985). Come and get it: distributional biases in social service delivery systems. *Policy and Politics, 13*, 109-125.

Goldenberg, S. M., Shoveller, J.A., Ostry, A.C. (2008). Sexually transmitted infection (STI) testing among young oil and gas workers: The need for innovative, place-based approaches to STI-control. *Canadian Journal of Public Health, 99*, 350-354.

Google Inc. (2013). Google Earth Pro, Version 7.1.2.2041. Mountain View, CA: Google.

Green, T. C., Pouget, E.R., Harrington, M., Taxman, F.S., Rhodes, A.G., O'Connell, D., Martin, S.S., Prendergast, M., Friedmann, P.D. (2012). Limiting Options: Sex ratios, incarceration rates and sexual risk behavior among people on probation and parole. *Sexually Transmitted Diseases, 39*(6), 424-430.

Guerro, E. G., Kao, D. (2013). Racial/ethnic minority and low-income hotspots and their geographic proximity to integrated care providers. *Substance Abuse Treatment, Prevention and Policy, 8*(34).

Hagan, J., Dinovitzer, R. (1999). Collateral consequences of imprisonment for children, communities, and prisoners. In M. Tonry, Petersilia, J. (Ed.), *Prisons* (Vol. 26). Chicago: University of Chicago Press.

Hall, K. S., Moreau, C., Trussell, J. (2012). Continuing social disparities despite upward trends in sexual and reproductive health service use among young women in the United States. *Contraception, 86*(6), 681-686.

Harawa, N. A., A. (2008). Incarceration, African Americans and HIV: advancing a research agenda. *Journal of the National Medical Association, 100*(1), 57-62.

Hattori, A., An, R., Sturm, R. (2013). Neighborhood Food Outlets, Diet, and Obesity Among California Adults, 2007 and 2009. *Preventing Chronic Disease, 10*. doi: 10.5888/pcd10.120123.

Haynes, R. (2003). Geographical access to health care. In M. Gulliford, & Morgan, M. (Ed.), *Access to Health Care* (pp. 13-35). London: Routeledge

Henry, K. A., Boscoe, F.P. (2008). Estimating the accuracy of geographical imputation. *International Journal of Health Geographics, 7*(3).

Herman-Stahl, M., Kan, M., McKay, T. (2008). Incarceration and the Family: A review of research and promising approaches for serving fathers and families. Research Triangle Park RTI International

Hogben, M., Leichliter, J.S. (2008). Social Determinants and Sexually Transmitted Disease Disparities. *Sexually Transmitted Diseases, 35*(12), S13-S18.

Johnson, D. C., Feldacker, C., Tweya, H. Phiri, S., Hosseinipour, M.C. (2013). Factors associated with timely initiation of antiretroviral therapy in two HIV clinics in Lilongwe, Malawi. *International Journal of STDs and AIDS, 24*(42-49).

Khan, A. A. (1992). An Integrated Approach to Measuring Potential Spatial Access to Health Care Service. *Socio-Econ. Planning Sci., 26*(4), 275-287.

Khan, M. R., Doherty, I.A., Schoenbach, V.J., Taylor, E.M., Epperson, M.W., Adimora, A.A. (2009). Incarceration and high-risk sex partnerships among men in the United States. *Journal of Urban Health, 86*(4), 584-601.

Khan, M. R., Wohl, D. A., Weir, S. S., Adimora, A. A., Moseley, C., Norcott, K., . . . Miller, W. C. (2008). Incarceration and risky sexual partnerships in a southern US city. *J Urban Health, 85*(1), 100-113. doi: 10.1007/s11524-007-9237-8

Knittel, A. K., Snow, R.C., Griffith, D.M., Morenoff, J. (2013). Incarceration and sexual risk: Examining the relationship between men's involvement in the criminal justice system and risky sexual behavior. *AIDS Behavior, 17*, 2703-2714.

Larson, P. S., Mathanga, D.P., Campbell, C.H., Wilson, M.L. . (2012). Distance to health services influences insecticide-treated net possession and use among six to 59 month-old children in Malawi. *Malaria Journal, 11*(18).

Lichtenstein, B., Hook III, E.W., Sharma, A.K. (2005). Public tolerance, private pain: Stigma and sexually transmitted infections in the American Deep South. *Culture, Health and Sexuality, 7*(1), 43-57.

Logan, T. K., Cole, J., & Leukefeld, C. (2002). Women, sex, and HIV: social and contextual factors, meta-analysis of published interventions, and implications for practice and research. *Psychol Bull, 128*(6), 851-885.

Marshall, B. D. L. (2008). The contextual determinants of sexually transmissible infections among street-involved youth in North America. *Culture, Health and Sexuality, 10*(8), 787-799.

Mayberry, R. M., Mili, F., Ofili, E. (2000). Racial and ethnic differences in access to medical care. *Medical Care Research, 57*(suppl 1), 108-145.

Mercer, C. H., Sutcliffe, L., Johnson, A. M., White, P. J., Brook, G., Ross, J. D., . . . Cassell, J. A. (2007). How much do delayed healthcare seeking, delayed care provision, and diversion from primary care contribute to the transmission of STIs? *Sex Transm Infect, 83*(5), 400-405. doi: 10.1136/sti.2006.024554

Monnet, E., Ramee, C., Minello, A., Jooste, V., Carel, D., & Di Martino, V. (2008). Socioeconomic context, distance to primary care and detection of hepatitis C: a French population-based study. *Soc Sci Med, 66*(5), 1046-1056. doi: 10.1016/j.socscimed.2007.11.044

Moran, J. S., Aral, S.O., Jenkins, W.C. et al. (1989). The impact of sexually transmitted diseases on minority populations. *Public Health Reports, 104*, 560-565.

Office of Population Affairs. (2013). *Title X: The National Family Planning Program*. Retrieved from http://www.hhs.gov/opa/pdfs/title-x-national-family-planning-overview.pdf.

Olonilua, O., Ross, J. D., Mercer, C., Keane, F., Brook, G., & Cassell, J. A. (2008). The limits of health-care seeking behaviour: how long will patients travel for STI care? Evidence from England's 'Patient Access and the Transmission of Sexually Transmitted Infections' ('PATSI') study. *Int J STD AIDS, 19*(12), 814-816. doi: 10.1258/ijsa.2008.008205

Pannell, D. J. (1997). Sensitivity analysis of normative economic models: Theoretical framework and practical strategies. *Agricultural Economics , 16*(139-152).

Penchansky, R., Thomas, J.W. (1981). The concept of access: definition and relationship to consumer satisfaction. *Medical Care, 19*(2), 127-140.

Phibbs, C. S., Luft, H.S. (1995). Correlation of Travel Time on Roads Versus Straight Line Distance. *Medical Care Research and Review, 52*, 532-542.

Pouget, E. R., Kershaw, T.S., Niccolai, L.M., Ickovics, J.R., Blankenship, K.M. (2010a). Associations of Sex Ratios and Male Incarceration Rates with Multiple Opposite-Sex Partners: Potential Social Determinants of HIV/STI Transmission. *Public Health Reports, 125*(Supplement 4), 70-80.

Pouget, E. R., Kershaw, T.S., Niccolai, L.M., Ickovics, J.R., Blankenship, K.M. (2010b). Associations of sex ratios and male incarceration rates with multiple opposite-sex partners: potential social determinants of HIV/STI transmission. *Public Health Report, 125*(Suppl 4), 70-80.

Rastogi, S., Johnson, T.D., Hoeffel, E.M., Drewery, M.P. (2011). *The Black Population: 2010*. (C2010BR-06). Retrieved from http://www.census.gov/prod/cen2010/briefs/c2010br-06.pdf.

Richardson, L. D. N., M. (2010). Access to Health and Health Care: How Race and Ethnicity Matter. *Mount Sinai Journal of Medicine, 77*, 166-177.

Smedley, B. D., Stith, A.Y., Nelson, A.R. (Ed.). (2003). *Unequal treatment: Confronting racial and ethnic disparities in health care* Washington D.C.: National Academies Press.

Song, R., Hall, H.I., McDavid Harrison, K., Sharpe, T.T., Lin, L., Dean, H.D. (2011). Identifying the impact of social determinants of health on disease rates using correlation analysis of area-based summary information. *Public Health Reports, 126*(Suppl 3), 70-80.

Stokols, D. (1992). Establishing and Maintaining Healthy Environments: Toward a Social Ecology of Health Promotion. *American Pyschologist, 47*(1), 6-22.

Talen, E., Anselin, L. (1998). Assessing Spatial Equity: An Evaluation of Measures of Accessibility to Public Playgrounds. *Environment and Planning A, 30*, 595-613.

Teach, S. J., Guagliardo, M.F., Crain, E.F., McCarter, R.J., Quint, D.M., Shao, C., Joseph, J.G. . (2006). Spatial accessibility of primary care pediatric services in an urban environment: association with asthma management and outcome. *Pediatrics, 117*(4), S78-85.

The American Congress of Obstetricians and Gynecologists. (2012). ACOG Physicial Lookup: Search by State. Retrieved April 3,, 2012, from http://www.acog.org/About_ACOG/Find_an_Ob-Gyn/Search_by_State

Thomas, J. C., Levandowski, B.A., Isler, M.R., Torrone, E., Wilson, G. (2007). Incarceration and Sexually Transmitted Infections: A Neighborhood Perspective. *Journal of Urban Health, 85*(1), 90-99.

Thomas, J. C., Levandowski, B.A., Isler, M.R., Torrone, E., Wilson, G. (2008). Incarceration and Sexually Transmitted Infections: A Neighborhood Perspective. *Journal of Urban Health, 85*(1), 90-99.

Thomas, J. C., Torrone, E. . (2006). Incarceration as forced migration: Effects on selected community health outcomes. *Am J Public Health, 96*(10), 1762-1765.

Thornton, L. E., Pearce, J.R., Macdonald, L., Lamb, K.E., Ellaway, A. (2012). Does the choice of neighbourhood supermarket access measure influence associations with individual-level fruit and vegetable consumption? A case study from Glasgow. *INternational Journal of Health Geographics, 11*(29).

U.S. Census Bureau. (2010). Age Groups and Sex. Retrieved May 8,, 2014, from <http://factfinder2.census.gov>

Wang, F. M., S., Escamilla, V., Luo, L. (2008). Late-Stage Breast Cancer Diagnosis and Health Care Access in Illinois *Professional Geographer, 60*(1), 54-69.

Washington, H. A. (2006). *Medical Apartheid: The dark history of medical experimentation on Black Americans from Colonial times to the present*. New York: Harlem Moon.

Wiehe, S. E., Rosenman, M.B., Wang, J., Katz, B.P., Fortenberry, D. (2011). Chlamydia screening among young women: individual- and provider-level differences in testing *Pediatrics, 127*(2), e336-344.

Yang, D. H., George, R., Mullner, R. (2006). Comparing GIS-Based Methods of Measuring Spatial Accessibility to Health Services. *Journal of Medical Systems, 30*(1), 23-32.

Chapter 5: Summary and Conclusions

There are many factors that contribute to geographic variations in rates of HIV and other STIs, however, social and contextual factors (e.g. economic oppression, housing instability, healthcare access) appear to play an important role in shaping STI transmission dynamics (Adimora and Schoenbach 2002, Hogben 2008, Marshall 2008) and STI prevalence (Moran 1989, Fullilove 2006, Geisler 2006, Song 2011). Male incarceration has emerged as one potentially powerful contextual determinant of sexual health outcomes in the US (Thomas 2006, Thomas 2007, Pouget 2010). Research examining the relationship between male incarceration rates and STI prevalence remains a relatively new area of inquiry (Thomas 2005, Thomas 2006, Thomas 2007). The study of pathways and moderators of the relationships between male incarceration and the prevalence of newly diagnosed STIs is an important area of research.

This dissertation used mixed methods to examine whether and how male incarceration and the health care service environment were associated with sexual health. The research presented here provides a deeper understanding of the relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs over time. It also highlights several mechanisms through which male incarceration can shape sexual risk among a racial/ethnic group disproportionately impacted by incarceration and tests the influence that an additional contextual factor, spatial access to health care, has on the relationship between male incarceration and the prevalence of newly-diagnosed STIs. The theoretical framework guiding this research was based on the social ecological model (SEM) and Social Cognitive Theory (SCT).

The aim of the first paper (Chapter 2) was to use qualitative methods to explore how male incarceration rates and resulting sex ratio imbalances impacted the nature and structure of sexual partnerships to create conditions that increase the risk of HIV/STI

transmission for heterosexual Black women. Our findings support and extend previous research examining incarceration rates, sex ratios and heterosexual women's sexual risk for HIV and other STIs. It is widely recognized that male incarceration reduces the number of male partners (Adimora, Schoenbach et al. 2001, Ferguson 2007, Pouget 2010, Green 2012, Adimora 2013, Knittel 2013). The present study highlights the importance that the *desirability* of available male partners has on the nature and structure of partnerships. The paucity of available and *desirable* male partners produced a unique vulnerability to the transmission of HIV/STIs by leading women to engage in partnerships with male partners who may have a higher sexual risk (e.g. older male partners) and to engage in short-term partnerships focused on sexual activity. High local rates of male incarceration also contributed to women engaging in transactional sex relationships in order to provide financial support to their household during periods when sexual partners were incarcerated or during times where their partner's incarceration history prevented them from securing gainful employment. This study helps to illuminate the collateral consequences of male incarceration by describing new pathways through which heterosexual women living in neighborhoods disproportionately impacted by male incarceration may be at risk for the transmission of HIV and other STIs.

The paper presented in Chapter 3 examined the longitudinal relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs in Atlanta census tracts from 2005 to 2010. The results from this paper support previous work that found a positive correlation between rates of incarceration and STI prevalence (Thomas 2005, Thomas 2006, Thomas 2007), however, our results suggest that the relationship between rates of male incarceration and the prevalence of STIs may be more nuanced that originally thought. We found that census tracts with higher baseline rates of male incarceration had a higher prevalence of newly-diagnosed STIs and census tracts

with a greater increase in their rate of male incarceration experienced a more rapid increase in the prevalence of newly-diagnosed STIs. Contrary to our expectations, census tracts with higher baseline rates of male incarceration experienced a decrease in their prevalence of newly-diagnosed STIs over time. Our findings extend previous research by isolating rates of male incarceration alone, not in combination with rates of female incarceration, on the prevalence of newly-diagnosed STIs and by demonstrating that a longitudinal relationship exists between rates of incarceration and the prevalence of newly-diagnosed STIs.

The last dissertation paper presented here (Chapter 4) examined whether spatial access to health care moderated the relationship between male incarceration rates and the prevalence of newly-diagnosed STIs. The findings suggest that while spatial access to health care does act as an effect modifier for the relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs, it was not in the direction hypothesized. As the distance to the nearest sexual health facility increased, the magnitude of the relationship between rate of male incarceration and the prevalence of newly-diagnosed STIs decreased (not increased as was expected). In census tracts with the best spatial access to health care, male incarceration rates predicted a slight positive increase in the prevalence of newly-diagnosed STIs. To our knowledge no other studies have explored whether spatial access to health care attenuates the relationship between male incarceration rates and the prevalence on newly-diagnosed STIs. This study presents an important first step in understanding how the prevalence of newly-diagnosed STIs may be the result of multiple factors that intersect in complex ways.

Taken together the findings from this dissertation underscore the relationship between rates of male incarceration and sexual health outcomes in the Atlanta MSA. The results from the qualitative phase (Chapter 2) of the dissertation research can help us understand some of the findings from the quantitative papers (Chapters 3 and 4). Our

findings regarding the longitudinal relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs (Chapter 3) supports previous research on incarceration rates and STIs (Thomas 2005, Thomas 2007, Thomas 2008). Participants from our qualitative study describe some of the factors present in a neighborhood with a high rate of male incarceration that may shape the local prevalence of STIs. These include: women engaging in short-term sexual relationships with high-risk sexual male partners (e.g. partners paying for sex, older male partners), engaging in transactional sex relationships and having male sexual partners who may be engaged in multiple and concurrent sexual partnerships. An unexpected finding was that some participants believed that high neighborhood rates of HIV and other STIs were caused in part by men engaging in same-sex sexual behavior, a behavior that some women believed began during periods where their partner was incarcerated. Women's perceptions of the risk characteristics of their male sexual partners may help explain our finding that census tracts with high baseline rates of male incarceration have high baseline rates of male incarceration experience a decrease in their prevalence of newly-diagnosed STIs over time. Men who are at high-risk for STIs are removed during periods of incarceration and may receive treatment for their STI(s) during their period of incarceration, both of which contribute to a reduction in the overall prevalence of newly-diagnosed STIs.

Results from the qualitative phase of the dissertation (Chapter 2) are particularly useful to help understand our findings regarding the moderating effect of spatial access to health care on the relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs (Chapter 4). Specifically we found that in census tracts with the best spatial access to health care there was a positive association between rates of male incarceration and the prevalence of newly-diagnosed STIs. Census tracts with the best spatial access to health care services were also those with the highest rates of male incarceration. Participants in the qualitative phase of the dissertation study who lived in

an area with high rates of male incarceration described living in environments that were severely economically distressed. In this environment, women described making decisions about engaging in transactional sex relationships in order to provide "fast cash" to help support their household. Transactional sex relationships were viewed as beneficial because they allowed women to work in situations where their childcare responsibilities were largely uninterrupted and they wouldn't incur additional childcare expenses. Given that women in neighborhoods with high rates of male incarceration made decisions about economic opportunities based on associated "costs", it follows that they might also consider associated "costs" (i.e. transportation, childcare) when seeking out health care services. In this context, the costs associated with accessing health care may represent too high of a burden to overcome, regardless of their spatial location. Therefore there may be other, unmeasured, aspects of health care access that may be more influential on sexual health outcomes in neighborhoods with high rates of male incarceration.

Evaluation of the dissertation research

Limitations. The dissertation research presented here should be understood in the context of several limitations. First, all of the papers from the dissertation (Chapters 2 – 4) used census tracts to estimate an individual's neighborhood. There has been some debate about the use of census tracts in terms of their scale and boundaries because they are not necessarily representative of the community or neighborhood. Census tracts were used as they were the smallest administrative unit for which our outcome data were available and census tracts are used frequently in studies examining reproductive, sexual, and other health outcomes at the neighborhood level (Anderson 1996, O'Campo 1997, Culhane J.F. & Elo 2005, Apparicio 2008). Furthermore, research suggests that high risk heterosexual adults are likely to select their sexual partners from their own

census tract or an adjacent one (Gindi 2011). Second, in the qualitative phase of the dissertation (Chapter 2) every attempt was made to select two census tracts from the urban core, we were unable to identify a census tract in the urban core with a low male incarceration rate, a male: female sex ratio close to 1.00, and a high proportion of Black residents. The difficulty in identifying this type of census tract highlights the racialization of incarceration in the US. As a result, *Blackrock* was located outside of the urban core. Our findings therefore could be a reflection of the different perceptions that women living within and those living outside of the urban core may have of sex ratios, partner availability, and romantic relationships instead of a product of their perceptions of local incarceration rates and sex ratios. Finally, the quantitative papers (Chapters 3 and 4) have an ecologic design and are therefore unable to explore how individual-level factors (i.e. condom use) influence study outcomes. The qualitative phase of the dissertation (Chapter 2) was designed to explore some of these factors. Third, the Census Bureau counts individuals in correctional institutions (e.g. prisons, jails, detention centers or halfway houses) as residents of the facility where they are incarcerated rather than being counted as residents of their pre-incarceration residence. This decision is based on the US Census Bureau's definition of "usual residence" which was defined as "the place where the person lives and sleeps most of the time"(U.S. Census Bureau 2000). In most cases, the correctional institution's location is not the same as an incarcerated individual's pre-incarceration residence (the location where the individual is most likely to return post-incarceration). The Census has been frequently criticized for undercounting these individuals in their pre-incarceration neighborhood of residence and over-counting individuals in census tracts were correctional facilities are located (Hamsher 2005, Smith-Socaris 2009, Brennan Justice Center 2011). The methods used for counting individuals in in the 2000 and 2010 decennial data impacted demographic data used in the all papers from the dissertation study (Chapters 2 – 4). Notably, the

2000 and 2010 Census data could represent an undercount in census tracts that have high rates of short-term incarceration and overestimate the number of men in the possible partner pool in census tracts where correctional facilities are located. Census counts are problematic for the denominator used to calculate statistics in this study, including sex ratios and male incarceration rates (Williams 2000).

Strengths. Despite the limitations described above, this dissertation research has several strengths and helps further current understandings of the complex relationship between rates of male incarceration and the prevalence of HIV and other STIs. To begin, the dissertation research study utilized both qualitative and quantitative methodologies to examine the relationship between male incarceration, spatial access to health care and sexual health outcomes. Employing a combination of both small scale qualitative and large scale quantitative methodologies is a promising approach to investigate the relationship between neighborhood factors and individual health (Diez Roux 2001). Mixed methods research can help by providing a more thorough understanding of a relationship (Salazar 2006). To our knowledge, this is the first study that has used qualitative methods to explore how male incarceration rates and resulting sex ratio imbalances impact the nature and structure of sexual relationships to create conditions that increase the risk of HIV/STI transmission among heterosexual Black women. It is also the first study to establish a causal relationship, using longitudinal analyses, between rates of male incarceration and the prevalence of newly-diagnosed STIs. Finally, we were unable to identify other studies that have considered the health care service environment, specifically spatial access to health care, as a potential modifier of the relationship between male incarceration rates and rates of newly-diagnosed STIs. The findings from this dissertation study address several critical gaps in the literature.

Implications for Research and Practice

Future research based on dissertation data. This dissertation research represents a selection of the possible findings from the data collected. Far more data was generated from this study then we are able to present here. In order to further examine the complex relationship between male incarceration and the prevalence of newly-diagnosed STIs, two additional analyses have been identified and outlined below. These analyses will be conducted using the data that was collected for the dissertation research.

1. Relationship Power and Sexual Decision-Making. Several researchers have posited that imbalanced sex ratios (created in part by incarceration) make it difficult for women to negotiate condom use with male sexual partners because they fear losing the partner to another woman (Adimora and Schoenbach 2002, Logan, Cole et al. 2002, Adimora 2005, Adimora 2006, Adimora, Schoenbach et al. 2007, Harawa 2008, Khan 2009). We identified only one qualitative study confirming these hypotheses (Ferguson 2007), and this study was conducted in an environment where sex ratios weren't shaped by local incarceration rates. Further research into the role that imbalanced sex ratios, shaped by incarceration, have on sexual relationship power and decision-making is needed to better understand sexual risk and the transmission of HIV and other STIs among heterosexual Black women. Although we were unable to explore this topic in the present study, future analyses from this dissertation will focus on examining and comparing heterosexual Black women's perspectives on relationship power and sexual decision-making in two census tracts: one with high rates of male incarceration and an imbalanced sex ratio and another with lower rates of male incarceration and a sex ratio closer to 1.00.
2. Examining person-time spent incarcerated. In the paper presented in Chapter 3, we found that census tracts with medium and high baseline rates of male

incarceration experienced a decrease in their prevalence of newly-diagnosed STIs over time. In this study we operationalized male incarceration as the tract-level rate of male incarceration (per 1,000 adult men). Our findings regarding baseline rates of male incarceration may be better understood by operationalizing male incarceration using person-time spent in prison. Using this measure would allow for the examination of whether longer periods of incarceration, not just the average rate of male incarceration, contribute to a lower prevalence of newly-diagnosed STIs over time. It may be that not only are a large number of high-risk men being removed from their sexual network, but that they may be incarcerated for longer periods of time, contributing to a lower prevalence of newly-diagnosed STIs over time. Future analyses will examine whether average tract-level person-time spent in prison annually helps to explain the reduction in the prevalence of newly-diagnosed STIs over time.

Future research building off of dissertation results. This dissertation provides important information regarding the relationship between rates of male incarceration and the prevalence of the newly-diagnosed STIs and helps to identify possible mechanisms through which male incarceration may contribute to racial disparities in rates of HIV and other STIs. The findings also point to several areas of additional research that build off of the dissertation results. The proposed studies outlined below would require additional data collection. To begin, the theme of *desirability* emerged from the qualitative data (Chapter 2) as a factor influencing the nature and structure of sexual partnerships in the context of high rates of male incarceration. Participants also described engaging in transactional sex relationships as a direct result of their partners' incarceration experiences. To better understand racial/ethnic disparities in rates of HIV and other STIs, future research should focus on perceptions of partner desirability and how perceived desirability impacts sexual risk among heterosexual Black women and

should examine economically motivated sexual relationships among Black women in the US, specifically among women living in communities disproportionately impacted by incarceration.

In both quantitative papers (Chapters 3 and 4) we were unable to examine racial/ethnic variations in rates of male incarceration or in the prevalence of newly-diagnosed STIs. Given that rates of male incarceration are highest among Black men (Carson 2012) and that Black adults have the highest rates of newly-diagnosed STIs of all racial/ethnic groups in the US (Centers for Disease Control and Prevention 2014), examining the relationship between these factors among Black adults may be a particularly important area of study. To better understand racial disparities in sexual health outcomes, future research should focus on examining the longitudinal relationship between rates of male incarceration and the prevalence of newly-diagnosed STIs among Black adults. Racial disparities also exist in health care access and utilization. Black adults have lower rates of health care utilization than their White counterparts and may be more distrusting of the healthcare system (Washington 2006, Burgess 2008, Wiehe 2011, Gaskin 2012, Guerro 2013). Future research should examine racial differences in health care access as a moderator of rates of male incarceration and the prevalence of newly-diagnosed STIs because these barriers may be particularly relevant for understanding health care utilization among Black adults (Lichtenstein 2005, Barth 2010).

Lastly, the results from the final paper (Chapter 4) suggest that as spatial access to sexual health services worsened, the magnitude of the relationship between rate of male incarceration and prevalence of newly-diagnosed STIs decreased. Because this was a cross-sectional study we were unable to determine the moderation effect over time. Public health clinics may be more likely to be located in areas with high rates of newly-

diagnosed STIs. Longitudinal research is needed to examine whether the moderation effect of spatial access to health care changes over time.

Intervention development and practice. When combined with past research the results from this dissertation study can help guide the development of interventions and programs aimed at reducing the prevalence of newly-diagnosed HIV and other STIs. First, together the findings from this study highlight the negative consequences that high rates of male incarceration have on neighborhoods and their residents. Black men receive a disproportionate number of convictions and harsher sentences than their White counterparts. Efforts should be made to implement more equitable enforcement, conviction and sentencing practices. These changes could have important effects on the composition and stability of sexual networks. Second, the qualitative phase of this study describes how male incarceration and sex ratios influence partner availability and the nature and structure of sexual relationships to favor the transmission of HIV and other STIs. Policies and programs aimed at reducing the risk of HIV and other STIs among heterosexual Black women should consider the role of local male incarceration rates, marriage rates and the resulting sex ratio imbalances. Lastly, findings from the paper presented in Chapter 3 can be used to help identify geographic areas where rates of male incarceration are increasing rapidly, where STI prevention programs interventions may be most needed.

Conclusion

The presented dissertation research contributes to our current understanding of the relationship between rates of male incarceration and the prevalence of STIs. Furthermore, the findings identified potential pathways through which high rates of male incarceration may contribute to racial disparities in sexual health outcomes and how additional contextual factors (e.g. spatial access to health care) may work together

with male incarceration to influence the prevalence of newly-diagnosed STIs. Findings from this dissertation research fill critical gaps in the literature and emphasized future areas of research to better understand the complex relationship between male incarceration, the health care service environment and sexual health outcomes.

References

Adimora, A. A., & Schoenbach, V. J. (2002). Contextual factors and the black-white disparity in heterosexual HIV transmission. *Epidemiology, 13*(6), 707-712. doi: 10.1097/01.EDE.0000024139.60291.08

Adimora, A. A., Schoenbach, V. J., & Doherty, I. A. (2007). Concurrent sexual partnerships among men in the United States. *Am J Public Health, 97*(12), 2230-2237. doi: 10.2105/AJPH.2006.099069

Adimora, A. A., Schoenbach, V. J., Martinson, F. E., Donaldson, K. H., Fullilove, R. E., & Aral, S. O. (2001). Social context of sexual relationships among rural African Americans. *Sex Transm Dis, 28*(2), 69-76.

Adimora, A. A., SChoenbach, V.J. . (2005). Social context, sexual networks and racial disparities in rates of sexually transmitted infections. *Journal of Infectious Disease, 291*, S115-S122.

Adimora, A. A., Schoenbach, V.J., Doherty, I.A. (2006). HIV and African Americans in the southern United States: sexual networks and social context. *Sexually Transmitted Diseases, 33*(7 Suppl), S39-45.

Adimora, A. A., Schoenbach, V.J., Taylor, E.M., Khan, M.R., Schwartz, R.J., Miller, W.C. (2013). Sex ratio, poverty and concurrent partnerships among men and women in the United States: a multilevel analysis. *Annals of Epidemiology, 23*(11), 716-719.

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

Apparicio, P., Abdelmajid,M., Riva, M., Shearmur, R. (2008). Comparing alternative approaches to measuring the geographical accessibility of urban health services:

Distance types and aggregation-error issues. *International Journal of Health Geographics, 7*(7).

Barth, K. R., Cook, R.L., Downs, J.S., Switzer, G.E., Fischhoff, B. (2010). Social stigma and negative consequences: Factors that influence college students' decisions to seek testing for sexually transmitted infections. *Journal of American College Health, 50*(4), 153-159.

Brennan Justice Center. (2011). U.S. Census and Incarceration. Retrieved April 2, 2012, from http://www.brennancenter.org/content/section/category/us_census_and_the_incarcerated_people

Burgess, D. J., Ding, Y., Hargreaves, M., van Ryn, M., Phelan, S. (2008). The association between perceived discrimination and underutilization of needed medical and mental health care in a multi-ethnic community sample. *Journal of Health Care for the Poor and Underserved, 19*, 894-911.

Carson, E. A., Sabol, W.J. (2012). *Prisoners in 2011*. (NCJ 239808). Retrieved from http://www.doc.wa.gov/aboutdoc/measuresstatistics/docs/BJSReport.Prisonersin2011.pdf.

Centers for Disease Control and Prevention. (2014). 2012 Sexually Transmitted Diseases Surveillance. Retrieved April 22,, 2014, from http://www.cdc.gov/std/stats12/minorities.htm

Culhane J.F. & Elo, I. T. (2005). Neighborhood context and reproductive health. *American Journal of Obstetrics and Gynecology, 192*, SS22-29.

Diez Roux, A. V. (2001). Investigating neighborhood and area effects on health. *American Journal of Public Health, 91*(11), 1783-1789.

Ferguson, Y. O., Quinn, S.C., Sandelowski, M. (2007). The gender ratio imbalance and its relationship to risk of HIV/AIDS among African American women at historically black colleges and universities. *AIDS Care, 18*(4), 323-331.

Fullilove, R. E. (2006). Health Disparities and HIV/AIDS: Recommendations for Confronting the Epidemic in Black America. Washington, D.C. : National Minority AIDS Council.

Gaskin, D. J., Dinwiddle, G.Y., Chan, K.S., McCleary, R. (2012). Residential segregation and disparities in health care service utilization. *Medical Care Research and Review, 69*(2), 158-175.

Geisler, W. M., Chyu, L., Kusonoki, Y. (2006). Health insurance coverage, health care-seeking behaviors, and genital chlamydial infection prevalence in sexually active young adults. *Sexually Transmitted Diseases, 33*, 389-396.

Gindi, R. M., Sifakis, F., Sherman, S.G., Towe, V.L., Flynn, C., Zenilman, J.M. (2011). The Geography of Heterosexual Partnerships in Baltimore City Adults. *Sexually Transmitted Diseases, 38*(4), 260-266.

Green, T. C., Pouget, E.R., Harrington, M., Taxman, F.S., Rhodes, A.G., O'Connell, D., Martin, S.S., Prendergast, M., Friedmann, P.D. (2012). Limiting Options: Sex ratios, incarceration rates and sexual risk behavior among people on probation and parole. *Sexually Transmitted Diseases, 39*(6), 424-430.

Guerro, E. G., Kao, D. (2013). Racial/ethnic minority and low-income hotspots and their geographic proximity to integrated care providers. *Substance Abuse Treatment, Prevention and Policy, 8*(34).

Hamsher, D. (2005). Counted out Twice: Power, Representation, and the "Usual Residence Rule" in the Enumeration of Prisoners: A State-Based Approach to Correcting Flawed Census Data. *The Journal of Criminal Law and Criminology, 96*(1), 299-328.

Harawa, N. A., A. (2008). Incarceration, African Americans and HIV: advancing a research agenda. *Journal of the National Medical Association, 100*(1), 57-62.

Hogben, M., Leichliter, J.S. (2008). Social Determinants and Sexually Transmitted Disease Disparities. *Sexually Transmitted Diseases, 35*(12), S13-S18.

Khan, M. R., Doherty, I.A., Schoenbach, V.J., Taylor, E.M., Epperson, M.W., Adimora, A.A. (2009). Incarceration and high-risk sex partnerships among men in the United States. *Journal of Urban Health, 86*(4), 584-601.

Knittel, A. K., Snow, R.C., Griffith, D.M., Morenoff, J. (2013). Incarceration and sexual risk: Examining the relationship between men's involvement in the criminal justice system and risky sexual behavior. *AIDS Behavior, 17*, 2703-2714.

Lichtenstein, B., Hook III, E.W., Sharma, A.K. (2005). Public tolerance, private pain: Stigma and sexually transmitted infections in the American Deep South. *Culture, Health and Sexuality, 7*(1), 43-57.

Logan, T. K., Cole, J., & Leukefeld, C. (2002). Women, sex, and HIV: social and contextual factors, meta-analysis of published interventions, and implications for practice and research. *Psychol Bull, 128*(6), 851-885.

Marshall, B. D. L. (2008). The contextual determinants of sexually transmissible infections among street-involved youth in North America. *Culture, Health and Sexuality, 10*(8), 787-799.

Moran, J. S., Aral, S.O., Jenkins, W.C. et al. (1989). The impact of sexually transmitted diseases on minority populations. *Public Health Reports, 104*, 560-565.

O'Campo, P., Xue, X., Wang, M-C., Caughy, M.O. (1997). Neighborhood risk factors for low birth weight in Baltimore: a multi-level analysis. *American Journal of Public Health, 87*, 1113-1118.

Pouget, E. R., Kershaw, T.S., Niccolai, L.M., Ickovics, J.R., Blankenship, K.M. (2010a). Associations of sex ratios and male incarceration rates with multiple opposite-sex partners: potential social determinants of HIV/STI transmission. *Public Health Report, 125*(Suppl 4), 70-80.

Pouget, E. R., Kershaw, T.S., Niccolai, L.M., Ickovics, J.R., Blankenship, K.M. (2010b). Associations of Sex Ratios and Male Incarceration Rates with Multiple Opposite-Sex Partners: Potential Social Determinants of HIV/STI Transmission. *Public Health Reports, 125*(Supplement 4), 70-80.

Salazar, L. F., Crosby, R.A., DiClemente, R.J. (2006). Qualitative Research Strategies and Methods for Health Promotion. In L. F. Salazar, Crosby, R.A., DiClemente, R.J. (Ed.), *Research Methods in Health Promotion* (pp. 150-198). San Francisco Jossey-Bass.

Smith-Socaris, C. (2009). Prisoners of the Census: How the incarcerated are counted distorts our politics. Retrieved April 2, 2012, from http://www.progressivestates.org/news/dispatch/prisoners-the-census-how-the-incarcerated-are-counted-distorts-our-politics

Song, R., Hall, H.I., McDavid Harrison, K., Sharpe, T.T., Lin, L., Dean, H.D. (2011). Identifying the impact of social determinants of health on disease rates using correlation analysis of area-based summary information. *Public Health Reports, 126*(Suppl 3), 70-80.

Thomas, J. C., Levandowski, B.A., Isler, M.R., Torrone, E., Wilson, G. (2007). Incarceration and Sexually Transmitted Infections: A Neighborhood Perspective. *Journal of Urban Health, 85*(1), 90-99.

Thomas, J. C., Levandowski, B.A., Isler, M.R., Torrone, E., Wilson, G. (2008). Incarceration and Sexually Transmitted Infections: A Neighborhood Perspective. *Journal of Urban Health, 85*(1), 90-99.

Thomas, J. C., Sampson, L.A. . (2005). High rates of incarceration as a social force associated with community rates of sexually transmitted infection. *Journal of Infectious Disease, 191*(Suppl 1), S55-60.

Thomas, J. C., Torrone, E. . (2006). Incarceration as forced migration: Effects on selected community health outcomes. *American Journal of Public Health, 96*(10), 1762-1765.

U.S. Census Bureau. (2000). Residence Rules. Retrieved April 2, 2012, from http://www.census.gov/population/www/censusdata/resid_rules.html - usual

Washington, H. A. (2006). *Medical Apartheid: The dark history of medical experimentation on Black Americans from Colonial times to the present*. New York: Harlem Moon.

Wiehe, S. E., Rosenman, M.B., Wang, J., Katz, B.P., Fortenberry, D. (2011). Chlamydia screening among young women: individual- and provider-level differences in testing *Pediatrics, 127*(2), e336-344.

Williams, D. R. (2000). Race/Ethnicity and the 2000 Census: Recommendations. *American Journal of Public Health, 90*, 1728-1730.