Social Environmental Factors and Their Effects on Risky Sexual Behavior: A Multilevel Approach

by

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Dedication

I am dedicating this book to my loving Grandmom Watts. Although you have been gone

from this earth for some time, I know that you have been with me watching over me

throughout this process. I love you!

Acknowledgements

First and foremost, I have to thank God for bringing me through this process. At times I wanted to quit, but I knew that this was bigger than me. Thanks to my parents for all the love and support. Special thanks to my entire committee. You were the best dream team ever!!

Table of Contents

List of Figures

List of Tables

List of Appendices

Abstract

HIV continues to disproportionately plague select communities across the United States. Individual sexual behavior serves as a dominant explanation for differences in HIV infection. In public health, little attention has been placed on community context and features of the community environment as important predictors of sexual health. The community environment and resources or lack of resources may influence sexual behavior. This may contribute to disparate rates of HIV transmission. I examine how socioenvironmental factors and sex ratios influence sexual behavior and HIV rates, and contribute to race/ethnic differences in risky sexual behavior. I used multilevel models and data from the Behavioral Risks Factor Surveillance System (BRFSS) to determine the cross-sectional association across 15 states between county-level factors and risky sexual behavior for different racial/ethnic groups. The measure of sexual behavior examined was the number of sexual partners. The county level factors examined included imbalanced sex ratio, residential segregation, and the percent of residents below poverty. **Results:** Increased residential segregation was associated with higher odds of risky sexual behavior in all groups although a clear dose response trend was only observed in Whites.   The association between sexual behavior and county sex ratios partly followed the pattern predicted by the Alternative Sex Ratio Mate Preference Shifts Hypothesis.

xi

Racial/ethnic differences in risky sexual behavior were reduced after adjustment for

marital status and age. I did not find a substantial effect of adjustment for racial

residential segregation, percent below poverty, or the sex ratio at the county level.

Conclusion This is one of the first studies to examine the hierarchical association of

county-level variables with risky sexual behavior. Future multilevel work with different

measures of sexual behavior and alternative contextual measures is needed to better

understand the social processes affecting HIV risk and the factors contributing to

persistent race/ethnic differences.

Chapter 1

INTRODUCTION

The number of persons becoming infected with HIV continues to increase annually throughout the United States. A study of 33 states from the Centers for Disease Control and Prevention (CDC) showed that at the end of 2004, an estimated 1,147,697 HIV or AIDS cases had been diagnosed and reported to the CDC, with 56,300 new cases of HIV being diagnosed in 2006 (CDC, HIV Prevention in the Third Decade, 2005) (CDC, Epidemiology of HIV/AIDS—United States, 1981–2005, 2006) (Hall, et al., 2008). In 2008, the CDC released a study, which re-examined the actual depth and size of the HIV epidemic (CDC, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention Annual Report, 2008). The results showed that the epidemic is at least 40% larger than previously believed and is growing by between 55,000 and 58,000 infections a year (CDC, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention Annual Report, 2008).

A major focus of studies of the determinants of HIV infection in the U.S. is individual sexual behavior. While this is seen as a major contributor, relatively little attention has been placed on community context and features of the community environment that may play an important role in sexual health.   The reason more focus

needs to be put on community effects is that the community environment and resources or lack of resources associated with it can influence sexual behavior, which, in turn may contribute to disparate rates of HIV transmission (Poundstone, Strathdee, & Celentano, 2004) (Sevgi, 1996).

In this dissertation, I examine the multilevel aspects, of how socioenvironmental factors affect risky sexual behavior. There are 3 basic questions of interest: 1) How does residential segregation affect risky sexual behavior? 2) How does an imbalanced sex ratio affect risky sexual behavior in different racial/ethnic groups? And 3) How do residential segregation, the percent below poverty line, and the sex ratio at the county level contribute to racial/ethnic differences in risky sexual behavior? All 3 questions will be answered using hierarchical models to determine the cross-sectional association between county-level variables and the association of risky sexual behavior across 15 states. I define counties as the group level of interest because prior work has shown that county-level variables are relevant predictors of individual-level outcomes, especially for variables such as residential segregation (Fabio, Sauber-Schatz, Barbour, & Li, 2009).

Background and Significance

Racial and ethnic minority populations have been disproportionately affected by the HIV epidemic. During 1981-1995, non-Hispanic whites were the predominant racial/ethnic group among persons who had AIDS diagnosed (47%) (Hall, et al., 2008) (CDC, Epidemiology of HIV/AIDS—United States, 1981–2005, 2006) (Safren, Wingood, & Altice, 2007) (Safren, Wingood, & Altice, 2007); however over time, the proportion of HIV cases among racial and ethnic minorities increased (2006 cohort: non-Hispanic blacks accounted for 49% with an incidence rate 7 times higher than among

whites, and Hispanics accounted for 18% with an incidence rate 3 times higher than among whites) (CDC, HIV/AIDS Surveillance Report, 2004. Vol. 16., 2005) (CDC, Trends in HIV/AIDS Diagnoses-33 states, 2001-2004., 2005). African Americans are being hit hardest with epidemic (CDC, HIV/AIDS Surveillance Report, 2004. Vol. 16., 2005) (CDC, Trends in HIV/AIDS Diagnoses-33 states, 2001-2004., 2005) (Hall, et al., 2008). From previous work, I have been able to identify a number of factors that may contribute to the disproportionate HIV burden among race and ethnic minorities including the prevalence of HIV/AIDS within a community, levels of immunity, the transmission dynamics of the infection, and the availability of early diagnosis and treatment (Finer, Darroch, & Singh, 1999). Behavioral factors such as the number of sexual partners an individual has, condom use, and the type of intercourse may also affect rates and disparities have also been previously studied (Finer, Darroch, & Singh, 1999). For the purposes of this study, I want to investigate environmental determinants of these behaviors that can lead to disproportionate rates.

In addition to race/ethnic differences, there are also important gender differences in the distribution of HIV risk. Women are one of the fasting growing groups of newly HIV infected individuals, with the major mode of transmission being through heterosexual intercourse (CDC, HIV/AIDS Surveillance Report, 2004. Vol. 16., 2005) (CDC, Trends in HIV/AIDS Diagnoses-33 states, 2001-2004., 2005). If the rates of infection among women continue to grow, women may soon outnumber men in HIV infection (CDC, HIV/AIDS Surveillance Report, 2004. Vol. 16., 2005) (CDC, Trends in HIV/AIDS Diagnoses-33 states, 2001-2004., 2005). As in the case of race/ethnic

differences, behavioral factors, which are often constrained by environmental factors outside of women's control, could be contributing to HIV rates in women.

Research Purpose

While individual sexual behavior is an issue, lack of understanding and studying social determinants of this behavior needs more attention. For example, previous research has shown that patterns in the 'structure of relationships' affect the distribution of HIV risk (Sevgi, 1996). The geographic area where one lives provides the social/sexual context that can influence HIV risk within that area (Sevgi, 1996). A major contribution to prior research is understanding how sexual behavior is affected by variables at a higher level, therefore helping in the development of appropriate policies and interventions. My framework is adapted from a similar model developed by Lane, Rubinstein, Keefe, for the study of structural violence and its effects on HIV (Lane, et al., 2004). The authors believe that there are three general ecologic pathways that lead to disparate HIV infection between race/ethnic groups: community-level, relationship-level, and the biological-level. My study focuses on certain aspects of the community- and relationship- level pathways, in which increased HIV infection is due to structural community characteristics (at the county levels) as well as features of social/sexual networks. I also based my multilevel work on the framework by Poundstone, Strathdee, and Celentano (Poundstone, Strathdee, & Celentano, 2004). The authors discuss three levels of determinants of HIV/AIDS: individual, social, and structural factors (Poundstone, Strathdee, & Celentano, 2004). Therefore instead of focusing solely on individual-level behavior, this research considers how social and environmental determinants (outside the control of the individual) at the community level may affect behavior. This provides a complement to the existing work

done at an individual-level, as multilevel analysis affords the opportunity to examine influences that social and group-level context have in choosing to engage (or not) in risky behaviors.

In Chapter 2, I examine the cross sectional effects of racial residential segregation on risky sexual behavior. Specifically, I use multilevel analysis to study the associations of county white/black residential segregation with risky sexual behavior at the individual level, while controlling for individual-level characteristics. I want to determine if greater county white/black residential segregation will be associated with higher probability of risky sexual behavior, independently of individual-level characteristics. I hypothesize that living in a county with greater segregation will be associated with greater odds of risky sexual behavior, after controlling for individual-level characteristics.

This study adds to the work done in sexual health. Not much work has examined the effects of county-level residential segregation on risky sexual behavior. Previous studies in the area have mainly focused on teen sexual health, while my study looks at the adult population. A number of studies have shown a significant ecological association between increased residential segregation and elevated risks of outcomes such as infant mortality (in particular, Blacks) (LaVeist, 1992) (LaVeist, 1993) (LaVeist, 1989; Polednak, 1991), as well as overall adult mortality (Polednak, 19 (CDC, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention Annual Report, 2008)93) (Collins & Williams, 1999) (Fang, Madhavan, Bosworth, & Alderman, 1998) (Guest, Almgren, & Hussey, 1998); however relatively few have examined effects of residnetial segregation on sexual behaviors in a multilevel context.

In Chapter 3, I examine the effects of imbalanced sex ratios on risky sexual behavior – guided by this research question: what shifts occur in the pattern of risky sexual behavior when the sex ratio departs more than 10% from unity, (e.g. significantly more males than females or females than males) (Guttentag & Secord, 1983) (Kiecolt & Fossett, 1995)? In particular, I examine the multilevel associations of county sex ratios (stratified by race/ethnicity and gender) with risky sexual behavior at the individual-level, while controlling for individual-level characteristics. The hypothesis is that living in a county with an imbalanced sex ratio (departing more than 10% from unity or significantly more males than females or females than males) will be associated with differences in risky sexual behavior, after controlling for individual-level characteristics. Specifically, I hypothesized that a low sex ratio environment (fewer males than females) will be associated with an increase in male and female risky sexual behavior, and a high sex ratio environment (fewer females than males) will be associated with an increase in male risky sexual behavior. Very few studies have examined associations of the sex ratio with health related sexual behaviors.

Chapter 4 is an extension of chapters 2 and 3 and examines how the county-level socioenvironmental characteristics investigated in prior chapters as well as county poverty rates contribute to race/ethnic differences in risky behavior. Specifically, I observe whether county-level factors, sex ratio, percent below poverty, racial residential segregation, contribute to race/ethnic difference in risky sexual behavior at the individual-level among men and women. These county characteristics along with SES may contribute to race/ethnic differences in sexual behavior – that is, I would expect to

see similar behaviors in all populations if they were comparable in these factors. Therefore, race differences may not be due to race itself, but to environmental factors.

I first fit a model with race, age, sex, and marital status. Then I examine how the race coefficient changes as I add: (1) individual-level SES and (2) the county level variables. The reductions in the coefficient for race will indicate the possible magnitude of the contribution of individual-level SES and county-level factors to these differences.

Chapter 5 is the conclusion chapter, and it places the findings of the dissertation in context and discusses the implications of the three previous chapters.

In summary, through the chapters of this dissertation I examine the contribution of community(county) level characteristics to variations in numbers of sexual partners within race/ethnic groups as well as to differences in number of sexual partners between race/ethnic groups.

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Chapter 2

RESIDENTIAL SEGREGATION AND RISKY SEXUAL BEHAVIOR

"Racial residential segregation is the single most important historical factor in

creating concentrated poverty in America" –Unknown

"Racial segregation, like all other forms of cruelty and tyranny, debases all human beings – those

who are its victims, those who victimize, and in quite subtle ways those who are mere accessories." –

Kenneth B. Clark

With this growing increase in HIV infection yearly, disproportionate rates continue to exist in disadvantage communities. There are a number of factors that may contribute to this HIV burden among certain communities, including behavioral factors such as the number of sexual partners an individual has, condom use, and the type of intercourse (Finer, Darroch, & Singh, 1999). Understanding these factors at the community level is important because patterns in the structure of relationships affect the distribution of HIV risk (Sevgi, 1996). A potential influential community factor that can contribute to risky sexual behavior is residential segregation. It is measured as the differential distribution of social groups over space and may affect interactions within a

community such as social and sexual networks (Reynolds). In addition, community-level

factors associated with segregation may affect educational and economic opportunities

which may have consequences for sexual behavior.

The major objective of my study is to examine the associations of county-level

white/black residential segregation (stratified by race/ethnicity) with individual-level

risky sexual behavior, while controlling for individual-level characteristics. I focus on

racial residential segregation because while communities are typically divided by SES,

and these SES divisions are typically varied by race/ethnicity, previous research has

shown that there is a stronger relationship between segregation and race/ethnicity then

segregation and SES (Acevedo-Garcia, Lochner, Osypuk, & Subramanian, 2003). I

hypothesize that greater county white/black residential segregation will be associated

with higher probability of individual risky sexual behavior, independently of individual-

level characteristics. Although I examine only white/black residential segregation as the

segregation variables, I investigate its effects on all race/ethnic groups because in the US

context, white/black residential segregation can affect multiple race/ethnic groups

(Glaeser & Vigdor, 2001) (Williams & Collins, 2001). Regardless of their race/ethnicity,

individuals living in segregated areas may be exposed to hazardous conditions, poor

medical access, and other forms of disadvantage associated with white/black segregation

(Weiss, Ompad, Galea, & Vlahov, 2007) (Williams & Collins, 2001) (Mayberry, Mili, &

Ofili, 2005) (Galea & Vlahov, 2005). These factors may affect the adoption of risky

sexual behaviors independently of individual-level characteristics. Overall, this study

provides a complement to the existing work done at an individual level, as multilevel

analysis affords the opportunity to examine influences that social and group-level context of residential segregation have in choosing to engage (or not) in sexual behavior.

Conceptual Framework

Figure 2.1 portrays the hierarchical relationships among white/black residential segregation at the county level, individual-level factors, and risky sexual behavior at the individual level. I define counties as the group level of interest because prior work has shown that county-level variables are a relevant level for which to examine residential segregation (Fabio, Sauber-Schatz, Barbour, & Li, 2009). For example, increased county-level residential segregation has been linked to wider disparities of violent injury among white and non-white individuals. Individual-level variables age, sex, socioeconomic status (SES), and marital status are controlled for as they are associated with both the residential segregation and risky sexual behavior. Residential segregation and individual-level variables are associated because persons with certain individual-level attributes may be more likely to live in segregated areas (Fabio, Sauber-Schatz, Barbour, & Li, 2009).

The Effects of Residential Segregation on Risky Behavior

There are different measures of residential segregation. For my analysis, I will measure racial residential segregation using the index of dissimilarity, which is a measurement of the 'evenness' with which two racial groups are distributed across a particular geographic area that is part of a larger area (Reynolds). The index ranges from 0 (even distribution of 2 races across an area) to 100 (complete segregation of 2 races across an area) (Reynolds). In the case of my study, the index score can be interpreted as the percentage of either racial groups (i.e., whites or blacks) that would have to move to a

14

different area, across census tracts within the county, in order to achieve a completely even distribution (Massey & Denton, 1989) (Williams & Collins, 2001) (Reynolds). According to the Lewis Mumford Center for Comparative Urban and Regional Research, which tracks segregation through dissimilarity, exposure and isolation indices, a value of 60 or above is considered to indicate a high level of segregation or hypersegregation, 40 to 50, a moderate level, and under 30 a low level (Massey & Denton, 1989) (Williams & Collins, 2001) (Degree of segregation & dissimilarity).

When there is a low level of racial residential segregation within an area, resources are generally more likely to be evenly distributed and available to most people throughout that area. Although small segregated pockets may exist within this area (i.e., low income housing), structural resources, such as educational, economic, and health-related resources related are still available because the distribution of those resources is approximately even over space. However there is a different trend when an area has a high level of racial residential segregation. Structural resources are no longer evenly distributed and available to most people across the area. Instead, the resources are focused more in some areas, while other areas get little to no resources. In other words, these resources are mostly available to the more fortunate group (i.e., high SES census tract) (Adimora & Schoenback, 2005). While among the less fortunate population, there is centralization of poverty that brings about harmful economic and social influences. In addition, areas of concentrated poverty are more likely to have higher rates of ill-health such as HIV infection, therefore increasing the risk of socioeconomic failure of this population (Poundstone, Strathdee, & Celentano, 2004) (Laumann & Youm, 1999) (Adimora & Schoenback, 2005).

15

The process through which segregation leads to risky behavior is schematically depicted in Figure 2.2. Figure 2.2 portrays an area in which residential segregation is approaching a level of hypersegregation, and Figure 2.3 depicts the expected trend of the distribution of resources and levels of residential segregation. In this case (Scenario 1) as segregation reaches levels of hypersegregation, there is greater spatial isolation of the Advantaged and Disadvantaged. The Advantaged (or more fortunate group) will obtain most resources (i.e., educational, economical, and health related); whereas, the Disadvantaged will receive less resources. This limited access to resources among the Disadvantaged contributes to increases in risky behavior. Also, the extreme division of resources for these two groups limits the educational and employment opportunities available to the disadvantaged.

In education, residential segregation brings about segregated schools. This segregation in schools is a major cause of racial differences in the quality of educational opportunities (Williams & Collins, 2001). Black and Hispanics predominate in poor public schools; while, White students from middle-class backgrounds predominate in wealthier schools (Williams & Collins, 2001) (Orfield & Eaton, 1996). Both types of schools differ significantly in test scores, qualified teachers, advanced placement courses, academic counseling, and college and employers connections (Williams & Collins, 2001) (Orfield & Eaton, 1996). Thus, the Disadvantaged area is more likely to have higher levels of teen pregnancy, peer pressure against achievement, and an increase in substance abuse. This leads to an increase of risky behavior through lack of knowledge regarding safe sex, increased sexual partners, and potential needle sharing through substance abuse (Williams & Collins, 2001).

16

Another mechanism through which segregation may affect risky sexual behavior is through access to occupational opportunities. Segregation results in disadvantaged and often predominantly African American areas with little access to good paying jobs, or the available jobs in these areas require a level of skill that many African Americans do not have, therefore limiting socioeconomic status (SES) mobility (Williams & Collins, 2001). This limited SES mobility and access to certain types of jobs leads to thwarted expectations that may have consequences for the adoption of risky behaviors. Poor segregated areas may also have poor quality primary health care services, which in turn, has been associated with riskier health behavior (Williams & Collins, 2001) (Macintyre, Maciver, & Sooman, 1993). Thus residential segregation affects the quality of education systems (i.e., segregated schools), contributes to differences in quality economic opportunities, and also may affect the quality of access to health care all of which may have implications for sexual behavior. Because of the lack of resources in educational and economic opportunities for the Disadvantaged population, there is an increase chance of risky sexual behavior within that area.

MATERIALS AND METHODS

Study Population

Data were obtained from two sources: the Behavioral Risk Factor Surveillance System (BRFSS) and the Year 2000 Unites States Census. The Behavioral Risk Factor Surveillance System is a continuous health survey system via telephone that has tracked health and risk behaviors throughout the United States each year since 1984 (CDC, Behavioral Risk Factor Surveillance System Survey Questionnaire). Data for this study was obtained from questionnaires administered as part of the 1998, 1999, 2000, 2001, &

2004 surveys. Each survey consists of Core Sections and Optional Modules. The Core

Sections are a standard set of questions asked by all states. Optional Modules are sets of

questions that cover additional health topics with more detailed questions on a health

topic included in the core. Each state selects which optional modules will be included on

their BRFSS questionnaire. The sexual behavior questions are part of an optional

module, and are only asked by states that elect to do so. The states incorporated into this

analysis are Delaware, Florida, Maine, Minnesota, Montana, New Jersey, New Mexico,

New York, North Carolina, North Dakota, Ohio, South Dakota, Tennessee, Texas, and

Vermont. Data from years 2002 and 2003 are not included because there were no sexual

behavior questions asked during those years. The BRFSS data also includes weights that

were incorporated into my analysis. BRFSS data are weighted directly for the probability

of selection of a telephone number, the number of telephones in a household, and the

number of adults in a household (CDC, Behavioral Risk Factor Surveillance System

Survey Questionnaire). A final poststratification adjustment was made for noncoverage

and nonresponse of those households without telephones (CDC, Behavioral Risk Factor

Surveillance System Survey Questionnaire). Weights for each factor of relevance were

multiplied together to generate a final weight (CDC, Behavioral Risk Factor Surveillance

System Survey Questionnaire).

      The Population Studies Center (PSC) at the University of Michigan has generated

racial residential segregation indexes for all counties, states, metropolitan areas, and cities

of 100,000 or more with the use of information from the 2000 Census (Reynolds). Racial

residential segregation can be characterized using 5 geographic pattern measures:

isolation, dissimilarity (or evenness), centralization, clustering, and concentration of 2 or

more racial groups (Massey & Denton, 1988) (Reynolds) (Acevedo-Garcia, Lochner, Osypuk, & Subramanian, 2003). For my study I use the most common measure, the index of dissimilarity, which is a measurement of the 'evenness' in which two racial groups are distributed across a particular geographic area that is a part of a larger area (Reynolds). The index ranges from 0 (even distribution of 2 races across an area) to 100 (complete segregation of 2 races across an area) (Reynolds).

Data Description

Outcome Variable

The outcome variable is risky sexual behavior. The indicator I use to measure risky sexual behavior is the number of sexual partners within the past year categorized as 0-1 vs. 2 or more and treated as a binomial variable. I dichotomized the variable because when examining the number of sexual partners as a continuous variable, it was highly skewed, with most participants reported having only one sexual partner within the past 12 months. Previous research has used a similar dichotomization (Dolcini, et al., 1993) (Finer, Darroch, & Singh, 1999).

Group Variable

The index of dissimilarity was obtained for U.S. counties from the PRC for Whites and Blacks. For this analysis, the index looks at the segregation of whites and blacks across census tracts within a county, ranging from 0 (even distribution of Whites and Blacks across census tracts within a county) to 100 (complete segregation of Whites and Blacks across census tracts within a county). From the 2000 Census, 74 out of 317 MSAs had a dissimilarity index greater than 60, meaning 60 percent of whites or 60

19

percent of blacks within that area would have to move across census tracts in order to have a completely even distribution across that entire MSA (Glaeser & Vigdor, 2001) (Williams & Collins, 2001).

Additional Variables

Individual-level variables examined as covariates included: Age, Sex, Education Status, Marital Status. The group-level covariate examined is % Below Poverty. A marker for individual SES was the level of education completed (less than HS, grade 12 or GED, some college, and college grad or higher), Age and Poverty are examined as a continuous variable, and Marital Status is categorized (married, divorce, widowed/separated, never married, and a member of an unmarried couple). These covariates were included in the model because they are associated with both the exposure and the outcome variables.

Statistical Analysis

Data was analyzed using SAS version 9.1, SPSS 14.0, and HLM version 6.0. Multilevel analysis was used to account for the hierarchical structure of the data. Three two-level hierarchical models were used to determine the cross-sectional association between county-level black/white residential segregation and the prevalence of risky sexual behavior for each race/ethnic group after accounting for individual-level covariates.

The level-1 (individual response) and level-2 (county response) models are shown below and contain a logistic outcome variable.

The level-1 model represents persons within counties:

Level 1:

$$\log\left(\frac{p_{ij}}{1-p_{ij}}\right) = b_{0j} + b_{1j}\sum_{i=1}^{n} Age_{ij} + b_{2j}\sum_{i=1}^{2} Sex_{ij} + b_{3j}\sum_{i=1}^{3} EducationStatus_{ij} + b_{4j}\sum_{i=1}^{5} MaritalStatus_{ij}$$

Where: P_{ij}: is the probability of risky sexual behavior for the ith person in

county j

b_{0j}: is the expected log odds of risky sexual behavior for an ith

individual in county k when all covariates are 0

$$\sum_{i=1}^{n} b_{ij} \left| x_{ij} \right| \quad : \text{the sets of level-1 covariates}$$

The level 2 model represents counties and was modeled as follows:

Level 2:

$$b_{0j} = \gamma_{00} + \gamma_{0j}\sum_{j=1}^{n} \mathrm{Re}\,sSeg_{j} + \gamma_{0k}\% BelowPoverty_{j} + U_{0j} \qquad U_{0j} \sim N(0,\tau_{00})$$

Where: γ_{00}: the average log-odds of risky behavior across counties

γ_{0j}: change in log-odds of intercept per change in Moderate or High

Segregation vs. Low Residential Segregation

$\gamma_{0\kappa}$: change in log-odds of intercept per unit change in Poverty

variable

U_{0j}: random effects of county j

In addition to the full model described above, an unconditional model (FUM) was

fitted to calculate the intraclass correlation (ICC), which determines whether there is

significant variance in risky sexual behavior between counties (Raudenbush & Bryk,

2002). The ICC for a logistic model is defined below and τ_{00} is the variance of the

random intercept in the FUM (Raudenbush & Bryk, 2002).

$$ICC = \frac{\tau_{00}}{\tau_{00} + \pi^2/3}$$

In order to examine the variance being explained by the county-level variable, I

compared the FUM of my "null" model (model with no variable) with FUM from the

model that included the county-level variable to see the proportion of reduction, and

therefore how much variance was being explained by the white/black residential

segregation.

RESULTS

A total of 68,575 adults aged 18 and over responded to the BRFSS in the states

and years in which the sexual activity questionnaire was administered[1]. Of these, 57,250

had available information on the county of residence, of which 32,363 were between the

ages of 18 and 49 and were asked the question on total number of partners. Of the 32,363

participants, there were 30,434 who were White, Black, and Hispanic. After merging the

PRC and BRFSS datasets, there were a total number of 30,061 observations in 290

counties for analysis (See Appendix).

Table 2.1 displays individual-level characteristics. My study sample included

23203 Whites, 3524 Blacks, and 3334 Hispanics. In my study, the mean age was 35.8 in

Whites, 31 in Blacks, and 23.5 in Hispanics as compared to 36.6 of the U.S. population

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[1] States: Delaware, Florida, Maine, Minnesota, Montana, New Jersey, New Mexico, New York, North
Carolina, North Dakota, Ohio, South Dakota, Tennessee, Texas, & Vermont
        And
Years: 1998, 1999, 2000, 2001, & 2004

from the 2000 census (U.S. Census Bureau, 2004). Women were overrepresented in all groups: 42.4% of whites, 35.5% of Blacks and 42.6% of Hispanics were male. Whites were more likely than Blacks or Hispanics to be in the higher educational categories: 37.2% of Whites are college graduates or higher compared to of 23.2% Blacks and 17.4% of Hispanics; 32 % of whites had only complete HS or less compared to 46.6% of Blacks and 57.1% of Hispanics. Whites and Hispanics were more likely to be married than Blacks (56.9%, 34.2% and 50.4% were married for Whites, Blacks and Hispanics, respectively). For all racial groups, most participants have had only one sexual partner within the past 12 months (62.2%, 54.2%, and 57.5% for Whites, Blacks, and Hispanics, respectively). The second highest percent had no partners (10.8%, 14.7%, and 9.2% for Whites, Blacks, and Hispanics, respectively).

Table 2.2 shows the distribution of the index of dissimilarity within my study and numbers of BRFSS respondents for the counties included in the analyses. There are a total of 290 counties represented in the data, with a median number of 62.5 persons per county. The White BRFSS participants represented 290 counties. Black participants were drawn from 202 counties and Hispanic participants were drawn from 237 counties. The median county dissimilarity index was 38.7 for Whites, 44.1 for Blacks, and 39.8 for Hispanics.

Table 2.3 shows the distribution of counties and persons by categories of residential segregation. A majority of the Whites in the sample (26.5% of persons (n=6157)) have an index of dissimilarity between 30 and 40, meaning that they live in counties where between 30 to 40 percent of Blacks would have to move across census tracts in order to achieve perfect representation across that particular county. The

majority of Blacks and Hispanics live in hypersegregated counties (32.7%: n=1152 and 30.3%: n=1009, respectively), i.e. in counties where 60% or more of Blacks would have to move across census tracts in order to achieve perfect representation across that particular county. For the purposes of my final analysis and to small numbers in Blacks and Hispanics, some of the residential segregation categories were combined for analysis.

Individual-level Predictors of Number of Sexual Partners

Table 2.4 shows associations of individual-level variables and county level residential segregation with risky sexual behavior in multivariable adjusted models. There is a statistically significant association between risky sexual behavior and age for each racial/ethnic group – that is, the odds of risky sexual behavior decreased between 4% and 7% for every one year increase in age. In all race/ethnic groups males have higher odds or risky sexual behavior than females. For Whites and Hispanics, education is not significantly associated with the odds of risky sexual behavior; whereas Blacks show statistically significant decreased odds of risky behavior in the lower compared to the higher educational categories. In all race/ethnic groups, married persons have lower odds of risky sexual behaviors than any of the other marital status categories.

Residential Segregation as a Predictor of Number of Sexual Partners

My results generally followed the expected positive, linear trend between increasing levels of residential segregation and increasing odds of having 2 or more sexual partners (Table 2.4). For all racial groups, the odds of having two or more sexual partners versus 1 or less was greater in more segregated than in less segregated counties. For Whites, there is a clear dose response trend relationship between segregation and the

24

odds of having more than 1 sexual partner (vs. 2 or more). The OR for the highest vs. the lowed category of segregation was 1.40 (CL 1.00-1.95). Increased in segregation were also associated with greater odds of 2 or more partners in Hispanics and Blacks but no clear dose response trend was observed and none of the differences were statistically significant, possible due to small sample sizes.

The % below poverty was associated with 1% increased odds for White and Black (Not Hispanics) populations for; however, it was only significant in Whites.

Variance Component

The ICC values for each racial/ethnicity in the model with no covariates were 0.064, 0.124, and 0.159 for Whites, Blacks, and Hispanics, respectively. In the full model, the ICCs were 0.057, 0.120, and 0.131 for Whites, Blacks, and Hispanics, respectively. However, previous work notes the limitations of the ICC for binary outcomes because correlation coefficients are difficult to interpret for a dichotomous variable (Twisk, 2006). The addition of residential segregation to a model with the individual level covariates reduced the between county variance by 2.7%, 1.6%, and 12.6% in Whites blacks and Hispanics, respectively.

DISCUSSION

Residential segregation is a key factor in the creation of unequal resources among certain groups, therefore affecting health outcomes. My results concur with the expected trend of the association between greater residential segregation and greater odds of risky sexual behavior. For all racial groups persons living in counties with greater levels of

racial residential segregation had greater odds of risky sexual behavior; however, not all results were statistically significant.

Although patterns were generally consistent across race/ethnic groups, some differences were observed. For Whites, as levels of segregation increased, the odds of risky sexual behavior increased. For Blacks and Hispanics, the odds of risky sexual behavior were greatest for the counties that had an index of dissimilarity between 35 and 60. There was some evidence that the association between segregation and behavior was slightly stronger in Blacks than in the other racial groups. A reason for this stronger association may be because in areas of high segregation, Blacks typically live in areas with higher concentration of poverty with consequences for access to resources as illustrated in Figure 2, Scenario 1. I also tested to see if there were similar trends in all populations if in fact these populations were comparable. However differences across race/ethnic groups in the association between residential segregation and the outcomes were not statistically significant (See Appendix B). Further research is needed to truly understand whether residential segregation effects of sexual behavior truly differ by race or ethnicity.

In addition to the impact of differential resource distribution (as shown in Figure 2), the patterns or interactions between individuals can also impact how segregation affects risky sexual behavior. Although my main focus is through the impact of resource distributions, processes involving interactions between in individuals within and between groups are also important to understand. Patterns of interactions between individuals within a segregated community may tend to reinforce behavioral differences between communities. For example, if the resource-related mechanisms described in Figure 2

create differences in risky sexual behaviors between disadvantaged and advantaged groups, and members of segregated groups are more likely to interact with each other than with members of other groups, this will create a vicious cycle by which the dominant behavior is reinforced through social norms and social interaction (Acevedo-Garcia D. , 2000).

Figure 2.4 illustrates a different scenario in which the cycle of interaction between groups also affects the distribution of contagious outcomes or behaviors. Within a segregated area, if person 'A' living in the Disadvantaged community engages in some form of sexual interaction with person 'B' from the Advantaged community, then there is an increased chance of a high risk behavior for person 'B' (Phase 1). From this point onwards, two options are possible for each individual (Phase 2): 1) he/she can go back into his/her community and interact with those individuals or 2) he/she can continue to interact with persons from the other community. If person 'A' (from the Disadvantaged community) takes path 2 (continues to interact with people from the Advantaged community), then there is increased probability of others in the Advantaged community engaging in risky behavior. If person 'B' (from the Disadvantaged community) decides to take path 1 (i.e., continues to engage with others in the advantaged community), then he/she may transmit the risky behavior to others within that community, as well. In the Advantaged community, other individuals may interact with person 'B' and these individuals may have potential social and sexual networks within their community, increasing the probability of risky behavior throughout. Person B may also continue to interact with others in the Disadvantaged community thus increasing the probability of risky behavior in this community even more. This cycle can continue within both

communities, increasing the chances of the Advantaged and the Disadvantaged in engaging in risky behavior. This model illustrates how segregation can impact risky sexual behavior in both advantaged and disadvantaged groups. My results are consistent with this model in that I found associations of segregation with risky sexual behavior in all race/ethic groups, including whites.

My study shows that where a person lives, regardless of race, can play a role in his or her sexual behavior. My results show that residential segregation may affect not only disadvantaged groups segregated into poor areas but also other groups. My results show that white_black residential segregation can affect everyone within that community, regardless of race/ethnicity. Whites, Blacks, and Hispanics all showed increased odds of risky behavior as residential segregation increased. However, not all results were statistically significant. This could be because of the small sample sizes within certain groups. Nonetheless, it is still important to observe the trends.

In general, my results are consistent with effects of segregation on economic, educational, and health resources, resulting in fewer health resources, poorer quality medical care, and limited safe sex knowledge and access in Disadvantaged and segregated groups. This lack of appropriate resources may be associated with increased chance of higher risky behavior. I have also shown that segregation may have behavior consequences for advantaged and disadvantaged groups through the mechanisms illustrated in figure 4.

A number of studies have shown a significant ecological association between increased residential segregation and elevated risks of outcomes such as infant mortality (in particular, Blacks) (LaVeist, 1992) (LaVeist, 1993) (LaVeist, 1989; Polednak, 1991),

as well as overall adult mortality (Polednak, 1993) (Collins & Williams, 1999) (Fang, Madhavan, Bosworth, & Alderman, 1998) (Guest, Almgren, & Hussey, 1998). Also, residential segregation (assessed using the isolation index) was ecologically found to be associated with injection drug use among Blacks in 93 MSAs (Cooper, Friedman, Tempalski, & Friedman, 2007). Segregation has also been linked to mental health outcomes (Lee & Ferraro, 2007). Lee, et al, in a multilevel study found that for Hispanics increased residential segregation is harmful to mental health (Lee & Ferraro, 2007).

A number of studies have examined the association between increased area segregation and poor health status (Gee, 2008) (Subramanian, Acevedo-Garcia, & Osypuk, 2005) (Williams & Collins, 2001) (Lee & Ferraro, 2007) In a multilevel study, Gee examined the effects of segregation and self-perceived discrimination on different health outcomes among Chinese Americans residing in Los Angeles (Gee, 2008). Another multilevel study found that zip code-level race/ethnic segregation was associated with very high TB rates in Hispanics and African Americans but not in Whites or Asians) (Acevedo-Garcia D. , 2001). One ecologic study found the association between residential segregation and individual self-reported hypertension (White, 2008).

This is one of the first studies to examine the multilevel association between segregation and sexual behavior in adults. Previous work examined ecological associations between residential segregation and teen sexual behavior (i.e, teen pregnancy) (Sugland, 2006) (Sugland, Ross, Chandra, & Jelenewicz, 2006) and found that increased levels residential segregation was assocated with increased teen pregnancy and sexually transmitted infections among certain groups (in particular, people of color).

Several multilevel studies have examined the neighborhood context of sexual behavior in teens (Browning, Burrington, Leventhal, & Brooks-Gunn, 2008) (Brooks-Gunn, 2004) (Brooks-Gunn, 2005). This work has found that teens living in the more disadvantaged segregated neighborhoods had an increase in sexual partners (Browning, Burrington, Leventhal, & Brooks-Gunn, 2008). Other work has shown that neighborhood collective efficacy is associated with delays in a teens first sexual experience (but only for those who have low parental monitoring levels) (Brooks-Gunn, 2005).

This study adds to the work done in sexual health. Not much work has examined the effects of county-level residential segregation on risky sexual behavior. Previous studies in the area have mainly focused on teen sexual health, while my study looks at the adult population. Browning, et al (2008), did find similar results for their teen population. It is important to note that this behavior may start at a young age and needs further work to understand these effects.

There are some limitations to my study. Sample size may have limited some of my results. When a group's population is less than 1,000, then the index of dissimilarity may be high even if that group's population is evenly distributed throughout that area (Placeholder3) (Parrillo, 2008). However, I ran a sensitivity analysis in which I deleted those counties with less than 1000 blacks and/or whites. The results showed to have similar results as the model with no deleted counties.

Another issue posed is the choice of the index of dissimilarity as the measure for residential segregation. Although the index is a typical measure used for residential segregation, it is still limited to only examining two racial groups at a time. There are other measures such as the multigroup information theory index that can measure the

evenness of several racial groups (Parrillo, 2008). However, the index of dissimilarity continues to be a primary measure of residential segregation due to its easy interpretation and detection of evenness (Parrillo, 2008).

My results may be sensitive to the cut-points I used to categorize residential segregation. There are several ways to categorize segregation indices and no clear theoretical basics for the category decision. In general my results were robust to the different categorizations I used.

There is a concern with measurement error when using self-reporting questionnaires pertaining to topics of sex, and how truthful individuals are and whether they select not to answer certain questions. My results may also reflect confounding by unmeasured individual-level variables related to the processes through which individuals choose to live in neighborhoods with particular normative or structural characteristics (Bell, Zimmerman, Mayer, Almgren, & Huebner, 2007). Although my analyses controlled for county-level poverty, confounding by other county level variables cannot be categorically ruled out ruled out. It is also unclear whether the county is the best geographic unit for which to measure segregation. It is plausible that other units which better reflect social or economic processes such as MSAs may be more relevant.

Overall, I was able to find the expected relationship between risky sexual behavior and racial residential segregation. Not all results were statistically significant possibly due to small sample sizes in some populations. Also, this study needs to be replicated with different sexual behavior outcomes. It is important to understand that segregation can be an indicator of inequality in society, and a strong community requires communication and interaction between individuals of different backgrounds and points

of view (Degree of segregation & dissimilarity). Future work is needed to better understand the processes through which residential segregation may affect sexual behavior.

Figure 2.1: Conceptual Framework
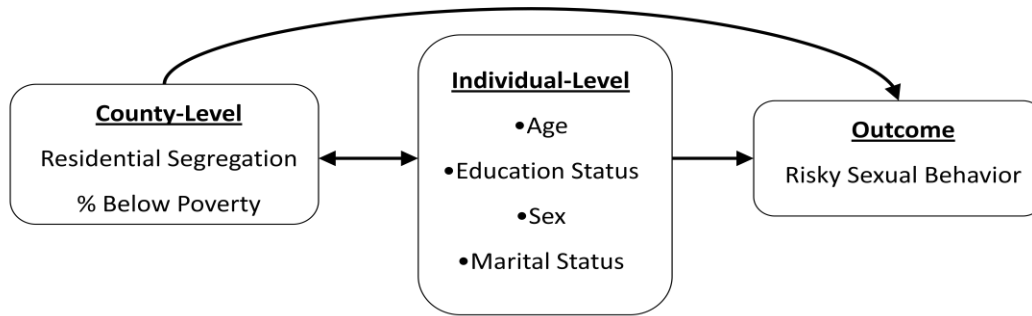
Figure 2.2: SCENARIO 1_Residential Segregation for the Advantaged and
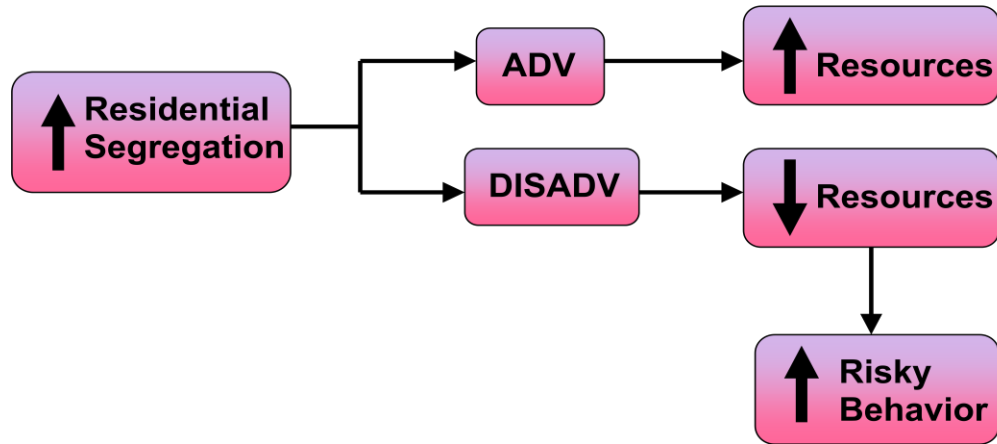
Disadvantaged

Figure 2.3: Residential Segregation Trend in Resources for the Advantaged and

Disadvantaged
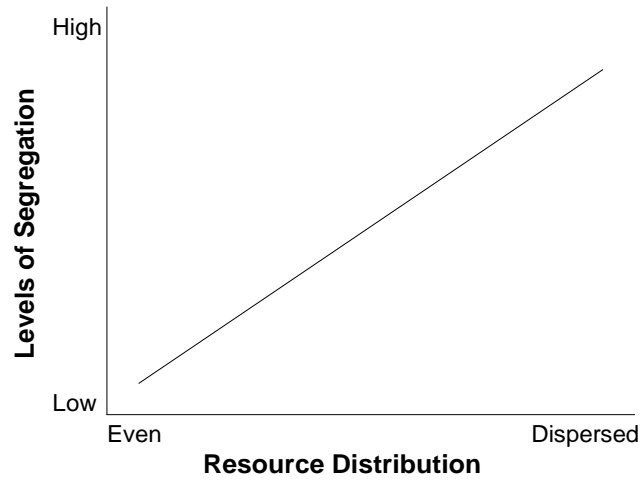
Figure 2.4: SCENARIO 2_ Residential Segregation and Sexual Behavior
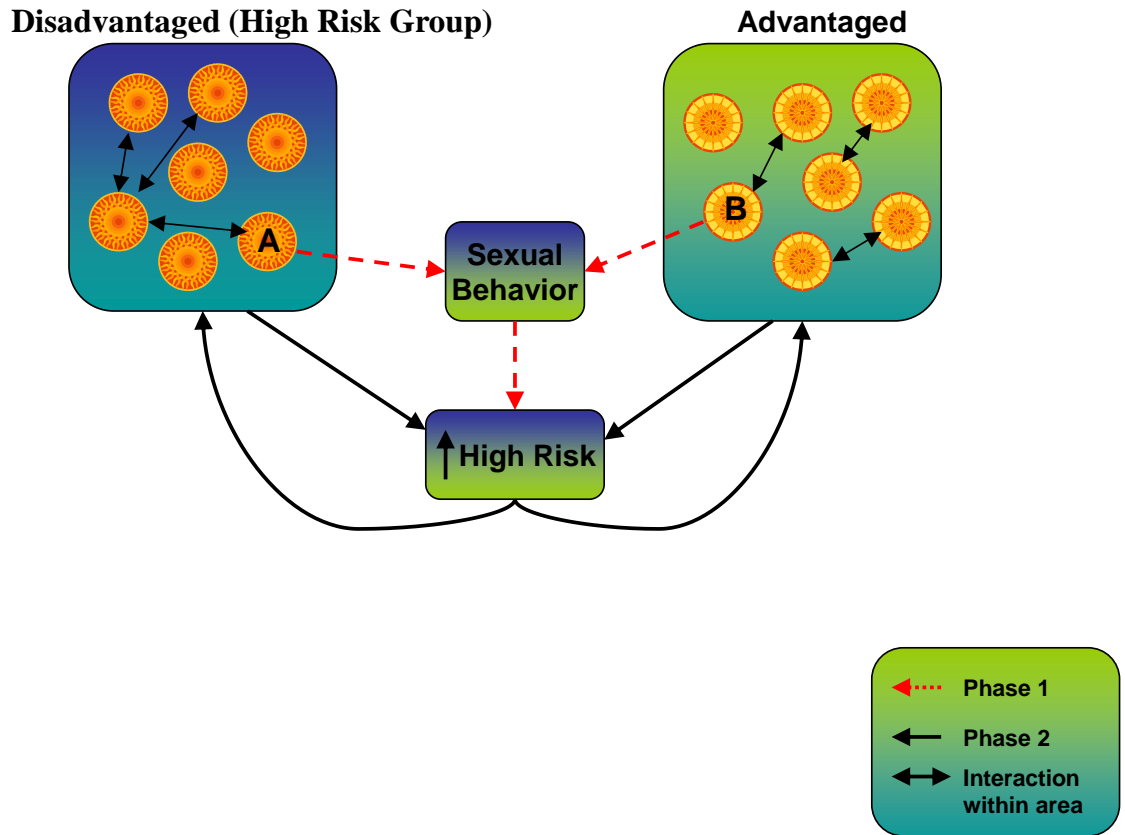
Table 2.1: Individual-Level Characteristics by Race

	White	*Black*	*Hispanic*
Total (N)	23202	3524	3334
Frequency Percentages (%)			
Age			
18-29	22.9	27.6	33.8
29-40	38.2	38.6	40.6
40-50	38.9	33.9	25.6
Sex			
Male	42.4	35.5	42.6
Education Status			
Grade 12/GED or Less	32	46.6	57.1
Some college	30.8	30.1	25.3
College Grad or higher	37.2	23.2	17.4
Refused	0.1	0.1	0.2
Marital Status			
Married	56.9	34.2	50.4
Divorced/Separated	15.7	18.6	14.8
Widowed	1	1.8	1.1
Never Married	23	42.2	25.6
Unmarried couple	3.1	2.9	8
Refused	0.2	0.3	0.1

Number of Sexual Partners

	White	*Black*	*Hispanic*
Frequency Percentages (%)			
None	10.8	14.7	9.2
1	62.2	54.2	57.5
2	4	6.5	4.3
3 or more	3.8	5.6	4.5
Don't know/Not sure	0.1	0.5	0.4
Refused	3.7	5.4	3.8
Missing	15.6	13.3	20.3

Table 2.2: County-Level Characteristics of participants in the sample

Counties	Number of participants per county *Mean/Median* *25th-75th percentile*	Residential Segregation *Mean/Median* *25th-75th percentile*
Total (n=290)	103.7/62.5 35-135	--
Counties with white BRFSS participants (n=290)	80/47.5 28-101	41.3/38.7 28.9-52.5
Counties with Black BRFSS participants (n=202)	17.4/7.5 2--23	89.2/44.1 82-56.8
Counties with Hispanic BRFSS participants (n=237)	14.1/4 2-14	42.9/39.8 29.7-54.9

Table 2.3: Distribution of Counties and Persons by Categories of Residential

Segregation

	<30	*30-40*	*40-50*	*50-60*	*60>*	*Total*
Whites						
Counties (n)	83	71	56	37	43	290
%	28.6	24.5	19.3	12.8	14.8	
Persons (n)	4949	6157	3655	4610	3832	23203
%	21.3	26.5	15.8	19.9	16.5	
Blacks						
County (n)	44	44	43	31	40	202
%	21.8	21.8	21.3	15.4	19.8	
Persons (n)	441	643	389	899	1152	3524
%	12.5	18.3	11	25.5	32.7	
Hispanics						
County (n)	62	57	44	33	41	237
%	26.2	24.1	18.6	13.9	17.3	
Persons (n)	494	836	489	506	1009	3334
%	14.8	25.1	14.7	15.2	30.3	

Table 2.4: Odds ratios of 2 or more partners (vs. 1 or less) by county-level residential segregation and individual level characteristics

	Whites				Blacks			Hispanics		
	OR	CI	P		OR	CI	P	OR	CI	P
Residential Segregation				**Residential Segregation**						
≤ 30	1			≤ 35	1			1		
30-40	1.27	(0.92,1.77)	0.15	35-60	1.50	(0.82,2.75)	0.19	1.20	(0.66,2.17)	0.55
40-50	1.35	(0.94,1.96)	0.11	≥ 60	1.20	(0.71,2.07)	0.52	1.17	(0.65,2.10)	0.60
50-60	1.50	(1.05,1.96)	0.02							
≥ 60	1.43	(1.01,1.06)	0.02							
%Below Poverty										
	1.03	(1.01,1.06)	0.01		1.02	(0.97,1.08)	0.36	0.99	(0.96,1.02)	0.52
Age										
	0.96	(0.95,0.98)	0		0.93	(0.91,0.96)	0	0.95	(0.90,0.998)	0.04
Sex										
Male	2.17	(1.76,2.69)	0		4.42	(3.02,6.47)	0	7.23	(4.17,12.53)	0
Female	1				1			1		
Education Status										
$\leq$ Grade 12/GED	0.94	(0.74,1.20)	0.63		0.54	(0.32,0.91)	0.02	0.68	(0.23,1.00)	0.49
Some College	0.83	(0.63,1.08)	0.17		0.51	(0.28,0.93)	0.03	0.70	(0.20,2.40)	0.57
College Grad or Higher	1				1			1		
Marital Status										
Divorce	25.62	(17.61,37.27)	0		12.13	(6.35,23.18)	0	12.77	(3.62,45.01)	0
Widowed or Separated	22.12	(14.45,33.85)	0		15.81	(6.51,38.41)	0	5.60	(1.48,21.19)	0.01
Never Married	20.42	(14.59,28.57)	0		7.47	(4.05,13.77)	0	8.23	(3.83,17.67)	0
Member of an Unmarried Couple	7.66	(4.51,13.01)	0		5.09	(1.62,15.69)	0.01	4.76	(1.81,12.55)	0
Married	1				1			1		
t_{00}	0.20				0.45			0.50		
Null Model	0.23				0.47			0.62		

Appendix A:

Full BRFSS for the 15 States	
There are a total **68575** observations	
After excluding missing and unknown counties, the number of observations dropped to **57250**	
Excluding based on Age	32363
Excluding based on Race	30434
Those who Answered & Don't know/not sure	24483
Those who Refused	1180
Those Missing	4771
After Merging the PRC and BRFSS Datasets and deleting those excluded observations with no county white/black residential segregation value, there are a total number of **30061** observations	

Appendix B:

   I performed a likelihood ratio test (LRT) in which I examined a pooled model (i.e., a model with race and residential segregation and a model with race and residential segregation interaction). When testing the LRT, white_black residential segegration was estimated as a continuous variable. Since my outcome was a Bernoulli distribution, an EM Laplace was used to compute a maximum likelihood estimate. The interaction model was tested against the model without interactions, and the chi-square was not statistically significant.

Chi-square statistic = 1.23 DF = 2 P-value = >.500

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Chapter 3

SEX RATIOS AND RISKY SEXUAL BEHAVIOR

One feature of the social/geographic context that may affect HIV risk is the sex ratio. Sex ratios, defined as the number of males per 100 reproductive females (the age range commonly used for males and females is 15-49 years (Kiecolt & Fossett, 1995) can affect a community's sexual interactions. An imbalanced sex ratio within a specific geographic area affects the mate availability within that area, potentially leading to more risky sexual behavior by the scarcer gender and greater acceptance of risky behavior by the more available gender. Previous research demonstrates a significant relationship between sexual risk behavior and the male/female sex ratio, with a sex ratios of 1:1 (unity) being associated with increases in the frequency of marriage, and reductions in children born out of wedlock (Guttentag & Secord, 1983), (Stone, Shackelford, & Buss, 2007) (Sampson R. J., 1995) (Bedard, Hough, Weinberger, & Wright, 1987). However, sex ratios have been less frequently examined in relation to HIV-related behaviors. I propose the use of multilevel analysis to examine associations of sex ratio with risky behavior. This provides a complement to the existing work done at an individual-level, as multilevel analysis affords the opportunity to examine influences that social and group-level context of sex ratios have in choosing to engage (or not) in risky behaviors.

57

For my study, I examine the most well-known hypothesis, the Sex Ratio Theory discussed by Guttentag & Secord, which posits that persons of the scarcer gender (either males or females) have the "bargaining power" in the selection of a potential mate (Guttentag & Secord, 1983) (Kiecolt & Fossett, 1995) (Cox, 1940) (Akers, 1967) (Stone, Shackelford, & Buss, 2007). For my study, I was guided by this research question: what shifts occur in the pattern of risky sexual behavior when the sex ratio departs more than 10% from unity, (e.g. significantly more males than females or females than males) (Guttentag & Secord, 1983) (Kiecolt & Fossett, 1995)? The objective of my study is to examine associations of county sex ratios (stratified by race/ethnicity and gender) with risky sexual behavior at the individual-level, while controlling for individual-level characteristics. I hypothesize that living in a county with an imbalanced sex ratio (departing more than 10% from unity or significantly more males than females or females than males) will be associated with differences in risky sexual behavior, after controlling for individual-level characteristics. Specifically I hypothesized that a low sex ratio environment (fewer males than females) will be associated with an increase in male and female risky sexual behavior, and a high sex ratio environment (fewer females than males) will be associated with an increase in male risky sexual behavior.

Conceptual Framework

My study examines whether sex ratios at the county-level impact risky sexual behavior at the individual-level (See Figure 3.1). I define counties at the group-level, because prior work has examined the sex ratio for relatively large areas including cities and metropolitan areas. Individual-level variables, age, socioeconomic status (SES), and marital statue are being controlled as they are associated with both the sex ratios and

risky sexual behavior. Sex ratios and these individual-level variables are possibly

associated through some undefined covariates.

For my sex ratio variable, I incorporate the Sex Ratio Theory. This theory posits

that sex ratios affect men and women differently (See Figure 3.2). The hypothesis

purports that for women there is a linear relationship between the sex ratio and the

probability of mate selection (Guttentag & Secord, 1983) (Kiecolt & Fossett, 1995). That

is, when there is a high sex ratio environment (fewer females than males), then it is more

likely women will obtain a mate and marry (Guttentag & Secord, 1983) (Kiecolt &

Fossett, 1995) (Cox, 1940). However the lower the sex ratio environment (fewer males

than females), the less likely a woman is to obtain a mate and marry. In the latter

circumstance, women also tend to lose "bargaining power", placing themselves in risky

sexual situations (Guttentag & Secord, 1983) (Kiecolt & Fossett, 1995) (South & Trent,

1988) (Angrist, 2001) (Nathanson & Schoen, Liege, Belgium, IUSSP,1993). They are

more likely not to use condoms and be involved in sexual activities that are not healthy,

in order to assure that they can not only obtain a mate or sexual partner but keep their

mate in the presence of a male shortage (Guttentag & Secord, 1983) (Kiecolt & Fossett,

1995) (South & Trent, 1988).

For men, the Sex Ratio Theory predicts a different behavior pattern. It is

hypothesized that there is a curvilinear relationship between the sex ratio and the

probability of marriage and mate selection (Guttentag & Secord, 1983) (Kiecolt &

Fossett, 1995). In a high sex ratio environment, men are less likely to marry due to the

lack of potential mates (Guttentag & Secord, 1983) (Kiecolt & Fossett, 1995) (Cox,

1940). However, when the sex ratio is low, men are also less likely to marry and more

likely to obtain more casual mates due to the abundance of available companionship outside of a marriage (Guttentag & Secord, 1983) (Kiecolt & Fossett, 1995) (Cox, 1940). Consequently, men are more likely to acquire multiple sexual relationships (allowing for more risky sexual behavior) when the sex ratio is either high or low. This hypothesis also posits that men are more likely to marry when the sex ratio is approximately at unity (Guttentag & Secord, 1983).

As previously stated, an explanation for the contributing factors for disproportionate HIV rates affecting the African Americans community can be behavioral influences that are influenced by the sex ratio. Sex ratios are particularly low among African Americans in the U.S. The 2000 Census shows that throughout the United States for blacks over the age of 18, there are 85 males per 100 females compared to 94 males per 100 females, and 106 males per 100 females for whites and Hispanics, respectively (U.S. Census Bureau, 2004). Factors that could explain these differences include: disproportionate incarceration rates among African American males (Guttentag & Secord, 1983) (CDC, HIV and African Americans, 2007), low sex ratio at birth and high mortality rates for African American males (Guttentag & Secord, 1983) (CDC, HIV and African Americans, 2007), and differences in migration patterns of young African Americans (Guttentag & Secord, 1983) (Kiecolt & Fossett, 1995) (CDC, HIV and African Americans, 2007). Low sex ratios could therefore be an important contributor to HIV risk in African Americans.

MATERIALS AND METHODS

Study Population

Data were obtained from two sources: the Behavioral Risk Factor Surveillance System (BRFSS) and the U.S. Census Bureau (2000 Census). The Behavioral Risk Factor Surveillance System (BRFSS) is a continuous health survey system via telephone that has tracked health and risk behaviors throughout the United States each year since 1984 (CDC, Behavioral Risk Factor Surveillance System Survey Questionnaire). Data for this study was obtained from questionnaires administered as part of the 1998, 1999, 2000, 2001, & 2004 surveys. Each survey consists of Core Sections and Optional Modules. The Core Sections are a standard set of questions asked by all states. Optional Modules are sets of questions that cover additional health topics with more detailed questions on a health topic included in the core. Each state selects which optional modules will be included on their BRFSS questionnaire. The sexual behavior questions are part of an optional module, therefore they are only asked by states that elect to do so. The states incorporated into this analysis are Delaware, Florida, Maine, Minnesota, Montana, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, South Dakota, Tennessee, Texas, and Vermont. Data from years 2002 and 2003 are not included because there were no sexual behavior questions asked during those years. The BRFSS data also includes a weighing measure that was incorporated into my analysis. BRFSS data are weighted directly for the probability of selection of a telephone number, the number of telephones in a household, and the number of adults in a household (CDC, Behavioral Risk Factor Surveillance System Survey Questionnaire). A final poststratification adjustment was made for noncoverage and nonresponse of those

households without telephones (CDC, Behavioral Risk Factor Surveillance System Survey Questionnaire). The weights for each factor of relevance were multiplied together to get the final weight. County sex ratio data were obtained from the 2000 Census from Summary File 1 (SF1) (U.S. Census Bureau, 2004). SF1 data include the number of males per 100 females between the ages of 18 and 49 for each racial/ethnic group (U.S. Census Bureau, 2004).

Data Description

Outcome Variables

The outcome variable is risky sexual behavior. The indicator I use to measure risky sexual behavior is the number of sexual partners within the past year categorized as 0-1 vs. 2 or more and treated as a binomial variable. I dichotomized the variable because when examining the number of sexual partners as a continuous variable, it was highly skewed, with most participants reported having only one sexual partner within the past 12 months. Previous research has used a similar dichotomization (Dolcini, et al., 1993) (Finer, Darroch, & Singh, 1999).

Group-Level Variable

The number of males per 100 females (the sex ratio) for each county was obtained from the 2000 US Census separately for each racial/ethnic group. These ratios are obtained for persons between the ages of 18 and 49 in order to match the BRFSS data. A proportionate sex ratio is 90 to 110 (unity sex ratio), a disproportionate sex ratio is less than 90 (low sex ratio), or greater than 110 (high sex ratio).

Individual-level variables examined as covariates included: Education Status, Age, and Marital Status. A marker for individual SES was the level of education completed (less than or equal to grade 12 or GED, i.e., some high school vs. some college or greater), Age is examined as a continuous variable, and Marital Status is categorized (married, divorce/widowed/separated, never married, & a member of an unmarried couple). These covariates were included in the model because they are associated with both the exposure and the outcome variables.

Statistical Analysis

Data was analyzed using SAS version 9.1, SPSS 14.0, and HLM version 6.0. Multilevel analysis was used to account for the hierarchical structure of the data. Six two-level hierarchical models were used to determine the cross-sectional association between county-level sex ratios and the prevalence of risky sexual behavior for each race/ethnic group after accounting for individual-level covariates.

The level-1 (individual response) and level-2 (county response) models are shown below and contain a logistic outcome variable.

The level-1 model represents persons within counties:

Level 1:

$$\log\left(\frac{p_{ij}}{1-p_{ij}}\right) = b_{0j} + b_{1j}\sum_{i=1}^{n} EducationStatus_{ij} + b_{2j}\sum_{i=1}^{n} Age_{ij} + b_{3j}\sum_{i=1}^{n} MaritalStatus_{ij}$$

Where: P_{ij}: is the probability of risky sexual behavior for the ith person in county j

b_{0j}: is the expected log odds of risky sexual behavior for an ith

individual in county k when all covariates are 0

$$\sum_{i=1}^{3} b_{ij} \left| x_{ij} \right| \quad : \text{the sets of level-1 covariates}$$

The level 2 model represents counties and was modeled as follows:

Level 2: $\quad b_{0j} = \gamma_{00} + \gamma_{0j} \sum_{j=1}^{n} SexRatio_j + U_{0j} \qquad U_{0j} \sim N(0, \tau_{00})$

Where: $\qquad \gamma_{00}$: the average log-odds of risky behavior across counties

γ_{0j}: change in log-odds of intercept per change in Low or High Sex

Ratio vs. Unity Sex Ratio

U_{0j}: random effects of county j

Models were run stratified by *Race* (Whites, Blacks, and Hispanics) and *Sex*, totaling to 6 models (See Table 3.5a and 3.5b).

In addition to the full model described above, an unconditional model (FUM) was fitted to calculate the intraclass correlation (ICC), which determines whether there is significant variance in risky sexual behavior between counties (Raudenbush & Bryk, 2002). The ICC for a logistic model is defined below and τ_{00} is the variance of the random intercept in the FUM (Raudenbush & Bryk, 2002).

$$ICC = \frac{\tau_{00}}{\tau_{00} + \pi^2/3}$$

In order to examine the variance being explained by the county-level variable, I compared the τ_{00} of my "null" model (model with no variables) with τ_{00} from the model

that included the county-level variable to see the proportion of reduction in τ_{00}, and therefore how much variance was being explained by the sex ratio.

RESULTS

A total of 68,575 adults aged 18 and over responded to the BRFSS in the states and years in which the sexual activity questionnaire was administered[2]. Of these 57,250 had available information on the county of residence, of which 32,363 were between the ages of 18 and 49 and were asked the question on total number of partners. Of the 32,363 participants, there were 30,502 who were White, Black, and Hispanic. After merging the Census and BRFSS datasets and deleting persons whose counties had no sex ratio values (i.e., counties with zero males or females within that county), there were a total number of 30,061 observations. In order to eliminate counties with very unstable sex ratios, I excluded persons living in counties with less than 500 people of their race/ethnic group. This resulted in a total of 29,924 persons living in 290 counties for analysis (See Appendix A). When comparing the sample of 29,924 participants with those 30,502 participants, I observe similar characteristics in terms of similar trends in all demographics by race/ethnic group.

Table 3.1 displays individual-level characteristics. My study sample included 23203 whites, 3496 Blacks, and 3225 Hispanics. The mean age was 35.8 in Whites, 31 in Blacks, and 23.5 in Hispanics. Women were overrepresented in all groups: 42.4% of whites, 35.4% of Blacks and 42.4% of Hispanics were male. Whites were more likely

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[2] States: Delaware, Florida, Maine, Minnesota, Montana, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, South Dakota, Tennessee, Texas, & Vermont
     And
Years: 1998, 1999, 2000, 2001, & 2004

than Blacks or Hispanics to be in the higher educational categories: 37.2% of Whites are college graduates or higher compared to of 23.1% Blacks and 17.2% of Hispanics; 32 % of whites had complete HS or less compared to 46.7% of Blacks and 57.3% of Hispanics. Whites and Hispanics were more likely to be married than Blacks (56.9%, 34.2% and 50.1% were married for Whites, Blacks and Hispanics, respectively). For all racial groups, most participants have had only one sexual partner within the past 12 months (62.2%, 54.2%, and 57.3% for Whites, Blacks, and Hispanics, respectively). The second highest percent had no partners (10.8%, 14.7%, and 9.3% for Whites, Blacks, and Hispanics, respectively).

Table 3.2 shows sex ratios and numbers of BRFSS respondents for the counties included in the analyses. There are a total of 290 counties represented in the data, with a median number of 62.5 persons per county. All 290 counties had sex ratio data for whites; 182 had sex ratio data for Blacks and 170 had sex ratio data for Hispanics. The median sex ratio was close to 1 for Whites and Hispanics (99.5 for Whites and 105.5 for Hispanics) but was substantially lower in Blacks (84.4).

Table 3.3 shows the distribution of counties and persons by categories of the sex ratio, low (<0.9), unity (0.9-1.1), and high (>1.1). The Black population has the largest low sex ratio environment, with significantly more counties having fewer males than females as compared to Whites and Hispanics; whereas, the majority of counties for Whites and Hispanics has sex ratio environments that are of unity and high.

Table 3.4 shows the distribution of the outcome by categories of county sex ratio after excluding those who had a response of 'didn't know' and were missing for the outcome. These are the numbers that are used for the final analysis. I did compare those with

'don't know', 'missing', and 'refused' with my sample of participants, and there is no apparent difference between the two groups in terms of age, sex, education, and marital status.

When examining the relationship between sex ratio category and number of partners (Figure 3.3 and Table 3.4), I expected to see a low sex ratio environment being associated with an increase in the number of partners in both males and females. I also expected that a high sex ratio environment would be associated with an increase in the number of partners in male participants. In males of all race/ethnic groups, there was evidence of greater number of sexual partners at lower compared to higher values of the sex ratio. However these differences were only statistically significant in Hispanics (although the chi-square may be invalid in this group due to low cell counts). The hypothesized increase in sexual partners at higher levels of the sex ratio was not observed. No consistent associations were observed in females.

Individual-Level Predictors of Number of Sexual Partners

When examining the associations between risky sexual behavior and demographic characteristics, I observed patterns similar to those shown in previous research (See Table 3.5a & 3.5b). For both males and females of all racial groups, there is an association between risky sexual behavior and age. For White males, the odds of risky sexual behavior decreased 2% for every one year increase in age; whereas the odds of risky sexual behavior decreased 5% for Black and Hispanic males for every one year increase in age. For females, the odds of risky sexual behavior decreased 5%, 10%, and 4% for every one year increase in age for Whites, Blacks, and Hispanics, respectively.

Education was not significantly associated with the odds of risky sexual behavior. In contrast the odds of 2 or more partners varied substantially across categories of marital status.   The odds of having more than one sexual partner were far greater for formerly married and never married couples than those who were married for each race/ethnicity. It is also interesting to note that members of an unmarried couple had higher odds of risky sexual behavior than members of a married couple, although this association did not hold in Black females.

Sex Ratio as a Predictor of Number of Sexual Partners in Males

For males, the Sex Ratio Theory suggests a curvilinear relationship between the sex ratio and risky sexual behavior for males of each race/ethnic group. Instead, my results revealed a linear trend. In White and Hispanic males, a low sex ratio environment (more females than males) was associated with greater odds of having 2 or more sexual partners within the past 12 months compared to none or 1 partner (odds ratios of 2 or more sexual partners for low sex ratio vs. unity sex ratio 1.9 and 1.3 for whites and Hispanics respectively).. That is, persons living in counties with where the sex ratio is low have higher odds of having 2 or more partners than those persons living in counties with a sex ratio at unity. When there is a high sex ratio environment (more males than females), then the odds ratios of having 2 or more sexual partner compared to none or 1 partner are 0.9 and 0.8 for whites and Hispanics, respectively. That is, persons living in counties with a high sex ratio have odds of having 2 or more partners lower than those persons living in counties with a sex ratio at unity. With the exception of the low sex ratio environment in whites, differences were not statistically significant.   However for Black males, both a low and high sex ratio environment were associated with lower odds

of having 2 or more partners compared to a unity sex ratio environment, with only a high sex ratio environment being statistically significant.

Sex Ratio as a Predictor of Number of Sexual Partners in Females

The female population also shows trends different from those hypothesized. The linear relationship is the opposite of what the Sex Ratio Theory hypothesizes. For all race/ethnic groups, there is a pattern of a low sex ratio environment having lower odds of 2 or more partners compared to none or 1 partner than when the sex ratio is at unity. When there is a high sex ratio environment, the odds of 2 or more partners is higher. None of the results for females were statistically significant; therefore, I was not seeing any significant differences in number of partners across categories of the sex ratio environment.

Variance Components

The ICC values for each race/ethnicity and sex in the model with no covariates were: White Males 0.072, Black Males 0.169, Hispanic Males 0.181, White Females 0.141, Black Females 0.144, and Hispanic Females 0.167. In the full model, the ICCs were: White Males 0.095, Black Males 0.163, Hispanic Males 0.145, White Females 0.120, Black Females 0.139, and Hispanic Females 0.188. The addition of the sex ratio variable to a model with the individual-level covariates reduced the between county variance by 0.6 % in Black Males, 3.6% in Hispanic Males, 2.1% in White Females, and 0.5% in Black Females. There were some increases: 2.3% in White Males and2.1% in Hispanic Females, which leads us to believe that the sex ratio is not contributing much to the between county variance for these race and sex groups. However, previous work

acknowledges the questionability of whether ICC estimates should be performed in logistic multilevel models, because correlation coefficients are difficult to interpret for a dichotomous variable (Twisk, 2006).

DISCUSSION

Sex Ratio Trends

As predicted by the Sex Ratio Theory, I expected to find strong relationships between sex ratios and risky sexual behavior in my population. However, my results did not completely follow the Sex Ratio Theory predictions. Figure 3.4 displays the trends of the results that I observed. For males, I did find an association between greater risky sexual behavior and living in a county with low sex ratios in White and Hispanic populations, after controlling for individual-level characteristics. For Black males, this association was not found. The expected curvilinear trend posed by the Sex Ratio Theory did not hold. Instead, I observed a linear trend for White and Hispanic males. Although Black males did have this curvilinear trend, it was in the opposite direction of what the Theory suggested. Although my analysis did not follow the trend that the Sex Ratio Theory entirely, in White and Hispanic men there still seems to be more risky sexual behavior in counties when there is a low sex ratio environment as compared to counties with a unity sex ratio environment. When there is a high sex ratio environment, there appears to be less risky sexual behavior than when there is a unity sex ratio environment.

I documented a linear trend for females that was inconsistent with the direction of the Sex Ratio Theory. For Black and Hispanic females, there appears to be more risky sexual behavior in counties with higher sex ratio environment as compared to counties

with lower sex ratio environments; in contrast White females engaged in more risky sexual behavior in counties with both low and high sex ratios.

One explanation for the patterns that I observed is a recent hypothesis, the Alternative Sex Ratio Mate Preference Shift Hypothesis that was derived from the Sex Ratio Theory (Stone, Shackelford, & Buss, 2007). The Alternative Sex Ratio Mate Preference Shifts Hypothesis predicts that in lower sex ratio societies, men will lower their standards to secure more short-term mating, whereas women will raise their standards to avoid deception by men seeking short-term relationships. Thus the Alternative Sex Ratio Mate Preference Shift Hypothesis predicts that for males a low sex ratio environment is associated with greater number of partners whereas the opposite is true for females (See Figure 5) (Stone, Shackelford, & Buss, 2007).

The primary reason for this gender difference is the difference in male's and female's parental investment. Males are less likely to have parental obligations than females (Stone, Shackelford, & Buss, 2007), and therefore, are more likely to seek short-term, casual sex with a number of partners when the sex ratio is low (Buss & Schmitt, 1993), (Stone, Shackelford, & Buss, 2007). In a low sex ratio environment males are more likely to obtain more mates to fulfill their desires for casual sex (Stone, Shackelford, & Buss, 2007). Therefore, males lower their standards and increase rates of promiscuity (Stone, Shackelford, & Buss, 2007). In contrast, females are less likely to obtain casual sex partners, leading to a shift in the 'bargaining power' in favor of the female. When there is a low sex ratio environment, females are more likely to be selective in their mate choice due to having more parental obligation than males (Stone, Shackelford, & Buss, 2007).   Also when looking for a mate, females tend to carefully

scrutinize a male's probable level of commitment and are more aware of males seeking short-term relationships; and therefore they will be more likely to increase their standards (Brizendine, 2006), (Stone, Shackelford, & Buss, 2007). For males, the relationship between the sex ratio and number of partners is in the opposite direction as for females (Stone, Shackelford, & Buss, 2007). That is when there is a low sex ratio environment, males are more likely to obtain more mates to fulfill their desires for casual sex (Stone, Shackelford, & Buss, 2007). Therefore, males lower their standards and increase rates of promiscuity (Stone, Shackelford, & Buss, 2007). The Alternative Sex Ratio Mate Preference Shifts Hypothesis does not state anything regarding a high sex ratio environment.

Results partly follow the trend of the Alternative Sex Ratio Mate Preference Shifts Hypothesis. For example, results for White and Hispanic males correspond with the predictions of the Alternative hypothesis; whereas, Black males did not. The pattern for Blacks males was an inverted U shape which did not correspond with the classic hypothesis either. For females, both Blacks and Hispanics correspond with the Alternative hypothesis trend; whereas White females followed an entirely different trend. For White females, I find a curvilinear trend in which both low and high sex ratio environments are associated with high risk and an unity environment is associated with low risk behavior.

However, there still may be situations when the classic Sex Ratio Theory holds. For instance, differences in culture and traditions could affect the relationship between the sex ratio and risky behavior. Also, previous research has shown that the effects of the sex ratio are influenced by the degree of development of a country (Stone, Shackelford,

& Buss, 2007). I must keep in mind that the patterns that I observed were not statistically significant so further studies are needed to determine whether the patterns I observed are real.

Racial/Ethnic Differences in Sexual Behavior

There appears to be different trends in the pattern of risky sexual behavior and the sex ratio by race/ethnicity. For males, Whites and Hispanics followed a negative linear trend between the sex ratio and risky sexual behavior; while Blacks followed an inverted U shape.   For females, Whites followed a positive curvilinear trend between the sex ratio and risky sexual behavior; while Blacks and Hispanics followed a positive linear trend. I expected to find similar trends in all populations, which would lead us to believe that if there was a comparable situation for the Whites and Hispanics population as that of Blacks, then they would expect to see similar trends in behavior. However these differences across race/ethnic groups in the association between the sex ratio and the outcomes were not statistically significant (See Appendix B). Further research is needed to truly understand whether sex ratio effects of sexual behavior truly differ by race or ethnicity.

There are some limitations to my study. There is a concern with measurement error when dealing with self-reporting questionnaires, especially with the topic of sex. Consideration must go into how truthful individuals are, and to the fact that individuals may select not to answer certain questions related to sexual behavior because of the perception that goes along with certain sexual questions. This could also vary by sociodemographic factors, such as age, race, and gender. Therefore, misclassification of outcome status could have resulted in biased results. This misclassification is unlikely to

be differential by sex ratio categories, and although the direction of the resulting bias is impossible to predict with certainty, it most likely resulted in bias towards the null.

Another issue posed is whether counties are appropriate units for analyzing the effects of sex ratio. Persons may not select mates exclusively within counties so these may not be the most meaningful units. Another issue posed is whether counties are appropriate units for analyzing the effects of sex ratio. However, the sex ratio at the state level does not provide enough variance, and the census tract level provides too much variance which can lead to bias. Also, prior work has examined the sex ratio for relatively large areas including cities and metropolitan areas. Identifying the reference groups within which persons select mates would allow a better characterization of the sex ratios relevant to sexual behaviors.

I examined race-specific sex ratios which assume that everyone chooses a mate within their own race/ethnic group. This could affect my results since I was not looking across racial groups. This may also leads to bias towards the null because I am misspecifying the sex ratio people are exposed to by only focusing on their own race/ethnic group. However previous research has shown that Blacks are more likely to be in a relationship with other Blacks compared to Whites and Hispanics (Laumann & Youm, 1999).

While there is no one gold standard for measuring risky sexual behavior, this study uses the number of sexual partners within the past 12 months. This is the same outcome variable and measurement that previous studies have used. Future work needs to be done to find a more refined approach to measuring sexual behavior.

A concern is the low cell counts within my Hispanic study population. The analysis may not depict accurate results for this particular group. More work needs to be done in the Hispanic population, due to the fact that behavioral risk factors for HIV infection differ by country of birth, and particular cultural beliefs can affect risky behavior, as well (Sabogal, Faigeles, & Catania, 1993).

I investigated associations of both individual-level and county level variables (the sex ratio) with risky sexual behavior. This is one of the first studies to examine the effects of the sex ratio in a multilevel analysis. Overall, I did not find the expected trends in the relation of risky sexual behavior and the sex ratio. However, the study has suggested that the Alternative Sex Ratio Mate Preference Shifts Hypothesis may be more valid than the traditional Sex Ratio Hypothesis. I also suggest that this same study be done with a larger sample size, and more examination of counties with high sex ratio environment.

Figure 3.1: Conceptual Framework for each Race and Gender
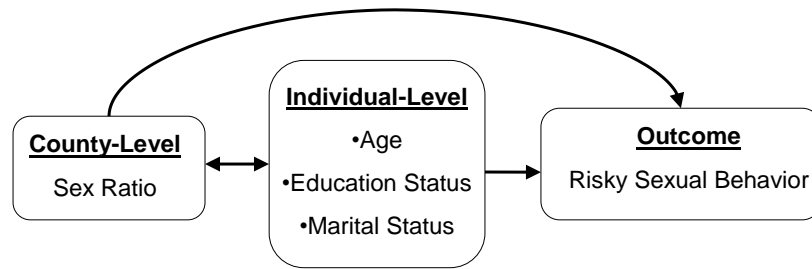
Figure 3.2: Hypothesized relationships between Sex Ratio and number of sexual partners by Gender

For Women

For Men
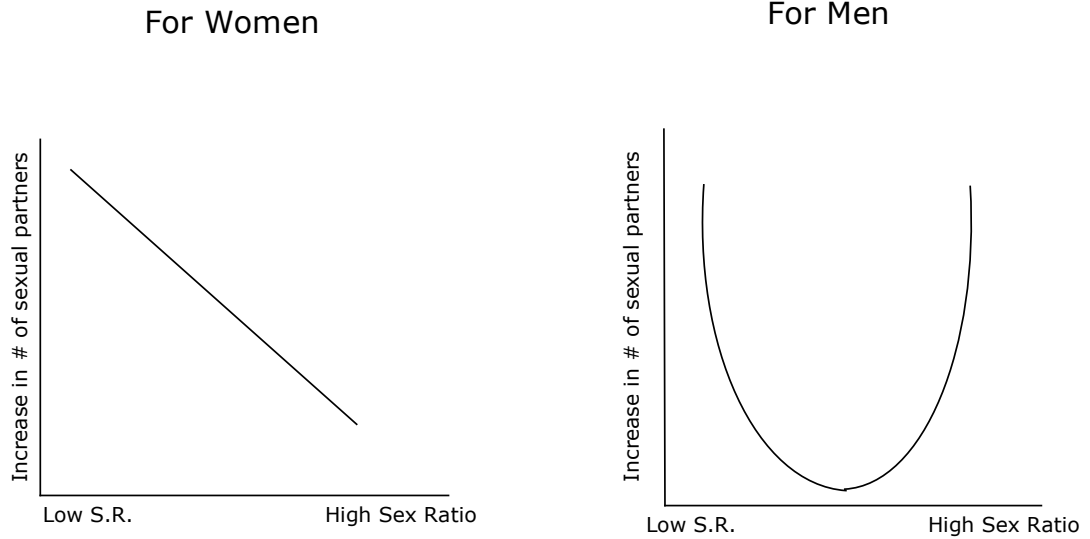
Figure 3.3: Distribution of number of sexual partners by race and gender
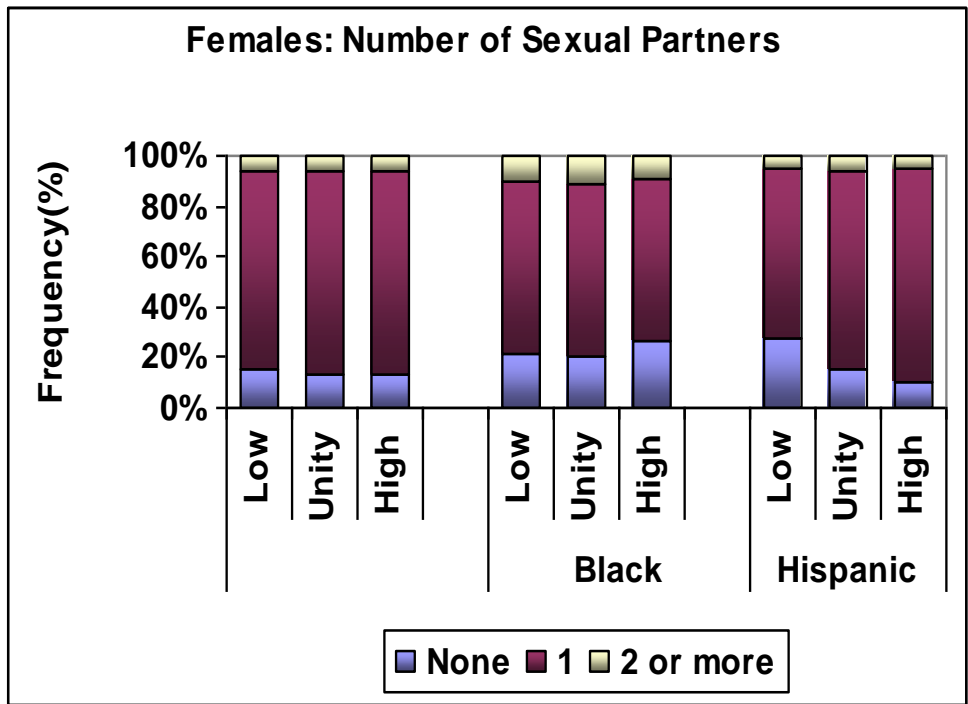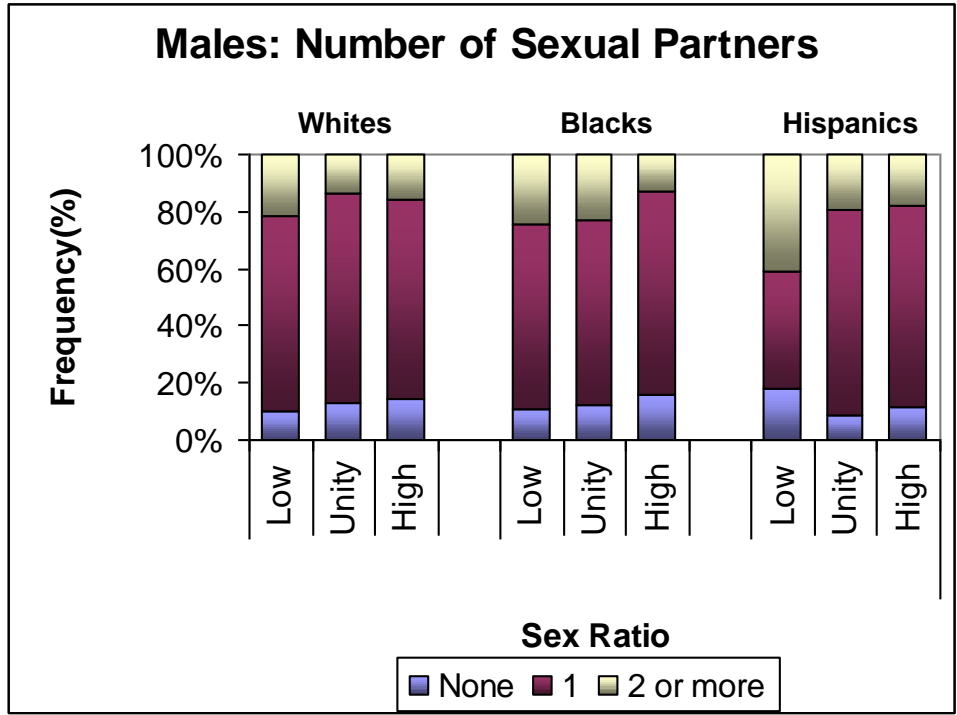
Figure 3.4: Graphic trends of low risk vs. high risk sexual behavior by county level sex ratios*

For Males   For Females

Whites
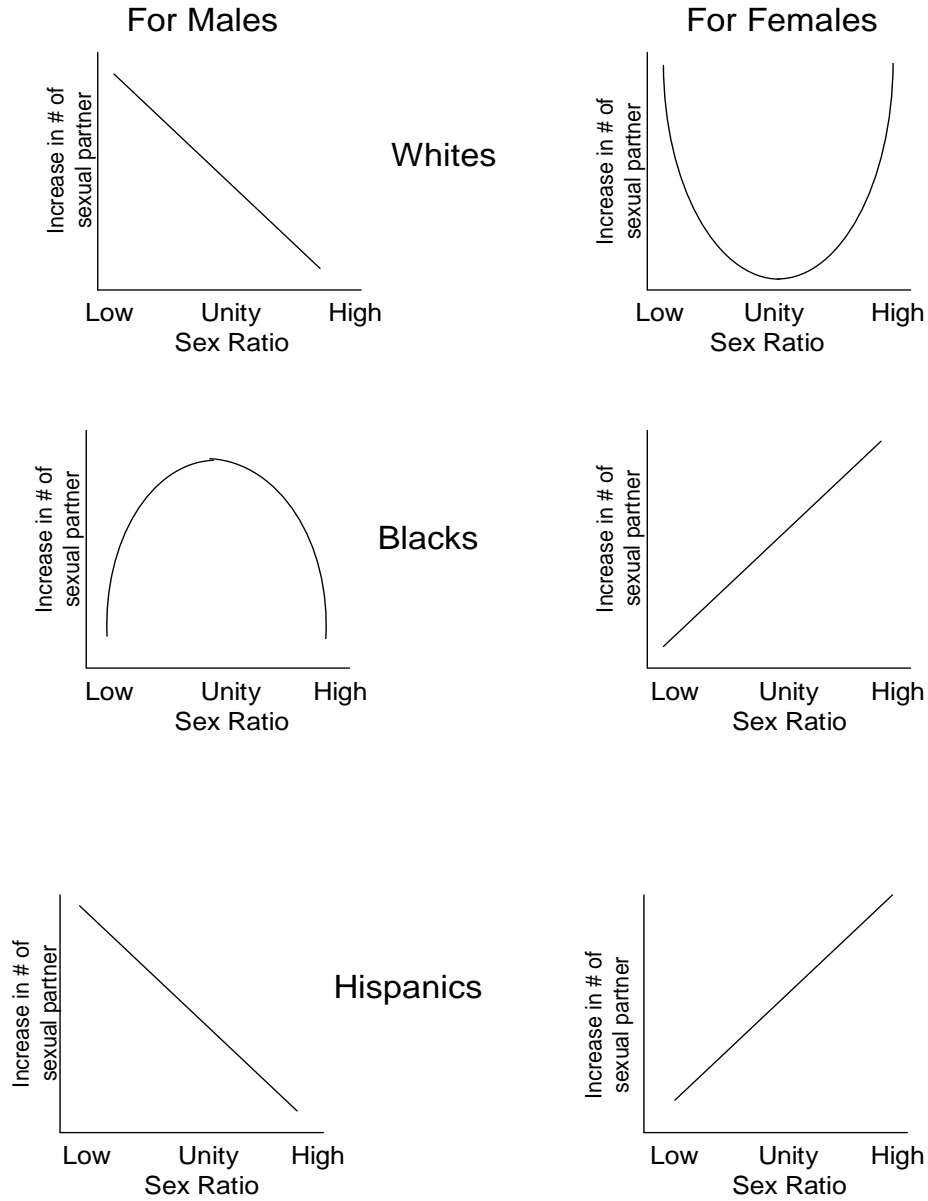
Blacks

Hispanics

*Graphs not to scale of actual values

Figure 3.5: Graphic trend of the Alternative Sex Ratio Mate Preference Shift Hypothesis
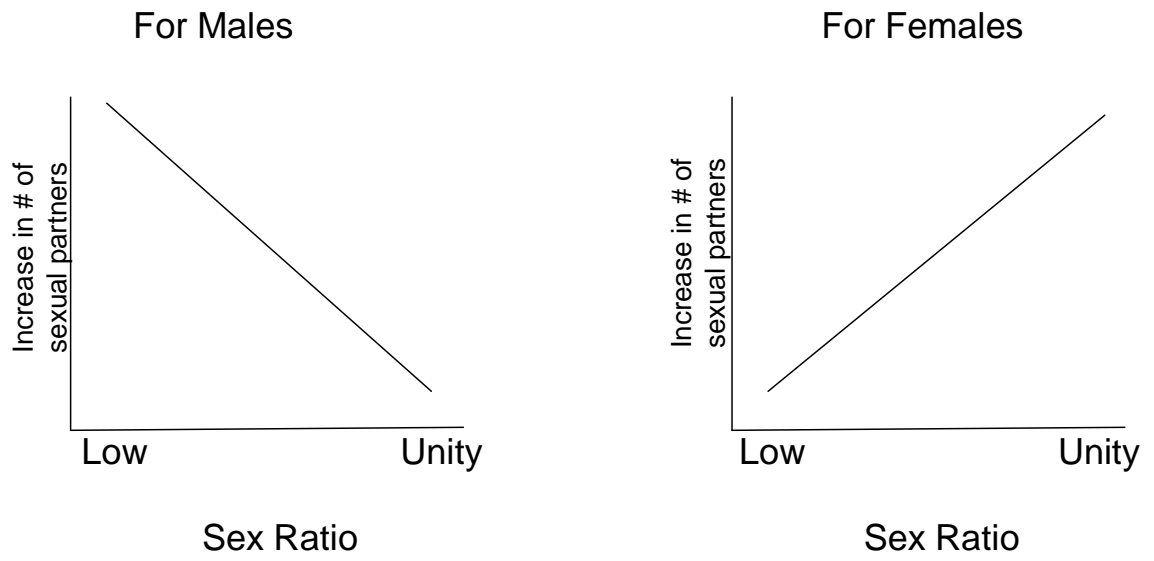
Table 3.1: Individual-Level Characteristics by Race

	White	Black	Hispanic	Total (N)
Total (N)	23203	3496	3225	29924
Frequency Percentages (%)				
Age				
18-29	22.9	27.4	33.9	7370
29-40	38.2	38.6	40.7	11529
40-50	38.9	34	25.4	11025
Sex				
Male	42.4	35.4	42.4	12437
Education Status				
Less than High School	4.8	9.6	27.5	2329
Grade 12 or GED	27.2	37.1	29.8	8563
Some college	30.8	30	25.3	9011
College Grad or higher	37.2	23.1	17.2	9983
Refused	0.1	0.1	0.2	38
Marital Status				
Married	56.9	34.2	50.1	16006
Divorced/Separated	15.8	18.7	15	4806
Widowed	1	1.8	1.1	339
Never Married	23	42.2	25.7	7637
Unmarried couple	3.1	2.9	8.1	1089
Refused	0.2	0.3	0.1	47

Number of Sexual Partners

	White	Black	Hispanic	P Value
Frequency Percentages (%)				<0.0001
None	10.8	14.7	9.3	
1	62.2	54.2	57.3	
2	4	6.5	4.3	
3 or more	3.7	5.6	4.4	
Don't know/Not sure	0.1	0.5	0.4	
Refused	3.7	5.4	3.9	
Missing	15.6	13.3	20.5	

Table 3.2: County-Level Characteristics

Number of counties			Number of people per county		
Total		290	Total	Mean	103.2
			n=290	25%	35
				Median	62.5
Sex Ratio				75%	135
White	Mean	100.4	White	Mean	80
N=290	25%	97.2	n=290	25%	28
	Median	99.5		Median	47.5
	75%	101.2		75%	101
Black	Mean	89.2	Black	Mean	19.2
N=176	25%	82	n=176	25%	3
	Median	84.43		Median	9
	75%	92.1		75%	25
Hispanic	Mean	117.6	Hispanic	Mean	17.2
N=170	25%	98.2	n=170	25%	3
	Median	105.5		Median	7
	75%	121.2		75%	18.5

Table 3.3 Distribution of Counties and Persons by Categories of Sex Ratio [3]

	Low (<0.9)	Unity(0.9-1.1)	High (>0.1)	Total
Whites				
Counties	2	271	17	290
%	0.7	93.5	5.9	
Persons	210	17730	751	18691
%	1.1	94.9	4	
Blacks				
County	86	66	30	176
%	47.3	36.3	16.5	
Persons	1936	737	155	2828
%	68.5	26.1	5.4	
Hispanics				
County	4	64	120	170
%	2.1	34	63.8	
Persons	39	1576	820	2435
%	1.6	64.7	33.7	

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[3] Restricting to counties with more than 500 people for Blacks and Hispanics

Table 3.4: Number of partners by sex ratio category for men and women of the three race/ethnic groups

White					Black					Hispanic[4]				
Male					*Male*					*Male*				
	Low	*Unity*	*High*	*P Value*		*Low*	*Unity*	*High*	*P Value*		*Low*	*Unity*	*High*	*P Value*
Total n	88	7475	315		Total %	640	276	71		Total %	17	653	377	
% distribution														
None	10.2	13.1	14.3		None	10.9	12.3	15.5		None	17.7	8.6	11.4	
1	68.2	73.3	70.2		1	64.5	64.9	71.8		1	41.2	72.1	70.3	
2 or more	21.6	13.7	15.6	0.266	2 or more	24.6	22.9	12.6	0.311	2 or more	41.2	19.3	17.8	0.012
Female					*Female*					*Female*				
	Low	*Unity*	*High*	*P Value*		*Low*	*Unity*	*High*	*P Value*		*Low*	*Unity*	*High*	*P Value*
Total n	132	10255	436		Total %	1296	461	84		Total %	22	923	443	
% distribution														
None	15.2	13.6	13.5		None	21.9	20	26.2		None	27.3	15.7	10.6	
1	78.8	80.1	79.8		1	68	68.8	64.3		1	68.2	78.4	84.7	
2 or more	6.1	6.3	6.6	0.894	2 or more	10.1	11.2	9.5	0.625	2 or more	4.6	5.9	4.7	0.06

84

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[4] Due to low cell counts for the Hispanic population, Chi-square may not be valid test

Table 3.5a: Male odds ratios of 2 or more partners (vs. 1 or less) by county level sex ratio and individual level characteristics

	White Males			Black Males			Hispanic Males		
	OR	CI	P	OR	CI	P	OR	CI	P
Low	1.9	(1.12,3.22)	0.02	0.8	(0.40,1.59)	0.45	1.3	(0.82,1.75)	0.21
Unity	1			1			1		
High	0.8	(0.64,1.12)	0.24	0.3	(0.14,0.88)	0.02	0.8	(0.41,1.42)	0.44
Age	0.98	(0.96,0.99)	0	0.9	(0.91,0.99)	0.005	0.9	(0.88,1.02)	0.09
$\leq$ Grade 12/GED	0.87	(0.68,1.13)	0.3	0.4	(0.18,0.89)	0.03	0.7		0.46
Some College	0.67	(0.51,0.88)	0.005	0.5	(0.18,1.19)	0.11	1.9	(0.52,1.89)	0.35
College Grad or Higher	1			1			1		
Divorce, Widowed, or Separated	29.4	(19.48,44.48)	0	18.0	(8.48,38.18)	0	6.4	(1.32,23.67)	0.01
Never Married	26.6	(17.47,40.38)	0	10.1	(5.40,18.77)	0	6.5	(2.42,14.48)	0
Member of an Unmarried Couple	10.4	(5.32,20.35)	0	20.1	(5.13,78.45)	0	4.3	(1.40,10.57)	0
Married	1			1			1		
τ_{00}	0.344			0.643			0.556		
Null Model	0.254			0.667			0.729		

Table 3.5b: Female odds ratios of 2 or more partners (vs. 1 or less) by county level sex ratio and individual level characteristics

	White Females			Black Females			Hispanic Females		
	OR	CI	P	OR	CI	P	OR	CI	P
Low	12	(0.76,1.82)	0.46	0.9	(0.48,1.66)	0.71	0.5	(0.22,1.21)	0.13
Unity	1			1			1		
High	1.5	(0.89,2.39)	0.13	1.1	(0.33,3.92)	0.83	1.3	(0.57,2.93)	0.54
Age	0.95	(0.93,0.97)	0	0.9	(0.86,0.94)	0	0.97	(0.92,1.01)	0.25
$\leq$ Grade 12/GED	1.02	(0.63,1.64)	0.94	0.7	(0.39,1.43)	0.37	1.1	(0.28,3.95)	0.94
Some College	1.2	(0.74,2.03)	0.43	0.5	(0.24,1.13)	0.10	2.0	(0.47,8.42)	0.35
College Grad or Higher	1			1			1		
Divorce, Widowed, or Separated	16.4	(10.13,26.49)	0	8.03	(2.28,28.28)	0	22.9	(6.13,85.16)	0
Never Married	11.3	(7.18,17.70)	0	4.2	(1.17,15.40)	0.03	26.7	(6.70,92.32)	0
Member of an Unmarried Couple	4.3	(2.27,8.13)	0	0.9	(0.14,5.35)	0.88	7.0	(1.53,32.34)	0.01
Married	1			1			1		
τ_{00}	0.449			0.529			0.760		
Null Model	0.542			0.553			0.659		

Appendix A:

Full BRFSS for the 15 States	
There are a total **68575** observations	
After excluding missing and unknown counties, the number of observations dropped to **57250**	
Excluding based on Age	
Total Number of Partners	32363
Excluding based on Age and Race	
Total Number of Partners	30502
Those who Answered & Don't know/not sure	24529
Those who Refused	1200
Those Missing	4773
After Merging the Census and BRFSS Datasets and deleting those excluded observations with no sex ratios, there are a total number of **30061** observations	
After restricting counties for Black and Hispanics to those with more than 500 people of their respective population, the final number used was **29924**	

Appendix B:

I performed a likelihood ratio test (LRT) in which I examined a pooled model (i.e., a model with race and sex ratio and a model with race and sex ratio interaction). When testing the LRT, the sex ratio was estimated as a continuous variable. Since my outcome was a Bernoulli distribution, an EM Laplace was used to compute a maximum likelihood estimate. The interaction model was tested against the model without interactions, and the chi-square was not statistically significant.

Chi-square statistic = 0.5507   DF = 2   P-value = >.500

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Chapter 4

Race/Ethnic Differences and Risky Sexual Behavior

"Racial residential segregation and poverty. Two things most Americans
would rather not think about." - Stephen Merino

As previously discussed in Chapter 1, racial and ethnic minority populations,
along with women have been disproportionately affected by the HIV epidemic. Previous
work has identified a number of factors that may contribute to the disproportionate HIV
burden among race and ethnic minorities in the transmission dynamics of the infection,
and the availability of early diagnosis and treatment (Finer, Darroch, & Singh, 1999)
(Adimora & Schoenback, 2005). These factors include low socioeconomic status (SES),
lower sex ratio, demographic factors, and neighborhood environment (Finer, Darroch, &
Singh, 1999) (Adimora & Schoenback, 2005). Behavioral factors such as the number of
sexual partners an individual has, cultural beliefs, condom use, and the type of
intercourse may also affect rates and disparities (Finer, Darroch, & Singh, 1999). Most
importantly, the extent of these factors may be determined by the environment in which
the individuals live. Therefore, the increase in risky sexual behavior in blacks is not

because they are black. It is due in large to the environment and opportunities allotted to them.

Previous research has shown large differences in risky sexual behavior by race (Laumann & Youm, 1999) (Poundstone, Strathdee, & Celentano, 2004) (Adimora & Schoenback, 2005). A number of factors including differences in SES and in features of living environments may contribute to these race/ethnic differences. Blacks and Hispanics often have lower SES than whites. Lower SES is frequently linked to poorer education, and these individuals with lower levels of education participate in more risky behavior (Lantz, et al., 2001). Lower SES has also been shown to be associated with risky behavior due to limited or poor access to resources, lack of knowledge, and poor medical access (Beggs, Villemez, & Arnold, 1997). Also, population groups with similar SES share similar social/sexual networks, and because of this, they may share similar risky behavior patterns which can lead to increased rates of HIV infection.

Persons of different race/ethnic groups also live in very different environments (Garofalo & Fogarty, 1979) (Beggs, Villemez, & Arnold, 1997) (Grant & Parcel, 1990) (Tienda & Lii, 1987) (Williams & Collins, 2001). For example in the United States, Blacks and Hispanics are more likely to live in disadvantaged and predominantly same-race neighborhoods, and may be more likely to live in areas with more segregation and lower SES (Garofalo & Fogarty, 1979) (Beggs, Villemez, & Arnold, 1997) (Grant & Parcel, 1990) (Tienda & Lii, 1987) (Williams & Collins, 2001). Differences in distribution of racial groups over space, known as racial residential segregation, may contribute to risky sexual behavior. Increased white_black residential segregation produces areas with higher concentration of poverty that are more likely to have higher

rates of HIV infection than those with lower poverty (Laumann & Youm, 1999) (Poundstone, Strathdee, & Celentano, 2004). Within these higher poverty areas, which tend to be Black communities, come less resources, restricted medical access, and reduced awareness of existing programs; therefore, contributing to more risky behavior (Laumann & Youm, 1999) (Poundstone, Strathdee, & Celentano, 2004). These higher levels of poverty are not due to of lack of income but to three aspects: discrimination, public policy, and prejudice (Martin & Yaquinto, 2007). For these reasons individuals who live in highly segregated areas tend to have higher risky sexual behavior.

Poverty rates are different by race/ethnicity, and are associated with differences if health outcomes. In the United States, poverty affects a considerable number of people, and has been racialized (Hartman & Bradley, 1997). Although poverty rates have declined over time, they continue to be substantially higher in Blacks and Hispanics than in whites (See Figure 4.1) (Besharov, 2007). In 2007, the Census Bureau announced that a total of 12.5% people lived in poverty, including 10.5% of Whites, 24.5% of Blacks, and 21.5% of Hispanics (DeNavas-Walt, Proctor, & Smith, 2008). As previously discussed, areas of poverty are less likely to have access health care, information, education, and political power (Krieger, 2002) (Lewandowski, 2008). Gillies et al., ask whether AIDS is a disease of poverty. They discuss social and economic factors that contribute to increases in HIV/AIDS rates throughout the country (Gillies, Tolley, & Wolstenholme, 1996). Although the paper mostly focuses on countries other than the U.S., this question also need to be considered within the US.

The sex ratio may also contribute to differences in risky sexual behavior by race. The Sex Ratio Theory purports that when there is a high sex ratio environment (fewer

females than males), then it is more likely women will obtain a mate and marry

(Guttentag & Secord, 1983) (Kiecolt & Fossett, 1995) (Cox, 1940). However the lower

the sex ratio environment (fewer males than females), the less likely a woman is to obtain

a mate and marry. Sex ratios are particularly low among American Blacks, with the U.S.

2000 Census showing that for blacks over the age of 18, there are 85 males per 100

females compared to 94 males per 100 females, and 106 males per 100 females for whites

and Hispanics, respectively (U.S. Census Bureau, 2004).

Within these low sex ratio environments, women tend to lose "bargaining power",

placing themselves in risky sexual situations (Guttentag & Secord, 1983) (Kiecolt &

Fossett, 1995) (South & Trent, 1988) (Angrist, 2001) (Nathanson & Schoen, Liege,

Belgium, IUSSP,1993). They are more likely not to use condoms and be involved in

sexual activities that are not healthy, in order to assure that they can not only obtain a

mate or sexual partner but keep their mate in the presence of a male shortage (Guttentag

& Secord, 1983) (Kiecolt & Fossett, 1995) (South & Trent, 1988). A low sex ratio may

therefore be associated with unhealthy sexual behavior including large numbers of sexual

partners.

In the United States, factors that contribute to the differences in the sex ratio in

Blacks compared to Whites and Hispanics include: disproportionate incarceration rates

among African American males (Guttentag & Secord, 1983) (CDC, HIV and African

Americans, 2007), low sex ratio at birth and high mortality rates for African American

males (Guttentag & Secord, 1983) (CDC, HIV and African Americans, 2007), and

differences in migration patterns of young African Americans (Guttentag & Secord,

1983) (Kiecolt & Fossett, 1995) (CDC, HIV and African Americans, 2007).   Low sex

ratios could therefore be an important contributor to sexual behavior in African Americans.

These county characteristics along with SES may contribute to race/ethnic differences in sexual behavior – that is, I would expect to see similar behaviors in all populations if they were comparable in these factors. This study will examine if race differences (stratified by gender) in risky sexual behavior are due to race differences in living environments as reflected in SES and county characteristics. I hypothesize that racial/ethnic differences in risky behaviors will be reduced after controlling for individual-level SES, county-level segregation, poverty and sex ratio.

Conceptual Framework

My study examines whether county-level factors, sex ratio, percent below poverty, racial residential segregation, contribute to race/ethnic difference in risky sexual behavior at the individual-level by different racial group when stratified by sex (See Figure 4.2). As in the previous chapters, I define counties at the group-level; and individual-level variables: race/ethnicity and socioeconomic status (SES), with age and marital statue being included as covariates.

For each sex, my study will first fit a model with a race variable only and then add age and marital status for each sex. I will then examine how the race coefficient changes as I add: (1) individual-level SES and (2) the county level variables one at a time and then all variables together. The reductions in the coefficient for race will indicate the possible magnitude of the contribution of individual-level SES and county-level factors to these differences.

MATERIALS AND METHODS

Study Population

Data were obtained from three sources: the Behavioral Risk Factor Surveillance System (BRFSS), Population Studies Center (PSC), and the U.S. Census Bureau (2000 Census). The Behavioral Risk Factor Surveillance System (BRFSS) is a continuous health survey system via telephone that has tracked health and risk behaviors throughout the United States each year since 1984 (CDC, Behavioral Risk Factor Surveillance System Survey Questionnaire, 1998, 1999, 2000, 2001, 2004). Data for this study was obtained from questionnaires administered as part of the 1998, 1999, 2000, 2001, & 2004 surveys. Each survey consists of Core Sections and Optional Modules. The Core Sections are a standard set of questions asked by all states. Optional Modules are sets of questions that cover additional health topics with more detailed questions on a health topic included in the core. Each state selects which optional modules will be included on their BRFSS questionnaire. The sexual behavior questions are part of an optional module, therefore they are only asked by states that elect to do so. The states incorporated into this analysis are Delaware, Florida, Maine, Minnesota, Montana, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, South Dakota, Tennessee, Texas, and Vermont. Data from years 2002 and 2003 are not included because there were no sexual behavior questions asked during those years. The BRFSS data also includes a weighing measure that was incorporated into my analysis. BRFSS data are weighted directly for the probability of selection of a telephone number, the number of telephones in a household, and the number of adults in a household (CDC, Behavioral Risk Factor Surveillance System Survey Questionnaire, 1998, 1999, 2000,

2001, 2004). A final poststratification adjustment was made for noncoverage and nonresponse of those households without telephones (CDC, Behavioral Risk Factor Surveillance System Survey Questionnaire, 1998, 1999, 2000, 2001, 2004). The weights for each factor of relevance were multiplied together to get the final weight. County percent below poverty data were obtained from the 2000 Census from Summary File 4 (SF4) (U.S. Census Bureau, 2004). SF4 data is based on a sample of the population with information on the population and housing data (U.S. Census Bureau, 2004).

The Population Studies Center (PSC) at the University of Michigan has generated racial residential segregation indexes for all counties, states, metropolitan areas, and cities of 100,000 or more with the use of information from the 2000 Census (Reynolds). Racial residential segregation can be characterized using 5 geographic pattern measures: isolation, dissimilarity (or evenness), centralization, clustering, and concentration of 2 or more racial groups (Massey & Denton, 1988) (Reynolds) (Acevedo-Garcia, Lochner, Osypuk, & Subramanian, 2003). For my study I use the most common measure, the index of dissimilarity, which is a measurement of the 'evenness' in which two racial groups are distributed across a particular geographic area that is a part of a larger area (Reynolds). The index ranges from 0 (even distribution of 2 races across an area) to 100 (complete segregation of 2 races across an area) (Reynolds).

Data Description

Outcome Variables

The outcome variable is the same as Chapter 2 and 3 – that is the number of sexual partners within the past 12 months. It will be computed the same way as the 2

previous Chapters. The models will also follow the general structure noted for Chapters 2 and 3.

Group-Level Variable

The three group-level variables are racial residential segregation, poverty, and the race-specific sex ratio. Racial residential segregation is defined by the index of dissimilarity for Blacks vs. whites, poverty is defined by the percent below poverty, and the sex ratio is defined as the race-specific number of males per 100 females (the sex ratio) for each county. All data were obtained from the Year 2000 US Census.

Additional Variables

Individual-level variables examined as covariates included: Race, Age, Sex, Education Status, and Marital Status. The racial groups I am examining are (Blacks (Non-Hispanic), Whites (Non-Hispanic), Hispanic). A marker for individual SES was the level of education completed (less than HS, grade 12 or GED, some college, and college grad or higher), Age is examined as a continuous variable, and Marital Status is categorized (married, divorce, widowed/separated, never married, and a member of an unmarried couple).

Statistical Analysis

Data was analyzed using SAS version 9.1, SPSS 14.0, and HLM version 6.0. Multilevel analysis was used to account for the hierarchical structure of the data. The two-level hierarchical models were used to determine the cross-sectional association for each sex between county-level factors and the prevalence of risky sexual behavior after accounting for individual-level covariates.

The level-1 (individual response) and level-2 (county response) models are shown below and contain a logistic outcome variable. These models will be stratified by sex.

My first models will consist of individual-level variables only:

$$\log\left(\frac{p_i}{1-p_i}\right) = b_o + b_1 \sum_{i=1}^{n} Race_i$$

and

$$\log\left(\frac{p_i}{1-p_i}\right) = b_0 + b_1 \sum_{i=1}^{n} Race_i + b_2 \sum_{i=1}^{n} Age_i + b_3 \sum_{i=1}^{n} MaritalStatus_i$$

I will then examine how the race coefficient changes as I add:

(1) individual-level SES (ignoring the *j*s)

$$\log\left(\frac{p_{ij}}{1-p_{ij}}\right) = b_{0j} + b_{1j} \sum_{i=1}^{n} Race_{ij} + b_{2j} \sum_{i=1}^{n} Age_{ij} + b_{3j} \sum_{i=1}^{n} EducationStatus_{ij} + b_{4j} \sum_{i=1}^{n} MaritalStatus_{ij}$$

(2) the county level variables (including the *j*s)

$$b_{oj} = \gamma_{0j} \sum_{j=1}^{n} Re\,sSeg_j + \gamma_{0j} \%BelowPov_j + \gamma_{0j} \sum_{j} SexRatio_j + U_{0j} \quad U_{0j} \sim N(0, \tau_{00})$$

RESULTS

A total of 68,575 adults aged 18 and over responded to the BRFSS in the states and years in which the sexual activity questionnaire was administered[5]. Of these, 57,250 had available information on the county of residence, of which 32,363 were between the ages of 18 and 49 and were asked the question on total number of partners. Of the 32,363

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[5] States: Delaware, Florida, Maine, Minnesota, Montana, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, South Dakota, Tennessee, Texas, & Vermont
    And
Years: 1998, 1999, 2000, 2001, & 2004

participants, there were 30,434 who were White, Black, and Hispanic. After merging the PRC, Census, and BRFSS datasets, there were a total number of 30,061 observations in 290 counties for analysis.

Table 4.1 displays individual-level characteristics. My study sample included 23203 Whites, 3524 Blacks, and 3334 Hispanics. In my study, the mean age was 35.8 in Whites, 31 in Blacks, and 23.5 in Hispanics as compared to 36.6 of the U.S. population from the 2000 census (U.S. Census Bureau, 2004). Women were overrepresented in all groups: 42.4% of whites, 35.5% of Blacks and 42.6% of Hispanics were male. Whites were more likely than Blacks or Hispanics to be in the higher educational categories: 37.2% of Whites are college graduates or higher compared to of 23.2% Blacks and 17.4% of Hispanics; 32 % of whites had only complete HS or less compared to 46.6% of Blacks and 57.1% of Hispanics. Whites and Hispanics were more likely to be married than Blacks (56.9%, 34.2% and 50.4% were married for Whites, Blacks and Hispanics, respectively). For all racial groups, most participants have had only one sexual partner within the past 12 months (62.2%, 54.2%, and 57.5% for Whites, Blacks, and Hispanics, respectively). The second highest percent had no partners (10.8%, 14.7%, and 9.2% for Whites, Blacks, and Hispanics, respectively).

Table 4.2 shows the distribution of the index of dissimilarity, percent below poverty and sex ratio within my study and numbers of BRFSS respondents for the counties included in the analyses. There are a total of 290 counties represented in the data, with a median number of 62.5 persons per county. The White BRFSS participants represented 290 counties. Black participants were drawn from 202 counties and Hispanic participants were drawn from 237 counties. The median county dissimilarity index was 38.7 for

Whites, 44.1 for Blacks, and 39.8 for Hispanics; the median county % below poverty was 11.85 for Whites, 12.1 for Blacks, and 11.9 for Hispanics; and the median county sex ratio was 99.5 for Whites, 84.43 for Blacks, and 105.5 for Hispanics.

Table 4.3 shows the distribution by persons of different race/ethnic groups by number of sexual partners, and county residential segregation, poverty, and sex ratio. In men, Blacks and Hispanics were more likely than Whites to have two or more sexual partners. In women, Blacks had more sexual partners than Whites but Hispanics had less. Blacks and Hispanics were also more likely than Whites to live in higher residential segregation, higher poverty neighborhoods. A higher percent of Whites and Hispanics lived in unity sex ratio environments; whereas a higher percent of Blacks lived in a low sex ratio environment.

Racial Differences in the Number of Sexual Partners for Males

In Table 4.4a, I examine the association of race/ethnicity with the number of sexual partners for males. The odds of having 2 or more sexual partners were approximately twice as high in Blacks and Hispanics compared to Whites (OR=2.04;*P*=<0.001 and OR =2.01;*P*=<0.001, respectively). When I adjust for individual age and marital status, the odds ratio for Blacks and Hispanics versus Whites decreased slightly to 1.78 for Blacks and 1.77 for Hispanics but remained statistically significant. When education status was included, there was a marginal increase in the odds ratio for Blacks and Hispanics (compared to Whites), and the differences remained statistically significant (OR 1.81 and 1.78, respectively).

I then included the 3 county-level variables first one at a time and then in the same model. In general odds ratios were not substantially modified from the model

106

with only individual-level characteristics. The odds ratio of 2 or more sexual partners were 1.86 (CI: 1.31,2.64) for Blacks and 1.75 (CI:1.20,2.54) for Hispanics when all individual and county level variables were in the model.

Racial Differences in the Number of Sexual Partners for Females

In Table 4.4b, I examine the associations of race/ethnicity with the number of sexual partners for females. The odds of having 2 or more sexual partners was higher in Blacks compared to Whites (OR=1.45;*P*=<0.001) and the odds of having 2 or more sexual partners was lower in Hispanics compared to Whites (OR =0.68;*P*=<0.001). When I adjust for individual age and marital status, the odds ratio for Blacks versus Whites decreased to 1.03 whereas, the odds ratio for Hispanics versus Whites decreased to 0.52 and remained statistically significant (*P*=<0.001). For Black females, there was a small marginal change in the OR of two or more partners which dropped below 1 when all group variables were in the models; however, the association was not statistically significant. Overall, odds ratios for Blacks and Hispanics vs. Whites were not substantially modified after additional adjustment for education or the three county-level variables separately or in combination.

Discussion

My study showed that racial differences in the odds of having two or more sexual partners only changed when age and marital status were added to the model. In men this reduced the odds ratio, although it remained elevated in Blacks and Hispanics compared Whites. In women, the race difference between Blacks and whites disappeared when age and marital status were accounted for. Hispanic women had lower odds of 2 or more

sexual partners than white women in all models regardless of the adjustment variables and the association became more strongly protective after adjustment for age and marital status.

Why do we not see important changes in the race differences when individual SES and the county level measures are included? There is great debate regarding the use of education status as a proxy for SES (Campbell, 1983) (Rose, Pevalin, & Elias, 2001) (Winkleby, Jatulis, Frank, & Fortmann, 1992). Previous work has suggested that using one SES proxy may be insufficient to adjust for SES (Winkleby, Jatulis, Frank, & Fortmann, 1992). The implications of education for income may differ by race/ethnicity so education may be insufficient to capture SES differences (Braveman, Cubbin, Marchi, Egerter, & Chavez, 2001). For my study, I only investigated education as an SES marker due to the large number of missing data for the income variable. Better measures of socioeconomic conditions are needed in order to fully explore the contributions of SES to race differences (Oakes & Rossi, 2003).

I expected to see a significant decrease in the odds ratios associated with race when county measures were incorporated into the model. However a possible reason for not seeing this trend could be measurement error in group-level variables. The county level variables I included may not be the most relevant ones. In addition the county may not be the most important geographic context to investigate. More refined measures of context perhaps for smaller spatial scales may be relevant to sexual behaviors. Counties may be too heterogeneous to capture meaningful social exposures. For example different race/ethnic groups may live in very different sections of a county, so the overall county

measure may not capture the relevant exposures. Overall, more work needs to be done to examine the effects of group-level variables on individual behavior.

I had strong reason to expect race differences to be reduced after accounting for poverty and residential segregation. The community environment and resources or lack of resources associated with it can influence sexual behavior for different racial groups. For example, differences in access to traditional socioeconomic resources, most frequently measured by socioeconomic status (SES) is likely to influence sexual decision making and behavior. Most notably the influence of poverty may profoundly impact the sexual behaviors of those living in its grip. Although there are more impoverished Whites than Blacks in the United States, impoverished Whites are more likely to be residentially located near non-impoverished Whites, while Blacks, more often than not, live in the most residentially segregated communities with extreme poverty levels with little access to only a few health-related resources (Williams & Collins, 2001) (Wilson, 1987). This segregation of Blacks is highly prominent, and they are the only immigrant population that has experienced very extreme levels of segregation within the United States (Williams & Collins, 2001). County segregation was associated with sexual behavior in the expected direction but did not explain much of the race difference perhaps because by being a county level variable it does not fully capture the implications of segregation for whites and blacks within counties.

Prior research has shown that the characteristics of small areas or neighborhoods are associated with behaviors and other health-related outcomes (Laumann & Youm, 1999) (Poundstone, Strathdee, & Celentano, 2004). Areas with higher concentration of poverty are more likely to have higher rates of infection than those with lower poverty

(Laumann & Youm, 1999) (Poundstone, Strathdee, & Celentano, 2004). With higher poverty rates come less resources, restricted medical access and reduced awareness of existing programs; therefore, contributing to more risky behavior (Laumann & Youm, 1999) (Poundstone, Strathdee, & Celentano, 2004). Although I found that poverty was positively associated with number of partners the race difference was not substantially modified after poverty adjustment perhaps because county poverty is not the appropriate indicator.

I also expected associations of race with number of sexual partners to be reduced after adjustment for the sex ratio can also affect a community's sexual interactions. These relationships may be stronger in communities segregated by race/ethnicity and SES. Where a person lives, how racially segregated and impoverished a community is can play a role in the social and sexual networks within that community. However I did not see much of an effect of sex ratio, perhaps because the county-level was not the appropriate level of measurement for this variable.

Other contextual variables may be more relevant than the ones I examined in explaining race/ethnic differences in sexual behavior. Laumann and Youn discuss the differences in sexual networks between different race/ethnicity groups (Laumann & Youm, 1999). They first divide the population into three different sexual groups: peripherals (persons who only had one sexual partner in the past 12 months), adjacents (those who have had two or three sexual partners in the past 12 months), and core members (those who have had four or more sexual partners in the past 12 months) (Laumann & Youm, 1999). They show that although black peripherals only have had one sexual partner within the past 12 months, they are 5 times more likely and 4 times

more likely to have a partner who is in the core group than whites and Hispanics

peripherals, respectively (Laumann & Youm, 1999). Since the core is considered a

higher risky sexual group, then I would expect to see higher rates of HIV infection within

the black population (Laumann & Youm, 1999). Also, blacks are more likely to be in a

relationship with other blacks compared to whites and Hispanics, therefore increasing the

likelihood of obtaining a partner from the core group (Laumann & Youm, 1999).

Adimora and Schoenback also show that there are different concurrency rates between

races, in which concurrent sexual partnership overlap in time (Adimora & Schoenback,

2005). African Americans tend to have more concurrent partners than do whites.

Unfortunately my data did not allow examination of these detailed sexual network

measures.

Besides the limitations discussed in Chapters 2 and 3, an important limitation in

this study is the use of the number of sexual partners as the single measure of sexual

behaviors. Other measures such as condom use may be more relevant measure; however,

I could not investigate that with these data due to the small number of participants who

answered that question.

The overall lower ORs for Hispanic women compared to white women needs

additional study. Due to the clumping together of different Hispanic cultures, I am not

able to decipher and pinpoint the exact reason for the lower odds when compared to

Whites.

Overall, I found that race differences in sexual behavior were reduced when I

adjusted for marital status and age. However, I did not find a substantial effect of

adjustment for racial residential segregation, % below poverty, or the sex ratio at the

county level. Race/ethnic differences in sexual behavior and the factors that may explain then need to be investigated with other dataset using alternative measures of sexual behavior and more appropriate measures of contextual variables. Future work is needed to better understand the processes through which group-level variables may affect racial differences in sexual behavior.

Figure 4.1: Poverty Rates by Race/Ethnicity (1959-2006)
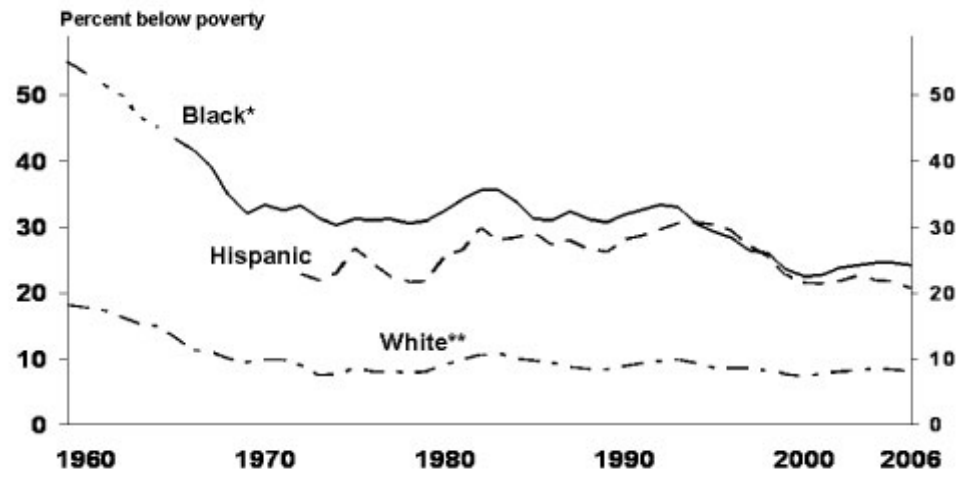
SOURCE: Author's calculations based on U.S. Census Bureau, Current Population Survey (CPS), various years. *Figures for blacks between 1960 and 1965 are interpolated. **Including white Hispanics between 1959 and 1972.

Figure 4.2: Conceptual Framework for both Males and Females
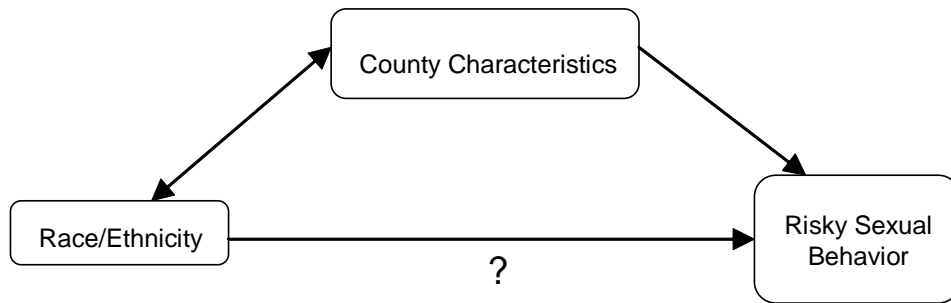
Table 4.1: Individual-Level Characteristics by Race

	White	*Black*	*Hispanic*
Total (N)	23202	3524	3334
Frequency Percentages (%)			
Age			
18-29	22.9	27.6	33.8
29-40	38.2	38.6	40.6
40-50	38.9	33.9	25.6
Sex			
Male	42.4	35.5	42.6
Education Status			
Grade 12/GED or Less	32	46.6	57.1
Some college	30.8	30.1	25.3
College Grad or higher	37.2	23.2	17.4
Refused	0.1	0.1	0.2
Marital Status			
Married	56.9	34.2	50.4
Divorced/Separated	15.7	18.6	14.8
Widowed	1	1.8	1.1
Never Married	23	42.2	25.6
Unmarried couple	3.1	2.9	8
Refused	0.2	0.3	0.1

Number of Sexual Partners

	White	*Black*	*Hispanic*
Frequency Percentages (%)			
None	10.8	14.7	9.2
1	62.2	54.2	57.5
2	4	6.5	4.3
3 or more	3.8	5.6	4.5
Don't know/Not sure	0.1	0.5	0.4
Refused	3.7	5.4	3.8
Missing	15.6	13.3	20.3

Number of Sexual Partners (0, 1, & 2 or more only)

	White	*Black*	*Hispanic*
	N = 18701	N=2846	N=2517
Frequency Percentages (%)			
None	13.40	18.24	12.24
1	77.16	66.94	76.16
2 or more	9.44	14.83	11.60

Table 4.2: County-Level Characteristics of participants in the sample

Counties	Number of participants per county *Mean/Median* *25th-75th percentile*	County Characteristics of group variable *Mean/Median* *25th-75th percentile*		
		Residential Segregation	% Below Poverty	Sex Ratio
Total (n=290)	103.2/62.5 35-135	--		
Counties with White BRFSS participants (n=290)	80/47.5 28-101	41.3/38.7 28.9-52.5	12.96/11.85 9.4-14.9	100.4/99.5 97.2-101.2
Counties with Black BRFSS participants (n=202)	17.4/7.5 2--23	89.2/44.1 82-56.8	12.61/12.1 9.4-15	89.2/84.43 82-92.1
Counties with Hispanic BRFSS participants (n=237)	14.1/4 2-14	42.9/39.8 29.7-54.9	12.91/11.9 9.4-15	117.6/105.5 28.2-121.2

Table 4.3: Distribution by Sex of Persons by Categories of Residential Segregation,

Race, and Number of Partners

Males							
	Whites(n)	*%*	*Blacks(n)*	*%*	*Hispanics(n)*	*%*	*P*
# sexual partners							
None	1031	*13.09*	116	*11.66*	104	*9.60*	
One	5759	*73.10*	649	*65.23*	767	*70.82*	
Two or more	1088	*13.81*	230	*23.12*	212	*19.58*	<.0001
Residential Segregation							
0-35	3347	*34.96*	325	*23.88*	479	*31.91*	<.0001
36-59	4647	*48.53*	617	*45.33*	599	*39.91*	<.0001
60-100	1581	*16.51*	419	*30.79*	423	*28.18*	<.0001
Poverty							
≤10.99	5447	*56.89*	564	*41.44*	451	30.05	
11-20.99%	3807	*39.76*	724	*53.20*	864	*57.56*	
≥21%	321	*3.35*	73	*5.36*	186	*12.39*	
							<.0001
Sex ratio							
Low	90	*0.94*	872	*64.07*	59	*3.93*	
Unity	9100	*95.04*	385	*28.29*	797	*53.10*	
High	385	*4.02*	104	*7.64*	645	*42.97*	
							<.0001

117

Table 4.3(con't): Distribution by Sex of Persons by Categories of Residential

Segregation, Race, and Number of Partners

Females

	Whites(n)	%	Blacks(n)	%	Hispanics(n)	%	P
# Sexual Partners							
None	1475	*13.63*	403	*21.77*	204	*14.23*	
One	8670	*80.11*	1256	*67.86*	1150	*80.20*	
Two or more	678	*6.26*	192	*10.37*	80	*5.58*	<.0001
Residential Segregation							
0-35	4781	*36.12*	525	*22.56*	544	*28.30*	<.0001
36-59	6288	*47.50*	1029	*44.22*	753	*39.18*	<.0001
60-100	2169	*16.38*	773	*33.22*	625	*32.52*	<.0001
Poverty							
≤10.99	7457	*56.33*	839	*36.06*	520	*27.06*	
11-20.99%	5362	*40.50*	1292	*55.52*	1082	*56.30*	
≥21%	419	*3.17*	196	*8.42*	320	*16.65*	
							<.0001
Sex Ratio							
Low	140	*1.06*	1639	*70.43*	93	*4.84*	
Unity	12580	*95.03*	578	*24.84*	1118	*58.17*	
High	518	*3.19*	110	*4.73*	711	*36.99*	
							<.0001

Table 4.4a: Male odds ratios of 2 or more partners (vs. 1 or less) by county-level variables and individual level characteristics

	Race Only				add Age and Marital				add Education		
	OR	CI	P		OR	CI	P		OR	CI	P
Black	2.04	(1.94,2.15)	<.0001	Black	1.78	(1.68,1.87)	<.0001	Black	1.81	(1.72,1.92)	<.0001
Hispanic	2.01	(1.92,2.12)	<.0001	Hispanic	1.77	(1.68,1.86)	<.0001	Hispanic	1.78	(1.69,1.88)	<.0001
White	1			White	1			White	1		
				Age	0.97	(0.967,0.97)	<.0001	Age	0.97	(0.96,0.97)	<.0001
				Divorced	16.59	(15.35,17.93)	<.0001	Divorced	17.62	(16.30,19.05)	<.0001
				Widowed	16.81	(15.15,18.65)	<.0001	Widowed	17.79	(16.03,19.76)	<.0001
				Never Married	14.37	(13.45,15.36)	<.0001	Never Married	14.8	(13.85,15.82)	<.0001
				Member of an unmarried couple	8.10	(7.34,8.93)	<.0001	Member of an unmarried couple	8.34	(7.56,9.20)	<.0001
				Married	1			Married	1		
								Grade12 or Less	0.81	(0.77,0.85)	<.0001
								Some College	0.62	(0.59,0.65)	<.0001
								Grad or Higher	1		

Table 4.4a (Continue): Male odds ratios of 2 or more partners (vs. 1 or less) by county-level variables and individual level characteristics

With Res Seg only	OR	CI	P	with Poverty only	OR	CI	P	with Sex Ratio only	OR	CI	P	add All groups	OR	CI	P
Black	1.89	(1.33,2.70)	0.001	Black	1.87	(1.32,2.64)	0.001	Black	1.90	(1.34,2.69)	0.001	Black	1.86	(1.31,2.64)	0.001
Hispanic	1.78	(1.23,2.57)	0.002	Hispanic	1.75	(1.22,2.53)	0.003	Hispanic	1.78	(1.24,2.55)	0.002	Hispanic	1.75	(1.20,2.54)	0.004
White	1			White	1			White	1			White			
Age	0.97	(0.95,0.99)	0.001	Age	0.97	(0.95,0.99)	0.001	Age	0.97	(0.95,0.99)	0.001	Age	0.97	(0.95,0.98)	0.001
Divorced	17.88	(11.53,27.72)	0	Divorced	17.83	(11.51,27.61)	0	Divorced	17.85	(11.52,27.64)	0	Divorced	17.81	(11.55,27.45)	0
Widowed	18.42	(9.28,36.58)	0	Widowed	18.28	(9.18,36.39)	0	Widowed	18.41	(9.30,36.44)	0	Widowed	18.24	(9.35,37.92)	0
Never Married	14.61	(9.60,22.25)	0	Never Married	14.62	(9.64,22.17)	0	Never Married	14.64	(9.65,22.23)	0	Never Married	14.49	(9.58,21.92)	0
Member of an unmarried couple	8.61	(5.08,14.61)	0	Member of an unmarried couple	8.56	(5.08,14.44)	0	Member of an unmarried couple	8.59	(5.07,14.54)	0	Member of an unmarried couple	8.55	(5.10,14.34)	0
Married	1			Married	1.00			Married	1.00			Married			
Grade12 or Less	0.83	(0.63,1.10)	0.19	Grade12 or Less	0.82	(0.63,1.08)	0.16	Grade12 or Less	0.82	(0.63,1.08)	0.16	Grade12 or Less	0.83	(0.63,1.10)	0.19
Some College	0.63	(0.44,0.89)	0.01	Some College	0.62	(0.44,0.88)	0.01	Some College	0.62	(0.44,0.88)	0.01	Some College	0.63	(0.44,0.88)	0.01
Grad or Higher	1			Grad or Higher	1			Grad or Higher	1			Grad or Higher	1		
Residential Segregation				Below Poverty				Sex Ratio				Residential Segregation			
0-35	1			10% Below	1.10	(0.90,1.35)	0.36	Low	1.48	(0.67,3.26)	0.33	0-35	1		
36-59	1.37	(1.06,1.79)	0.02					Unity	1			36-59	1.43	(1.08,1.82)	0.31
60-100	1.29	(0.92,1.81)	0.15					High	0.97	(0.73,1.29)	0.83	60-100	1.29	(0.93,1.80)	0.12
												10% Below Poverty	1.12	(0.93,1.48)	0.31
												Low	1.93	(0.81,3.84)	0.12
												Unity	1		
												High	1.05	(0.67,1.56)	0.8

Table 4.4b: Female odds ratios of 2 or more partners (vs. 1 or less) by county-level variables and individual level characteristics

Race Only	OR	CI	P	add Age and Marital	OR	CI	P	add Education	OR	CI	P
Black	1.45	(1.39,1.51)	<.0001	Black	1.03	(0.99,1.08)	0.12	Black	1.05	(1.01,1.10)	0.02
Hispanic	0.68	(0.64,0.72)	<.0001	Hispanic	0.52	(0.49,0.55)	<.0001	Hispanic	0.54	(0.51,0.57)	<.0001
White	1			White	1			White	1		
				Age	0.94	(0.94,0.94)	<.0001	Age	0.94	(0.94,0.94)	<.0001
				Divorced	17.83	(16.70,19.05)	<.0001	Divorced	18.04	(16.89,19.27)	<.0001
				Widowed	12.91	(11.93,13.97)	<.0001	Widowed	13.18	(12.18,14.27)	<.0001
				Never Married	11.06	(10.41,11.75)	<.0001	Never Married	11.00	(10.35,11.68)	<.0001
				Member of an unmarried couple	4.29	(3.88,4.74)	<.0001	Member of an unmarried couple	4.33	(3.92,4.79)	<.0001
				Married	1			Married	1		
								Grade12 or Less	0.89	(0.85,0.93)	<.0001
								Some College	1.03	(0.99,1.08)	0.16
								Grad or Higher	1		

Table 4.4b (Continue): Female odds ratios of 2 or more partners (vs. 1 or less) by county-level variables and individual level characteristics

add Segr

	OR	CI	P
Black	1.01	(0.65,1.57)	0.95
Hispanic	0.53	(0.33,0.85)	0.01
White	1		
Age	0.94	(0.91,0.96)	<.0001
Divorced	18.17	(11.03,29.95)	<.0001
Widowed	13.26	(6.93,25.38)	<.0001
Never Married	11.13	(7.41,16.73)	<.0001
Member of an unmarried couple	4.37	(2.37,8.09)	<.0001
Married	1		
Grade12 or Less	0.90	(0.62,1.32)	0.60
Some College	1.03	(0.68,1.57)	0.89
Grad or Higher			
Residential Segregation			
0-35	1		
36-59	1.22	(0.932,1.605)	0.15
60-100	1.23	(0.932,1.612)	0.14

add Poverty

	OR	CI	P
Black	0.99	(0.63,1.57)	0.98
Hispanic	0.52	(0.31,0.85)	0.01
White	1		
Age	0.94	(0.92,0.96)	<.0001
Divorced	18.16	(11.02,29.95)	<.0001
Widowed	13.19	(6.88,25.31)	<.0001
Never Married	11.18	(7.43,16.82)	<.0001
Member of an unmarried couple	4.39	(2.39,8.10)	<.0001
Married	1		
Grade12 or Less	0.90	(0.62,1.31)	0.59
Some College	1.03	(0.68,1.55)	0.90
Grad or Higher	1		
10% Below Poverty	1.13	(0.93,1.38)	0.21

add Sex Ratio

	OR	CI	P
Black	1.02	(0.66,1.57)	0.93
Hispanic	0.53	(0.33,0.85)	0.01
White	1		
Age	0.94	(0.92,0.96)	<.0001
Divorced	18.21	(11.05,30.01)	<.0001
Widowed	13.27	(6.94,25.38)	<.0001
Never Married	11.22	(7.44,16.91)	<.0001
Member of an unmarried couple	4.38	(2.38,8.09)	<.0001
Married	1		
Grade12 or Less	0.90	(0.61,1.32)	0.58
Some College	1.03	(0.68,1.56)	0.91
Grad or Higher			
Sex Ratio			
Low	1.01	(0.80,1.26)	0.96
Unity	1		
High	1.12	(0.80,1.56)	0.52

add All groups

	OR	CI	P
Black	0.99	(0.62,1.56)	0.95
Hispanic	0.51	(0.31,0.85)	0.01
White	1		
Age	0.94	(0.92,0.96)	<.0001
Divorced	18.11	(10.98,29.86)	<.0001
Widowed	13.16	(6.86,25.23)	<.0001
Never Married	11.12	(7.41,16.69)	<.0001
Member of an unmarried couple	4.39	(2.38,8.11)	<.0001
Married	1		
Grade12 or Less	0.90	(0.62,1.32)	0.6
Some College	1.03	(0.68,1.56)	0.89
Grad or Higher	1.00		
Residential Segregation			
0-35	1		
36-59	1.27	(0.97,1.68)	0.09
60-100	1.24	(0.94,1.64)	0.13
10% Below Poverty	1.14	(0.93,1.39)	0.2
Low	1.22	(0.91,1.64)	0.18
Unity	1		
High	1.18	(0.84,1.65)	0.34

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Chapter 5

CONCLUSION

Explanation for the ongoing increase in HIV infections have focused largely on individuals and their sexual behavior. While individual sexual behavior does contribute to the epidemic, understanding the determinants of this behavior needs more attention. Previous research has shown that patterns in the structure of relationships affect the distribution of HIV risk (Sevgi, 1996). The geographic area where one lives provides the social/sexual context that can influence HIV risk within that area. Therefore, the importance of examining population or community aspects is needed along with individual factors. I have found that potential influential community aspects that can contribute to risky sexual behavior are racial residential segregation, sex ratios, and percent below poverty.

Summary of Findings

Chapter 2 (Specific Aim 1). To examine the associations of county-level white/black residential segregation (stratified by race/ethnicity) with individual-level risky sexual behavior, while controlling for individual-level characteristics.

In Chapter 2, I was able to confirm the expected relationship between risky sexual behavior and racial residential segregation. Not all results were statistically

significant possibly due to small sample sizes in some populations. Segregation is an indicator of inequality in society, and can have behavioral consequences for both advantaged and disadvantaged groups through a number of social mechanisms operating between group and within groups. I showed that increased segregation within an area leads to greater risk of sexual behavior participation, due to the potential of direct or indirect interaction of people of higher risk with all people throughout the area.

In general, the results from this chapter are consistent with effects of segregation on economic, educational, and health resources, resulting in fewer health resources, poorer quality medical care, and limited safe sex knowledge and access in disadvantaged and segregated groups. This lack of appropriate resources is associated with increased chance of higher risky behavior.

Chapter 3 (Specific Aim 2). To examine the effects of imbalanced sex ratios on risky sexual behavior. In particular, I examined the multilevel associations of county sex ratios (stratified by race/ethnicity and gender) with risky sexual behavior at the individual-level, while controlling for individual-level characteristics.

In Chapter 3, I investigated associations of both individual-level and county-level variables (the sex ratio) with risky sexual behavior. Overall, I did not find the expected trends in the relation of risky sexual behavior and the sex ratio. However, the findings supported the Alternative Sex Ratio Mate Preference Shifts Hypothesis over the more conventional Sex Ratio Hypothesis. I also suggest that this same study be done with a larger sample size of Blacks and Hispanics and more examination of counties with high sex ratio environments.

Chapter 4 (Specific Aim 3). To examine how the county-level socioenvironmental characteristics investigated in prior chapters as well as county poverty rates contribute to race/ethnic differences in risky behavior. Specifically, I observed whether county-level factors, sex ratio, percent below poverty, racial residential segregation, contribute to race/ethnic difference in risky sexual behavior at the individual-level among men and women.

In Chapter 4, I found that race differences in sexual behavior were reduced when I adjusted for marital status and age. However, I did not find a substantial effect of adjustment for racial residential segregation, % below poverty, or the sex ratio at the county level. Race/ethnic differences in sexual behavior and the factors that may explain them need to be investigated with other dataset using alternative measures of sexual behavior and more appropriate measures of contextual variables. Future work is needed to better understand the processes through which group-level variables may affect racial differences in sexual behavior.

Limitations and recommendations for future research

Generalizability

There may be a problem with generalizability, since BRFSS data used for all chapters were collected via cross sectional telephone survey. There may be concern with people willing to participate in the survey and answer questions honestly. There may also be coverage limitations when using data from standardized surveillance systems in terms of whether certain subgroups (i.e., persons with cellular phones only) are excluded systematically, and therefore the ability to generalize from my sample to the general population and to certain subgroups may be limited. Other work recommends using

cellular phone random-digit-dialed (RDD) surveys in order to be able to generalize to those other target populations (Delnevo, Gundersen, & Hagman, 2007). Despite its limitations however the BRFSS is the largest telephone survey worldwide and is routinely used for a number of surveillance activities.

Temporality

Since my study is cross-sectional, there may be an issue of temporal ambiguity with my outcome of risky sexual behavior and my group-level variables. Although it is unlikely for risky sexual behavior to cause imbalanced sex ratios, racial residential segregation, or county-level poverty, it is plausible that persons with certain behavioral characteristics are more likely to move to certain kinds of areas. Unfortunately the cross-sectional design does not allow me to determine whether living in an area with certain characteristics preceded the development of the risky sexual behavior.

The study populations from the BRFSS dataset were combined over the course of several years. Data for this study was obtained from questionnaires administered as part of the 1998, 1999, 2000, 2001, & 2004 surveys. Each survey consists of Core Sections and Optional Modules. Data from years 2002 and 2003 are not included because there were no sexual behavior questions asked during those years. Due to limited sample size it was not possible to examine time trends or differences by calendar year. However, I adjusted for year of survey as a group-level variable in the model to examine whether any observed associations were confounded by year. In general, results were similar when analyses were adjusted for the year of the survey.

Outcome definition

While there is no one optimal standard for measuring risky sexual behavior, this study uses the number of sexual partners within the past 12 months. This is the same outcome variable and measurement that previous studies have used (Finer, Darroch, & Singh, 1999) (Dolcini, et al., 1993). However, a number of other measures, such as condom use, may be more appropriate than the number of sexual partners In terms of HIV risk reduction, condom use is considered a primary outcome measure (Robinson, Karen, & Cherry, 2005). In addition, summaru measures of risky sexual behavior may be more appropriate. For example, Bachanas, et al. created a weighted measure in which they incorporated frequency of condom use, the sexual partners over past 60 days, and prior history of STDs and pregnancy to determine risky sexual behavior (Bachanas, Sirl, Morris, Lewis, & Sawyer, 1999). This type of information on individuals is hard to obtain for large sample sizes and with telephone surveys, so we were not able to calculate this kind of measure for the data we had available. Future work using different and variations of outcomes for sexual behavior needs to be done to find a more refined approach to measuring sexual behavior.

Measurement error

There is a concern with measurement error when dealing with self-reported questionnaire responses, especially with the topic of sex. Consideration must go into how truthful individuals are, and to the fact that individuals may select not to answer certain questions related to sexual behavior because of the perception that goes along with certain sexual questions (Binson & Catania, 1998). This could also vary by sociodemographic factors, such as age, race, and gender. Therefore, misclassification of

133

outcome status could have resulted in biased results. If this misclassification varies

systematically by the county-level variables I examined it could have introduced

important bias; however although the direction of the resulting bias is impossible to

predict with certainty, it most likely resulted in bias towards the null.

Another issue posed is the choice of the index of dissimilarity as the measure for

residential segregation in Chapter 2. Although the index is a typical measure used for

residential segregation, it is still limited to only examining two racial groups at a time.

There are other measures such as the multigroup information theory index that can

measure the evenness of several racial groups (Parrillo, 2008). However, the index of

dissimilarity continues to be a primary measure of residential segregation due to its easy

interpretation and detection of evenness (Parrillo, 2008). Also, my results may be

sensitive to the cut-points I used to categorize residential segregation. There are several

ways to categorize segregation indices and no clear theoretical basics for the category

decision. In general my results were robust to the different categorizations I used.

In Chapter 4, there is concern whether the percent of a county below the poverty

line is an appropriate measure for poverty, because some researchers believe that poverty

is understated (J.Q. & Strother-Adams, 2001). The National Research Council's

Committee on National Statistics organized panel to discuss the measuring of poverty in

terms of defining the actual poverty line (Harms, 1995). They discuss using a disposable

income model:

> "According to the panel's recommended measure, income would include,
> in addition to money received, the value of non-cash benefits such as food
> stamps, school lunches and public housing that can be used to satisfy basic
> needs. The new measure also would subtract from gross income certain
> expenses that cannot be used for these basic needs, such as income taxes,

child-support payments, medical costs, health-insurance premiums and
work-related expenses, including child care (Harms, 1995)."

However, only standard poverty measures were available in my analyses.

Confounding

Confounding by omitted or mismeasured individual-level variables is always a

concern when estimating the effects of county-level variables on individual-level

outcomes. For example, in Chapters 2 and 3 my results may also reflect confounding by

unmeasured individual-level variables related to the processes through which individuals

choose to live in neighborhoods with particular normative or structural characteristics

(Bell, Zimmerman, Mayer, Almgren, & Huebner, 2007). Confounding by other county

level variables is also a possibility.

Units of Analysis

A concern is whether counties are appropriate units for the contextual variables

we examined. Although a number of prior studies have investigated the effects of

county-level variables and there are plausible mechanism through which these effects

could operate, it is not clear that counties are the most relevant contexts for all the

variables we investigated. For example, the relevant grouped for the sex ratio is unclear.

The state level does not provide enough variance, and the census tract level provides too

much variance which can both lead to bias. Also, prior work has examined the sex ratio

for relatively large areas including cities and metropolitan areas (LeClere, 2000).

Identifying the reference groups within which persons select mates would allow a better

characterization of the sex ratios relevant to sexual behaviors.

For the measure of residential segregation, the county level is an appropriate measure, since I am examining the distribution of Whites and Blacks across census tracts within counties using the index of dissimilarity. The use of the index of dissimilarity is consistent in the health literature, in which the units of interest are typically measured in counties, MSAs, and cities, and are traditionally calculated using census tract data (Reynolds).

It is also unclear whether the county is the best geographic unit for which to measure poverty. It is plausible that other units such as MSAs which better reflect social or economic processes may be more relevant. Alternatively for some measures such as poverty, counties may be too heterogeneous and smaller geographic units may be more appropriate. Unfortunately data for a smaller level of aggregation was not available for BRFSS respondents.

The use of counties also has several advantages. Overall, counties range from rural to metropolitan and have coverage for the full country so nonmetropolitan areas are not ignored (LeClere, 2000). Counties have large variation in social infrastructure, demographic heterogeneity, and prosperity (LeClere, 2000). Also, large geographic areas such as counties are better than smaller areas when dealing with policy (Kim, Subramanian, Gortmaker, & Kawachi, 2006). With a larger area there is more possibility for policy implications and also able to influence local levels to implicate certain policy changes (Kim, Subramanian, Gortmaker, & Kawachi, 2006).

Race/ethnicity, sample size, and other sample characteristics

A concern with my study is the low cell counts within my Hispanic study population. The analysis may not depict accurate results for this particular group. More work needs to be done in the Hispanic population, due to the fact that behavioral risk

136

factors for HIV infection differ by country of birth, and particular cultural beliefs can affect risky behavior, as well (Sabogal, Faigeles, & Catania, 1993).

In Chapter 3, I examined race-specific sex ratios which assume that everyone chooses a mate within their own race/ethnic group. This could affect my results since I was not looking across racial groups. This may also leads to bias towards the null because I am misspecifying the sex ratio people are exposed to by only focusing on their own race/ethnic group. However previous research has shown that Blacks are more likely to be in a relationship with other Blacks compared to Whites and Hispanics (Laumann & Youm, 1999).

A potential limitation is that the population of my study consists mostly of older individuals. This goes back to the issue of generalizability in terms of being able to make true inference on the younger population, where most of the rates of HIV are seen. However, previous research has shown that the older population is increasingly growing in newly diagnosed HIV infections (CDC: Persons Aged 50 and Older, 2008). Therefore, the study of older populations is still of interest. This study (particularly the analyses on sex ratios) focus primarily on heterosexual transmission. Future work is needed to examine relevant contextual factors for other type of transmission

Overall Future Work

The policy implications of this work are that group-level factors may need to be taken into account in developng HIV prevention strategies. Since a focus of my dissertation pertains to community factors that may not be able to change, interventions should be tailored to making people more aware of their group environment. A person's

understanding of the mechanisms through which social contexts affect their behaviors may help in the reduction of HIV rates.

Overall, future work is needed to better understand the processes through which group-level variables influence individual risk behavior and may affect racial and gender differences in sexual behavior. The type of work illustrated in my dissertation is necessary to develop effective strategies for the reduction of HIV/AIDS-related risk behavior and to inform policies. Poundstone et al. discusses several challenges that still remain in the area of methodological and conceptual development in the field of HIV/AIDS (Poundstone, Strathdee, & Celentano, 2004). There needs to be future work in the area of proper testable hypotheses for the understanding of what larger social, environment factors matter in the transmission of HIV/AIDS and progression of disease, which requires specifications of theory-based modeling (Poundstone, Strathdee, & Celentano, 2004). Second, future work needs to be done in the understanding of complex analytical and measurement issues involved in understanding these multilevel effects (Diez-Roux A. , 2002) (Poundstone, Strathdee, & Celentano, 2004). Lastly, for the implementation of effective social-level interventions, multisectoral approaches that address the economic and social aspects of HIV/AIDS are needed (Poundstone, Strathdee, & Celentano, 2004) (Global HIV Prevention Working Group, 2003) (Global HIV Prevention Working Group, 2002).Major Contributions and Conclusion

In the area of social epidemiology, race/ethnicity has been an "indicator of social forces rather than physical difference (Poundstone, Strathdee, & Celentano, 2004)." Therefore the understanding of disparate HIV/AIDS incidence rates by race/ethnicity is of central importance (CDC, HIV Prevention in the Third Decade, 2005) (CDC, HIV and

African Americans, 2007) (Poundstone, Strathdee, & Celentano, 2004). To better understand why HIV tends to be concentrated in different areas in terms of race/ethnicity, I have to look beyond individual behavior and examine pathways in which these individual behavior patterns are triggered (Lane, et al., 2004) (Poundstone, Strathdee, & Celentano, 2004) (Krieger, 2000) (Sevgi, 1996). Previous work has shown that structural and contextual factors play key roles in the determination of socialization patterns that contribute to HIV/AIDS disparities in racial/ethnic (Poundstone, Strathdee, & Celentano, 2004) (Sevgi, 1996). For instance due to disproportionate incarceration of Black men, a low sex ratio environment has a negative effect of monogamous relationships and also brings about sexual concurrent partnership (Poundstone, Strathdee, & Celentano, 2004) (Adimora & Schoenback, 2005) (Guttentag & Secord, 1983). Racial residential segregation has been shown to shape risk and social networks in such a way that may contribute to widespread disease patterns (Williams & Collins, 2001) (Wilson, 1987) (Massey & Denton, 1993) (Poundstone, Strathdee, & Celentano, 2004). Racial residential segregation has had an independently, strongly association with prevalent gonorrhea rates at the county level in the southeastern United States (Thomas & Gaffield, 2003). My work in this area is the next steps in social epidemiology to provide the new stages and insight to racial/ethnic differences in sexual behavior.

Overall, this dissertation work of the associations of structural factors with sexual behavior has been a much needed extension to the previous social epidemiological work done. It is one of the few studies to examine risky sexual behavior in the adult population at the county level. Poundstone, et al. discuss the importance of multilevel modeling and social factors in the enhancement in my ability to develop and test better causational

hypotheses that most closely match the form of the epidemic of HIV/AIDS (Poundstone, Strathdee, & Celentano, 2004) (Krieger, Waterman, Chen, Soobader, & Subramanian, 2003) (Diez-Roux, 2000) (Krieger, Chen, Waterman, Soobader, Subramanian, & Carson, 2002). "To address the disproportionately high rate of heterosexual HIV transmission among African American women adequately, policy and research must be multilevel in design, taking into account multiple levels of risk in crafting a coherent research model and in public health policy (Lane, et al., 2004)." Future work that builds on the analyses reported in this dissertation is needed to better understand these processes.

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144

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Appendix 1: List of Survey Questions from the Behavioral Risk Factor Surveillance System

1. Number of sex partners - During the past twelve months, with how many people have you had sexual intercourse? 1-76, None, Don't know/Not sure, Refused

2. Race/Ethnicity - Which one of these groups would you say best represents Asian, Native Hawaiian or Other Pacific Islander, American Indian, Alaska Native, Hispanic, Other, Do not know/Not sure, Refused

3. Marital Status - Are you: Married, Divorced, Widowed, Separated, Never married, A member of an unmarried couple, Refused

4. SES -What is the highest grade or year of school you completed? Never attended school or only kindergarten, Grades 1 - 8 (Elementary), Grades 9 - 11 (Some high school), Grade 12 or GED (High school graduate), College 1 year to 3 years (Some college or technical school), College 4 years or more (College graduate), Refused

5. County - What county do you live in?

6. Sex - Indicate sex of respondent: Male or Female

7. Weight - Final weight assigned to each respondent (Post-stratification weight (_POSTSTR) multiplied by design weight (_WT2).)

8. Age - What is your age? 18-99, Don't know/Not sure, Refused

Appendix 2: Calculation Formula for Segregation Measures directly from the

Population Studies Center: Racial Residential Segregation Measurement Project

The Index of Dissimilarity

This index measures the evenness with which two mutually exclusive groups are distributed across the geographic units that make up a larger geographic entity; for example, the distribution of blacks and whites across the census tracts that make up a metropolis. Its minimum value is zero and its maximum value is 100.

Suppose:

b_i = the black population of the ith areal unit, e.g. census tract
B = the total black population of the large geographic entity for which the index of dissimilarity is being calculated.

w_i = the white population of the ith area unit, e. g. census tract
W = the total white population of the large geographic entity for which the index of dissimilarity is being calculated

Then the index of dissimilarity measuring the segregation of whites from blacks

$$(1/2) \text{ SUM } (b_i / B - w_i / W)$$

The summation is over the component areal units such as census tracts.

With a change in notation, the identical calculation formula will produce an index of dissimilarity measuring the segregation of any one racial group from any other mutually exclusive racial group. The value of this index is statistical independent of the relative size of the groups used in its computation.

Appendix 3: Hierarchical Linear Modeling Assumptions

1. Linearity: function forms are linear at each level

2. Normality: level-1 residuals are normally distributed and level-2 random effects U's have a multivariate normal distribution

3. Homoscedasticity: level-1 residual variance is constant

4. Independence: level-1 residuals and level-2 residuals are uncorrelated

5. Independence: observations at highest level are independent of each other

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