STI/HIV and Incarceration in the United States: Modifiable Factors of Risky Sexual Partnerships and Depression

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ABSTRACT

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STI/HIV and Incarceration in the United States:
Modifiable Factors of Risky Sexual Partnerships and Depression
(Under the direction of William C. Miller, MD, PhD, MPH)

Incarceration is strongly, and alarmingly, associated with sexually transmitted infection (STI), including the human immunodeficiency virus (HIV).¹ This dissertation was devoted to investigating determinants of the disproportionately high levels of STI/HIV in populations with a history of and/or at risk of incarceration in the United States (US). Given incarceration is endemic in many communities, the effect of incarceration on health is a subject of great significance.

Incarceration may contribute to STI/HIV transmission by disrupting stable partnerships and promoting high-risk partnerships. We examined the relationship between incarceration and risky partnerships using the NC Rural Health Project (NCRHP) dataset (N=320), a population-based case-control study of sexual HIV transmission among African Americans living in eastern rural NC and the NC Priorities for Local AIDS Control Efforts (PLACE) study dataset (N=373), a sample recruited from venues where people meet sexual partners in an urban NC setting. Both analyses indicated that personal incarceration and partner’s history of incarceration were strongly associated with risky partnerships in multivariable analyses adjusting for demographic and socio-economic variables. We hypothesize that incarceration and substance abuse reciprocally contributed to one another and worked in concert to increase sexual risk behaviors.

Mental illness, which disproportionately affects populations with high levels of both STI/HIV²-⁴ and incarceration,⁵ may contribute to STI/HIV among incarcerated populations. We explored this hypothesis by measuring associations between chronic depression and STI, by arrest history, among a sub-sample of 11,594 participants of the National Longitudinal Study of
Adolescent Health. Young adults with chronic major depression - detected both early in adolescence (Wave I) and six years later in young adulthood (Wave III) - were particularly vulnerable to STI acquisition in young adulthood compared to those with no prior major depression, controlling for baseline STI. We measured higher prevalences of depression and STI and stronger associations between depression and STI among young adults with a prior history of arrest compared to those with no prior arrest history. These findings suggested that greater integration of mental health and STI services for adolescents and young adults is needed, particularly among youth involved in the criminal justice system.
DEDICATION

I dedicate this dissertation research to the memories of Andrew Kaplan and Willie Garrison, who continue to inspire our efforts to prevent HIV transmission in North Carolina and beyond.
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The people who have made completion of this dissertation possible – the five members of my dissertation committee - have also served as role models of how to study disease with intellectual rigor, public health pragmatism, enthusiasm, grace, and a sense of humor. I am greatly appreciative of their spoken and unspoken guidance through these doctoral years, which I will I carry with me throughout my career.

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I owe many thanks to Dr. David Wohl. David readily accepted me as a member of both his North Carolina Priorities for Local AIDS Control Efforts (NC PLACE) study field team and his Bridges to Good Health and Treatment (BRIGHT) prison working group. I have learned a great deal through participation in both teams. David spent hours brainstorming with me about how to study the effect of incarceration on STI/HIV. He also provided me with the opportunity to ask dissertation research questions about incarceration, partnership disruption, and risky partnerships on both NC PLACE community and in-prison surveys; these questions reflect concepts I have learned from David and/or ideas that emerged from conversations with David.
I thank him for his support, and moreover, for his tenacity in seeking to understand the effect of incarceration on health.

I am deeply grateful to Dr. Sharon Weir, who has played the role of teacher, advisor, colleague, and friend during my public health career and throughout this dissertation process. I thank Sharon for recommending to David Wohl that I participate in their collaborative NC PLACE study, for supporting me in the study of that which makes me passionate, and for offering numerous insightful comments on the conception of these research questions and the manuscript drafts. I am also thankful to Sharon for sending me to Burkina Faso to perform my first field study. This transformative experience, with Sharon’s enthusiasm for the study of STI and related behaviors, inspired me to choose a career in epidemiology. Burkina Faso has provided me with energy and a sense of purpose through the doctoral program, including during this study of STI and related behaviors among the resource-poor here in my own backyard of North Carolina.

I also am very grateful to Dr. Adaora Adimora. Ada was an enormously influential researcher even prior to my meeting her. Her work on factors of partnership concurrency among African Americans, presented at the UNC Carolina Population Center, in large part inspired my interest in studying determinants of HIV among African American populations. Her investigation of incarceration and partnership concurrency among the Rural Health Project sample served as the groundwork from which I built my dissertation analyses on incarceration and risky partnerships. I am greatly appreciative of Ada’s guidance during this dissertation. Despite her busy clinical schedule, Ada always made time to discuss determinants of HIV transmission among poor and vulnerable populations or to help me think through the best way to study incarceration and HIV-related behaviors. Ada spent numerous hours helping to formulate incarceration questions for the NC PLACE survey based on her experience with the NCRHP sample. She also provided substantial comments on the dissertation data analyses and the interpretation of study findings. Working with Ada has been extremely rewarding, and I look forward to our future collaborations.
I wish to express my heartfelt thanks to Dr. Jay Kaufman. Jay served as my academic advisor early in the doctoral program and he is the person from whom I have learned the most about the building of epidemiologic conceptual and statistical models. Jay is the most effective and enjoyable classroom instructor I have had in more than 20 years of schooling. I greatly appreciate Jay’s gift for communicating difficult concepts in simple terms, and his willingness to provide advice about methodological puzzles whether in the classroom, in person, or over email within a few hours notice. I have consulted Jay numerous times in designing conceptual models for the effect of incarceration on HIV-related behaviors and depression on STI, which serve as the foundation of my dissertation analyses. Jay has also provided important feedback on these dissertation manuscripts.

I owe thanks to many others. I thank Sherri Harris, Willie Garrison, and Anthony Anderson for their collaboration during the NC PLACE study field work. I also thank them for their friendship and for sharing their stories, which have made tangible for me the ways adverse social and structural factors affect health and wealth of African Americans in North Carolina.

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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>Add Health</td>
<td>National Longitudinal Study of Adolescent Health</td>
</tr>
<tr>
<td>AIDS</td>
<td>acquired immunodeficiency syndrome</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
</tr>
<tr>
<td>CH</td>
<td>Chapel Hill</td>
</tr>
<tr>
<td>CI</td>
<td>confidence interval</td>
</tr>
<tr>
<td>CPC</td>
<td>Carolina Population Center</td>
</tr>
<tr>
<td>GIS</td>
<td>geographic information systems</td>
</tr>
<tr>
<td>HIV</td>
<td>human immunodeficiency virus</td>
</tr>
<tr>
<td>NC</td>
<td>North Carolina</td>
</tr>
<tr>
<td>NCRHP</td>
<td>North Carolina Rural Health Project</td>
</tr>
<tr>
<td>PLACE</td>
<td>Priorities for Local AIDS Control Efforts</td>
</tr>
<tr>
<td>POR</td>
<td>prevalence odds ratio</td>
</tr>
<tr>
<td>PR</td>
<td>prevalence ratio</td>
</tr>
<tr>
<td>STI</td>
<td>sexually transmitted infection</td>
</tr>
<tr>
<td>UNC</td>
<td>University of North Carolina</td>
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CHAPTER ONE: OVERVIEW

Incarceration is strongly, and alarmingly, associated with sexually transmitted infection (STI) in the United States (US), including the human immunodeficiency virus (HIV), the virus that causes acquired immunodeficiency syndrome (AIDS). Incarceration may contribute to STI/HIV transmission by disrupting stable partnerships and promoting high-risk partnerships. Preliminary evidence has indicated that incarceration is associated with elevated levels of risky sexual partnership, though research into the association is cursory and limited. In addition, underlying factors of the disproportionately high prevalence of risky sexual partnership and STI in populations with high levels of incarceration have not been identified.

This dissertation was devoted to exploring two formative research areas that described the modifiable factors of risky sexual partnership and STI/HIV in populations with a history of and/or at risk of incarceration. Given that incarceration is endemic in many US communities, the effect of incarceration on health is a subject of great significance. Study findings could inform community- and prison-based STI/HIV prevention programs, as well as lay ground for future investigations into the causal effect of incarceration on health.

First, the cross-sectional relationship between incarceration and self-reported risky sexual partnership/STI was described at the individual level in two North Carolina (NC) populations, a state with high incidence of STI/HIV (Aim 1). Second, mental illness, which disproportionately affects populations with high levels of both STI/HIV and incarceration, was examined as a potential contributing factor to STI/HIV among a population with prior involvement in the criminal justice system. Among a nationally-representative sample of adolescents, the temporal associations of depression and STI, by status prior arrest, were described (Aim 2).
1.1. Aim 1

**Aim 1:** To measure the association between incarceration and risky sexual partnership.

**Rationale for Aim 1:** Though correctional facility-based surveys indicate that STI/HIV and related behaviors cluster in incarcerated populations, few research studies have compared prevalence of risky partnerships among populations with incarceration history to prevalence among a referent population with no prior incarceration. Improved understanding of the relationship between incarceration and risky partnership provides needed information to improve STI/HIV programming in NC correctional facilities and in neighborhoods with high incarceration rates.

**Hypothesis for Aim 1:** Recent risky sexual partnership will be positively associated with the respondent’s incarceration experience, including the respondent’s personal incarceration and the respondent’s sexual partnership with someone who was ever incarcerated.

**Overview of Aim 1:** We examined the relationship between risky partnerships and incarceration variables - the respondent’s personal incarceration history and recent sexual partnership with someone who had ever been incarcerated – using the NC Rural Health Project (NCRHP) dataset (N=320), a population-based case-control study of HIV among African Americans living in eastern rural NC (Aim 1a) and the NC Priorities for Local AIDS Control Efforts (PLACE) study dataset (N=373), a sample recruited from venues where people meet sexual partners in an urban NC setting (Aim 1b).

1.2. Aim 2

**Aim 2:** To measure the association between depression – based on depression during adolescence (Wave I) and in young adulthood (Wave III) – and a positive test result with *Chlamydia trachomatis*, *Neisseria gonorrhrea*, or *Trichomonas vaginalis*, by arrest history, an indicator of prior involvement in the criminal justice system and likely future incarceration.

**Rationale for Aim 2:** Depression, more prevalent among incarcerated populations, may contribute to the association between incarceration and STI. Investigating the association between depression and STI, by likelihood of incarceration, provides information needed to
inform mental health services in the context of STI/HIV prevention programming in communities with high and low levels of incarceration.

**Hypothesis for Aim 2:** Chronic depression, experienced from early adolescence to young adulthood, will be positively associated with acquisition of STI in young adulthood. Associations between chronic depression and STI will be stronger among those who have been involved in the criminal justice system, as indicated by prior arrest history.

**Overview of Aim 2:** Analyses were performed using the National Longitudinal Study of Adolescent Health (Add Health), among a sub-sample of approximately 10,000 male and female respondents with measures from Wave I (1995: adolescence) and Wave III (2001-2002: young adulthood). The association between depression - based on depression during adolescence (Wave I) and in young adulthood (Wave III) – and biologically-confirmed STI in young adulthood (Wave III) was measured, stratified by history of prior arrest (Wave III).
CHAPTER TWO: BACKGROUND AND SIGNIFICANCE

2.1. Incarceration and Risky Sexual Partnership/STI (Aim 1)

2.1.1. STI/HIV and Incarceration among African Americans

The Racial Disparity in STI/HIV Prevalence

HIV rates are disproportionately high among African Americans in the US. Though African Americans represented 12% of the United States population in 2005,\textsuperscript{10} they accounted for nearly half of persons living with HIV/AIDS in 33 states that year\textsuperscript{11} and 74% of heterosexually-transmitted HIV cases in 29 states from 1999 to 2002.\textsuperscript{12} In 2002, HIV/AIDS was the second-leading cause of death among all African Americans aged 35 to 44 years and the leading cause of death among African American women aged 25 to 34 years.\textsuperscript{13}

African Americans nationwide are also three times as likely as whites be infected with an STI.\textsuperscript{14} The disparity in HIV/STI prevalence is particularly marked in the southern US. For example, in NC in 2006, African Americans comprised the overwhelming majority of reported cases of HIV (66%), chlamydia (60%), gonorrhea (75%), and primary or secondary syphilis (67%).\textsuperscript{15}

Numerous factors have been identified as potential determinants of the relatively high levels of STI/HIV among African Americans, though the extreme racial disparity remains largely unexplained. High prevalence of HIV infection among African Americans’ pool of sexual partners, multiple and concurrent partnerships, and intravenous drug use are all determinants of HIV transmission among African Americans.\textsuperscript{16-18} Contextual factors are also assumed to be important, though they are not well understood. Specifically, disease clusters in communities plagued by a myriad of adverse social and economic conditions including: high levels of poverty, crime, and incarceration; lack of educational and job opportunities; lack of housing; broken families; and a high female/male sex ratio.\textsuperscript{16} This research examined the impact of one potential underlying contextual
determinant: jail and prison incarceration. This phenomenon has increased rapidly over the past 30 years and become endemic in many communities.

**The Racial Disparity in Incarceration Prevalence**

From 1973 to 1997, the US experienced a five-fold increase in the incarcerated population. The Bureau of Justice Statistics (BJS) indicates that at mid-year 2005 the incarceration rate, a measure of the number of persons held in State or Federal prison or in local jails, was 738 per 100,000. The US currently has the highest incarceration rate in the world, 6 to 10 times the rate of most Western European countries.

The incarcerated population is 92% male and 44% African American. By 1995, about one-third of all African American men between the ages of 20 to 29 years were in jail, in prison or on probation, up from about 25% in 1990.

Our analysis of BJS trend data between 1977 to 1998 indicates that incarceration rates have disproportionately impacted southern states, with the greatest rate increases between 1977 and 1998 also observed in the South (350 per 100,000), followed by the West (323 per 100,000), North (246 per 100,000), and Midwest (252 per 100,000). For this reason, investigating the effects of incarceration in a southern population such as in North Carolina was appropriate.

African Americans are disproportionately affected by STI/HIV, and incarceration is one of many deleterious life events that African Americans are more likely to experience than whites; the role of incarceration in STI/HIV transmission warranted investigation.

### 2.1.2. Incarceration and STI/HIV

**Incarceration and HIV**

According to the BJS, 1.9% of state prison inmates and 1.1% of federal prison inmates were known to be infected with HIV in 2004. These levels are between 3 to 5 times the prevalence of HIV in the US general population.

Based on 1999 BJS estimates, greater than one-fifth of all HIV-positive persons in the US passed through a US correctional facility. The highest regional burdens of HIV are found among
releasees from southern correctional facilities (26% of all those living with HIV/AIDS in the south were released from jail or prison that year).

**Incarceration and Other STI**

Substantially higher STI prevalence is observed in incarcerated populations than in general-population samples. Particularly high chlamydia prevalence has been measured among incarcerated adolescent females (13-28%) and males (6-14%),\(^{23-32}\) with high estimates also observed among adults (men and women: 7%; women: 6-21%; men who have sex with men: 3%).\(^{33-36}\) In contrast, general-population household surveys indicate that male and female aggregated chlamydia prevalence ranges from approximate 3% to 5%,\(^{37-40}\) depending on the sample.

High prevalence of gonorrhea has also been measured among incarcerated adolescent females (5-13%) and males (1-7%),\(^ {23,24,26,28,30-32}\) and among adults (men and women: 3.1%; women: 3-9%; men who have sex with men: 1.5%).\(^ {33-36}\) General-population gonorrhea prevalence surveys are less common than those for chlamydia, but the few studies conducted indicate lower levels of infection than among incarcerated populations. Less than 1% of a nationally-representative sample of adolescents was infected,\(^ {40}\) while in inner-city Baltimore, about 5% of a household sample of men and women aged 18 to 35 years was infected.\(^ {39}\)

Syphilis is also high in incarcerated populations, with varying prevalence, depending on the study sample and diagnosis criteria (men and women aggregated: 1.6-2.0%; women: 2-16%; men: 0.3-2.5%).\(^ {23,28,33,41-44}\) Two studies, one at a jail in Chicago and another at a correctional facility in New York City, indicated that greater than one-fourth of women included in the sample needed syphilis treatment.\(^ {45,46}\) A secondary data analysis among the sample indicated that the syphilis incidence density was 6.5 infections per 100 woman-years (95% confidence interval, 5.7-7.2), which exceeded the 1997 early syphilis rate among women in the New York City general population by greater than 1000-fold.\(^ {47}\)

**Incarceration of a Sexual Partner and HIV**

HIV infection not only clusters in incarcerated populations but is also associated with having had a partner with an incarceration history. Among the NCRHP sample, the odds that a
respondent reported that at least one of the last three sexual partners had been incarcerated during the previous year was much higher among HIV-positive than HIV-negative men (odds ratio (OR): 6.3, 95% CI: 2.9-13.7) and women (OR: 4.4, 95% CI: 2.8-6.9). Approximately one-quarter (26%) of the HIV-positive women with less than 10 lifetime partners and low profile risk behavior reported that one of their last three sexual partners had been incarcerated, as did 48% of all HIV-positive men and 81% of all HIV-positive women.48

2.1.3. Proximate Determinants Framework: Incarceration as a Determinant of STI/HIV

We further modified the proximate determinants framework of HIV transmission, originally adapted by Boerma and Weir (2005)49 from earlier family planning50 and child health models,51 to inform understanding of the hypothesized effect of incarceration on STI/HIV acquisition. Boerma and Weir indicated that underlying determinants of HIV transmission, including social, cultural, political, and economic conditions affect proximate determinants of transmission, including sexual behaviors and access to HIV care. The proximate determinants, in turn, affect the biological determinants of HIV transmission, including exposure to HIV, transmission efficiency, and duration of infectiousness. The underlying proximate and biological determinants jointly determine HIV infection probability.

Incarceration is an underlying determinant that works at the socio-structural-, community-, peer-, family-, and individual-levels. Underlying determinants such as changes in sentencing laws, lead to increases in incarceration rates experienced at the community-, family-, and/or individual-levels. These changes influence individual-level proximate determinants (middle-left column), biological determinants and subsequent STI/HIV infection. Experiencing incarceration personally and/or living in a community with high levels of incarceration could influence an individual’s sexual risk of acquiring STI/HIV by increasing the proximate determinants of STI/HIV transmission, which, in turn, influence the biological determinants of transmission and STI/HIV infection.

This research investigated whether incarceration potentially increases numbers of new, multiple, and concurrent partnerships, which, in turn, influences the probability that an infected person and has sexual contact with an uninfected partner. The top portion of Figure 1 indicates that incarceration leads to dissolution and inhibited formation of serious, stable partnerships. As
marital partnership is protective against partnership concurrency\textsuperscript{52} we hypothesized that the diminishment of stable partnerships is one pathway through which incarceration works to increase risky sexual partnership and subsequent STI. Incarceration physically separates partners in intimate relationships, which leads to loneliness and emotional division\textsuperscript{53-59} and, in some cases, eventual partnership dissolution\textsuperscript{56, 58, 60}. Risk of new, multiple, and concurrent partnership could increase as a result\textsuperscript{61}, both during the incarceration, for the prisoner's partner, and after incarceration, for both the prisoner and his or her partner. During the incarceration, the prisoner's partner may seek new partners to fill an emotional or financial void\textsuperscript{56}. Upon the prisoner's release, the partner may no longer be waiting; absence of a partner combined with freedom from restrictions on sexual behavior may lead newly released prisoners to engage in increased risky sexual behaviors. Second, while incarceration could fracture partnerships, it could also inhibit stable partnerships from forming as it diminishes employment prospects and financial solvency,\textsuperscript{60, 62-64} lowering marriageability\textsuperscript{65, 66}.

The bottom portion of Figure 1 indicates the ways in which incarceration diminishes prospects for stable partnership, whether marital or non-marital, at the population level. First, the low male to female ratio, further decreased by incarceration, has been identified as an important determinant of low marriage rates and high partnership rates in the African American community\textsuperscript{64, 67, 68}. When the sex ratio is skewed, men hold disproportionate power in the relationship and women remain at a disadvantage in negotiating and maintaining long-term, and monogamous partnerships. Second, incarceration negatively affects the economic environment of the entire community\textsuperscript{62, 63} and hence reifies the impoverishment, racism, and resulting “tangle of pathology”\textsuperscript{64, 69} already characterizing many communities. In turn, stability in relationships and families is diminished. Finally, not only does incarceration lead to increased poverty, but it contributes to a chaotic environment in which a substantial proportion of the community remains itinerant, cycling in and out of correctional facilities\textsuperscript{70}. The effect of mobility on increased sexual risk-taking behaviors and STI/HIV transmission is well documented and provides insight into how and why movement in and out of the community at the time of incarceration may negatively affect relationships and health in the community\textsuperscript{49, 71-78}. 

\textsuperscript{52}
The proximate determinants inform the biological determinants of transmission, indicated at the right-hand portion of Figure 1. The probability that an uninfected person is exposed to an STI/HIV-positive partner constitutes an important biological determinant, as contact with infection is necessary for infection to spread. This biological determinant is likely much higher among those with a history of incarceration, as sexual partners accessible to those with a history of incarceration likely have a much higher prevalence of STI/HIV infection than the pool of sexual partners available to those without an incarceration history. When contact between an uninfected person and an infected person occurs, another important biological determinant is the per-act infection transmission probability, which is influenced by biological factors including hereditary, innate, or acquired resistance and immunologic characteristics, which are influenced by other infections, including STIs. Per-act STI/HIV transmission probability may be higher among those with a history of incarceration. For example, non-HIV STIs are much higher among incarcerated than general populations, and infection with another STI increases the probability that HIV is transmitted during the sexual act. These biological determinants of STI transmission - the probability that a sexual partner was infected and the probability of STI among either of the two partners - were not examined in this dissertation.

2.1.4. Incarceration and Risky Sexual Partnership

History of incarceration is associated with concurrent sexual partnership among HIV-negative (OR: 3.4, 95% CI: 1.3-8.8)\textsuperscript{6} and HIV-positive African-Americans in NC (OR: 2.3, 95% CI: 1.2-4.2)\textsuperscript{7} and among a household sample of Seattle residents (OR: 1.99, 95% CI: 1.0-3.8)\textsuperscript{6}, as well as with sex work among intravenous drug users (OR: 1.8, 95% CI: 1.2-2.6).\textsuperscript{9} These studies suggest that risky sexual behavior is a variable in the causal pathway between incarceration and STI/HIV and provide insights into the potential role of incarceration in risky sexual partnership and thus STI/HIV. However, these studies are limited in that the purpose was to examine a multitude of risk factors of risky sexual partnership, including incarceration. To our knowledge, no study has carefully examined incarceration as a primary explanatory variable in which those with a history of incarceration are compared to an appropriate referent group, those unexposed to incarceration.
Interviews with prisoners provide additional evidence that risky sexual behavior is common both prior to incarceration and upon release,\textsuperscript{79-82} much higher than observed among the general population.\textsuperscript{83} The inference that can be made from these studies is limited, due to lack of inclusion of an appropriate referent group.

### 2.1.5. Summary of Gaps in Prior Research and Current Research

**Summary of Gaps in Prior Research**

Improved understanding of the relationship between incarceration exposure and risky sexual partnership/STI was needed. The few studies in which incarcerated and non-incarcerated populations are compared on sexual behavior outcomes provide only a glimpse into the sexual behavior differences between incarcerated and non-incarcerated population, as the primary purpose of these studies was not to examine incarceration as a primary exposure. Surveillance of risk behaviors among incarcerated populations provides important data, though lack of a relevant “non-incarcerated” comparison group greatly limits interpretability of estimates. Further investigation into the association of incarceration and the outcomes of STI/HIV and/or relevant risk behaviors was warranted. Different durations of incarceration needed to be systematically investigated, controlling for potential confounding factors.

**Current Research**

We explored sexual partnership outcome indicators by incarceration exposure among two NC populations, using the NCRHP dataset (Aim 1a) and the PLACE data set (Aim 1b).

**Public Health Implications of Research**

Improved understanding of the relationship between incarceration and risky partnership provides needed information to improve STI/HIV programming in NC correctional facilities and in NC neighborhoods with high incarceration rates. The cost-effectiveness of correctional facility-based STI testing, diagnosis and care has been documented.\textsuperscript{84} Correctional facilities also provide an opportunity to forge links between persons infected with STI/HIV and community-based health and social services, particularly since the disruptive effect of incarceration and release may inhibit seeking appropriate health care.\textsuperscript{85} In addition, effective community-based STI prevention
programming requires data on the sub-groups at greatest risk of STI acquisition. Data which indicate an association between incarceration and STI-related behaviors indicates that STI prevention resources should be targeted to communities with high levels of incarceration.

2.1.6. Importance of Study Population

The two data sources analyzed for Aim 1 arise from NC populations, a state greatly affected by STI/HIV. According to the Centers for Disease Control (CDC), in 2003, NC had one of the highest numbers of new HIV cases reported in the country. While African Americans represented 21% North Carolina’s population in 2005, they comprised the overwhelming majority of reported cases of HIV (66%), chlamydia (60%), gonorrhea (75%) and primary or secondary syphilis (67%) in 2006. In addition, the increase in incarceration was most common in the south than in any other area of the US.

2.2. Depression, STI, and Incarceration (Aim 2)

We explored the hypothesis that depression contributes to the high levels of STI among incarcerated populations. In the following paragraphs, literature that documents associations among mental illness, STI, and incarceration is reviewed.

2.2.1. Determinants of STI/HIV among Incarcerated Populations

We explored the hypothesis In the paragraphs below, literature that documents the prevalence of mental illness and risky sexual partnership/STI among incarcerated populations is reviewed, and the associations between these variables is described.

2.2.1. Mental Illness and Substance Abuse among Incarcerated Populations

Mental Illness among Incarcerated Populations

Most depression prevalence studies among incarcerated populations are based on persons using or requiring health services, hence prevalence estimates are likely biased downwards. One study performed among Cook County, Illinois jail inmates provides among the
most valid estimates of mental illness among jail inmates, as diagnosis of mental illness was made
among all inmates at the time of booking. Study findings indicate that acute symptoms of serious
mental illness requiring treatment were present in about 15% of females and 6% of males at
booking. Major depression was diagnosed among 14% of women and 3% of men.\textsuperscript{88, 89}

Because mental illness prevalence data for incarcerated populations are difficult to obtain,
Veysey et al.\textsuperscript{5} estimated the prevalence of mental illness among incarcerated populations based on
an analysis of the United States National Comorbidity Survey. Inmates experience higher levels of
6\textsuperscript{th} month and, for the most part, lifetime mental illness than the general population. Depression,
the most prevalent mental illness classification, was estimated to be comparable between inmate
and general populations when considering lifetime prevalence. The fact that 6-month prevalence is
generally higher among those likely to be inmates suggests that inmates experience increased
frequency of this mental illness.

\textbf{Substance Abuse among Incarcerated Populations}

Though the increased rate of incarceration in the US is largely attributable to increased
drug-related crime and drug abuse, relatively few inmates receive treatment, and existing
interventions tend to be short-term or non-clinical. The 1997 Survey of Inmates in State
Correctional Facilities, a nationally-representative sample of 14,285 inmates from 275 state
prisons,\textsuperscript{90} indicated that 69% had ever used illegal drugs at least weekly for at least one month,
24% were convicted of a drug violation, 51% were under the influence of drugs and/or alcohol at
the time of the crime, 19% committed the crime to get money to buy drugs, and 82% fit into at least
one of the above substance abuse indicators.

Researchers in our group have observed that NC HIV-positive prison inmates experience
high levels of substance abuse and low levels of substance abuse treatment, prior to, during, or
between jail/prison sentences.\textsuperscript{91} Almost 95% of soon-to-be released inmates surveyed used
crack/cocaine during the year prior to incarceration and 69% had been in drug rehab at least once.
Between incarcerations, 86% of recidivists used crack cocaine and 31% had participated in
substance abuse treatment since last release.
Levels of substance abuse observed among incarcerated populations are markedly higher than has been measured in the US general population, in which less than 0.8% had used crack in the past year, 0.3% had injected drugs in the past three years, and 1.6% had ever injected drugs in their lifetime.92

2.2.2. Depression, Substance Abuse, and Risky Sexual Partnership/STI

Depression and Risky Sexual Partnership/STI

Populations infected with STI, including HIV, are likely to experience mental illness and related substance abuse co-morbidities.93-97 A nationally-representative sample of HIV-positive patients receiving care in the United States indicated that nearly half of respondents reported symptoms of depression, dysthymia, generalized anxiety disorder, and/or panic disorder (48%), while one-third were diagnosed with at least one of the four disorders.96 Surveys among STI (non-HIV) clinic populations also indicate that substantial proportions were diagnosed at the time of the STI visit with current depression (52% of women and 32% of men)97 and current major depression (14% of women and 10% of men).95 Depression prevalence measured among the STI/HIV populations greatly exceeded estimates of US general-population mental illness prevalence,5, 98 for whom 6-month and lifetime history of “major depression” was estimated at about 8.4% and 18.1%, respectively.

Though the quality of the studies varies, and the definitions of both depression and sexual partnership/STI variables differ, findings generally indicate that depression is associated with 2 to 3 times the odds of elevated levels of risky sexual partnership/STI among adolescent and young adult general-population samples,2, 99-105 as well as among STI clinic patients,96 residents living in ZIP codes with high levels of STI,106, 107 drug users,108 gay and bisexual young men,109 and adolescents receiving gateway social services.110 However, there is also evidence that high levels of sexual activity are associated with lower levels of depression101 and higher self-esteem within regular partnerships.104

As the majority of studies are cross-sectional, the direction of the association between depression and risky sexual partnership/STI has not been well elucidated. Depression may
contribute to sexual risk behaviors and subsequent STI. It is hypothesized that depression disrupts self-regulation and encourages maladaptive behaviors.\textsuperscript{111, 112} Empirical evidence suggests that depressed adolescents are more emotionally reactive in peer relationships than non-depressed youth,\textsuperscript{111} which has implications for STI-related sexual partnerships. Longitudinal evidence indicates that depression predicts multiple sexual partnership among drug users in Baltimore (OR: 1.6, 95% CI: 1.1-2.1).\textsuperscript{108} Two studies have examined the temporal relationship between depression and risky behavior/STI among the Add Health sample, both of which found bi-directionality in the relationship. Shrier et al.\textsuperscript{2} indicated that depression predicted STI at one year follow-up among boys (OR: 3.9, 95% CI: 1.4-11.0), but not among girls (OR: 1.5, 95% CI: 0.7-3.3), while STI predicted depression among both boys (OR: 3.3, 95% CI: 1.3-10.8) and girls (OR: 2.1; 95% CI: 1.2-4.8). Hallfors et al.\textsuperscript{3} indicated depression did not predict risky sex and drug-use behaviors at one year follow-up, except among girls who were abusing substances at baseline; however, risky behaviors predicted depression.

**Depression, Substance Abuse, and Risky Sexual Partnership/STI**

Depression may lead to elevated levels of risky sexual partnership/STI by working through the pathway of increased substance abuse. Mental illness, including depression, is strongly associated with substance abuse\textsuperscript{113-128} and the association between substance abuse and STI and/or sexual transmission behaviors is well established.\textsuperscript{106, 118, 119, 129-141} There is evidence that the association between depression and risky sexual partnership/STI, when controlling for substance abuse in the multivariable setting, was slightly attenuated\textsuperscript{2, 102} or fully attenuated,\textsuperscript{106, 109, 110} though this was not observed in all studies.\textsuperscript{95, 102} An attenuated association of depression and risky sexual partnership/STI in multivariable modeling indicates that substance abuse either serves as an intermediary between depression and risky sexual partnership/STI or a confounder of the relationship.

### 2.2.3. Summary of Gaps in Prior Research and Current Research

**Summary of Gaps in Prior Research**
Numerous gaps in the research exist, and analysis of the relationship depression and STI, making use of the Add Health dataset, has not been exhausted. First, the relationship between depression and STI has not been examined specifically among incarcerated populations, though these variables are both highly prevalent in incarcerated populations. Second, the existing studies using Add Health Wave I and Wave II data have provided insights into the relationship between depression and sexual partnerships/STI, though contradictory results within and between the studies indicate that further investigation is warranted. Add Health Wave III measures are now available, and we examined a long-term measure of depression based on depression at adolescence (Wave I) and young adulthood (Wave III). Greater detail on the exposure measurement provides additional insight into the relationship between depression and risky sexual partnership/STI. Third, all of the analysis conducted by Shrier et al. and Hallfors examined the relationship between depression and self-reported STI. Analysis of the relationship between depression and biologically-confirmed measurement of STI, taken during Wave III data collection, was performed in the current analysis.

**Current Research**

Future investigation into the effect of incarceration on STI/HIV necessitates improved understanding of the role mental illness. We measured association between depression based on measurements taken at Wave I and Wave III and biologically-confirmed STI (Wave III), stratified by prior arrest history, an indicator of involvement in the criminal justice system.

**Public Health Implications of Research**

Given the high cost of HIV and STI treatment, psycho-social interventions to reduce HIV transmission are cost-effective. Investigating the relationship between depression and risky sexual partnership/STI, among populations with a “high” and a “low” probability of experiencing incarceration provides information needed to inform mental illness programming in the context of STI/HIV prevention and treatment for communities impacted by “high” and “low” levels of incarceration. Findings of this study will also inform planning of future investigations into the independent effect of incarceration on risky sexual partnership/STI, taking into account background variables of depression and substance abuse, when the
longitudinal data needed to rigorously assess this relationship become available (Add Health Wave IV, 2008).

2.2.4. Importance of Study Population

Importance of Adolescent Depression

We conducted this research among a nationally-representative sample who were interviewed in adolescence and again in young adulthood. Diagnosis and treatment of adolescent depression is vital, as depression prevalence is highest during adolescence and then decreases from young adulthood and over the life course\textsuperscript{143, 144}. Analysis of a sample most likely to experience depression is relevant from both a public health perspective, as this group is in greatest need of diagnosis and treatment, as well as from an analytic perspective, as increased prevalence of exposure will improve statistical power. Many studies have examined the associations between depression and STI among high-risk populations. Examining this relationship among a nationally-representative sample enables us to interpret findings as generalizeable to young adults in the US.
3.1. Incarceration and Risky Sexual Partnership in Rural North Carolina (Aim 1a)

3.1.1. The NC Rural Health Project Dataset (Aim 1a)

Overview

The NC Rural Health Project (NCRHP) was a 5 year NIH-funded study developed and conducted by others in our group, based out of the University of North Carolina-Chapel Hill (UNC-CH) (Adaora Adimora, Principal Investigator). The NCRHP was carried out to determine the roles of risky sexual partnerships and curable STIs in heterosexually-transmitted HIV infection among African Americans living in rural North Carolina. A total of 432 African Americans aged 18 to 59 years and living in eastern, rural NC were successfully recruited, consented, and considered eligible, including 206 HIV-positive cases (77 men, 129 women) and 226 HIV-negative controls (79 men, 147 women). Men who have sex with men and injection drug users were excluded.

Sampling, Enrollment and Data Collection

Enrollment of Cases and Controls

Enrollment of cases took place from January 1997 through March 2000. All HIV-positive cases in NC are reported to the NC HIV/Sexually Transmitted Disease (STD) Prevention and Care Section and receive counseling by a NC Disease Intervention Specialist (DIS). DIS staff contacted the reported HIV-positive cases and explained the NCRHP, obtained written informed consent for release of name, and obtained cases' contact information. DIS then reported willing and eligible HIV-positive cases to NCRHP study staff. Injection drug users and men who reported sex with men were excluded. Less than half of men (44%) and women (49%) recruited agreed to participate. Participating women were slightly younger and
participating men were slightly older than their non-consenting counterparts. Of the 243 men and women who were consented, an additional 17 proved ineligible (11 subsequently reported a history of injection drug use or sex with another man, 5 were referred greater than 6 months after their HIV infection was reported, and 1 had uncertain HIV status); 10 could not be located; 7 were unavailable for reasons such as illness or incarceration; and 3 declined to participate after learning more about the study. A total of 206 cases were interviewed and their data were included in the study.

Controls were selected randomly from the 1996 NC driver’s license records for all African American men and women aged 18 to 59 years and residing in 13 contiguous eastern rural counties with elevated levels of heterosexually-acquired HIV infection. HIV testing indicated that all controls were HIV-negative. Prospective participants were frequency-matched by gender and 5-year age categories to cases. Of the 1063 potential subjects sampled from the driver’s license file, 101 refused participation; 697 could not be located (largely due to incorrect or outdated address information); 22 potential controls were unavailable for reasons such as illness or incarceration; and 17 were ineligible (5 were not the target age, 4 were African American, 6 were homosexual men, 1 reported a history of injection drug use and 1 reported HIV infection). A total of 226 controls were interviewed, representing 69% of the potential subjects who could be found and were eligible.

Each potential case and control was first sent a letter with information about the study. Attempts to recruit prospective participants were continued for approximately 6 weeks through visits and/or phone calls. Intensive effort was taken to locate potential participants whose residence had changed.

Data Collection

NCRHP study staff obtained written informed consent for study participation, administered a one-hour structured face-to-face survey on HIV transmission risk factors, drew a blood specimen for syphilis testing, and provided a $50 cash incentive. The interview collected the following information on HIV risk factors: HIV-related sexual behavior, including information on recent sexual partnerships and prevalence of concurrent partnerships; drug use behaviors; STD history; health care access; and demographic information. Interviewers signed
a Certificate of Confidentiality and assured participants that information collected would remain completely confidential and that their names would be erased following data cleaning. Participants were informed that one exception to non-disclosure was in the case of a positive syphilis test, for which reporting to the local health department was obligatory.

The study was approved by the UNC-CH School of Medicine Committee on the Protection of the Rights of Human Subjects.

Data Preparation and Acquisition

NCRHP data were entered and datasets have been maintained on a restricted server at UNC-CH. Access to the data for the proposed research was provided through an agreement with the NCRHP.

Preliminary Results

Preliminary analysis among 156 men and 276 women (cases and controls aggregated) indicated that substantial proportions of men and small proportions of women had ever spent at least 24 hours incarcerated in jail/prison (44% men, 14% women), at least one month incarcerated (29% men, 9% women), and at least six months incarcerated (17% men, 3% women). Within the past 5 years, 21% of men and 7% of women had spent one month incarcerated and 12% of men and 2% of women had spent six months incarcerated. Incarceration was much more likely among the cases (31% men, 13% women) than controls (10% men, 1% women).

3.1.2. Analytic Methods (Aim 1a)

Overview

Aim 1a: To measure the associations between incarceration—timing and duration of the respondent’s incarceration and incarceration of the respondent’s recent sexual partners - and risky sexual partnership.

Overview of Aim 1a Methods: We examined risky sexual partnership indicators by status of incarceration variables. We estimated unadjusted and adjusted prevalence ratios (PRs) and 95% CIs for the associations between each incarceration exposure and risky partnership using
a generalized linear model with probability weights, log link, and Poisson distribution without an offset.\textsuperscript{145, 146} Sample weights were calculated and applied to all analyses to account for differential sampling probabilities between cases and controls.

**Inclusion and Exclusion Criteria**

We included cases and controls who resided in the original 13 county study area. Thus, the 138 cases residing in the original thirteen-county area and all 226 controls, all of whom resided in this area, were included in this analysis on incarceration and risky partnership.

**Main Study Variables**

**Outcome: Risky Sexual Partnership**

The outcome was one dichotomous indicator defined as engaging in multiple partnerships or transactional sex in the past year. A respondent with two or more partnerships were coded as having multiple partnerships. Transactional sex was defined as giving or receiving sex in exchange for drugs or money.

**Exposures: Incarceration**

Respondents were asked if they had spent longer than 24 hours in jail or prison in the past 10 years and, if so, they were asked to report the number of months and the last time they were incarcerated in the past 10 years. Respondents were also asked to report whether each of their three most recent sexual partners had ever spent more than 24 hours in jail or prison. The following incarceration variables were defined based on these survey items.

*Time since Respondent’s Most Recent Incarceration:* Three-level variable assessing the number of years since the respondent’s most recent incarceration: within the past five years, six to 10 years ago, or never.

*Duration of Respondent’s Incarceration:* Three-level variable measuring the duration of time the respondent had ever been incarcerated in the past 10 years: one month or greater, less than one month, or never.
Sexual Partner’s Incarceration: Dichotomous indicator defined as having a recent sexual partner (one of the last three) who had ever been incarcerated for at least 24 hours versus no partner incarceration history.

Covariates

We assessed confounding by the following factors, identified based on conceptual models: age at first sex; high school graduate; homeless in the past 10 years; food insecurity in the past month; currently receives food stamps or welfare; and currently resides in an unsafe neighborhood. Age at first sex was entered as a continuous variable after confirmed linearity in the log prevalence. All other variables were dichotomous. Figure 2 presents the hypothesized confounding effects of measured and unmeasured variables on the association between incarceration and risky partnership.

Sample Weights

We aggregated NCRHP cases and controls and applied sampling weights to account for differential case and control sampling probabilities. The weighting yielded parameters were representative of the African American source population aged 18 to 61 years living in the original 13 NCRHP counties in eastern, rural North Carolina.

Each HIV-positive case was assumed to represent him- or herself in the population and was assigned a weight of one.

The weight assigned to each control was equivalent to the number of HIV-negative individuals in the source population represented by each NCRHP control. Control weights were calculated within strata of gender and five-year age categories, as controls were recruited for participation in the NCRHP within these strata. For the weight calculation, participants aged 18 or 19 years were categorized with those aged 20 to 24 years, and those aged 60 or 61 years were categorized with those aged 55 to 59 years. We calculated control weights by dividing the estimated population of HIV-negative African Americans residing in the 13 counties in each gender and age-specific stratum, calculated based on US Census Bureau estimates, by the number of NCRHP controls in each gender and age-specific stratum.
Analytic Techniques

Univariable Analysis

Univariable frequencies of all variables, including main exposure, outcome and other study variables were determined for men and women separately. Specifically, means, standard deviations, medians, and distributions of continuous variables were described using graphic techniques and tabulations. Frequencies of all categorical variables created were also determined.

Outliers were identified for each variable and, when possible, corrected if inconsistent with raw data. Each variable was checked for missing values. A complete case analysis was used in all analyses.

Alternate approaches to coding that appeared to be more meaningful were explored for each variable. For example, some continuous variables were categorized at meaningful cut-points. Similarly, some categorical variables were dichotomized if necessary, while other nominal variables were transformed into indicator variables to avoid enforcing ordinality or linearity.

Biviarable Analysis

Assessment of Main Research Question

Bivariable analyses were conducted to examine the unadjusted PRs and 95% CIs between incarceration variables and risky sexual partnership outcome indicators.

Assessment of Linearity of the Log Prevalence

Continuous variables were categorized. To evaluate the assumption of the linearity of the log prevalence, the log prevalence of the outcome within strata of each ordinal and categorized continuous variable was computed and plotted. If the assumption was not upheld, alternate coding of ordinal and continuous variables was considered.

Assessment of Confounding

The bivariable relationship was measured between each covariate and incarceration exposures and risky sexual partnership outcomes. Strong associations between the covariate and both incarceration and risky partnership outcomes suggested confounding. All potential
confounders were also included in the multivariable analysis to examine the potential confounding in the presence of other covariates.

Assessment of Potential for Collinearity

The PR for the association between each covariate and incarceration exposure variables was examined. A PR of ≥3 was considered a strong association, and the variable was noted as a potentially collinear variable with the main exposure.

Multivariable Analysis

Assessment of Effect Measure Modification

Due to small sample size, only a limited number of stratifications could be made, hence the potential modifying effect of each variable was not examined. Because risk of incarceration and risky sexual partnership differ by gender, and because gender-specific intervention approaches are feasible and currently considered appropriate, we examined the modifying effect of gender in this analysis. Effect modification by gender was investigated by assessing the significance of the product-interaction term between gender and each incarceration exposure. We assessed the product-interaction terms at an alpha equal to 0.3, a high cut-point for determining the presence of effect measure modification. Because there was evidence of effect measure modification for two of the three exposure-outcome relationships explored, we presented gender-specific estimates throughout, for consistency.

Multivariable Poisson Regression to Estimate Prevalence Ratios

For each gender, we estimated unadjusted and adjusted PRs and 95% CIs for the associations between each incarceration exposure and risky partnership using a generalized linear model of the form

$$\ln[E(Y|x)] = \alpha + \beta x$$

with probability weights, log link, Poisson distribution without an offset, and a robust variance estimator to correct for overestimation of the error term resulting from use of Poisson regression with binomial data.

In initial multivariable models, we used a manual change in estimate backwards elimination procedure to identify the particular set of socio-demographic confounding variables
necessary to include in each final model. We assessed confounding by the following factors, identified based on conceptual models: age at first sex; high school graduate; homeless in the past 10 years; food insecurity in the past month; currently receives food stamps or welfare; and currently resides in an unsafe neighborhood. Age at first sex was entered as a continuous variable after confirmed linearity in the log prevalence. All other variables were dichotomous. Indicator variables representing five-year categories of respondent’s age were included in all models, as controls were selected within these strata.

The full starting model included the exposure, outcome, all covariates. The confounding effect of the variable most likely to confound the relationship, the variable with the highest $\chi^2$ p-value, was dropped from the model first. The PR derived from the original, fully-adjusted model was compared to a restricted model that omitted the potential confounder. If the $\ln(|\text{PR}_{\text{unrestricted}}/\text{PR}_{\text{restricted}}|)$ of $\geq 10\%$, we assumed that the estimate was confounded by the omitted variable, hence the variable should remain in the model. If the change in estimate between the fully adjusted and the restricted model was $<10\%$, then we assumed the variable did not confound the effect appreciably and thus could be dropped. The variable with the next highest $\chi^2$ p-value was then be dropped and the change in estimate procedure again repeated, and so on, until all potential confounders have been assessed. All restricted models will be compared with the original, fully-adjusted model.

In subsequent models, we controlled for two dichotomous substance abuse variables in addition to respondent age and socio-demographic factors identified in initial models: hard drug use (used crack/cocaine or heroine in the past 10 years) and frequent soft drug use (drank at least five alcoholic beverages per day or used marijuana at least once per week during a period in the past 10 years).

The models for the association between the three-level variable representing timing of respondent’s personal incarceration – never, six to 10 years ago (distant past), or within the past five years (recent) - and risky partnership, stratified by gender, are represented by the following equation:

$$\ln [E(Y|x)] = a + \beta_1(\text{inc}_{\text{distant}}) + \beta_2(\text{inc}_{\text{recent}}) + \beta_3(\text{gender}) + \beta_4(\text{inc}_{\text{distant}} \times \text{gender}) + \beta_5(\text{inc}_{\text{recent}} \times \text{gender}) + \betaK(\text{covariatesK})$$
inc_distant = incarcerated 6 to 10 years ago (referent: never incarcerated)
inc_recent = incarcerated past 5 years (referent: never incarcerated)
gender = male (referent: female)
inc_distant*gender = product-interaction for distant incarceration and gender
inc_short*gender = product-interaction for recent incarceration and gender
covariatesK = vector of all included covariates

The models for the association between the three-level variable representing duration of respondent's personal incarceration – never, less than one month (short-term), or one month or greater (long-term) - and risky partnership, stratified by gender, are represented by the following equation:

\[
\ln [E(Y|x)] = \alpha + \beta_1(inc_{short}) + \beta_2(inc_{long}) + \beta_3(gender) + \beta_4(inc_{short} \ast gender) + \beta_5(inc_{long} \ast gender) + \beta K(covariatesK)
\]

inc_short = incarcerated <1 month (referent: never incarcerated)
inc_long = incarcerated \geq 1 month (referent: never incarcerated)
gender = male (referent: female)
inc_short \ast gender = product-interaction for short-term incarceration and gender
inc_long \ast gender = product-interaction for long-term incarceration and gender
covariatesK = vector of all included covariates

The models for the association between the dichotomous variable representing recent sexual partnership with someone who was ever incarcerated, stratified by gender, are represented by the following equation:

\[
\ln [E(Y|lx)] = \alpha + \beta_1(inc_{partner}) + \beta_2(gender) + \beta_3(inc_{partner} \ast gender) + \beta K(covariatesK)
\]

inc_partner = one of last three partners was ever incarcerated (referent: no recent partner was incarcerated)
gender = male (referent: female)
inc_partner \ast gender = product-interaction for partner incarceration and gender
covariatesK = vector of all included covariates
**Model Fit**

For the purposes of diagnostics, a logistic regression formulation of each regression model was estimated so that a Hosmer & Lemeshow goodness-of-fit test could be performed as measure of model fit. The null hypothesis of this test was that model fit was adequate, and a large p value indicated acceptance of the null hypothesis. Model fit was evaluated at p<0.05, so that p values of 0.05 or less indicated inadequate model.

### 3.2. Incarceration and Risky Sexual Partnership in Urban North Carolina (Aim 1b)

#### 3.2.1. The NC PLACE Method Dataset (Aim 1b)

**Overview**

The Priorities for Local AIDS Control Efforts (PLACE) method is an HIV/AIDS program-planning and monitoring tool developed by others in our group, who are housed at the Carolina Population Center (CPC) at UNC-CH (Weir et al. 2003). The PLACE method identifies the geographic areas and social venues within these areas where levels of new, multiple and concurrent sexual partnership are high and condom provision is low, areas where elevated STI/HIV incidence is likely. Specifically, cross-sectional survey data are collected to measure the unmet need for STI/HIV prevention programming. The method has been applied in numerous, diverse settings worldwide.

With funding from the Center for AIDS Research (CFAR) at UNC-CH, we piloted the PLACE method for the first time in a domestic US setting from August through October 2005 (David Wohl, Principal Investigator; Sharon Weir, Co-Principal Investigator). The chosen study area was a city in central NC with elevated levels of STI/HIV, substance abuse, crime, poverty, and incarceration. Local program planners needed data to design STI/HIV prevention programming that is targeted in locations within the city where STI/HIV transmission is most likely.

The NC PLACE method was composed of three stages of interviewing. First, community informants were interviewed to obtain a list of venues where people meet new sexual partners. Interviews were then conducted with venue representatives (i.e., managers or
on-site workers) to ascertain current on-site STI/HIV prevention activity and, finally, with venue patrons to measure STI/HIV-transmission risk behaviors among those who socialize at the venues.

**Sampling, Enrollment and Data Collection**

Before each interview, interviewers explained the purpose and scope of the study and obtained a verbal informed consent for a confidential and anonymous 15 to 20 minute interview. No compensation was systematically offered to respondents. However, if appropriate, interviewers provided a small snack or token gift (value of less than $1) to respondents.

The study was approved by the UNC-CH School of Public Health Institutional Review Board.

**Phase I: Community Informant Interviews**

In the first stage of interviewing, community informants assumed to be knowledgeable about their city were recruited for a brief interview, during which time they responded to the question, “Where do people in this town go to meet new sexual partners?” Each informant provided the name of the venue, the type of venue and the precise venue location, so that each venue could later be revisited. Local health officials identified a diverse list of community informants, so that locations and types of venues were varied. Based on informant reports, a list of all venues and events in the study areas was compiled.

**Phase II: Venue Verification Interviews and Mapping**

The second interviewing stage involved visits to each of the unique venues named by community informants to verify the location and interview a person knowledgeable about the venue, such as a manager, owner or on-site worker. A total of 146 unique venues were named by community informants. Of these, 9 were closed temporarily, 10 were closed permanently and 3 were not located because the address was insufficient. Interviews were attempted at the 124 identified venues. At one venue all potential respondents were too young to participate. Of the remaining 123 eligible venue representatives, 96 agreed to participate (78%).
Venue representatives reported on venue characteristics, including the potential to meet sexual partners on venue and HIV/AIDS intervention activity. In cases when the venue had no “owner” or “worker,” including venues such as streets, public parks, or abandoned lots, the interview was conducted with a person knowledgeable about the venue, such as a nearby resident or a person who socialized at the venue. Though community informants reported both fixed venues and periodic events (e.g., dances, special music events), it was only possible to verify venues. If the venue was closed at first visit, the interviewer returned at least three times to attempt the interview.

GPS coordinates of each verified venue were obtained. Coordinates were entered into Census 2000 TIGER/Line (US Census Bureau, Geography Division, 2000) and LANDSAT Project (US Department of the Interior, US Geological Survey). Geographic data were used to depict the spatial distribution of risky sexual partnership/STI and contextual factors of transmission in the study city.

Phase III: Interviews with Patrons Socializing at Venues

During the third phase of interviewing, a structured face-to-face sexual behavior survey was administered to a representative sample of individuals socializing at a stratified, random sample of venues. To ensure that the selection of venues represented different populations within High Point, the venues were categorized based on venue type prior to randomization. Strata included “Adult bars and clubs,” “Eating establishments,” “Public areas,” “Hotels/Housing,” “Open-air venues,” and “Private Homes.” Within each strata of venue type, venues were randomly chosen with a probability proportional to the number of venues in the strata.

The number of interviews attempted at each venue was based on venue size; venue size was assessed based on the number of men and women who socialize daily on venue, reported by venue managers during the Venue Verification Interviews. At small venues (average of <20 persons socializing at the venue), medium venues (20 – 50 persons socializing) and large venues (greater than 50 persons socializing), 8, 12-16 and 18-24 interviews were attempted, respectively.
To select a representative sample of individuals socializing at the venues, interviewers followed a protocol that distributed interviewers systematically throughout the venue. For example, when the interviewing team entered a venue with four walls, each interviewer claimed either the right or the left corner at the front of the venue, and each visualized an imaginary line that traversed the venue area diagonally to the opposing corner. Each interviewer recruited the target number of potential respondents at even intervals along the imaginary line. Venues that did not have four walls utilized an adaptation of this method to minimize interviewer discretion in selecting respondents by convenience. Interviewers brought the respondents to a private area to assure confidentiality during the interview. If a potential respondent had already been interviewed and he or she reported this to the interviewer, the recruitment was ended.

A total of 377 individuals recruited while socializing on-site agreed to participate (75% participation rate).

**Data Preparation and Acquisition**

PLACE data were entered and have been maintained on a restricted server at UNC-CH. Access to the data for the proposed research was provided through an agreement with the PLACE NC research team.

**Preliminary Results**

Preliminary analysis indicates that community informants (N=120) identified 133 unique venues, including open-air venues such as streets and parks (22%), stores (19%), restaurants (17%), and bar/clubs (9%). Maps of social venues indicate that social venues are distributed widely throughout the study area (see Figure 3). A total of 377 individuals socializing at venues were interviewed (61% men, 65% African-American, median age 29 years). In the preceding month, 21% of men and 18% of women had a new sexual partner, 48% of men and 35% of women had more than 2 partners, 39% of men and 35% of women met a new sexual partner at the venue, 15% of men and 17% of women traded sex and 8% of men and 15% of women had STI symptoms. Condom use with the most recent new sexual partner within the past year was 57% for men and 40% for women. In past year, 5% of men
and 3% of women reported intravenous drug use and 10% of men had sex with a man. HIV prevention activities had been hosted by only 16% of venues visited.

3.2.2. Analytic Methods (Aim 1b)

Overview

Aim 1b: To measure the associations between incarceration—respondent’s incarceration in the past year and incarceration of the respondent's recent sexual partners - and risky sexual partnership.

Overview of Aim 1b Methods: We examined risky sexual partnership indicators by status of incarceration variables. We estimated unadjusted and adjusted PRs and 95% CIs for the associations between each incarceration exposure and risky partnership outcomes generalized estimating equations (GEE) to account for clustering by the venue where the individual was interviewed.\textsuperscript{150} We specified a log link, a Poisson distribution,\textsuperscript{145,146} an exchangeable correlation matrix structure, and a robust variance estimator to correct for overestimation of the error term resulting from use of Poisson regression with binomial data.\textsuperscript{148}

Inclusion and Exclusion Criteria

All individuals interviewed while socializing at social venues (PLACE Method Phase III) were included in analyses.

Main Study Variables

Outcome: Sexual Partnerships

Multiple new sexual partnerships in the past 4 weeks: Dichotomous outcome defined as report of having at least two new sexual partners in the past four weeks.

Transactional sex in the past 4 weeks: Dichotomous outcome defined as report of having given or received money, goods or services for sex in the past four weeks.

Exposure: Incarceration

Respondent incarceration history: Dichotomous exposure defined as incarceration for at least 24 hours in the past 12 months among men, and lifetime history of incarceration for at least 24 hours
among women. This exposure definition differed by gender due to the low prevalence of recent incarceration among women.

Partner incarceration history: Defined as having a sexual partner in the past 12 months who had ever been incarcerated for at least 24 hours.

Covariates

Each of the following, identified as a potential confounding variable based on conceptual models and prior research, was considered for inclusion in each adjusted model: age, black race, high school graduate, currently unemployed, respondent substance abuse (used injection drugs, crack/cocaine, methamphetamine, ecstasy or speed in past 12 months) and partner crack/cocaine use (had a partner in the past 12 months who used crack/cocaine). For models examining the association between sexual partnership outcomes and respondent incarceration history, confounding by partner incarceration history was assessed. For models examining the association between sexual partnership outcomes and partner incarceration history, confounding by respondent incarceration history was assessed. Figure 2 presents the hypothesized confounding effects of measured and unmeasured variables on the association between incarceration and risky partnership.

Analytic Techniques

Univariable Analysis

Univariable frequencies were calculated separately for men and women. Univariable frequencies of all variables, including main exposure, outcome and other study variables were determined. Specifically, means, standard deviations, medians and distributions of continuous variables were described using graphic techniques and tabulations. Frequencies of all categorical variables created were also determined.

Outliers were identified for each variable and, when possible, corrected if inconsistent with raw data. Each variable was checked for missing values. A complete case analysis was used in all analyses.

Alternate approaches to coding that appeared to be more meaningful were explored for each variable. For example, some continuous variables were categorized at meaningful cut-
points. Similarly, some categorical variables were dichotomized if necessary, while other nominal variables were transformed into indicator variables to avoid enforcing ordinality or linearity.

**Bivariant Analysis**

*Assessment of Main Research Question*

Bivariant analyses were conducted to examine the unadjusted PRs and 95% CIs between incarceration variables and risky sexual partnership outcome indicators.

*Assessment of Linearity of the Log Prevalence*

Linearity in the log prevalence by age was assessed and not upheld, so age was coded as two indicator variables.

*Assessment of Confounding*

The bivariant relationship was measured between each covariate and both incarceration exposures and risky sexual partnership outcomes. Strong associations between the covariate and both incarceration and risky partnership outcomes suggested confounding. All potential confounders were also included in the multivariable analysis to examine the potential confounding in the presence of other covariates.

*Assessment of Potential for Collinearity*

The PR for the association between each covariate and incarceration exposure variables was examined. A PR of ≥3 was considered a strong association, and the variable was noted as a potentially collinear variable with the main exposure. The collinearity was discussed in the text.

**Multivariable Analysis**

*Assessment of Effect Measure Modification*

Due to small sample size, only a limited number of stratifications could be made, hence the potential modifying effect of each variable was not examined.

Gender-specific indicators of personal incarceration were measured (recent incarceration among male respondents and lifetime history of incarceration among women
respondents). It was therefore necessary to estimate gender-specific associations between personal incarceration and risky partnership outcomes.

Partner incarceration was assessed using the same variable for both men and women. Therefore, it was possible to aggregate men and women for this analysis, in the absence of modification of the association between partner’s incarceration and risky sexual partnership. Effect modification by gender was investigated by assessing the significance of the product-interaction terms between gender and incarceration of a sexual partner for each risky partnership outcome. We assessed the product-interaction terms at an alpha equal to 0.3, a high cut-point for determining the presence of effect measure modification. The interaction terms for the associations between partner incarceration and both risky partnership outcomes were highly significant, indicating that presentation of gender-specific estimates was appropriate.

**Multivariable Poisson Regression to Estimate Prevalence Ratios**

For each gender, we estimated unadjusted and adjusted PRs and 95% CIs for the associations between each incarceration exposure and risky partnership using generalized estimating equations (GEE) to account for clustering by the venue where the individual was interviewed. We estimated a model of the form

$$\ln [E(Y|x)] = \alpha + \beta x$$

with probability weights, log link, Poisson distribution without an offset, and a robust variance estimator to correct for overestimation of the error term resulting from use of Poisson regression with binomial data.

The full starting model included the exposure, outcome, all covariates. The confounding effect of the variable most likely to confound the relationship, the variable with the highest $\chi^2$ p-value, was dropped from the model first. The PR derived from the original, fully-adjusted model was compared to a restricted model that omitted the potential confounder. If the $\ln(|PR_{unrestricted}/PR_{restricted}|)$ of $\geq 10\%$, we assumed that the estimate was confounded by the omitted variable, hence the variable should remain in the model. If the change in estimate between the fully adjusted and the restricted model was $<10\%$, then we assumed the variable
did not confound the effect appreciably and thus could be dropped. The variable with the next highest \( \chi^2 \) p-value was then be dropped and the change in estimate procedure again repeated, and so on, until all potential confounders have been assessed. All restricted models will be compared with the original, fully-adjusted model.

The male-specific models for the association between the dichotomous variable representing recent incarceration and risky partnership outcomes are represented by the following equation:

\[
\ln [E(Y|x)] = \alpha + \beta_1 (inc\_recent) + \beta K(covariatesK) \text{ if } gender=1
\]

- \( inc\_recent \) = incarcerated in past year (referent: no recent incarceration)
- \( covariatesK \) = vector of all included covariates
- \( gender \) = 1 for males

The female-specific models for the association between the dichotomous variable representing lifetime history of incarceration and risky partnership outcomes are represented by the following equation:

\[
\ln [E(Y|x)] = \alpha + \beta_1 (inc\_life) + \beta K(covariatesK) \text{ if } gender=0
\]

- \( inc\_life \) = was ever incarcerated (referent: no incarceration)
- \( covariatesK \) = vector of all included covariates
- \( gender \) = 0 for females

The male-specific models for the association between the dichotomous variable representing recent sexual partnership with someone who was ever incarcerated and risky partnership outcomes are represented by the following equation:

\[
\ln [E(Y|x)] = \alpha + \beta_1 (inc\_partner) + \beta K(covariatesK) \text{ if } gender=1
\]

- \( inc\_partner \) = had a sexual partner in the past year who was incarcerated (referent: no partner incarceration)
- \( covariatesK \) = vector of all included covariates
- \( gender \) = 1 for males
The female-specific models for the association between the dichotomous variable representing recent sexual partnership with someone who was ever incarcerated and risky partnership outcomes are represented by the following equation:

\[
\ln[E(Y|x)] = \alpha + \beta_1(\text{inc\_partner}) + \beta K(\text{covariatesK}) \text{ if gender} = 0
\]

- inc\_partner = had a sexual partner in the past year who was incarcerated (referent: no partner incarceration)
- covariatesK = vector of all included covariates
- gender = 0 for females

Model Fit

For the purposes of diagnostics, a logistic regression formulation of each regression model was estimated so that a Hosmer & Lemeshow goodness-of-fit test could be performed as a measure of model fit. The null hypothesis of this test was that model fit was adequate, and a large p value indicated acceptance of the null hypothesis. Model fit was evaluated at p<0.05, so that p values of 0.05 or less indicated inadequate model.

3.3. Depression and STI by Prior Arrest in the United States (Aim 2)

3.3.1. The National Longitudinal Study of Adolescent Health Dataset (Aim 2)

Overview

The National Longitudinal Study of Adolescent Health (Add Health) is a nationally-representative, prospective cohort study designed to investigate social factors of health experienced by adolescents and young adults at the individual-, family-, school-, and community-levels. Add Health is the largest, most comprehensive survey of adolescents ever undertaken. Initiated in 1994 under a grant from the National Institute of Child Health and Human Development (NICHD) with co-funding from 17 other federal agencies, Add Health has been developed and coordinated by an interdisciplinary team housed at the CPC at UNC-CH (Richard Udry, Principal Investigator).
Between April-December 1995, over 20,000 adolescents in grades 7 through 12 completed a 90-minute baseline interview on demographics, daily activities, romantic partnerships, sexual activity, contraceptive use, health care utilization, and risk-taking behaviors (Wave I). Parents, school peers, and school administrators were also interviewed. Approximately one year later, a shorter follow-up interview was completed by 13,368 adolescents (12th graders and those in the sub-sample of adolescents with disabilities were not re-interviewed) (Wave II). Updates from school administrators were also obtained. In 2001 through 2002, 66% of the original sample, then aged 18 to 26 years, responded to a 90-minute follow-up interview that included questions on relationship, marital, childbearing, education, and employment histories (Wave III). Urine specimens for determination of prevalent STI, including chlamydia, gonorrhea, and trichomonas were also collected.

The study protocol was approved by the UNC-CH Institutional Review Board.

**Sampling, Enrollment and Data Collection**

**Sampling and Enrollment of Schools**

A two-stage sampling design was used. The primary sampling frame included all public and private high schools in the US with an 11th grade, with at least 30 students per school and registered in the Quality Education database, and the feeder middle schools associated with the enumerated high schools that included a seventh grade and that sent at least five graduates to a high school. In 1994, a sample of 80 high schools and 52 middle schools was chosen with a systematic, stratified method that yielded a sample representative of US middle and high schools with respect to region of the country, degree of urbanicity, school type, ethnicity, and school size. A total of 132 schools (79%) participated.

**Sampling, Enrollment of Participants, and Data collection**

Excepting height and weight, STI and GIS measurements, all measurements were self-reported characteristics and behaviors.

*Wave I. In-School Interview (Adolescents and Administrators):* A brief in-school interview was completed by adolescents (N=90,118) and school administrators (N=164) at the selected schools. We will not use information from these interviews for the proposed study.
Wave I. In-Home Interview (Adolescents and Parents at Baseline): Based on the list of adolescents who responded to the In-School Interview, a stratified, random sample of adolescents was recruited for a 90-minute, In-Home Interview. The roster enumerating all students in each school was obtained, the list was stratified by grade and sex, and about 17 students per strata were randomly chosen. With approximately 200 students from each of the 80 school clusters, the total core sample included approximately 17,600 students. To complement this core sample, oversampled groups were enrolled, including blacks with college-educated parents, Chinese, Cubans, Puerto Ricans, disabled youth, adopted youth, twins, half-siblings, and unrelated adolescents living the same household, resulting in a total of about 27,000 eligible adolescents. A total of 20,745 students responded to the In-Home Interview (76.8% participation rate). In 16 schools, all enrolled students were selected for in-home interviews to facilitate social network analysis.

After obtaining written informed consent, an interview was conducted in a private area of the home/interview location. All data were recoded on laptops. For less sensitive topics, interviewers delivered a face-to-face interview and entered responses into the laptop using a Computer-Assisted Personal Interview program. For sensitive issues, Audio Computer Assisted Self-Interview (A-CASI) allowed the participant to listen to questions through earphones and enter the responses directly into the computer; use of A-CASI is thought to increase the validity of reporting on sensitive issues by decreasing social desirability bias.\textsuperscript{151, 152}

Analysis proposed for the study will use baseline demographic, socio-economic, mental illness, substance abuse, and sexual behavior variables from the In-Home Interview.

A resident parent or guardian, preferable the mother, of adolescents who completed the In-Home Interview was asked to complete a 40-minute interviewer-assisted, op-scanned questionnaire (N=17,841; 86% participation rate). Parent interviews were face-to-face, paper interviews. Analysis proposed for the proposed study will use family-level background variables from the In-home Parent Interview (e.g., parent education).

Wave III. In-Home Interview (Adolescents at Follow-Up): The Wave III sample included most of those who took part in the Wave I In-Home Interview currently living in the continental US,
Alaska, and Hawaii, including military personnel stationed domestically and participants in detention facilities (N=14,322; 75.7% participation rate). Interviews were also held with a small sample of the Core Sample partners (N=1,507). Biological specimens were collected and results were determined for approximately 12,000 of the Wave III participants and a sample of partners. At the end of the In-Home Interview, participants were consented for provision of urine for the STI testing. An incentive of $10 was provided to those who participated in STI testing. Urine specimen of participants and partners were tested for infection with *Chlamydia trachomatis*, *Neisseria gonorrhea* and *Trichomonas vaginalis*. Participants were instructed to call a toll-free telephone to receive confidential test results and post-test counseling; test results were not reported to local health department, based on terms of a Certificate of Confidentiality obtained from the US Department of Health and Human Services. Participants were also given the toll-free number for the CDC’s National STI and AIDS Hotline and printed information on STI. Computer-assisted methods of data collection used during Wave I In-Home Interview were also used during Wave III.

Analysis proposed for the proposed study will use Wave III mental health, substance abuse, and biologically-confirmed STI outcome data from the In-Home interview.

To account for persons who could not be located or who refused to participate in the Wave III interview, post-stratification sampling weights were calculated. The Add Health cohort provides a representative sample of young adults living in the US when these weights are applied, when school is considered primary sampling unit and when region of the US where school is located is included as a stratifying variable.

**Data Preparation and Acquisition**

The Add Health datasets are maintained on a restricted and highly monitored server at CPC. Participant identification numbers are linked to identifying information only in a secured database outside the US to ensure that data cannot be subpoenaed by the US government.

We have access to Add Health data needed for the proposed research through an agreement with CPC. CPC also provides technical assistance in the analysis to ensure appropriate methods are used to account for the probability sampling.
Preliminary Studies

Two studies have examined the temporal relationship between depression and risky behavior/STI among the Add Health sample, both of which found bi-directionality in the relationship. Shrier et al. ² indicated that depression predicted STI at one year follow-up among boys (OR: 3.9, 95% CI: 1.4-11.0), but not among girls, while STI predicted depression among both boys (OR: 3.3, 95% CI 1.4-10.8) and girls (OR: 2.1; 95% CI: 1.2-4.8). Hallfors et al. ³ indicated depression did not predict risky sex and drug-use behaviors at one year follow-up, except among girls who were abusing substances at baseline; however, risky behaviors consistently predicted depression.

3.3.2. Analytic Methods (Aim 2)

Overview

Aim 3: To measure the association between depression and STI and investigate differences by arrest history.

Overview of Aim 3: We conducted analyses among a sub-sample of 11,594 male and female participants of Add Health with measures taken during Wave I (1995: early adolescence) and Wave III (2001-2002: late adolescence/young adulthood). Stratifying analyses by Wave III arrest history, we used multivariable logistic regression to estimate adjusted ORs (aORs) and 95% CIs for the associations between Wave III biologically-confirmed infection with *Chlamydia trachomatis, Neisseria gonorrhoea* or *Trichomonas vaginalis*, and two depression measures: severity of Wave III depression symptom levels (very high, an indicator of major depression; high; moderate; or low) and timing and persistence of major depression (Waves I and III (chronic major depression); Wave III only (recent major depression); Wave I only (prior major depression); or neither Wave I nor III (no history of major depression).

Inclusion and Exclusion Criteria

The study population includes all In-Home Interview participants for whom both Wave I and Wave III In-Home Interviews were completed. The analysis in which biologically-confirmed
STI is an outcome is restricted to those for whom biological specimen were collected and tests results were obtained.

Main Study Variables

Outcome: STI (Wave III)

*Biologically-confirmed STI:* Having a positive test result for *Chlamydia trachomatis*, *Neisseria gonorrhea*, or *Trichomonas vaginalis* on Wave III urine specimen versus having a negative result for all three tests.

Exposure: Depression (Waves I and III)

Depression was assessed using a modified version of the Center for Epidemiologic Studies Depression Scale (CES-D). The original CES-D is composed of 20 items, each of which assesses the frequency of experiencing depressive symptoms in the past week (0 - never or rarely, 1 - sometimes, 2 - a lot of the time, 3 - most of the time/all of the time). Four items assess positive symptoms (i.e., frequency of happiness, enjoying life, etc.) and are reversed before the score is computed. The composite score based on the 20-item scale ranges from 0 to 60, with higher scores indicating increased severity of depression. A score of 24 among men and 22 among women have been validated as sensitive and specific cut-points indicating current major depression among adolescents.

We used a subset of nine CES-D items common to Waves I and III to calculate each participant's Wave I and Wave III depression scores (score range: 0-27). The Cronbach alpha for the analytic sample was 0.84 for Wave I and 0.77 for Wave III, indicating the reliability of the modified CES-D as a measure of depression. A nearly complete version of the CES-D composed of 18 items assessing depression in the past week was administered at Wave I. Compared to the Wave I 18-item scale, the modified Wave I nine-item scale had a sensitivity of 97% and specificity of 90% for detection of Wave I major depression, further indicating that the 9-item scale is a valid tool for detection of major depression.

Following Shrier et al., we identified the male and female cut-points major depression based on our nine-item scale that were proportional to the cut-points indicating major depression based on the full CES-D. Since the cut-points for major depression based on the modified CES-
D were 9.9 for males and 10.4 for females, for convenience, we assumed that a score of 10 or greater indicated major depression for both genders. We then divided the remaining scores to obtain categories of low (score: 0 to 3), moderate (score: 4 to 6), and high (score: 7 to 9) depression symptom levels at each Wave.

Based on our categorizations of depression symptom levels at Waves I and III, we defined two four-level depression exposures:

Severity of depression symptoms at Wave III: Major depression; high depression levels; moderate depression levels; and low depression levels.

Adolescent major depression timing and duration: Major depression, detected at Waves I and III (chronic major depression); Wave III only (recent major depression); Wave I only (prior major depression); or neither Wave I nor Wave III (no history of major depression).

Stratification Variable: Arrest History (Wave III)

Prior arrest: Stopped by the police and arrested by Wave III versus no prior arrest.

Covariates

Potential confounding factors of the relationship between depression and STI were identified through causal models.

Baseline STI risk: Wave III self-reported age at first sex (15 years or less, 16 years, 17 to 18 years, 19 to 25 years, or never had sex by Wave III) and Wave I self-reported STI (respondent reported diagnosis with chlamydial infection, gonorrhea, trichomoniasis, syphilis, genital herpes, or HIV versus no self-reported STI diagnosis).

Socio-demographic: age (18 to 20 years, 21 years, 22 years, 23 years, or 24 to 28 years), biological sex (male versus female), and Wave III self-reported race/ethnicity (Latino (all participants reporting Hispanic or Latino origin), African American, Native American, Asian American, or white).

Socio-economic: maternal education, measured by Wave I self-report if the mother was interviewed, otherwise by adolescent's report (less than high school, high school graduate, or greater than high school) and Wave III functional poverty status in the past year (respondent or
household did not have enough money to pay for housing or utilities such as gas or electricity versus had adequate money for housing and utilities).

**Substance abuse:** Wave I lifetime marijuana use (ever used marijuana versus no use) and frequent drinking in the past year (drank at least 3 days per week versus no frequent drinking), Wave III assessment of marijuana, cocaine, methamphetamine, or injection drug use in the past 30 days (yes versus no) and heavy drinking in the past two weeks (drank at least 4 alcoholic beverages per day versus no heavy drinking).

**Analytic Techniques**

To ensure nationally-representative estimates and the most unbiased, efficient standard errors, we used survey commands in Stata (Version 9.0, 2005) to account for survey design stratification, clustering, and sampling.

**Univariable Analysis**

Univariate frequencies were calculated separately for men and women. Univariate frequencies of all variables, including main exposure, outcome, and other study variables were determined. Specifically, means, standard deviations, medians, and distributions of continuous variables were described using graphic techniques and tabulations. Frequencies of all categorical variables created were also determined.

Outliers were identified for each variable and, when possible, corrected if inconsistent with raw data. Each variable was checked for missing values. A complete case analysis was used in all analyses.

Alternate approaches to coding that appeared to be more meaningful were explored for each variable. For example, some continuous variables were categorized at meaningful cut-points. Similarly, some categorical variables were dichotomized if necessary, while other nominal variables were transformed into indicator variables to avoid enforcing ordinality or linearity.
**Bivariable analysis**

*Assessment of Main Research Question*

Bivariable analysis will be conducted to examine the unadjusted prevalence odds ratios (PORs) and 95% CIs between history of depression and risky sexual partnership/STI indicators.

*Assessment of Linearity of the Logit*

Continuous variables including age and age at first sex were categorized. To evaluate the assumption of the linearity of the log odds, log odds for the each exposure-outcome relationships were plotted within strata of each ordinal and categorized continuous variable. If the assumption was not upheld, alternate coding of ordinal and continuous variables was be explored by using indicator variables.

*Assessment of Confounding*

The bivariable relationship between each covariate and both depression exposure variables and risky sexual partnership/STI outcome indicators was measured. The unadjusted association was compared with the association adjusted for the variable in question using the following equation: \( \ln(\text{POR}_{\text{crude}}/\text{POR}_{\text{adjusted}}) \). A change between the two estimates of \( \geq 10\% \) will indicate confounding the need to consider the variable as a confounder in the multivariable setting.

*Assessment of Potential for Collinearity*

PORs for the association between each covariate and incarceration exposure variables were examined. PORs of \( \geq 3 \) were considered strong associations, and the variable was noted as a potentially collinear variable with the main exposure variables.

*Multivariable analysis*

*Assessment of Effect Measure Modification*

Due to small sample size, only a limited number of stratifications could be made, hence the potential modifying effect of each variable was not examined. The primary study objective was measurement of the association between depression and STI, and comparison of the depression-STI association among those with and without prior arrest history.
Effect modification by arrest status was investigated by assessing the significance of the product-interaction term between arrest status and depression. We assessed the product-interaction terms at an alpha equal to 0.3, a high cut-point for determining the presence of effect measure modification. The product-interaction term was significant at this level for one of the depression exposures. For consistency, estimates of the association between both depression exposures and STI were presented stratified by arrest status.

Previous studies of the association between depression and STI have presented gender-specific results. Our preliminary analyses indicated that in models assessing gender-specific associations between depression variables and STI, the product-interaction terms between gender and each depression variable were not significant when setting alpha equal to 0.3, a high cut-point for determining the presence of effect measure modification. Therefore, we did not present gender-specific estimates.

**Multivariable Logistic Regression**

Unconditional logistic regression models of the general form:

\[
\text{logit } [E(Y|x)] = \alpha + \beta x
\]

were estimated to measure the associations between depression and STI, stratified by arrest status.

The model for the association between the four-level variable representing depression level at Wave III and STI at Wave III is represented by the following equation:

\[
\text{logit } [E(Y|X)] = \alpha + \beta_1(\text{dep_moderate}) + \beta_2(\text{dep_high}) + \beta_3(\text{dep_veryhigh}) + \beta_4(\text{arrest}) + \beta_5(\text{dep_moderate*arrest}) + \beta_6(\text{dep_high*arrest}) + \beta_7(\text{dep_veryhigh*arrest}) + \beta_k(\text{covariates})
\]

- dep_moderate = moderate depression level (referent: low level)
- dep_high = high depression level (referent: low level)
- dep_veryhigh = very high level (referent: low level)
- arrest = arrested (referent: not arrested)
- dep_moderate *arrest = product-interaction for moderate depression and arrest
- dep_high *arrest = product-interaction for high depression and arrest
- dep_veryhigh *arrest = product-interaction for very high depression and arrest
- covariates = vector of all included covariates
Likewise, the model for the association between the four-level variable representing major depression and STI at Wave III is represented by the following equation:

$$\text{logit}[E(Y|x)] = \alpha + \beta_1(MDD_{\text{Ionly}}) + \beta_2(MDD_{\text{IIonly}}) + \beta_3(MDD_{\text{IandIII}}) + \beta_4(\text{arrest}) + \beta_5(MDD_{\text{Ionly}} \ast \text{arrest}) + \beta_6(MDD_{\text{IIonly}} \ast \text{arrest}) + \beta_7(MDD_{\text{IandIII}} \ast \text{arrest}) + \beta_k(\text{covariates}_k)$$

- $MDD_{\text{Ionly}}$ = major depression at Wave I only (referent: no prior mdd)
- $MDD_{\text{IIonly}}$ = major depression at Wave III only (referent: no prior mdd)
- $MDD_{\text{IandIII}}$ = major depression at Waves I and III (referent: no prior mdd)
- arrest = arrested (referent: not arrested)
- $MDD_{\text{Ionly}} \ast \text{arrest}$ = product-interaction for major depression at Wave I and arrest
- $MDD_{\text{IIonly}} \ast \text{arrest}$ = product-interaction for major depression at Wave III and arrest
- $MDD_{\text{IandIII}} \ast \text{arrest}$ = product-interaction for major depression at Waves I/III and arrest
- $\text{covariates}_k$ = vector of all included covariates
Figure 1. Conceptual Model of the Effect of Incarceration on STI/HIV, based in the Proximate Determinants Framework of HIV Transmission. (Individual- and community-level exposures to incarceration work through proximate and biological determinants to influence STI and sexually-transmitted HIV. Boldface boxes indicate exposures and outcomes examined in Aim 1).
Figure 2. Geographic Distribution of Venues where People Meet New Sexual partners Identified in a city in central North Carolina with High Levels of STI/HIV (2005)
Figure 3. Directed Acyclic Graph for the Hypothesized Effect of Incarceration Experience – Respondent Incarceration and Respondent’s Sexual Partnership with Someone who Spent Time Incarcerated - on Risky Sexual Partnership Outcomes
4.1. Abstract

Objective: HIV disproportionately infects African Americans. Incarceration, endemic in many African American communities, may contribute to the racial disparity by disrupting stable partnerships and promoting high-risk partnerships. We evaluated the association between incarceration and risky sexual partnerships among African Americans in North Carolina (NC).

Methods: We conducted a weighted analysis using the NC Rural Health Project (N=320), a population-based case-control study of HIV among African Americans. We examined the relationship between risky partnerships and incarceration, including timing and duration of the respondent’s incarceration and incarceration of the respondent’s recent sexual partners.

Results: Respondent incarceration, whether it occurred recently or in the past, was associated with risky partnerships. After adjustment for socio-demographic indicators, risky partnerships were associated with respondent incarceration of <1 month versus no respondent incarceration (men: adjusted prevalence ratio (aPR): 1.9, 95% confidence interval (CI): 1.2-3.1; women: aPR: 2.6, 95% CI: 1.0-7.0) and partner incarceration versus no partner incarceration (men: aPR: 1.8, 95% CI: 1.0-3.2; women: aPR: 1.9, 95% CI: 0.9-3.7). Substance abuse and incarceration were closely interconnected, thus adjustment for substance abuse weakened estimates.

Conclusion: HIV prevention programs targeting currently- and formerly-incarcerated individuals and their partners may decrease HIV transmission in African American communities with high incarceration rates.

4.2. Introduction

HIV rates are disproportionately high among African Americans in the United States. Though African Americans represented 12% of the United States population in 2005, they accounted for
nearly half of persons living with HIV/AIDS in 33 states that year\textsuperscript{11} and 74\% of heterosexually-transmitted HIV cases in 29 states from 1999 to 2002.\textsuperscript{12} In 2002, HIV/AIDS was the second-leading cause of death among all African Americans aged 35 to 44 years and the leading cause of death among African American women aged 25 to 34 years.\textsuperscript{13}

Incarceration, endemic in many African American communities, may contribute to the racial disparity in HIV infection by disrupting stable sexual partnerships and promoting high-risk partnerships.\textsuperscript{16, 160, 161} Previous studies measured associations between incarceration history – personal incarceration or recent sexual partner’s incarceration - and participation in concurrent sexual partnerships\textsuperscript{6-8} and sex work.\textsuperscript{9} These studies, however, did not evaluate \textit{duration} of incarceration or its \textit{timing} during the individual’s life course, both of which could be important factors in incarceration’s potential contribution to sexual risk behaviors. More complete understanding of the dimensions of incarceration and its relationship to risk behaviors could facilitate design and implementation of more effective HIV prevention programs.

We investigated the cross-sectional associations between incarceration and HIV-related sexual partnerships among African Americans in North Carolina (NC), a state with high rates of sexually transmitted infection (STI), including HIV.\textsuperscript{86, 162} We used data from the NC Rural Health Project (RHP), a population-based case-control study conducted to investigate the heterosexual transmission of HIV infection among African American in NC.\textsuperscript{157} In previous analyses among the RHP sample, concurrent partnership was associated with dichotomous indicators of incarceration for longer than 24 hours and ever incarceration of a sexual partner.\textsuperscript{7, 8} The purpose of the current study was to capitalize on the RHP’s detailed measurement of the timing and duration of the respondent’s incarceration - a unique component of their sexual behavioral questionnaire - and further explore associations between multiple dimensions of incarceration and sexual risk partnerships.

4.3. Methods

Study Population

Recruitment, which occurred from January 1997 through March 2000, has been described in detail elsewhere.\textsuperscript{7, 8, 157} Briefly, the original case-control study area comprised 13
rural counties in eastern NC. All controls were recruited from the thirteen-county study area. Due to initial slow enrollment of HIV-positive cases, case recruitment was expanded to other NC counties. For this study on incarceration and risky sexual partnership, we aggregated cases and controls and applied sampling weights to obtain estimates that were generalizeable to the source population that gave rise to the study sample. Since all controls were recruited from one of the original 13 counties, we restricted the case population to those who resided in one of these 13 counties.

When HIV-positive cases aged 18 years and older and residing in the study area were contacted by a NC Disease Intervention Specialist (DIS) for routine HIV counseling, they were screened for inclusion in the RHP. The DIS referred eligible cases who provided written informed consent for release of name and contact information to the RHP. Controls were selected randomly within strata defined by gender and five-year age groups, based on the case distribution, from the 1996 NC driver’s license records for all African American men and women aged 18 to 61 years residing in one of the original 13 RHP counties. Due to the RHP interest in heterosexually-transmitted HIV infection, exclusion criteria included self-reported history of injection drug use and, among male participants, sex with men.

Eligible participants who were successfully located by RHP staff and who provided written informed consent were enrolled.

Data Collection

Staff administered a one-hour structured face-to-face sexual behavior survey; drew a blood specimen for syphilis testing; and provided a $50 cash incentive.

The RHP was approved by the UNC-CH School of Medicine Committee on the Protection of the Rights of Human Subjects. Ethical approval for the secondary analysis on incarceration and sexual behavior was obtained from the UNC-CH School of Public Health Institutional Review Board.
Measures

Outcome: Risky partnership

We examined a dichotomous indicator of risky partnership, defined as engaging in multiple partnerships in the past year (includes sequential or concurrent partnerships) or transactional sex in the past year. A respondent with two or more partnerships were coded as having multiple partnerships. Transactional sex was defined as giving or receiving sex in exchange for drugs or money.

Exposures: Incarceration

Respondents were asked if they had spent longer than 24 hours in jail or prison in the past 10 years and, if so, they were asked to report the number of months and the last time they were incarcerated in the past 10 years. Respondents were also asked to report whether each of their three most recent sexual partners had ever spent longer than 24 hours in jail or prison. Three incarceration variables were defined based on these survey items.

We examined a three-level variable measuring the number of years since the respondent’s most recent incarceration (never, six to 10 years ago, or within the past five years).

We examined a three-level variable measuring the duration of time the respondent had ever been incarcerated in the past 10 years (never, less than one month, or one month or greater).

We examined a dichotomous indicator of sexual partnership with someone who was incarcerated, defined as the respondent’s report that at least one of his or her last three sex partners had ever been incarcerated (yes versus no).

Sampling Weights

Though RHP data were collected as a part of a case-control study, we aggregated HIV-positive cases and population-based HIV-negative controls and applied inverse probability weights in analyses to account for differential case and control sampling probabilities, yielding parameters that were representative of African Americans aged 18 to 61 years living in the thirteen-county study area, excluding injection drug users and men who have sex with men. The weight assigned to each observation was equivalent to the number of persons in the source population that the observation in
the dataset represented. Thus, because HIV prevalence among AA in NC is quite rare (<1% in each age group), with even lower levels observed in rural areas, the analysis is heavily weighted to represent the HIV-negative controls.

Each HIV-positive case was assumed to represent him- or herself in the population and was assigned a weight of one.

The value of the weight assigned to each RHP control was equivalent to the approximate number of HIV-negative African Americans in the thirteen-country study area represented by each control, calculated by dividing the approximate number of HIV-negative African American residents of the thirteen-county study area within each gender and age-specific stratum\(^1\) by the number of RHP controls in each gender and age-specific stratum.

**Data Analysis**

We performed analyses in Stata Version 8.0 (Stata Corp., College Station, TX). We calculated weighted prevalences and means of demographic, socio-economic, and behavioral variables, separately by gender.

We estimated unadjusted and adjusted prevalence ratios (PRs) and 95% confidence intervals (CIs) for the associations between each incarceration exposure and risky partnership using a generalized linear model with probability weights, log link, Poisson distribution without an offset,\(^{145, 146}\) and a robust variance estimator to correct for overestimation of the error term resulting from use of Poisson regression with binomial data.\(^{148}\) Because preliminary analyses indicated that most associations between incarceration and sexual partnership variables differed by gender, we included a product-interaction term between gender and each incarceration exposure to obtain gender-specific associations.

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\(^1\)We determined the approximate gender- and age-specific populations of HIV-negative African American residents of the thirteen-county study area as follows. Because HIV prevalence is very low, we assumed that the HIV-negative population was roughly equivalent to the total population. We obtained the US Census Bureau year 2000 population estimate for the each of the 13 counties. We applied the US Census Bureau year 2004 county-specific ratio of men: women and county-specific ratio of African Americans: non-African Americans to each county’s population to determine the number of African American men and women in each of the 13 counties. We summed the gender-specific population estimates for the 13 counties to obtain the number of African American men and women in the study area. We applied the US Census Bureau year 2000 nationwide age distribution to the gender-specific African American populations to obtain the estimated number of African American men and women in the study area within each age stratum.
In initial multivariable models, we used a manual change in estimate backwards elimination procedure to identify the particular set of socio-demographic confounding variables necessary to include in each final model. We assessed confounding by the following factors, identified based on conceptual models: age at first sex; lack of high school education; homelessness in the past 10 years; food insecurity in the past month; current receipt of food stamps or welfare; and residence in an unsafe neighborhood. Age at first sex was entered as a continuous variable after confirmed linearity in the log prevalence. All other variables were dichotomous. We ensured that the PR derived from each final model was no greater than 10% different than the PR derived from the original model, which adjusted for all potential confounding variables. Indicator variables representing five-year categories of respondent’s age were included in all models, as controls were selected within these strata.

In subsequent models, we controlled for two dichotomous substance abuse variables in addition to respondent age and socio-demographic factors identified in initial mode: hard drug use (used crack/cocaine or heroin in the past 10 years) and frequent alcohol or marijuana use (drank at least five alcoholic beverages per day or used marijuana at least once per week during a period in the past 10 years).

4.4. Results

Enrollment of Cases and Controls

Enrollment has been described in detail previously. Of 451 cases who were screened by the DIS, deemed eligible, and re-located by RHP staff, 206 (46%) participated in the RHP interview. Consenting and non-consenting cases had comparable distributions of age, gender, and risk behaviors. Of 327 eligible, controls who could be found, 226 (69%) participated and were confirmed to have negative HIV tests.

The 138 cases residing in the original thirteen-county area and all 226 controls, all of whom resided in this area, were included in this analysis on incarceration and risky partnership.
Demographic and Socio-Economic Characteristics

The mean age among men and women was 39 years and 38 years, respectively (Table 4.1). The majority of participants had completed high school or higher. Approximately 10% of men and 32% of women received food stamps or welfare. Greater than 10% of men and women reported being worried about having enough food in the past month.

Prevalence of Incarceration and Risky Partnership

Twenty-five percent of men and 3% of women had been incarcerated for longer than 24 hours in the past five years. Additionally, 5% of men and 2% of women had been incarcerated for longer than 24 hours six to 10 years ago (Table 4.1).

In the past 10 years, 15% of men and 2% of women had been incarcerated for longer than 24 hours and less than one month. Additionally, 15% of men and 3% of women had been incarcerated for one month or greater.

More than half of women (53%) and 13% of men reported that at least one of their last three sex partners had ever been incarcerated.

In the past year, 47% of men and 28% of women were identified as having risky partnerships (multiple or concurrent partnerships or transactional sex), the primary outcome of interest.

Associations between Incarceration and Risky Partnership

Timing of Respondent’s Incarceration and Risky Partnership

Men

Men whose most recent incarceration occurred six to 10 years ago were twice as likely to report risky partnerships as men who were never incarcerated (unadjusted PR: 1.98, 95% CI: 1.07-3.68) (Table 4.2). The estimate changed minimally when adjusting for socio-demographic indicators including age, age at first sex, and socio-economic indicators. The association remained after further adjustment for substance abuse variables (fully-adjusted PR: 1.78; 95% CI: 1.01-3.15).

Men reporting incarceration within the past five years were somewhat more likely to report risky partnerships than men with no incarceration history (unadjusted PR: 1.57, 95% CI: 0.86-2.87). The association weakened considerably after adjustment for socio-demographics (adjusted PR: 1.22,
95% CI: 0.64-2.31) and disappeared after adjusting for substance abuse (fully-adjusted PR: 0.98, 95% CI: 0.48-2.01).

Women

Small sample size prevented estimation of reliable associations between previous incarceration and risky partnerships among women.

Women who were incarcerated within the past five years were much more likely to report risky partnerships than women who were never incarcerated (unadjusted PR: 3.80, 95% CI: 2.81-5.13) (Table 4.2). Adjustment for socio-demographics had little effect. When further adjusting for substance abuse, the PR weakened considerably but remained (fully-adjusted PR: 2.31, 95% CI: 1.32-4.01).

Duration of Respondent's Incarceration and Risky Partnership

Men

Men who were incarcerated for less than one month in the past 10 years were twice as likely to report risky partnerships as men with no incarceration history (unadjusted PR: 2.08, 95% CI: 1.31-3.31) (Table 4.2). After adjustment for socio-demographics the PR was 1.94 (95% CI: 1.22-3.06). The association between incarceration and risky partnerships remained, although somewhat weakened, after additional adjustment for substance abuse (fully-adjusted PR: 1.65, 95% CI: 0.93-2.92).

Among men, unadjusted analyses and analyses adjusted for socio-demographic and substance abuse variables indicated that incarceration of one month or greater, compared with no prior incarceration, was not associated with risky partnerships (fully-adjusted PR: 0.69, 95% CI: 0.27-1.73).

Women

Women who were incarcerated for less than one month in the past 10 years were more than twice as likely to report risky partnerships in the past year as women who had never been incarcerated (unadjusted PR: 2.67, 95% CI: 1.23-5.80) (Table 4.2). Adjustment for socio-demographics altered the estimate minimally. When further adjusting for substance abuse, the fully-adjusted PR was 1.66 (95% CI: 0.70-3.97) due to high correlations between incarceration and substance abuse.
Women who were incarcerated for one month or longer were also more than twice as likely to report risky partnerships as those who had never been incarcerated (unadjusted PR: 2.32, 95% CI: 1.02-5.28). Adjustment for socio-demographic characteristics weakened the association somewhat (adjusted PR: 1.99, 95% CI: 0.85-4.64). After further adjusting for substance abuse, the PR decreased to 1.39 (95% CI: 0.56-3.47) due to high correlations between incarceration and substance abuse. Women incarcerated for one month or longer were more likely to use hard drugs (53%) and frequently use marijuana or alcohol (80%) than women who had never been incarcerated (hard drugs: 2%, marijuana or alcohol: 17%).

**Sexual Partner’s Incarceration and Risky Partnership**

**Men**

Men reporting incarceration of at least one of the three most recent sexual partners had a higher prevalence of risky partnerships than men reporting none of the three most recent partners had been incarcerated (unadjusted PR: 1.61, 95% CI: 0.98-2.65) (Table 4.2). After adjustment for socio-demographic characteristics and substance abuse, the association between sexual partner’s incarceration and risky partnerships strengthened (fully-adjusted PR: 1.78, 95% CI: 1.03-3.08).

**Women**

Women reporting that at least one of the last three most recent sexual partner had an incarceration history were more than twice as likely to report risky partnerships as women whose three most recent partners had not been incarcerated (unadjusted PR: 2.18, 95% CI: 1.09-4.35) (Table 4.2). The estimate weakened when adjusting for socio-demographics (adjusted PR: 1.86, 95% CI: 0.93-3.74) and when further adjusting for substance abuse (fully-adjusted PR: 1.69, 95% CI: 0.84-3.41).

**4.5. Discussion**

African Americans in North Carolina who were recently incarcerated, and those whose sexual partners had been incarcerated, were much more likely to risky sexual partnerships than those without exposure to incarceration. When adjusting for socio-demographic indicators, the associations between incarceration variables and risky partnerships weakened but persisted. Adjustment for
substance abuse further weakened associations, particularly among women, as substance abuse and incarceration histories were closely interconnected. We interpret these findings to suggest that incarceration is closely entangled in a web of other adverse social and economic conditions that work independently and in concert to worsen the relationships and health of African Americans. A large-scale longitudinal study with frequent measurements would be needed to determine whether incarceration is causally associated with sexual risk behaviors and HIV independent of other adverse factors.

These results support existing evidence of the association between incarceration and sexual risk behaviors. Among a household sample of Seattle residents, men who had spent at least a night in jail were more likely to have concurrent partnerships. Previous analyses among HIV-positive and HIV-negative RHP participants revealed strong associations between partnership concurrency and history of incarceration for longer than 24 hours in the past 10 years, though these associations did not persist when adjusting for confounding factors. In these studies, however, the duration and timing of incarceration with respect to concurrency was not analyzed. Moreover multivariable regression models were constructed to examine the associations between concurrency and multiple risk factors, rather than incarceration alone.

To our knowledge, the current analysis among the RHP sample has been the most careful investigation of personal incarceration history and risky sexual partnerships thus far conducted. By exploring the timing and duration of incarceration separately by gender, and adjusting for variables carefully identified as potential confounding factors based on causal models, we illuminated associations between personal incarceration and sexual risk behavior. First, our findings indicated that risky partnerships were strongly associated with incarceration history, irrespective of whether incarceration occurred in the recent or distant past. The findings also suggested that risky partnerships were more common among those reporting short-term incarceration of less than one month than those reporting long-term incarceration of one month or greater; those who experience short-term incarceration may constitute a transient group whose lives are characterized by particular instability and who may experience increased vulnerability to risky sexual behaviors.
Study findings should be interpreted with caution despite improved measurement of personal incarceration. Small sample size yielded imprecise estimates in some strata and limited further exploration of duration and timing of incarceration. Further investigation of personal incarceration and HIV-related sexual behaviors among a large sample is needed to ensure that gender-stratified, multivariable analyses are adequately powered.

Incarceration of at least one of the three most recent sexual partners was strongly associated with risky partnerships in multivariable analyses among both men and women in the RHP source population. The results of this study further corroborated prior RHP analyses that measured robust associations between partner incarceration and partnership concurrency.\textsuperscript{7, 8} We lacked knowledge of the timing and duration of the partner’s incarceration, a limitation. A study is needed to measure the effect of incarceration on the partners of prisoners, in which risky partnerships are measured prior to, during, and after the incarceration.

In cases of strong correlation between incarceration and substance abuse histories, adjustment for substance abuse greatly diminished the association between incarceration and risky partnership. Though the goal of this study was to estimate an association between incarceration and sexual risk behaviors independent of adverse factors, such as substance abuse, doing so was methodologically challenging and likely inappropriate from a public health intervention perspective. Regardless of whether incarceration affects health independent of substance abuse, HIV interventions targeting those with a history of incarceration should incorporate substance abuse treatment to improve uptake of HIV prevention programs.

The rationale for why personal or sexual partner’s incarceration may contribute to sexual risk behaviors has been documented.\textsuperscript{16} Incarceration physically separates partners in stable relationships, which can lead to loneliness and emotional division\textsuperscript{53-59} and partnership dissolution.\textsuperscript{56, 58, 60} Absence of a stable partnership may contribute to multiple, new, or concurrent partnerships among the partners of prisoners during the incarceration\textsuperscript{56} or among the prisoners at the time of release.\textsuperscript{61} During an incarceration, the prisoner’s partner may seek other partners to fill an emotional or financial void.\textsuperscript{56} Absence of a partner, combined with freedom from restrictions on sexual behavior, may lead newly-released prisoners to risky sexual partnerships.\textsuperscript{81}
We note that in this investigation of incarceration and risky partnerships, we have explored only one of many proximate determinants of STI/HIV among the incarcerated. Additional reasons for disproportionate STI/HIV levels among incarcerated populations could include high likelihood of having a sexual partner who is infected; high levels of STIs that increase risk of acquiring HIV; low condom use; or elevated injection drug use behaviors. Given the multi-causal nature STI/HIV, there are many studies to be conducted in the future to determine the most important factors of STI/HIV transmission among incarcerated populations, including whether the disruption of the incarceration itself plays a role.

This study indicated that rural African Americans who were formerly incarcerated or had a sexual partner who had been incarcerated were particularly vulnerable to HIV-related sexual risk behaviors. Deleterious effects of incarceration on individuals have important population-level consequences on African American health given the high prevalence of incarceration among African Americans; in our study population, one-quarter of men had been incarcerated in the past five years and more than half of women had a recent sexual partner with an incarceration history. HIV prevention programs should target currently- and formerly-incarcerated individuals and their sexual partners and should strengthen substance abuse prevention and treatment programs for this population to help decrease HIV transmission in African American communities with high incarceration rates.
Table 4.1. Demographic, Socio-economic, Substance Abuse, and Sexual Characteristics among African Americans Aged 18-61 Years (UNC Rural Health Project, North Carolina, 1997-2000, N=320).

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>Men (N=115)</th>
<th>Women (N=205)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>N*</td>
<td>Weighted %†</td>
</tr>
<tr>
<td>18-24</td>
<td>6</td>
<td>16.2</td>
</tr>
<tr>
<td>25-29</td>
<td>9</td>
<td>11.6</td>
</tr>
<tr>
<td>30-34</td>
<td>11</td>
<td>12.2</td>
</tr>
<tr>
<td>35-39</td>
<td>36</td>
<td>13.6</td>
</tr>
<tr>
<td>40-44</td>
<td>23</td>
<td>13.4</td>
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<td>45-49</td>
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<td>12.0</td>
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<td>50-54</td>
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<tr>
<td>55-61</td>
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<td>10.6</td>
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<tr>
<td>Marital status</td>
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<tr>
<td>Married, lives with spouse</td>
<td>47</td>
<td>45.1</td>
</tr>
<tr>
<td>Married, does not live with spouse</td>
<td>8</td>
<td>2.0</td>
</tr>
<tr>
<td>Not married, lives with sexual partner</td>
<td>16</td>
<td>12.0</td>
</tr>
<tr>
<td>Not married, lives alone</td>
<td>43</td>
<td>40.9</td>
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<td>Socio-economic indicators</td>
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<tr>
<td>Educational attainment</td>
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<tr>
<td>8th grade or less</td>
<td>6</td>
<td>1.0</td>
</tr>
<tr>
<td>Some high school</td>
<td>24</td>
<td>17.3</td>
</tr>
<tr>
<td>High school graduate or equivalent</td>
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<td>44.4</td>
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<tr>
<td>Vocational or trade school</td>
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<td>9.4</td>
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<tr>
<td>Some college or 2 year degree</td>
<td>23</td>
<td>20.1</td>
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<tr>
<td>Finished college</td>
<td>9</td>
<td>6.9</td>
</tr>
<tr>
<td>Master’s or other advanced degree</td>
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<td>1.0</td>
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<tr>
<td>Annual household income in past year</td>
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<td></td>
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<tr>
<td>Less than $12000</td>
<td>20</td>
<td>12.8</td>
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<td>$12-16000</td>
<td>12</td>
<td>8.9</td>
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<tr>
<td>$16-25000</td>
<td>25</td>
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<td>$25-50000</td>
<td>21</td>
<td>23.3</td>
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<td>Over $50000</td>
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<td>Refused/unable</td>
<td>18</td>
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<tr>
<td>Currently unemployed (not working full- or part-time for pay)</td>
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<td></td>
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<tr>
<td>Yes</td>
<td>36</td>
<td>20.4</td>
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<tr>
<td>No</td>
<td>79</td>
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<td>Homeless in past 10 years</td>
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<td></td>
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<tr>
<td>Yes</td>
<td>16</td>
<td>6.5</td>
</tr>
<tr>
<td>No</td>
<td>99</td>
<td>93.5</td>
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<td>Worried about food for self or family in past month</td>
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<tr>
<td>Yes</td>
<td>25</td>
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</tr>
<tr>
<td>No</td>
<td>90</td>
<td>89.7</td>
</tr>
<tr>
<td>Currently receives federal aid (food stamps, welfare)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>29</td>
<td>9.9</td>
</tr>
<tr>
<td>No</td>
<td>86</td>
<td>90.1</td>
</tr>
<tr>
<td>Neighborhood safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe (feels quite safe or extremely safe from crime)</td>
<td>33</td>
<td>23.7</td>
</tr>
<tr>
<td>Unsafe (feels slightly safe or not at all safe from crime)</td>
<td>82</td>
<td>76.3</td>
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Table 4.1. Continued

<table>
<thead>
<tr>
<th>Time since most recent incarceration in the past 10 years‡</th>
<th>69</th>
<th>70.7</th>
<th>184</th>
<th>95.3</th>
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<td>Never incarcerated in the past 10 years</td>
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<td></td>
<td></td>
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<tr>
<td>Recent incarceration: &gt;24 hours 6-10 years ago</td>
<td>14</td>
<td>4.6</td>
<td>6</td>
<td>1.5</td>
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<tr>
<td>Prior incarceration: &gt;24 hours within the past 5 years</td>
<td>32</td>
<td>24.7</td>
<td>14</td>
<td>2.6</td>
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<table>
<thead>
<tr>
<th>Duration of time incarcerated‡</th>
<th>69</th>
<th>70.7</th>
<th>184</th>
<th>95.3</th>
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<tr>
<td>Never incarcerated in the past 10 years</td>
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<tr>
<td>Recent incarceration: &gt;24 hours 6-10 years ago</td>
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<td>14.5</td>
<td>9</td>
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<td>Prior incarceration: &gt;24 hours within the past 5 years</td>
<td>31</td>
<td>14.8</td>
<td>11</td>
<td>2.5</td>
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<tr>
<th>Incarceration of recent sexual partners‡</th>
<th>82</th>
<th>87.3</th>
<th>81</th>
<th>46.8</th>
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<tr>
<td>0 of last 3 partners ever incarcerated &gt;24 hours</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1 of last 3 partners ever incarcerated &gt;24 hours</td>
<td>17</td>
<td>10.3</td>
<td>66</td>
<td>28.3</td>
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<td>≥2 of last 3 partners ever incarcerated &gt;24 hours</td>
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<td>57</td>
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<th>23</th>
<th>5.8</th>
<th>24</th>
<th>4.5</th>
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<tbody>
<tr>
<td>Ever used crack, cocaine, or heroine in past 10 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
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<tr>
<td>No</td>
<td>92</td>
<td>94.2</td>
<td>181</td>
<td>95.5</td>
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<table>
<thead>
<tr>
<th>Frequent ≥once weekly use of ≥5 daily alcoholic beverages or marijuana in past 10 years</th>
<th>53</th>
<th>32.4</th>
<th>52</th>
<th>19.2</th>
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<tr>
<td>No</td>
<td>62</td>
<td>67.6</td>
<td>153</td>
<td>80.8</td>
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<table>
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<tr>
<th>Sexual behavior and sexually transmitted infections (STIs)</th>
<th>63</th>
<th>52.2</th>
<th>78</th>
<th>33.2</th>
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<tr>
<td>Age at first sex (years)</td>
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<td></td>
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<tr>
<td>15 or younger</td>
<td></td>
<td></td>
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<tr>
<td>16-18</td>
<td>42</td>
<td>39.5</td>
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<td>19-29</td>
<td>10</td>
<td>8.4</td>
<td>27</td>
<td>14.9</td>
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<table>
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<tr>
<th>Multiple (≥2) sexual partnerships in past year</th>
<th>52</th>
<th>44.3</th>
<th>67</th>
<th>25.3</th>
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<tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td>No</td>
<td>63</td>
<td>55.7</td>
<td>138</td>
<td>74.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concurrent sexual partnerships in past year</th>
<th>45</th>
<th>42.9</th>
<th>46</th>
<th>17.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>70</td>
<td>57.1</td>
<td>159</td>
<td>82.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transactional sex in past year</th>
<th>18</th>
<th>5.9</th>
<th>13</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>97</td>
<td>94.1</td>
<td>191</td>
<td>96.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Multiple partnerships, concurrent sexual partnerships, or transactional sex in past year§</th>
<th>58</th>
<th>47.3</th>
<th>73</th>
<th>27.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>57</td>
<td>52.7</td>
<td>131</td>
<td>72.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-reported STI diagnosis, lifetime</th>
<th>59</th>
<th>48.6</th>
<th>100</th>
<th>35.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>56</td>
<td>51.4</td>
<td>104</td>
<td>64.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-reported STI diagnosis in past year</th>
<th>15</th>
<th>4.5</th>
<th>24</th>
<th>3.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>98</td>
<td>94.1</td>
<td>180</td>
<td>97.0</td>
</tr>
</tbody>
</table>

*Totals may not sum to 115 among men or 205 among women due to missing values of some variables.
†Weighting accounted for differential sampling probabilities between HIV-positive and HIV-negative participants and yielded estimates generalizable to African Americans aged 18 to 61 years residing in the 13 eastern, rural North Carolina county study area, excluding injection drug users and men who have sex with men.
‡Incarceration exposure in main analysis (see Table 4.2).
§Sexual behavior outcome in main analysis (see Table 4.2).
Table 4.2. Prevalence Ratios (PRs) and 95% Confidence Intervals (CIs) for the Associations between Incarceration History and Risky Partnerships in the Past Year among African Americans aged 18-61 Years in Eastern, Rural North Carolina (UNC Rural Health Project, North Carolina, 1997-2000, N=320).

<table>
<thead>
<tr>
<th>Risky Sexual Partnership in the Past Year</th>
<th>PR (95% CI)</th>
<th>PR (95% CI)</th>
<th>PR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%*</td>
<td>Unadjusted</td>
<td>Adjusted for</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Socio-demographics:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Age, Age at First Sex, and Socio-economic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Indicators*†</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Adjusted for</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Socio-demographics and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Substance Abuse*†</td>
</tr>
</tbody>
</table>

### Respondent incarceration: time since most recent incarceration in the past 10 years

<table>
<thead>
<tr>
<th>Gender</th>
<th>Time Since Most Recent Incarceration in the Past 10 Years</th>
<th>Risky Partnership in the Past Year</th>
<th>PR (95% CI)</th>
<th>PR (95% CI)</th>
<th>PR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>39.9</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Never incarcerated in the past 10 years (N=69)</td>
<td>39.9</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Recent incarceration: &gt;24 hours 6-10 years ago (N=14)</td>
<td>79.1</td>
<td>1.98 (1.07, 3.68)</td>
<td>1.74 (1.03, 2.94)</td>
<td>1.78 (1.01, 3.15)</td>
</tr>
<tr>
<td></td>
<td>Prior incarceration: &gt;24 hours within the past 5 years (N=32)</td>
<td>62.7</td>
<td>1.57 (0.86, 2.87)</td>
<td>1.22 (0.64, 2.31)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>26.3</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Never incarcerated in the past 10 years (N=184)</td>
<td>26.3</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Recent incarceration: &gt;24 hours 6-10 years ago (N=6)§</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Prior incarceration: &gt;24 hours within the past 5 years (N=14)</td>
<td>99.9</td>
<td>3.80 (2.81, 5.14)</td>
<td>3.89 (2.42, 6.26)</td>
<td>2.31 (1.32, 4.01)</td>
</tr>
</tbody>
</table>

### Respondent incarceration: cumulative duration of time incarcerated in the past 10 years

<table>
<thead>
<tr>
<th>Gender</th>
<th>Time Since Most Recent Incarceration in the Past 10 Years</th>
<th>Risky Partnership in the Past Year</th>
<th>PR (95% CI)</th>
<th>PR (95% CI)</th>
<th>PR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>39.9</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Never incarcerated in the past 10 years (N=69)</td>
<td>39.9</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Short-term incarceration: &gt;24 hours and &lt;1month in the past 10 years (N=15)</td>
<td>83.0</td>
<td>2.08 (1.31, 3.31)</td>
<td>1.94 (1.22, 3.06)</td>
<td>1.65 (0.93, 2.92)</td>
</tr>
<tr>
<td></td>
<td>Long-term incarceration: ≥1 month in the past 10 years (N=31)</td>
<td>47.8</td>
<td>1.20 (0.51, 2.84)</td>
<td>0.66 (0.27, 1.62)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>26.3</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Never incarcerated in the past 10 years (N=184)</td>
<td>26.3</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Short-term incarceration: &gt;24 hours and &lt;1month in the past 10 years (N=9)</td>
<td>70.3</td>
<td>2.67 (1.23, 5.80)</td>
<td>2.64 (1.01, 6.95)</td>
<td>1.66 (0.70, 3.97)</td>
</tr>
<tr>
<td></td>
<td>Long-term incarceration: ≥1 month in the past 10 years (N=11)</td>
<td>61.1</td>
<td>2.32 (1.02, 5.28)</td>
<td>1.99 (0.85, 4.64)</td>
<td>1.39 (0.56, 3.47)</td>
</tr>
</tbody>
</table>
Table 4.2. Continued

Partner incarceration: ≥1 of last 3 sexual partners was incarcerated for >24 hours§

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No (N=82)</td>
<td>43.9</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Yes (N=31)</td>
<td>70.7</td>
<td>1.61</td>
<td>(0.98, 2.65)</td>
<td>1.81</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No (N=81)</td>
<td>17.2</td>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Yes (N=123)</td>
<td>37.4</td>
<td>2.18</td>
<td>(1.09, 4.35)</td>
<td>1.86</td>
</tr>
</tbody>
</table>

*Estimates were weighted to account for differential sampling probabilities between HIV-positive and HIV-negative participants and are generalizable to African Americans aged 18-61 years residing in the 13 county RHP study area, excluding injection drug users and men who have sex with men.
†Adjusted for respondent age plus any of the following socio-demographic variables, if identified as confounding factors in the backwards elimination strategy of variable selection: age at first sex; high school graduate; homeless in the past 10 years; recent food insecurity; current recipient of federal aid (food stamps or welfare); neighborhood crime exposure.
‡ Substance abuse covariates included: hard drug use in the past 10 years (ever used crack/cocaine, or heroine) and frequent soft drug use in the past 10 years (drank at least five alcoholic beverages per day or used marijuana least once per week during a period in the past 10 years).
§Stratum-specific sample size too small to yield reliable estimates.
CHAPTER FIVE: INCARCERATION AND RISKY SEXUAL PARTNERSHIPS AMONG A HIGH-RISK SAMPLE FROM A CITY IN CENTRAL NORTH CAROLINA

5.1. Abstract

Objective: Incarceration is strongly associated with HIV infection and may contribute to viral transmission by disrupting stable partnerships and promoting high-risk partnerships.

Methods: We investigated incarceration and STI/HIV-related partnerships among a community-based sample recruited for a sexual behavior interview while frequenting venues where people meet sexual partners in a North Carolina city (N=373).

Results: Men reporting incarceration in the past 12 months were more likely than men without recent incarceration to experience multiple new sexual partnerships (unadjusted prevalence ratio [PR] 1.8, 95% confidence interval [CI]: 1.1-3.1) and transactional sex defined as trading sex for money, goods, or services (unadjusted PR: 4.0, 95% CI: 2.3-7.1) in the past four weeks. Likewise, women who were ever incarcerated were more likely than never-incarcerated women to experience recent multiple new partnerships (unadjusted PR: 3.1, 95% CI: 1.8-5.4) and transactional sex (unadjusted PR: 5.3, 95% CI: 2.6-10.9). Sexual partnership in the past 12 months with someone who had ever been incarcerated versus with partners with no known incarceration history was associated with recent multiple new partnerships (men: unadjusted PR: 2.0, 95% CI: 1.4-2.9, women: unadjusted PR: 4.8, 95% CI: 2.3-10.1) and transactional sex (men: unadjusted PR: 3.3, 95% CI: 1.7-6.6, women: unadjusted PR: 6.1, 95% CI: 2.4-15.4). Adjustment for demographic and socio-economic variables had minimal effect on estimates. However, the strong overlap between incarceration, partner incarceration, and substance abuse had substantial effects in multivariable models.

Conclusions: Correctional-facility and community-based HIV prevention, with substance abuse treatment, should reach currently- and formerly-incarcerated individuals and their sexual partners.
5.2. Introduction

Incarceration is strongly associated with sexually transmitted infections (STIs) including human immunodeficiency virus (HIV). In 2004, prison inmates were three to five times more likely to be HIV-infected than those in the United States (US) general population. In 1999, greater than one-fifth all HIV-positive persons in the US passed through a US correctional facility. HIV infection also appears to be common among the partners of persons with an incarceration history.

The association between incarceration and STI/HIV infection may exist, in part, because incarceration disrupts stable sexual partnerships that protect against new, multiple and concurrent sexual partnerships, determinants of STI/HIV infection. Both history of incarceration and having a recent sexual partner who was incarcerated were associated with concurrent sexual partnerships and sex work in exploratory studies. As incarceration is endemic in many communities, careful investigation into the association between incarceration and risky sexual partnerships, accounting for incarceration exposures that precede sexual partnership outcomes and adjusting for potential confounding factors is warranted.

We aimed to examine the association between incarceration and risky sexual partnerships in North Carolina, a state with high incidence of STI/HIV. We conducted the study in a moderately-sized city affected by elevated levels of STI/HIV, substance abuse, crime, poverty, and incarceration. A research team including representatives of the local Department of Health, local non-governmental organizations, and the University of North Carolina at Chapel Hill (UNC-CH) Carolina Population Center and Center for AIDS Research implemented the North Carolina Priorities for Local AIDS Control Efforts (NC PLACE) Study to identify social venues within the study area where levels of new, multiple, and concurrent sexual partnerships were high. One PLACE Study objective was to investigate associations between incarceration – both respondent’s personal incarceration and sexual partnership with someone who was incarcerated - and risky sexual partnerships among the sample of individuals recruited for a sexual behavior interview at social venues.
5.3. Methods

Study design

We conducted the NC PLACE Study from August through October 2005. The PLACE methodology has been described in detail elsewhere. Briefly, field work was implemented in three phases. In the first phase, we interviewed community informants assumed to be knowledgeable about the area (N=120 informants) to identify a list of social venues where people meet new sexual partners in the study city. In the second phase, we visited each venue identified by community informants (N=146 venues) to verify the venue address and interview a venue representative about the potential for on-site HIV/AIDS intervention. We attempted to visit each venue at least twice if initially closed. We eliminated venues from the venue list if they could no be located (N=3 of 146) or if the venue manager requested that no further interviewing take place at their venue (N=12 of 146). In the final phase, we administered a structured face-to-face sexual behavior survey to individuals of unknown-HIV status socializing at a random sample of the verified social venues (N=54 of 131 venues). To ensure that the selection of social venues represented different populations within the study area, we selected venues within strata of different venue types. We attempted interviews at a total of 54 of venues in order to obtain a target number of 500 interviews. The number of social interviews attempted per venue was based on venue size, estimated by the venue representative as the number of men and women who socialized daily at his or her venue. Interviewers attempted to recruit a ratio of two men to one woman, because data obtained from venue representatives indicated that men comprised a higher proportion of the venue population than women.

To select a representative sample of individuals socializing at each venue, a protocol was followed that distributed interviewers systematically throughout the venue to minimize interviewer discretion in selecting respondents by convenience. Interviewers brought the respondents to a private area to protect confidentiality during the interview, obtained verbal informed consent for a confidential and anonymous 15 to 20 minute interview, and confirmed that
respondents were at least 18 years and sober. Interviewers did not systematically offer incentives but provided a small snack or token gift (value of less than $1) if appropriate.

The UNC-CH School of Public Health Institutional Review Board provided ethical approval for the study.

**Measures**

**Outcome: Sexual Partnerships**

We examined two dichotomous outcomes. We defined multiple partnerships as report of having at least two new sexual partners in the past four weeks. We defined transactional sex as report of having given or received money, goods, or services for sex in the past four weeks.

**Exposure: Incarceration**

We defined a dichotomous indicator of respondent’s personal incarceration as incarceration for longer than 24 hours in the past 12 months among men, and lifetime history of incarceration for longer than 24 hours among women. The exposure definition differed by gender due to the low prevalence of recent incarceration among women.

We defined a dichotomous indicator of sexual partner’s incarceration as having a sexual partner in the past 12 months who had ever been incarcerated for longer than 24 hours.

**Data Analysis**

We performed analyses in Stata, version 8.0 (Stata Corp., College Station, TX). We calculated frequencies and/or means of demographic, socio-economic and behavioral variables separately by gender.

We estimated unadjusted and adjusted prevalence ratios (PR) and 95% confidence intervals (CIs) for the associations between each sexual partnership outcome and each incarceration indicator using generalized estimating equations (GEE) to account for clustering by the venue where the individual was interviewed. We specified a log link, a Poisson distribution, an exchangeable correlation matrix structure, and a robust variance estimator to correct for overestimation of the error term resulting from use of Poisson regression with binomial data. Since personal incarceration was estimated using different variables for men and women, we used two separate models to estimate the association.
between personal incarceration exposures and risky partnership outcomes for men and women separately. For consistency, we also used gender-stratified models to estimate associations between partner’s incarceration and risky partnership outcomes; preliminary analyses indicated that the associations between partner incarceration exposures and sexual partnership outcomes differed by gender.

We considered each of the following, identified as a potential confounding variable based on conceptual models and prior research, for inclusion in each adjusted model: age, black race, less than high school education, currently unemployed, respondent substance abuse (used injection drugs, crack/cocaine, ecstasy, speed, or crystal methamphetamine in past 12 months) and partner crack/cocaine use (had a partner in the past 12 months who used crack/cocaine). We did not assess alcohol during the survey in efforts to minimize questionnaire length; obtaining specific and interpretable data on alcohol consumption necessitated a series of questions. For models examining the association between sexual partnership outcomes and respondent incarceration history, we assessed confounding by partner incarceration history. For models examining the association between sexual partnership outcomes and partner incarceration history, we assessed confounding by respondent incarceration history. We assessed linearity in the log prevalence by age. The assumption was not upheld, so age was coded as two indicator variables. All other variables were dichotomous.

For each adjusted model, we used a manual change in estimate backwards elimination procedure to identify the particular set of confounding variables necessary to include in each final model.149 We ensured that the PR derived from each final model was no greater than 10% different than the PR derived from the fully-adjusted model, which included all potential confounding variables listed above.
5.4. Results

Recruitment

The venues identified by community informants from which the study population was recruited were diverse and included bars and clubs, eating establishments, public areas, hotels, parks, parking lots, abandoned fields, and outside of private homes. At five of the 54 venues, no interviews were completed because the one person at each venue who was available and recruited for the interview refused to participate. At the remaining 49 venues, a total of 144 of 185 eligible women (78%) and 229 of 309 eligible men (74%) agreed to participate in the interview. Participation levels were higher among African Americans (79%) than Whites (70%) or other races (54%).

Study Population

Demographic and Socio-economic Characteristics

The mean age among men (33 years) was slightly older than the mean age among women (31 years), though the gender-specific age distributions were similar (Table 5.1). Approximately two-thirds of the sample was African American. Greater than 90% of respondents resided in the study city. Approximately one-third of men and one-quarter of women had not completed high school. Unemployment was reported by greater than one-third of men and women. Recent worry about food security was common among men (18%) and women (21%).

Substance Abuse

A substantial proportion of participants reported using injection drugs, crack/cocaine, ecstasy, speed, or crystal methamphetamine in the past 12 months (33% men, 20% women), with crack/cocaine use reported by the greatest percentages (31% men, 19% women) (Table 5.1).

Incarceration

The incarceration exposures examined in the main analysis - personal incarceration and sexual partnership with someone who spent time incarcerated – were commonly reported (Table 5.1). Among men, approximately 21% reported incarceration for longer than 24 hours in the past 12 months and 17% had a sexual partner in the past 12 months who had ever been incarcerated.
Among women, 29% reported ever being incarcerated for longer than 24 hours and 18% had a sexual partner in the past 12 months who had ever been incarcerated.

**Sexual Behavior and Sexually Transmitted Infections**

Daily visits to the PLACE social venues were common among the participants (45% men, 38% women) (Table 5.1). The majority of the sample reported having at least one new sexual partner in the past 12 months (68% men, 54% women). Substantial proportions of participants reported the sexual partnership outcomes examined in the main analysis: multiple new sexual partnerships in the past four weeks (25% men, 22% women) and transactional sex in the past four weeks (15% men, 17% women).

Among persons with a new partner, reported condom use at last sex with a new partner was high (78% men, 71% women). Approximately 15% of women and 8% of men reported symptoms of an STI in the past three months, including pain on urination (men), discharge from the penis (men), unusual vaginal discharge (women), lower abdominal pain (women), and/or genital ulcers (men and women). Half of men and 59% of women received an HIV test in the past 12 months, and an additional 21% of men and 15% of women were tested more than one year ago.

**Associations: Incarceration and Sexual Partnerships**

**Men**

Men who were incarcerated in the past 12 months had a higher prevalence of multiple new sexual partnerships in the past four weeks than men without a recent history of incarceration (unadjusted PR: 1.83, 95% CI: 1.07-3.11) (Table 5.2). After adjustment for demographic and socioeconomic variables, respondent substance abuse in the past 12 months, partner crack/cocaine use in the past 12 months, and incarceration of a recent sexual partner, the association remained though the precision decreased and the estimate was no longer statistically significant (adjusted PR: 2.09, 95% CI: 0.91-4.81).

Similarly, men who were incarcerated in the past 12 months were four times more likely to report transactional sex in the past four weeks than men without recent incarceration history (unadjusted PR: 4.01, 95% CI: 2.28-7.07) (Table 5.2). After adjustment, the PR was reduced to
2.62 (95% CI: 1.42-4.83). The decrease in the PR was primarily due to adjustment for respondent substance abuse history.

Men with a sexual partner in the past 12 months who themselves had ever been incarcerated for longer than 24 hours were twice as likely to have multiple new sexual partnerships in the past four weeks than men who did not have a recent sexual partner with an incarceration history (unadjusted PR: 2.01, 95% CI: 1.39-2.90). After adjustment, the PR became 1.02 (95% CI: 0.57-1.83). When sexual partner’s crack/cocaine use and personal incarceration were excluded from the model, but other confounding variables were included, the adjusted PR for sexual partner’s incarceration and multiple new sexual partnerships was 1.82 (95% CI: 1.29-2.57), indicating the strong confounding effect of these two variables. Partner incarceration status was highly correlated with partner substance abuse and the individual’s own incarceration status. Among men reporting incarceration of a recent partner, 72% had a recent partner who used crack/cocaine and 39% reported personal incarceration in the past 12 months. In contrast, among men not reporting partner’s incarceration, 19% reported partner’s crack/cocaine use and 15% reported recent personal incarceration.

Having a sexual partner in the past 12 months with an incarceration history was also strongly associated with transactional sex in the past four weeks (unadjusted PR: 3.32, 95% CI: 1.67-6.62). After adjustment, the PR was 1.34 (95% CI: 0.75-2.39). Again, adjustment for partner’s substance abuse and personal incarceration affected the adjusted estimate. Interestingly, among men who reported partner’s incarceration and transactional sex (n=10), all reported partner’s substance abuse. Excluding partner’s substance abuse and person incarceration from the model, the association between partner’s incarceration and transactional sex was robust (PR: 2.46, 95% CI: 1.23-4.90).

Women

Women who had ever been incarcerated were three times more likely to have had multiple new sexual partnerships in the past four weeks than women with no incarceration history (unadjusted PR: 3.13, 95% CI: 1.80-5.44) (Table 5.2). After adjustment, the PR was 1.54 (95% CI: 0.59-4.06). If substance abuse and partner’s incarceration status were excluded from the model,
the PR was 2.47 (95% CI: 1.11-5.47), demonstrating the profound effects of adjusting for these two variables. Substance abuse and partner incarceration were strongly associated with incarceration status among women. Among women who had ever been incarcerated, 54% reported substance abuse and 50% reported having a partner who had been incarcerated (among women with non-missing values on these covariates). In contrast, among women without a history of incarceration only 8% reported substance abuse and 10% reported incarceration of a sexual partner.

History of incarceration was also strongly associated with transactional sex among women (unadjusted PR: 5.34, 95% CI: 2.61-10.90). The adjusted PR was 3.22 (95% CI: 0.70-14.71). Once again, adjustment for substance abuse and partner's incarceration status had a pronounced effect on the estimate. When adjusting for all confounding variables except substance abuse and partner's incarceration, the association between incarceration history and transactional sex was strong (PR: 4.38, 95% CI: 2.14-8.96). Among women who reported both incarceration history and transactional sex (n=17), all but one woman abused substances in the past 12 months and 77% had a partner who was incarcerated (among women with non-missing values on these covariates).

Women with a sexual partner in the past 12 months who had ever been incarcerated were more likely to have multiple new sexual partnerships in the past four weeks compared to women who did not have a recent sexual partner with an incarceration history (unadjusted PR: 4.81, 95% CI: 2.28-10.12). After adjusting for confounding variables, including the woman's own incarceration history, sexual partner's incarceration was strongly associated with multiple new sexual partnerships (adjusted PR: 5.27, 95% CI: 2.19-12.68).

Among women, having a sexual partner in the past 12 months with an incarceration history was also associated with transactional sex in the past four weeks (PR: 6.07, 95% CI: 2.39-15.42). The adjusted PR was 1.64 (95% CI: 0.71-3.80). The strong interrelationship described above between partner’s incarceration with women’s own incarceration and women’s substance abuse was primarily responsible for the marked change. If we excluded personal incarceration history and substance abuse from the model, the PR was 5.51 (95% CI: 2.27-13.37).
5.5. Discussion

STI/HIV-related sexual behaviors clustered among the formerly incarcerated and their sexual partners in this urban NC setting. Men and women reporting recent incarceration or recent sexual partnership with someone who spent time incarcerated were much more likely to report multiple new sexual partnerships and transactional sex in the past four weeks than those without recent exposure to incarceration. Adjustment for demographic and socio-economic confounding variables had little effect. In fully-adjusted models adjusting for substance abuse variables, men’s personal incarceration and women’s sexual partnership with someone who had been incarcerated appeared to be independently associated with multiple new partnerships. However, the strong overlap between incarceration, partner incarceration, and substance abuse had substantial effects in some multivariable models.

Estimating an association between incarceration and sexual risk behaviors independent of confounding factors was a primary study objective. However, the reality is that incarceration and substance abuse were highly correlated among our respondents and the members of their sexual networks. We hypothesize that incarceration, substance abuse, and partner influences reciprocally contributed to one another and worked in tandem to increase sexual risk behaviors.

Although the NC PLACE Study was cross-sectional in design, incarceration exposures likely preceded sexual partnership outcomes. Therefore, we interpret these findings to suggest that incarceration not only was associated with but contributed to the development of risky sexual partnerships concurrently with other adverse factors. To disentangle the relationships among incarceration, substance abuse and partner influences, a large longitudinal study would be necessary, though estimating independent effects of each of these factors on sexual risk behavior would still be difficult given the high correlation among them. The high prevalence of incarceration among this sample indicates the population-level importance of incarceration as a potential factor of HIV transmission and highlights the need for more careful investigation of these relationships.

Our results confirm the association between personal incarceration and risky sexual partnerships observed in previous exploratory analyses. History of incarceration was associated with concurrent sexual partnerships among HIV-positive\(^7\) and HIV-negative\(^8\) African-Americans in
North Carolina and among a household sample of Seattle residents\textsuperscript{6} and with sex work among intravenous drug users in Vancouver.\textsuperscript{9} These previous studies were limited by the broad categorization of incarceration as ever incarceration in the past 10 years or during the lifetime. The incarceration may have occurred much earlier than the sexual behavior outcomes measured, limiting the interpretation of the relationship.

We improved measurement of the association between personal incarceration and risky sexual behaviors by capturing recent exposure to incarceration, within the past 12 months for most measures, and obtaining data on sexual partnership outcomes in the past four weeks. In addition, we controlled for potential confounding factors identified through conceptual models representing the hypothesized causal effect of incarceration on sexual partnership. Unfortunately, constraints on questionnaire length prevented more refined measurement of the timing and duration of the partner’s incarceration. We also did not measure recent incarceration among women as when designing the NC PLACE Method sexual behavior survey, we were primarily interested in effect of male incarceration on partner vulnerability to HIV infection due to the high prevalence of male incarceration at the national level.\textsuperscript{159}

The NC PLACE Study results also confirm prior findings that incarceration of a recent partner is an important factor associated with risky sexual partnerships. Having a recent partner who was ever incarcerated was associated with concurrent sexual partnerships among HIV-positive and HIV-negative African-Americans in North Carolina.\textsuperscript{7, 8} The current study suggested that multiple sexual partnerships and transactional sex, in addition to partnership concurrency, were likely important variables in the pathway between incarceration and elevated levels of STI/HIV infection among those whose sexual partners had a history of incarceration.

The disruptive effect of incarceration on relationships has been well documented and provides a rationale for why incarceration may be causally associated with risky sexual partnership. Incarceration physically separates partners in stable relationships, which can lead to loneliness and emotional division\textsuperscript{16, 53-59} and could result in partnership dissolution.\textsuperscript{56, 58, 60} For example, among the NC PLACE Study sample, approximately 10\% reported that incarceration was a reason that a serious sexual partnership of one year or longer in duration permanently ended. Absence of a
A stable partnership may contribute to multiple, new, or concurrent partnerships among the partners of prisoners during the incarceration or among the prisoners at the time of release. During an incarceration, the prisoner's partner may seek other partners to fill an emotional or financial void. Absence of a partner, combined with freedom from restrictions on sexual behavior, may lead newly-released prisoners to risky sexual partnerships.

Isolating an effect of incarceration independent of factors such as substance abuse and partner characteristics not only is difficult methodologically but may be inappropriate from a public health perspective. Numerous studies have indicated the strong associations between substance abuse and both incarceration and risky behaviors and/or sexually transmitted infections. When interpreting results for the purpose of planning interventions, whether substance abuse preceded or resulted from incarceration is irrelevant. The reality is that these two adverse experiences were highly interconnected, and that HIV interventions, whether based in the community or in prisons, should include substance abuse programs to improve uptake of HIV prevention.

The NC PLACE Study recruited individuals socializing at venues identified as places where people meet new sexual partners, a sample expected to have risky sexual behaviors and, likely, elevated levels of other adverse experiences such as incarceration and substance abuse. Estimates were therefore not representative of the general population living in the NC study city, a study limitation. However, a distinct strength of the PLACE method is access to a high-risk population in particular need of HIV/AIDS intervention. High prevalence of both incarceration and sexual risk behaviors among the NC PLACE Study sample enabled estimation of the associations between incarceration and risky sexual partnership variables, despite the modest sample size. The NC PLACE Study indicated that the sub-population of individuals exposed to incarceration experienced particular vulnerability to STI/HIV-related sexual behaviors above and beyond an already high-risk referent group.

The observation of a strong association between incarceration history and sexual risk behaviors supports the need for HIV prevention efforts to target former prisoners and their partners. Given high rates of recidivism, prison- and jail-based HIV interventions should be strengthened,
such as HIV testing and STI/HIV prevention education based in correctional facilities. In addition, community-based efforts should be designed for partners of those incarcerated and newly released prisoners. Social venues where those with a history of incarceration are likely to socialize and meet new sexual partners, such as those identified in the NC PLACE Study, are prime candidates for community-based HIV/AIDS education, HIV testing, and condom promotion. Inclusion of substance abuse treatment in HIV/AIDS prevention programming developed for those affected by incarceration will likely be a critical component of decreasing HIV-related sexual behaviors and improving health.
Table 5.1. Demographic, Socio-economic and Behavioral Characteristics and Sexually Transmitted Infections among Men and Women Aged 18 to 67 Years Socializing at Venues Where People Meet Sexual Partners in a North Carolina City (PLACE Method, 2005) (n=373).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Men N=229</th>
<th>Women N=144</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td><strong>Demographic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-19 years</td>
<td>17 (7.4)</td>
<td>14 (9.7)</td>
</tr>
<tr>
<td>18-19 years</td>
<td>52 (22.7)</td>
<td>31 (21.5)</td>
</tr>
<tr>
<td>20-24 years</td>
<td>44 (19.2)</td>
<td>29 (20.1)</td>
</tr>
<tr>
<td>25-29 years</td>
<td>25 (10.9)</td>
<td>19 (13.2)</td>
</tr>
<tr>
<td>30-34 years</td>
<td>31 (13.5)</td>
<td>19 (13.2)</td>
</tr>
<tr>
<td>35-39 years</td>
<td>23 (10.0)</td>
<td>16 (11.1)</td>
</tr>
<tr>
<td>40-44 years</td>
<td>37 (16.2)</td>
<td>16 (11.1)</td>
</tr>
<tr>
<td>45+ years</td>
<td>17 (7.4)</td>
<td>14 (9.7)</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>154 (67.3)</td>
<td>93 (64.6)</td>
</tr>
<tr>
<td>White</td>
<td>53 (23.1)</td>
<td>44 (30.6)</td>
</tr>
<tr>
<td>Other</td>
<td>10 (4.4)</td>
<td>4 (2.8)</td>
</tr>
<tr>
<td><strong>Residency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the study town</td>
<td>214 (93.5)</td>
<td>134 (93.1)</td>
</tr>
<tr>
<td>Outside the study town</td>
<td>15 (6.6)</td>
<td>10 (6.9)</td>
</tr>
<tr>
<td><strong>Socio-economic status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educational attainment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8th grade or less</td>
<td>13 (5.7)</td>
<td>3 (2.1)</td>
</tr>
<tr>
<td>Some high school</td>
<td>61 (26.6)</td>
<td>34 (23.6)</td>
</tr>
<tr>
<td>High school graduate or equivalent</td>
<td>108 (47.2)</td>
<td>62 (43.1)</td>
</tr>
<tr>
<td>Vocational or trade school</td>
<td>8 (3.5)</td>
<td>5 (3.5)</td>
</tr>
<tr>
<td>Some college or 2 year degree</td>
<td>26 (11.4)</td>
<td>28 (19.4)</td>
</tr>
<tr>
<td>Finished college</td>
<td>12 (5.2)</td>
<td>9 (6.3)</td>
</tr>
<tr>
<td>Master’s or advanced degree</td>
<td>1 (0.4)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td><strong>Employment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed full or part time</td>
<td>142 (62.0)</td>
<td>91 (63.2)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>79 (34.5)</td>
<td>49 (34.0)</td>
</tr>
<tr>
<td>Slept in homeless shelter or on street the night before the interview</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>211 (92.1)</td>
<td>136 (94.4)</td>
</tr>
<tr>
<td>Yes</td>
<td>17 (7.4)</td>
<td>6 (4.2)</td>
</tr>
<tr>
<td>Worried about having enough food for self or family in the past 4 weeks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>184 (80.4)</td>
<td>109 (75.7)</td>
</tr>
<tr>
<td>Yes</td>
<td>40 (17.5)</td>
<td>30 (20.8)</td>
</tr>
<tr>
<td><strong>Substance abuse (Past 12 months)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used any illicit drugs†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>150 (65.5)</td>
<td>110 (76.4)</td>
</tr>
<tr>
<td>Yes</td>
<td>75 (32.8)</td>
<td>29 (20.1)</td>
</tr>
<tr>
<td>Injected drugs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>214 (93.5)</td>
<td>135 (93.8)</td>
</tr>
<tr>
<td>Yes</td>
<td>12 (5.2)</td>
<td>4 (2.8)</td>
</tr>
<tr>
<td>Used crack/cocaine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>157 (68.6)</td>
<td>112 (77.8)</td>
</tr>
<tr>
<td>Yes</td>
<td>70 (30.6)</td>
<td>27 (18.8)</td>
</tr>
<tr>
<td>Used crystal methamphetamine or ecstasy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>211 (92.1)</td>
<td>134 (93.1)</td>
</tr>
<tr>
<td>Yes</td>
<td>16 (7.0)</td>
<td>5 (3.5)</td>
</tr>
<tr>
<td>Used speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>213 (93.0)</td>
<td>135 (93.8)</td>
</tr>
<tr>
<td>Yes</td>
<td>13 (5.7)</td>
<td>4 (2.8)</td>
</tr>
</tbody>
</table>
Table 5.1. Continued

<table>
<thead>
<tr>
<th>Exposure to incarceration</th>
<th>Men N=229</th>
<th>Women N=144</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n* (%)</td>
<td>n* (%)</td>
</tr>
<tr>
<td>Ever incarcerated for &gt;24 hours‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>125 (54.6)</td>
<td>103 (71.5)</td>
</tr>
<tr>
<td>Yes</td>
<td>96 (41.9)</td>
<td>41 (28.5)</td>
</tr>
<tr>
<td>Incarcerated in the past 12 months (men only)‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>173 (75.6)</td>
<td>---- ----</td>
</tr>
<tr>
<td>Yes</td>
<td>48 (21.0)</td>
<td>---- ----</td>
</tr>
<tr>
<td>Had a partner in the past 12 months who was ever incarcerated for &gt;24 hours‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>150 (65.5)</td>
<td>96 (66.7)</td>
</tr>
<tr>
<td>Yes</td>
<td>39 (17.0)</td>
<td>26 (18.1)</td>
</tr>
<tr>
<td>Sexual behavior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visited the social venue daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>125 (54.6)</td>
<td>86 (59.7)</td>
</tr>
<tr>
<td>Yes</td>
<td>103 (45.0)</td>
<td>54 (37.5)</td>
</tr>
<tr>
<td>Had at least one new sex partner in the past 12 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>63 (27.5)</td>
<td>57 (39.6)</td>
</tr>
<tr>
<td>Yes</td>
<td>156 (68.1)</td>
<td>77 (53.5)</td>
</tr>
<tr>
<td>Used a condom with the most recent new partner§</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>22 (14.1)</td>
<td>19 (24.7)</td>
</tr>
<tr>
<td>Yes</td>
<td>121 (77.6)</td>
<td>55 (71.4)</td>
</tr>
<tr>
<td>Had at least two new sex partners in the past 4 weeks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>165 (72.1)</td>
<td>104 (72.2)</td>
</tr>
<tr>
<td>Yes</td>
<td>57 (24.9)</td>
<td>31 (21.5)</td>
</tr>
<tr>
<td>Transactional sex: Gave or received money for sex in the past 12 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>185 (80.8)</td>
<td>116 (80.6)</td>
</tr>
<tr>
<td>Yes</td>
<td>35 (15.3)</td>
<td>25 (17.4)</td>
</tr>
<tr>
<td>Sexually Transmitted Infections (STIs) and HIV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Had a symptom of an STI in the past 12 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>206 (90.0)</td>
<td>112 (77.8)</td>
</tr>
<tr>
<td>Yes</td>
<td>18 (7.9)</td>
<td>22 (15.3)</td>
</tr>
<tr>
<td>HIV testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Been tested for HIV within the past 12 months</td>
<td>115 (50.2)</td>
<td>85 (59.0)</td>
</tr>
<tr>
<td>Been tested for HIV more than one 12 months ago</td>
<td>49 (21.4)</td>
<td>22 (15.3)</td>
</tr>
<tr>
<td>Never been tested for HIV</td>
<td>62 (27.1)</td>
<td>32 (22.2)</td>
</tr>
</tbody>
</table>

*Totals may not sum to 229 among men or 144 among women due to missing values
†Injected drugs or used crack/cocaine, ecstasy, speed, or crystal methamphetamine.
‡Incarceration exposures examined in bivariable and multivariable analyses (see Table 5.2). Respondent incarceration history was defined as ever incarceration for >24 hours among women and incarceration for >24 hours in the past 12 months among men. Partner incarceration history was defined as having a partner in the past 12 months who was ever incarcerated for >24 hours among men and women.
§Among the 156 men and 77 women who reported having a new partner in the past 12 months.
‖Sexual behavior outcomes examined in bivariable and multivariable analyses (see Table 5.2).
Table 5.2. Prevalence Ratios (PRs) and 95% Confidence Intervals (CIs) for the Associations between Incarceration and Risky Sexual Partnerships among Men and Women Aged 18 to 67 Years Socializing at Venues Where People Meet Sexual Partners in a North Carolina City (PLACE Method, 2005) (n=373).

<table>
<thead>
<tr>
<th></th>
<th>≥2 New Sex Partners in the Past 4 Weeks</th>
<th>Transactional Sex in the Past 4 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Unadjusted*</td>
<td>Adjusted†‡§</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever been incarcerated for &gt;24 hours within the past 12 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (N=173)</td>
<td>21.4</td>
<td>ref</td>
</tr>
<tr>
<td>Yes (N=48)</td>
<td>37.5</td>
<td>1.83</td>
</tr>
<tr>
<td>Had a sexual partner in the past 12 months who was ever incarcerated for &gt;24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (N=150)</td>
<td>19.3</td>
<td>ref</td>
</tr>
<tr>
<td>Yes (N=39)</td>
<td>38.5</td>
<td>2.01</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever been incarcerated &gt;24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (N=103)</td>
<td>12.6</td>
<td>ref</td>
</tr>
<tr>
<td>Yes (N=41)</td>
<td>43.9</td>
<td>3.13</td>
</tr>
<tr>
<td>Had a sexual partner in the past 12 months who was ever incarcerated for &gt;24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (N=96)</td>
<td>10.4</td>
<td>ref</td>
</tr>
<tr>
<td>Yes (N=26)</td>
<td>50.0</td>
<td>4.81</td>
</tr>
</tbody>
</table>

*All PRs were estimated using the generalized estimating equations methodology, which takes into account non-independence of responses due to clustering by venue of the interview.
†Adjusted for any of the following demographic, socio-economic, and substance abuse variables, if identified as confounders using the backwards elimination strategy of model building: age, race, education, employment, respondent substance abuse, and partner crack/cocaine use.
‡In models examining respondent incarceration as an exposure, we assessed confounding by sexual partner’s incarceration.
§In models examining sexual partner’s incarceration as an exposure, we assessed confounding by respondent incarceration.
6.1. Abstract

Objective: To measure the association between depression and STI among young adults reporting involvement in the criminal justice system - a sub-group with disproportionately high levels of depression and STI - and among adults with no prior criminal activity.

Methods: This analysis was conducted using Wave I (1995: adolescence) and Wave III (2001-2002: young adulthood) of the Add Health (N=11,594). We measured the association between depression in adolescence and adulthood and biologically-confirmed adult STI, stratified by adult arrest history.

Results: Among all participants, STI was higher among those with very high depressive symptom levels in adulthood who were categorized as having major depression, than adults without major depression. Among adults with a prior arrest history, we measured disproportionately high STI prevalence and strong associations between chronic major depression – detected in both adolescence and adulthood - and STI, versus no prior major depression, when adjusting for baseline STI (adjusted POR: 2.4, 95% CI: 0.9-6.8). When further adjusting for demographic, socio-economic, and substance abuse variables, the estimate remained strong but imprecise. The associations between major depression in adolescence and adulthood and STI were comparatively weaker among those with no prior arrest history.

Conclusions: The observed associations between major depression and STI support the need for integration of youth mental health and STI services, particularly among youth who have been arrested, a group with disproportionate major depression and STI prevalence. Service provision through the criminal justice system may be an appropriate way to reach this vulnerable population.
6.2. Introduction

Depression is strongly associated with risky sexual behaviors and STI among adolescents in the United States (US). While risky behaviors and STI diagnosis are risk factors of adolescent depression, depression also may increase susceptibility to sexual risk behaviors and subsequent STI. It is hypothesized that depression disrupts self-regulation and encourages maladaptive behaviors. Empirical evidence suggests that depressed adolescents are more emotionally reactive in peer relationships than non-depressed youth, which may influence STI-related sexual behaviors. Diagnosis and treatment of adolescent depression, important in itself, also may constitute an important component of adolescent STI prevention.

Longitudinal studies using Waves I and II of Add Health have indicated that depression predicted STI or related behaviors among some, but not all, groups. Shreir et al. indicated that depression strongly predicted self-reported STI among boys, but did not among girls. According to Hallfors et al., depression generally did not predict an increase in sexual risk behavior or drug use, except among one sub-group of girls who were already experimenting with drugs at baseline. These conflicting findings highlighted the need for further study of the association between depression and STI.

Young adult and adolescent incarcerated populations are disproportionately infected with STIs. Persons entering correctional facilities also are more likely to be diagnosed with a mental illness such as depression than non-incarcerated populations. If depression contributes to STI transmission, improved diagnosis and treatment of depression may constitute a particularly important element of STI prevention among adolescents with early involvement in the criminal justice system, on a trajectory towards incarceration. The vulnerability of incarcerated populations to both STI and depression called for investigation of the relationship between depression and STI among young adults who are likely to be incarcerated.

Add Health Wave III is currently available and provides data on depression, biologically-confirmed STI, and involvement in the criminal justice system in young adulthood. The purpose of
this study was to measure the association between depression during adolescence (Wave I) and adulthood (Wave III), and adulthood acquisition of *Chlamydia trachomatis*, *Neisseria gonorrhoea* or *Trichomonas vaginalis* (Wave III). We investigated whether the associations between depression and STI were different among those who had ever been arrested by adulthood (Wave III) and those with no prior arrest history.

6.3. Methods

Add Health is a prospective cohort study designed to investigate factors of health from adolescence into adulthood. The original study population was a stratified, random, school-based sample representative of US middle and high schools students. During Add Health Wave I (1995), over 20,000 adolescents completed a baseline interview assessing characteristics including sexual behavior and depression. Parents were also interviewed. During Wave III (2001 to 2002), Wave I participants were re-interviewed and urine specimens were collected for determination of *Chlamydia trachomatis* and *Neisseria gonorrhoea* by ligase chain reaction (Abbott LCx® Probe System, Abbott Laboratories, Abbott Park, IL) and *Trichomonas vaginalis* by polymerase chain reaction (Amplicor CT/NG Urine Specimen Prep Kit, Roche Diagnostic Systems, Indianapolis, IN). The study design, including the sampling frame and data collection procedures, has been described in detail elsewhere.

We used measures from Waves I and III for this analysis on depression and STI. Ethical approval for this research was obtained from the University of North Carolina at Chapel Hill School of Public Health Institutional Review Board.

**Measures**

**Outcome: STI (Wave III)**

We examined biologically confirmed STI (having a positive test result for *Chlamydia trachomatis*, *Neisseria gonorrhoea*, or *Trichomonas vaginalis* on Wave III urine specimen versus having a negative result for all three tests).
Exposure: Depression (Waves I and III)

Depression was assessed using a modified version of the Center for Epidemiologic Studies Depression Scale (CES-D).\textsuperscript{153} The original CES-D is composed of 20 items, each of which assesses the frequency of experiencing depressive symptoms in the past week (0 - never or rarely, 1 - sometimes, 2 - a lot of the time, 3 - most of the time/all of the time). Four items assess positive symptoms (i.e., frequency of happiness, enjoying life, etc.) and are reversed before the score is computed. The composite score based on the 20-item scale ranges from 0 to 60, with higher scores indicating increased severity of depression. The scores of 24 among men and 22 among women have been validated as sensitive and specific cut-points indicating current major depression among adolescents.\textsuperscript{154}

We used a modified version of the CES-D comprised of a subset of nine items common to both Waves I and III to calculate each participant’s depression scores at Wave I and Wave III (possible score range: 0-27). The Cronbach alpha for the analytic sample was 0.84 for Wave I and 0.77 for Wave III, indicating the reliability of the modified CES-D as a measure of depression.\textsuperscript{155} We also validated the modified version against a nearly complete version of the CES-D administered at Wave I that contained 18 items assessing depression in the past week. Compared to the Wave I 18-item scale, the modified nine-item scale had a sensitivity of 97% and specificity of 90% for detection of Wave I major depression, further suggesting that the nine-item scale was a valid tool for major depression detection.

Following Shrier et al.,\textsuperscript{2, 102} we identified the male and female cut-points for major depression based on our nine-item scale that were proportional to the cut-points for major depression based on the full CES-D.\textsuperscript{154} Since the cut-points for major depression based on the modified CES-D were 9.9 for males and 10.4 for females, for convenience, we assumed that a score of 10 or greater indicated major depression for both genders. We then divided the remaining scores to obtain categories of low (score: 0 to 3), moderate (score: 4 to 6), and high (score: 7 to 9) depression symptom levels at each Wave.

Based on our categorizations of depression symptom levels at Waves I and III, we defined two four-level depression exposures.
We assessed severity of adulthood depression symptoms (Wave III), categorizing respondents as having major depression; high depression symptoms; moderate depression symptoms; or low depression symptoms.

We also assessed major depression timing and duration through adolescence and adulthood (Waves I and III). Respondents were categorized as having chronic major depression if we detected major depression at Waves I and III; recent major depression if we detected major depression at Wave III but not Wave I; prior major depression if we detected major depression at Wave I but not Wave III; and no prior major depression if we detected major depression neither at Wave I nor at Wave III.

**Stratification Variable: Arrest History (Wave III)**

We examined the associations between each depression variable and STI, stratifying by a dichotomous variable measuring prior arrest (stopped by the police and arrested by Wave III versus no prior arrest).

**Covariates**

Potential confounding variables of the relationship between depression and STI were identified through causal models. The confounding effect of each was assessed in multivariable modeling.

Baseline STI risk variables included Wave III self-reported age at first sex (15 years or less, 16 years, 17 to 18 years, 19 to 25 years, or never had sex by Wave III) and Wave I self-reported STI (respondent reported diagnosis with chlamydial infection, gonorrhea, trichomoniasis, syphilis, genital herpes, or HIV versus no self-reported STI diagnosis).

Socio-demographic variables included age (18 to 20 years, 21 years, 22 years, 23 years, or 24 to 28 years) and biological sex (male versus female), and Wave III self-reported race/ethnicity (Latino (all participants reporting Hispanic or Latino origin), African American, Native American, Asian American, or white).

Socio-economic variables included maternal education, measured by Wave I self-report if the mother was interviewed, otherwise by adolescent’s report (less than high school, high school graduate, or greater than high school) and Wave III low functional income status.
in the past year (respondent’s household did not have enough money to pay for housing or utilities such as gas or electricity versus had adequate money for housing and utilities).

Substance abuse variables included Wave I lifetime marijuana use (ever used marijuana versus no use), Wave I frequent alcohol consumption in the past year (drank at least 3 days per week versus no frequent drinking), Wave III marijuana use in the past 30 days (yes versus no), Wave III cocaine use in the past 30 days (yes versus no), Wave III methamphetamine use in the past 30 days (yes versus no), Wave III injection drug use in the past 30 days (yes versus no), and Wave III heavy alcohol consumption in the past two weeks (drank at least 4 alcoholic beverages per day versus no heavy drinking). We included Wave III substance abuse covariates in models due to the potential confounding effects of young adult substance abuse on the association between depression and STI. We acknowledge that in cases where depression contributed to substance abuse, inclusion of substance abuse would bias the associations between depression and STI.

**Data Analysis**

For all analyses, we used survey commands in Stata Version 9.1 (Stata Corp., College Station, TX) to account for stratification, clustering, and unequal selection probabilities, yielding nationally-representative estimates.

We used bivariable analysis to calculate weighted prevalences and 95% CIs of Wave III STI by demographic, socio-economic, behavioral, and depression characteristics.

Using multivariable logistic regression for survey data, we estimated unadjusted PORs and 95% CIs for the associations between each depression variable and Wave III STI. We included a product-interaction term between arrest status and each depression exposure to obtain associations for those with and without arrest history.

Previous studies of the association between depression and STI have presented gender-specific results. Our preliminary analyses indicated that in models assessing gender-specific associations between depression variables and STI, the product-interaction terms between gender and each depression variable were not significant when setting alpha
equal to 0.3, a high cut-point for determining the presence of effect measure modification.\textsuperscript{147} Therefore, we do not present gender-specific estimates.

We constructed a series of five multivariable logistic regression models to estimate adjusted PORs and 95% CIs for the associations between each depression exposure and STI. Model 1 adjusted for baseline STI risk variables. Model 2 adjusted for baseline STI risk variables, gender, and age. Model 3 adjusted for baseline STI risk variables, gender, age, and substance abuse variables. Model 4 adjusted for STI risk variables, gender, age, substance abuse variables, and socio-economic variables. Models 5 adjusted for baseline STI risk variables, gender, age, substance abuse variables, socio-economic variables, and race/ethnicity. All covariates were entered as indicator variables, except maternal education, which was entered as an ordinal variable after confirmed linearity in the log odds.

6.4. Results

Of the 18,924 participants in the weighted Wave I sample, 14,322 (75.7%) were located and re-interviewed during Wave III and had no missing values for sample weight variables. The analytic sample was 50.8% male; had a mean age of 21.8 years (SD. 1.8 years); and was 67.6% white, 16.0% African American, 11.9% Latino, 3.7% Asian American, and 1.0% Native American (percentages do not total to 100% due to rounding) (Table 6.1).

STI testing procedures, participation, and results have been described in detail previously.\textsuperscript{40, 172, 173} Of Wave III participants (N=14,322), 1,130 (7.9%) refused to provide a urine specimen, 226 (1.6%) were unable to provide a specimen, 421 (2.9%) specimens could not be processed due to shipping or laboratory problems, and 951 (6.6%) did not have results for all three STI tests. The 11,594 (81.0%) Wave III participants with a result for all three tests - \textit{Chlamydia trachomatis}, \textit{Neisseria gonorrhea} and \textit{Trichomonas vaginalis} - were included in the analysis.

\textbf{Wave III STI Prevalence by Participant Characteristics}

The overall weighted prevalence of infection with \textit{Chlamydia trachomatis}, \textit{Neisseria gonorrhea}, or \textit{Trichomonas vaginalis} was 6.2% (95% 5.3-7.2%) (Table 6.1). STI was slightly
higher among women than men and markedly higher among African American and Native American participants than those reporting Latino, Asian/Pacific Islander, or white race/ethnicity.

Socio-economic factors were strongly associated with adult STI, including low maternal educational attainment, low functional income status, and prior arrest (Table 6.1). Behavioral and health factors associated with adult STI included early age at first sex, self-reported STI during adolescence, major depression during adolescence and adulthood, and frequent alcohol consumption during adolescence.

**Prevalence of Major Depression**

Overall, 11.4% had at Wave III, comprising 4.6% with chronic major depression and 6.8% with recent major depression (Table 6.1).

Prevalence of chronic or recent major depression was higher among adolescents with prior arrest histories (14.0%, 95% CI: 11.6-16.4) than those who had never been arrested (11.1%, 95% CI: 10.2-11.9%) (unadjusted POR: 1.31, 95% CI: 1.06-1.61).

**Overall Associations between STI and Depression**

**STI and Severity of Adulthood Depression Symptoms**

Among the full sample, major depression were more likely to have an STI than those with the lowest depression symptom levels, the referent (unadjusted POR: 1.62, 95% CI: 1.22-2.15). STI was not associated with moderate (unadjusted POR: 1.20, 95% CI: 0.95-1.51) or high adulthood depression levels (POR: 1.10, 95% CI: 0.77-1.56).

**STI and Major Depression Timing and Duration**

STI was more likely among those with chronic major depression (unadjusted POR: 1.63, 95% CI: 1.11-2.39) and recent major depression (unadjusted POR: 1.55, 95% CI: 1.08-2.20) and slightly more likely among those with prior major depression (unadjusted POR: 1.28, 0.96-1.69), compared to those with no prior major depression, the referent.
Associations between STI and Depression, by Prior Arrest

STI and Severity of Adulthood Depression Symptoms, by Prior Arrest

Previously arrested

In unadjusted analysis, previously-arrested adults with major depression were more likely to have an STI than adults with low symptom levels (Model 0: unadjusted POR=2.00, 95% CI=0.96-4.19) (Table 6.2). STI was not associated with high or moderate adult depression levels (Model 0: unadjusted POR=0.98, 95% CI: 0.42-2.28 for high levels; unadjusted POR=0.81, 95% CI: 0.36-1.81 for moderate levels).

The association between adulthood major depression and STI generally remained when additionally adjusting for age at first sex and Wave I self-reported STI (Model 1: adjusted POR=1.87, 0.89-3.90), though relatively small counts in this stratum contributed to imprecise and non-statistically significant estimates. The association further weakened when additionally adjusting for gender, age, substance abuse, and socio-economic variables (Model 4: adjusted POR=1.56, 95% CI=0.75-3.25) and essentially disappeared with additional adjustment for race/ethnicity.

Not previously arrested

Among those who were never arrested, adults with major depression were slightly more likely to have an STI than adults with low depression levels in unadjusted analysis (Model 0: unadjusted POR=1.50, 95% CI=1.08-2.10) (Table 6.2). STI was not associated with having high depression levels (Model 0: unadjusted POR=1.10, 95% CI: 0.77-1.59) but was weakly associated with having moderate depression levels (Model 0: 1.26, 95% CI: 0.98-1.63).

The association between major depression and STI generally remained when adjusting for age at first sex and baseline STI (Model 1: adjusted POR=1.38, 95% CI: 0.99-1.95) (Table 6.2). With adjustment for age and gender the association weakened and was not statistically significant (Model 2: adjusted POR=1.30, 95% CI=0.93-1.83).
STI and Major Depression Timing and Duration, by Prior Arrest

Previously arrested

In unadjusted analysis, previously arrested adults with chronic major depression were much more likely to have an STI than adults with no history of major depression (Model 0: unadjusted POR=2.77, 95% CI=1.00-7.69) (Table 6.3). Recent major depression appeared to be associated with STI (Model 0: unadjusted POR=1.79, 95% CI=0.80-3.98) though the estimate was imprecise due to small sample size and was not statistically significant. Prior major depression was not associated with STI (Model 0: unadjusted POR=0.90, 95% CI: 0.39-2.08).

In adjusted analysis, the point estimate for the association between chronic major depression and STI was strong when adjusting for age at first sex and Wave I STI, though the precision was poor due to small sample size, and the estimate was no longer statistically significant (Model 1: adjusted POR=2.41, 95% CI=0.86-6.77). When adjusting for gender, age, substance abuse, socio-economic status, and race/ethnicity the point estimate remained but the great imprecision prevented interpretation about whether chronic major depression acted independently of these covariates (Model 5: adjusted POR=1.72, 95% CI=0.62-4.78).

Not previously arrested

Among those with no prior arrest, STI was weakly associated with chronic, recent, and prior major depression, compared to no history of major depression, in unadjusted analysis (Model 0: unadjusted POR=1.45, 95% CI=0.93-2.27 for chronic major depression; unadjusted POR=1.46, 95% CI=0.98-2.18 for recent major depression; Model 0: unadjusted POR=1.34, 95% CI=1.00-1.81 for prior major depression) (Table 6.3).

These associations between STI and major depression essentially disappeared when adjusting for age at first sex, Wave I STI, gender, and age (Model 2: adjusted POR=1.17, 95% CI=0.72-1.89 for chronic major depression; unadjusted POR=1.31, 95% CI=0.87-1.97 for recent major depression; Model 2: adjusted POR=1.17, 95% CI=0.84-1.64 for prior major depression).
6.5. Discussion

Young adults with current major depression were much more likely to have an STI than their counterparts with no detected major depression. We further examined the relationship between major depression timing and duration and STI acquisition and observed that those categorized as having chronic major depression – detected in adolescence and adulthood - were more vulnerable to acquiring an STI in adulthood than those with no prior major depression.

We measured higher prevalences of depression and STI and stronger associations between depression and STI among young adults with a prior history of arrest, compared to those with no prior arrest history. Among previously-arrested youth, those with chronic major depression were more than twice as likely to be infected with an STI as those with no prior major depression when adjusting for age at first sex and baseline STI. When adjusting for additional potential confounding factors, the point estimates for the associations between chronic major depression and STI remained but were very imprecise due to the small numbers of respondents who experienced both major depression and prior arrest, an important study limitation. Though the strength of the associations suggested that major depression was associated with STI independent of factors such as age, gender, substance abuse, and socio-economics, the imprecision prevented drawing firm conclusions about whether depression was independently associated with STI. Nonetheless, we measured disproportionate levels of major depression and STI and a strong association between major depression and STI among youth who have been involved in the criminal justice system, highlighting the need for improved detection and treatment of major depression and STI among this high-risk sub-population.

Among those reporting no prior involvement in the criminal justice system, STI was slightly higher among those with major depression in adolescence, in young adulthood, or at both time periods, than those with no prior major depression. These associations essentially disappeared when adjusting for age at first sex, baseline STI, gender, and age, indicating that improved detection and treatment of depression among the general population would likely have minimal influence on STI prevention. Regardless, the observed associations between major
depression and STI among those without prior criminal activity provided support for greater integration of mental health and STI services among general-population youth.

Our study corroborated numerous previous studies indicating that depression was associated with STI and related behaviors among adolescent and young adult samples.\textsuperscript{2-4, 100-103} We improved estimation of the association between depression and STI by measuring biologically confirmed, rather than self-reported STI or related behaviors, and exposure to persistent depression, as opposed to depression measured at one point in time. Further, we explored the associations between depression and STI among youth who had been arrested and identified that depression was more prevalent and more strongly associated with STI among this high-risk sub-population than among those without prior arrest history.

Our study also contributed to the limited body of research into the longitudinal relationship between depression and STI or related behaviors. To our knowledge, only one study assessed the longitudinal relationship between depression and STI, also conducted among the Add Health sample.\textsuperscript{2} Boys with major depression at baseline were more than three times as likely to report an STI at follow-up as boys with the lowest depression symptom levels, when adjusting for baseline self-reported STI and socio-demographic, sexual activity, and substance abuse variables. In contrast, while levels of self-reported STI among girls with major depression were higher than girls with the lowest depression symptom levels, the association between major depression and STI was not statistically significant. Another study among the Add Health sample indicated that depression did not predict risky sexual and substance abuse behaviors, except among girls who were experimenting with drugs at baseline.\textsuperscript{2, 3} Finally, a longitudinal study provided evidence that depression predicted multiple sexual partnership among injection drug users in Baltimore, a high-risk sample of adults.\textsuperscript{108}

Because our analysis included components of a longitudinal study, including measurement of depression from early adolescence and control of baseline STI risk, we interpret our findings to suggest that chronic major depression through adolescence – working concurrently with other adverse social and economic factors – may have contributed to young-adult STI among those with early involvement in the criminal justice system, another high risk
sample. The question of whether depression influences STI among youth involved in the criminal justice system remains unanswered, though our findings point to the need for further investigation of the relationship among youth involved in the criminal justice system.

As prior studies have indicated there are gender-specific pathways between depression and STI-related behaviors, we explored gender differences in the association between depression and STI. Though we did not have adequate statistical power to justify presenting gender-specific associations, additional analyses suggested that among those with a prior arrest, the association between chronic major depression and STI was stronger among men than women. Further, prior arrest was much more prevalent among men (19.6%) than women (4.5%), indicating that the association between chronic major depression and STI among those with prior arrest reflected a relationship that, on a population level, essentially applied to men. Therefore, future studies should be powered to estimate associations among depression, STI, and criminal activity for men and women separately.

To confirm whether adolescent depression is causally associated with acquisition of STI in adulthood among those involved in the criminal justice system, a longitudinal study should be conducted among this population and should accurately measure depression, sexual risk behavior, STI, and important covariates such as substance abuse, at frequent time intervals. Future studies of the association between adolescent depression and STI acquisition among those likely to be incarcerated should recruit participants from neighborhoods with high arrest rates to ensure adequate statistical power to measure precise associations. Measurements should be taken at frequent time intervals in order to disentangle the specific effects each variable of interest—depression versus substance abuse versus other adverse factors—on STI. Our study was limited by the long duration of time between data collection in adolescence (Wave I) and young adulthood (Wave III), which prevented measurement of depression levels, STI, and important covariates over the course of adolescence. Finally, future studies should confirm that the depression measurement tool is highly sensitive and specific and functions adequately across all racial and ethnic groups included in the study population. Our nine-item depression measurement scale was not
validated against a reference-standard clinical diagnosis of depression, which may have resulted in misclassification of depression, another study limitation.

This study provided further evidence that STI-infected youth in the US are also likely to be affected by depression, further supporting the need for greater integration of STI and mental health prevention, diagnosis, and treatment. Levels of major depression and STI were higher and the associations between these variables were stronger among those with a prior history of arrest. Thus, improved mental health screening appears to be particularly important among youth involved in the criminal justice system. Screening for major depression and STI at the time an adolescent or young adult comes into contact with the criminal justice system may serve as a means of reaching a difficult-to-access population of youth who experience particular vulnerability to adverse physical and mental health outcomes.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N†</th>
<th>Weighted %‡</th>
<th>Weighted % with STI‡</th>
<th>Unadjusted Odds Ratio (95% Confidence Interval)</th>
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<tr>
<td><strong>Socio-demographic characteristics</strong></td>
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<td>&lt;High school graduate</td>
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<td>12217</td>
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<td>1941</td>
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<td>Depression</td>
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<td>Depression symptom levels at Wave III (late adolescence)</td>
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<td>Low</td>
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<td>25.8</td>
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<td>8.6</td>
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<td>6.8</td>
<td>8.2</td>
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<td>4.6</td>
<td>9.3</td>
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<tr>
<td>Yes</td>
<td>272</td>
<td>1.9</td>
<td>16.3</td>
<td>3.04 (1.53-6.05)</td>
</tr>
<tr>
<td>Substance abuse</td>
<td>No</td>
<td>72.5</td>
<td>5.9</td>
<td>1.</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Ever used marijuana in adolescence (Wave I)</td>
<td>10,244</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>27.5</td>
<td>6.9</td>
<td>1.17 (0.92-1.49)</td>
</tr>
<tr>
<td>Drank ≥3 days/week in the past year in adolescence (Wave I)</td>
<td>No</td>
<td>96.7</td>
<td>6.1</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>3.3</td>
<td>9.5</td>
<td>1.61 (1.00-2.60)</td>
</tr>
<tr>
<td>Marijuana in the past 30 days (Wave III)</td>
<td>No</td>
<td>77.3</td>
<td>5.9</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>22.7</td>
<td>7.1</td>
<td>1.22 (0.94-1.57)</td>
</tr>
<tr>
<td>Crack/cocaine in the past 30 days (Wave III)</td>
<td>No</td>
<td>96.7</td>
<td>6.2</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>3.3</td>
<td>6.6</td>
<td>1.07 (0.57-2.01)</td>
</tr>
<tr>
<td>Methamphetamine in the past 30 days (Wave III)</td>
<td>No</td>
<td>98.7</td>
<td>6.2</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1.3</td>
<td>7.5</td>
<td>1.21 (0.60-2.46)</td>
</tr>
<tr>
<td>Injection drugs in the past 30 days (Wave III)</td>
<td>No</td>
<td>99.7</td>
<td>6.2</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0.3</td>
<td>8.0</td>
<td>1.30 (0.29-5.74)</td>
</tr>
<tr>
<td>Drank ≥4 drinks per day in the past 2 weeks (Wave III)</td>
<td>No</td>
<td>65.2</td>
<td>7.0</td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>34.8</td>
<td>5.0</td>
<td>0.71 (0.56-0.90)</td>
</tr>
</tbody>
</table>

*Overall, 6.2% were confirmed to have a positive test result with Chlamydia trachomatis, Neisseria gonorrhoea or Trichomonas vaginalis.*
†Totals may not sum to 14,322 due to missing values.
‡Use of survey commands to account for stratification, clustering, and unequal selection probabilities yielded nationally-representative estimates.
Table 6.2. Prevalence Odds Ratios (PORs) and 95% Confidence Intervals (CIs) for the Associations between Adult Depression Symptoms (Wave III) and Biologically-confirmed STI (Wave III),* Stratified by Arrest History among Young Adults in the United States Aged 18-25 Years (Wave III, N=10,534†).

| Prior arrest | Adult depression symptoms (Wave III) | N  | Weighted % with STI‡ | Model 0: Unadjusted POR (95% CI) | Model 1: POR (95% CI) adjusted for age at first sex and Wave I self-reported STI | Model 2: POR (95% CI) adjusted for Model 1 variables plus gender and age | Model 3: POR (95% CI) adjusted for Model 2 variables plus Wave I and III substance abuse§ | Model 4: POR (95% CI) adjusted for Model 3 variables plus Wave I and III socio-economic indicators || Model 5: POR (95% CI) adjusted for Model 4 variables plus race/ethnicity |
|--------------|-------------------------------------|----|----------------------|----------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------|---------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
|              | Low                                 | 482| 7.3                  | Referent                         | Referent                          | Referent                                                              | Referent                                                              | Referent                                                              | Referent                                                              |
|              | Moderate                             | 335| 6.0                  | (0.36-1.81)                      | (0.37-1.84)                       | (0.37-1.83)                                                                          | (0.35-1.71)                                                                          | (0.33-1.65)                                                                          | (0.28-1.48)                                                                          |
|              | High                                 | 194| 7.2                  | (0.42-2.28)                      | (0.43-2.24)                       | (0.40-2.08)                                                                          | (0.36-1.95)                                                                          | (0.35-1.84)                                                                          | (0.24-1.47)                                                                          |
|              | Major depression                     | 169| 13.6                 | (0.96-4.19)                      | (0.89-3.90)                       | (0.83-3.63)                                                                          | (0.80-3.42)                                                                          | (0.75-3.25)                                                                          | (0.56-2.80)                                                                          |
|              | Low                                  | 4656| 5.2                 | Referent                         | Referent                          | Referent                                                              | Referent                                                              | Referent                                                              | Referent                                                              |
|              | Moderate                             | 2366| 6.5                 | (0.98-1.63)                      | (0.97-1.61)                       | (0.95-1.57)                                                                          | (0.94-1.57)                                                                          | (0.93-1.54)                                                                          | (0.85-1.44)                                                                          |
|              | High                                 | 1281| 5.7                 | (0.77-1.59)                      | (0.73-1.53)                       | (0.72-1.51)                                                                          | (0.72-1.53)                                                                          | (0.67-1.44)                                                                          | (0.61-1.35)                                                                          |
|              | Major depression                     | 1051| 7.6                 | (1.08-2.10)                      | (0.99-1.95)                       | (0.93-1.83)                                                                          | (0.92-1.81)                                                                          | (0.84-1.66)                                                                          | (0.73-1.46)                                                                          |

*Among those with results for all three tests (N=11,594), participants with a positive test result with *Chlamydia trachomatis*, *Neisseria gonorrhoea* or *Trichomonas vaginalis*, were coded as having an STI.
†A total of 10,534 respondents had non-missing values for outcomes, exposures, and all covariates included in Model 5.
‡Use of survey commands to account for stratification, clustering, and unequal selection probabilities yielded nationally-representative estimates.
§Wave I substance abuse covariates included: ever use of marijuana and consumption of alcohol at least three days a week in the past 12 months.
Wave III substance abuse covariates included: use of marijuana, crack/cocaine, methamphetamine, or injection drugs in the past 30 days and consumption of ≥4 drinks per day in the past 2 weeks.
||The Wave I socio-economic indicator was mother’s education (<HS graduate, HS graduate, or ≥college graduate). The Wave III socio-economic indicator was respondent’s functional income at Wave III (respondent or respondent’s household did not have enough money to pay rent/mortgage payment or utilities in the past year *versus* no problems paying housing and utilities).
Table 6.3. Prevalence Odds Ratios (PORs) and 95% Confidence Intervals (CIs) for the Associations between Adolescent Major Depression Timing and Duration and Wave III Biologically-confirmed STI* Stratified by Wave III Arrest History, among Young Adults in the United States Aged 18-25 Years (Waves I and III, N=10,519†).

<table>
<thead>
<tr>
<th>Prior arrest</th>
<th>No prior arrest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major depression</td>
<td>No depression</td>
</tr>
<tr>
<td>No depression</td>
<td>839</td>
</tr>
<tr>
<td>Referent</td>
<td>7.0</td>
</tr>
<tr>
<td>Weighted % with STI‡</td>
<td>Referent</td>
</tr>
<tr>
<td>Model 0: Unadjusted POR (95% CI)</td>
<td>Referent</td>
</tr>
<tr>
<td>Model 1: POR (95% CI)</td>
<td>Referent</td>
</tr>
<tr>
<td>adjusted for age at first sex and Wave I self-reported STI</td>
<td>Referent</td>
</tr>
<tr>
<td>Model 2: POR (95% CI)</td>
<td>Referent</td>
</tr>
<tr>
<td>adjusted for variables plus gender and age</td>
<td>Referent</td>
</tr>
<tr>
<td>Model 3: POR (95% CI)</td>
<td>Referent</td>
</tr>
<tr>
<td>adjusted for variables plus substance abuse§</td>
<td>Referent</td>
</tr>
<tr>
<td>Model 4: POR (95% CI)</td>
<td>Referent</td>
</tr>
<tr>
<td>adjusted for variables plus socio-economic indicators</td>
<td></td>
</tr>
<tr>
<td>Model 5: POR (95% CI)</td>
<td>Referent</td>
</tr>
<tr>
<td>adjusted for race/ethnicity</td>
<td>Referent</td>
</tr>
</tbody>
</table>

*Among those with results for all three tests (N=11,594), participants with a positive test result with *Chlamydia trachomatis*, *Neisseria gonorrhoea* or *Trichomonas vaginalis*, were coded as having an STI.
†A total of 10,519 respondents had non-missing values for outcomes, exposures, and all covariates included in Model 5.
‡Use of survey commands to account for stratification, clustering, and unequal selection probabilities yielded nationally-representative estimates.
§Wave I substance abuse covariates included: ever use of marijuana and consumption of alcohol at least three days a week in the past 12 months. Wave III substance abuse covariates included: use of marijuana, crack/cocaine, methamphetamine, or injection drugs in the past 30 days and consumption of ≥4 drinks per day in the past 2 weeks.
||The Wave I socio-economic indicator was mother’s education (<HS graduate, HS graduate, or ≥college graduate). The Wave III socio-economic indicator was respondent’s functional income at Wave III (respondent or respondent’s household did not have enough money to pay rent/mortgage payment or utilities in the past year versus no problems paying housing and utilities).
CHAPTER 7: CONCLUSIONS

This dissertation investigated potential determinants of the strong association between incarceration and STI/HIV infection. First, we explored the hypothesis that incarceration contributes to STI/HIV by disrupting stable partnerships and promoting high-risk partnerships. Because no longitudinal data source was available to enable investigation of the causal effect of incarceration on risky partnerships, we measured the association between incarceration and risky partnerships among two cross-sectional survey samples. Second, we explored the hypothesis that poor mental health contributes to STI/HIV among incarcerated populations. Among a nationally-representative sample, we measured the association between depression and STI among two sub-groups: young adults reporting involvement in the criminal justice system, who experience disproportionately high levels of both depression and STI, and adults with no prior criminal activity.

In the first portion of this dissertation, we observed that risky sexual partnerships clustered among the formerly incarcerated and their sexual partners in two NC populations: a population-based sample of African Americans residing in eastern rural NC (NCRHP) and a sample recruited from venues where people meet sexual partners in an urban NC setting (NC PLACE Study). Among both the population-based and the high-risk sample, those reporting recent incarceration or recent sexual partnership with someone who had ever been incarcerated were more likely to report multiple sexual partnerships and transactional sex than those without recent exposure to incarceration personally or through the experience of a sexual partner. Adjustment for demographic and socio-economic confounding variables had minimal effect. However, the strong overlap between incarceration, partner incarceration, and substance abuse had substantial effects in multivariable models.
Estimating an association between incarceration and sexual risk behaviors independent of background influences has been a goal of this dissertation. However, the reality is that incarceration and substance abuse were highly correlated among study participants and the members of their sexual networks. Among groups for whom incarceration, substance abuse, partner’s incarceration, and/or partner’s substance abuse were virtually inseparable, multivariable analyses controlling for all potential confounding variables yielded greatly diminished associations between incarceration and sexual risk behaviors. This substantial attenuation indicated that incarceration was closely entangled with substance abuse and influence by high risk peers. We hypothesize that incarceration, substance abuse, and partner influences reciprocally contributed to one another and worked in tandem to increase sexual risk behaviors.

Although the NC PLACE and the NCRHP studies were cross-sectional in design, incarceration exposures likely preceded sexual partnership outcomes. Therefore, we interpret these findings to suggest that incarceration not only was associated but contributed to the development of risky sexual partnerships concurrently with other adverse factors. To disentangle the relationships among incarceration, substance abuse and partner influences, a large longitudinal study would be necessary, though estimating independent effects of each of these factors on sexual risk behavior would still be difficult given the high correlation among them. Nevertheless, the high prevalence of incarceration highlights the population-level importance of incarceration as a potential factor of HIV transmission and the need for more careful investigation of these relationships.

The disruptive effect of incarceration on relationships has been documented and provides rationale for why incarceration may be causally associated with risky sexual partnership. Incarceration physically separates partners in stable relationships, which can lead to loneliness and emotional division\textsuperscript{16, 53-59} and could result in partnership dissolution.\textsuperscript{56, 58, 60} Among the North Carolina PLACE sample, for example, approximately 10% reported that incarceration played a role in at least one break-up with a serious sexual partner in the year prior to the survey (data not presented). Absence of a stable partnership may contribute to multiple, new or concurrent partnerships among the partners of prisoners during the incarceration\textsuperscript{56} or among the prisoners at
the time of release. During an incarceration, the prisoner’s partner may seek other partners to fill an emotional or financial void. Absence of a partner, combined with freedom from restrictions on sexual behavior, may lead newly-released prisoners to risky sexual partnerships.

The observation of a strong association between incarceration history and risky sexual partnerships supports the need for HIV prevention efforts targeting former prisoners and their partners. Given high rates of recidivism, prison- and jail-based HIV interventions should be strengthened. In addition, community-based efforts should be designed for partners of those incarcerated and newly released prisoners. Social venues where those with a history of incarceration are likely to socialize and meet new sexual partners, such as those identified in the NC PLACE study, are prime candidates for community-based HIV/AIDS education and condom promotion. Substance abuse treatment may be an important component of HIV prevention effort success among those affected by incarceration.

In the second research area of this dissertation, we estimated the association between depression and biologically-confirmed STI, stratified by arrest history. We measured higher prevalences of depression and STI and stronger associations between depression and STI among young adults with a prior history of arrest, compared to those with no prior arrest history. Among previously-arrested youth, those with chronic major depression - experienced in adolescence and young adulthood - were more than twice as likely to be infected with an STI as those with no major depression in adolescence or young adulthood. When adjusting for baseline age at first sex, baseline STI, gender, age, and substance abuse, the magnitude of the association remained, though the estimate was very imprecise due to the small sample size. After adjustment for socio-economic indicators and race, the association further weakened, indicating that those with lower socio-economic status and certain racial ethnic groups, namely African Americans and Latinos, were disproportionately affected by both chronic major depression and STI.

Because the design of our study included components of a longitudinal study, including measurement of depression from early adolescence and control of baseline STI risk, we interpret these findings to suggest that chronic major depression through adolescence – working
concurrently with other adverse social and economic factors – may have contributed to young adult STI among those with early involvement in the criminal justice system. While the question of whether depression influences STI remains unanswered, our findings point to the need for further investigation of the effect of depression on STI among youth involved in the criminal justice system.

These findings indicated improved detection and treatment of major depression among adolescents and young adults is warranted. Improved mental health and STI services appear to be particularly important for youth involved in the criminal justice system. Screening for major depression and STI at the time an adolescent or young adult comes into contact with the criminal justice system may serve as a means of reaching a difficult-to-access population of youth who experience heightened vulnerability to adverse physical and mental health outcomes.

The factors associated with the disproportionate STI/HIV among populations involved in the criminal justice system explored in this dissertation – risky partnership and poor mental health - represent only two of a multitude of potential determinants of the disproportionate STI/HIV among incarcerated populations. Incarcerated populations may also experience elevated likelihood of contact with an infected partner; high levels of curable STIs that increase risk of acquiring HIV; low condom use; elevated injection drug use behaviors; and experience of low economic and social status, which underlie the above determinants of STI/HIV. Given the multi-causal nature STI/HIV, there are many studies to be conducted in the future to determine the most important factors of STI/HIV transmission among incarcerated populations, including whether the disruption of the incarceration itself plays a role.
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