Where Have All the Men Gone?

The Impact of Imbalanced Sex Ratios on High-Risk Sexual Behaviors

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Outline

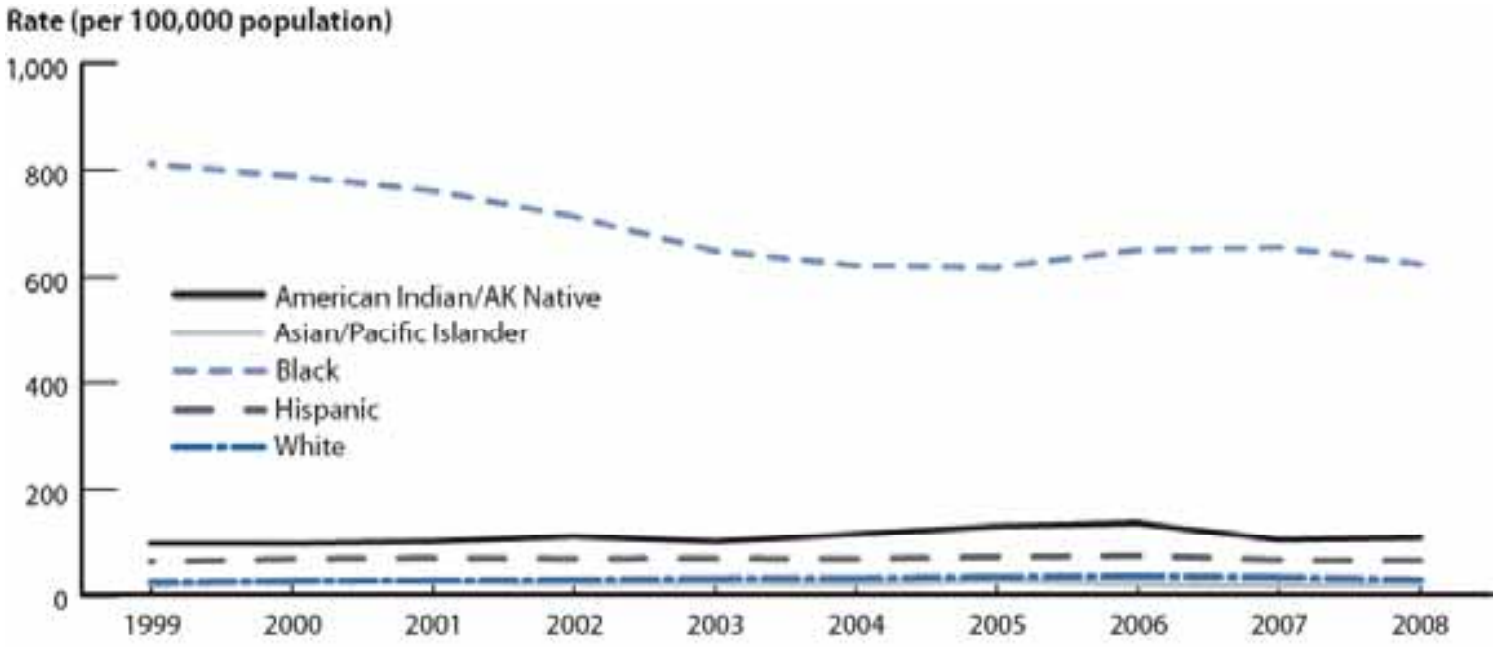
- Background
  - Disparities in STDs
  - Social determinants of health
  - Sex ratio theory
- Methods
  - Data sources
  - Analysis
- Results
  - Bivariate
  - Multi-level
- Conclusions

STD Disparities

- The epidemiology of STDs in the US continues to be characterized by immense inequality in the burden of disease.
  - Racial
  - Geographic
  - Economic
  - Education
  - Incarceration
  - Sexual orientation (in some areas)

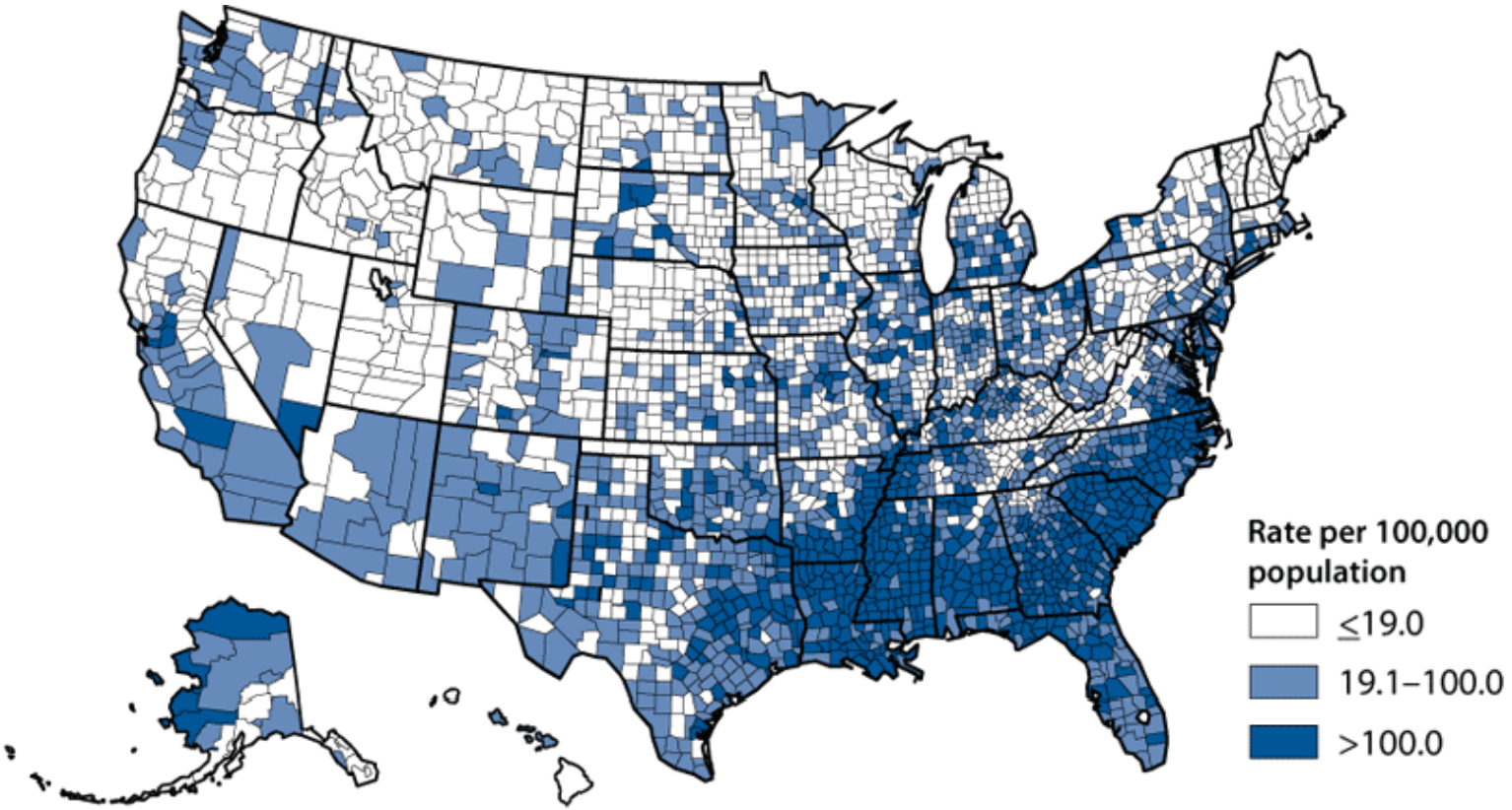
Racial Disparities - Gonorrhea

- Rate among blacks are approximately 20 times greater than the rates among whites
- This extreme variance in STD rates is one the greatest racial disparities observed for any disease.



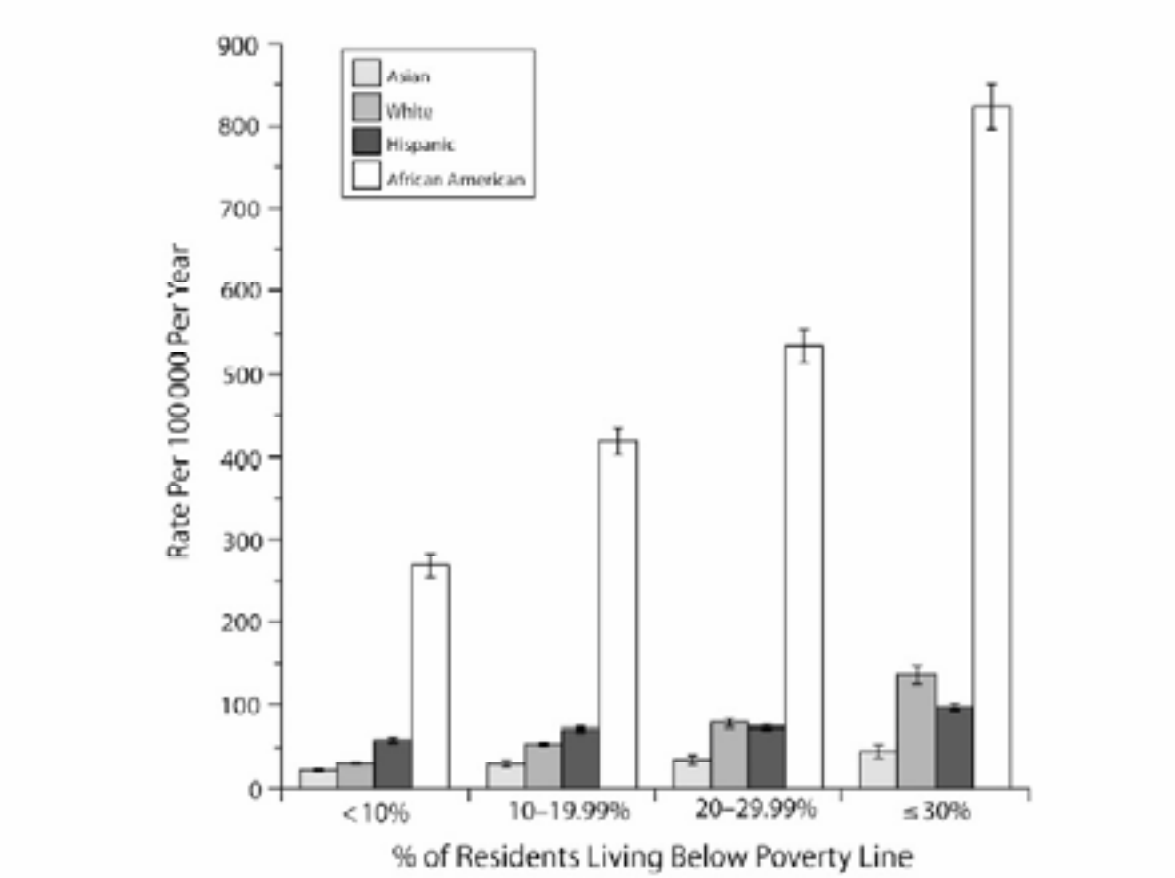
Centers for Disease Control and Prevention. *Sexually Transmitted Disease Surveillance, 2008*. Atlanta, GA: U.S. Department of Health and Human Services; November 2009.

Geographic Disparities - Gonorrhea



Centers for Disease Control and Prevention. *Sexually Transmitted Disease Surveillance, 2008*. Atlanta, GA: U.S. Department of Health and Human Services; November 2009.

Poverty, Race/Ethnicity and Gonorrhea



Note. Gonorrhea rates were calculated using case counts weighted for race/ethnicity. Error bars show 95% confidence intervals calculated with the exact Poisson method. Census tract and population count data for California were collected as part of the 2000 US Census and obtained from the US Census Bureau.

FIGURE 1—Gonorrhea infection rates, by race/ethnicity and percentage of census tract residents living below the poverty line: California, 2004–2006.

Springer YP, Samuel MC, Bolan G. Socioeconomic gradients in sexually transmitted diseases: a geographic information system-based analysis of poverty, race/ethnicity, and gonorrhea rates in California, 2004-2006. Am J Public Health. Published online ahead of print April 15, 2010.

Disparities and Contextual Factors

- Disparities continue to persist despite dedicated amelioration efforts.
- Some prevention efforts have shifted focus from individual-level risk factors to various contextual factors, such as:
  - poverty and economic disadvantage
  - social norms
  - segregation
  - incarceration rates
  - population composition

Social Determinants

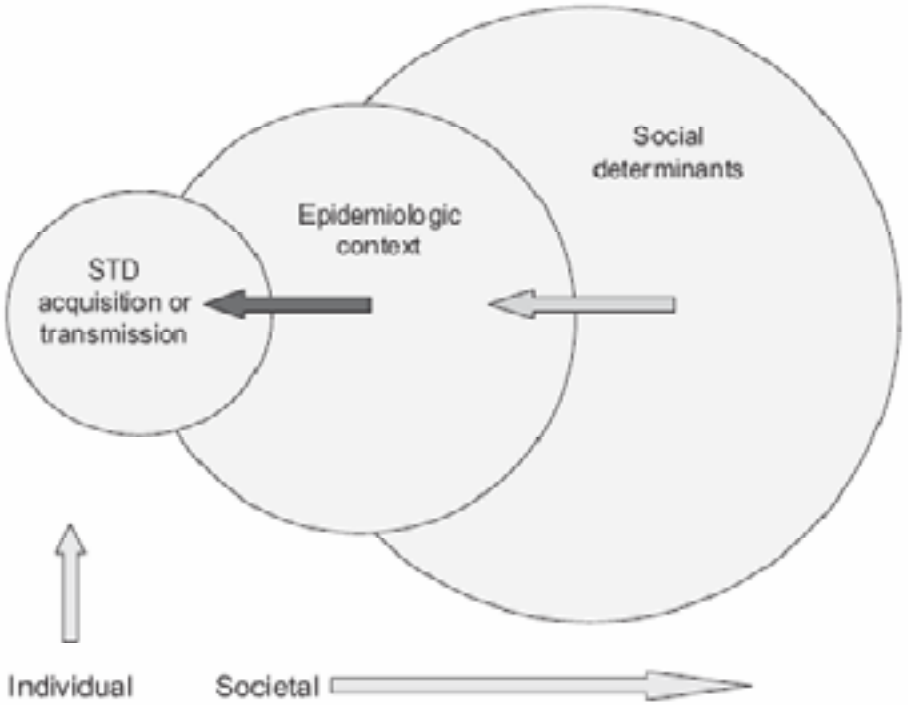


Fig. 1. Conceptual model of the relationship between social determinants of health and STD. Social determinants interact with societal norms and pathogen characteristics to influence the epidemiologic context (indicated via the right-hand arrow). The epidemiologic context interacts with behaviors to influence the nature or odds of STD acquisition or transmission (indicated via the left-hand arrow). The broader constructs (larger circles) do not completely occlude the smaller because other influences also operate upon STD rates and epidemiology.

Hogben & Leichliter, 2008

Neighborhood Context

- Neighborhood contextual factors may have an influence on individual sexual risk behaviors and subsequently STD rates.
  - Not normally targeted in STD prevention campaigns
- Identification of geographic areas associated with high-risk sexual behaviors and STD rates can be targeted for STD prevention efforts.
  - Using GIS technologies to identify geographic areas with elevated disease burden has been shown to enhance disease prevention efforts.

Sex Ratios

- Low male-to-female sex ratios, in which there is a relative shortage of men in the population, has been associated with…
  - elevated STD incidence at the population level
  - increased engagement in risky sexual behaviors at the individual level
- The large disparities observed between black and white Americans in terms of income, health status, and other socio-economic measures are also observed for sex ratios.

Hogben & Leichliter, 2008; Pouget *et al,* 2010; Thomas & Gaffield, 2003; Lane *et al*., 2004; Aral, 1996; Kilmarx *et al*., 1997; Thomas & Sampson, 2005

Sex Ratios by Race

- Based on 2009 U.S. Census estimates the ratio of all males to females in the U.S. is:
  - 0.98 among whites
  - 0.91 among blacks
- Sex ratios in the reproduce age range (15-49 years) range from:
  - 1.05 among whites
  - 0.95 among blacks
- In racially segregated and economically deprived communities, which also experience the highest STD rates, this ratio is often much lower.

Causes of Low Sex Ratios

- Combination of several social and economic forces
  - Birth rates generally higher for males
  - Males have higher death rates relative to females across almost all age groups
    - Premature death rates among blacks tend to be significantly higher than among whites
    - Differential environmental exposures and health care access
    - High crime rates and violent deaths
  - Incarceration rates are disproportionately high among black men, resulting in a type of non-voluntary or forced migration out of communities.

Crime and Incarceration

- According to 2008 statistics from the U.S. Department of Justice:
  - Black males were imprisoned at a rate six and a half times higher than white males.
  - Approximately 7 percent of the total black male population between the ages of 25 to 29 was incarcerated.
- High crime and incarceration rates are especially concerning with regard to STD prevention efforts as they have been associated with
  - increases in both teenage pregnancy and STD rates at the population-level
  - increased engagement in high-risk sexual behaviors at the individual-level

Impact of Low Sex Ratios

- At the population level, low male-to-female sex ratios have been linked to:
  - lower rates of marriage
  - increased rates of divorce
  - greater familial instability
  - higher rates of teenage pregnancy
  - increased incidence of STDs
- Conceptually, shifts in the balance of power in opposite-sex relations may mediate the observed impact of sex ratios on social norms and behavior.

Social Exchange Theory

- Theory used to the influence of sex ratios on sexual partnering dynamics
  - Posits that all human relationships are based on subjective cost-benefit analyses and the comparison of alternatives.
- A shortage of men…
  - Reduces women's dyadic power in interpersonal relationships by reducing the available alternative relationships for women
  - Increases men's dyadic power by increasing the available alternative relationships for men.
- Low sex ratios disrupt the balance of power between men and women, placing women at a disadvantage in sexual relations.

Sex Ratios and Behaviors

- In communities where males are in short supply, studies have indicated that men are more likely to have multiple sexual partners, and women are less likely to insist on condom use
- Both of these behaviors contribute substantially to increased transmission of STDs within social groups, as well as elevated individual risk of acquiring a STD.

Adimora *et al*., 2001; Ferguson *et al*., 2006; Uecker & Regnerus, 2010; Thomas & Thomas, 1999; Adimora & Schoenbach, 2005; Pouget et al, 2010

High-Risk Sexual Behaviors

- Multiple sexual partnerships and concurrency have been implicated as important indicator of elevated STD risk at both the individual and population levels
  - Number of sex partners is the single most important risk factor for getting a sexually transmitted disease (National Health and Social Life Survey)
  - At the population level, concurrent sexual partnerships can dramatically accelerate the spread of STDs through a population
- Condom use effective at preventing spread of STDs

Previous Qualitative Research

- Focus group studies
  - Indicated gender imbalance is a key component of sexual interactions between men and women
  - Perceived shortage of males impacts relationship attitudes, results in decreased dyadic power for women, and is at least partly responsible for the prevalence of concurrent sexual partnerships

Adimora *et al*., 2001; Ferguson *et al*., 2006; Uecker & Regnerus, 2010; Glenn & Marquardt, 2001; Bogle, 2008; Williams, 2010

Previous Ecological Research

- At the population or ecological level, studies have generally found that low male-to-female sex ratios, or high male incarceration rates, are associated with high STD rates.
  - This association does not always persist when controlled for other variables, such as poverty and marriage rates, and the association varies across different diseases.

Kilmarx et al., 1997; Thomas and Gaffield, 2003; Thomas and Sampson, 2005; Hogben & Leichliter, 2008; Lane *et al*., 2004; Aral, 1996

Previous Multi-Level Research

- Smith and Subramanian (2006) – Australia
  - Sex ratio was associated with the number of sexual partners in the previous year
  - Did not account for differential effects on men and women
- Pouget *et al*. (2010) – U.S. (county level)
  - Both sex ratios and incarceration rates at the county level associated with the reported number of opposite-sex partners.
  - Black men in particular had significantly higher odds of having two or more sex partners in the past year.
- Senn *et al*. (2010) – U.S. (census tract level)
  - Among the male STD clinic patients, no association was found between sex ratio and number of opposite-sex partners in the last three months.
  - For women, number of sexual partners actually increased as the sex ratio increased, although the researchers noted that this association was largely driven by women reporting trading sex.

Current Study

- Purpose:
  - Investigate the association between low male-to-female sex ratios at the population level and individual high-risk sexual behaviors.

- Hypothesis:
  - Low male-to-female sex ratios lead to increases in risky sexual behaviors such as multiple sex partners and lack of condom use
  - Differential effect of sex ratio by gender, such that lower ratios are associated with:
    - a greater number of sexual partners among men
    - reduced condom use among women

Study Setting: Richmond, VA

- Metropolitan area located in central Virginia.
- Richmond City has relatively high proportions of black persons (53.1%) and persons living below the federal poverty level (22.4%) compared to the surrounding counties of Henrico and Chesterfield.

Study Setting: STD Rates

- Richmond City has a disproportionately high STD burden.
  - Gonorrhea rate in 2007: 612.2 per 100,000
    - 5.1 times the national average
    - Approx. 7.5 times the state average
    - 7.5 times the rate in Chesterfield County
    - 5.0 times the rate in Henrico County
  - These large differences in rates within the same metropolitan area lend themselves to further study of the geographic and social factors involved.

Study Setting: STD Rates

Neisseria gonorrhoeae Infection Incidence Rate by Locality
Virginia, 2007

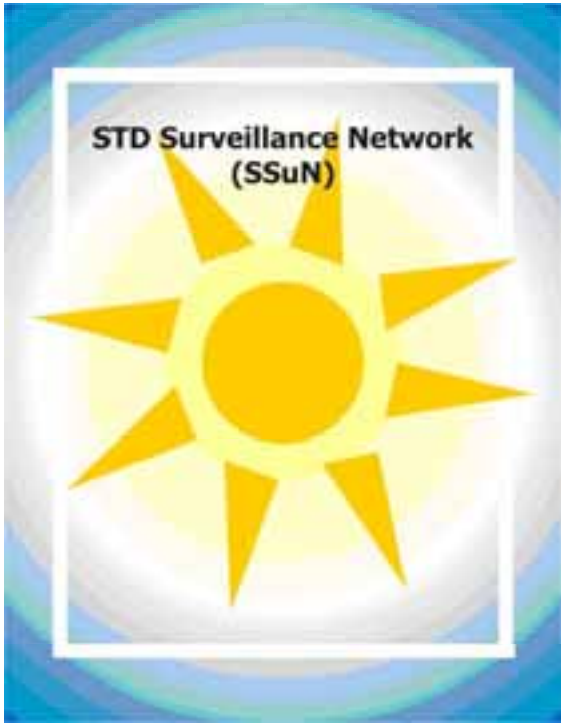
Table 2. Chlamydia and Gonorrhea Rates by Geographic Region and Year, 2003-2007

	Chlamydia Rates (per 100,000)					Gonorrhea Rates (per 100,000)				
City/County	2003	2004	2005	2006	2007	2003	2004	2005	2006	2007
Chesterfield County	200.8	192.6	195.5	232.3	253.8	84.5	78.8	73.9	63.7	81.2
Henrico County	277.4	324.8	277.1	295.1	359.7	136.1	123.7	118.3	104.8	121.7
Richmond City	1054.3	1208.4	1172.0	1134.3	1178.8	641.4	588.1	690.4	458.3	612.2
Virginia (State)	263.2	290.0	299.5	315.2	321.6	122.7	114.8	110.3	84.7	82.0
National (U.S.)	301.7	316.5	329.4	344.3	370.2	115.2	112.4	114.6	119.7	118.9

Data Sources

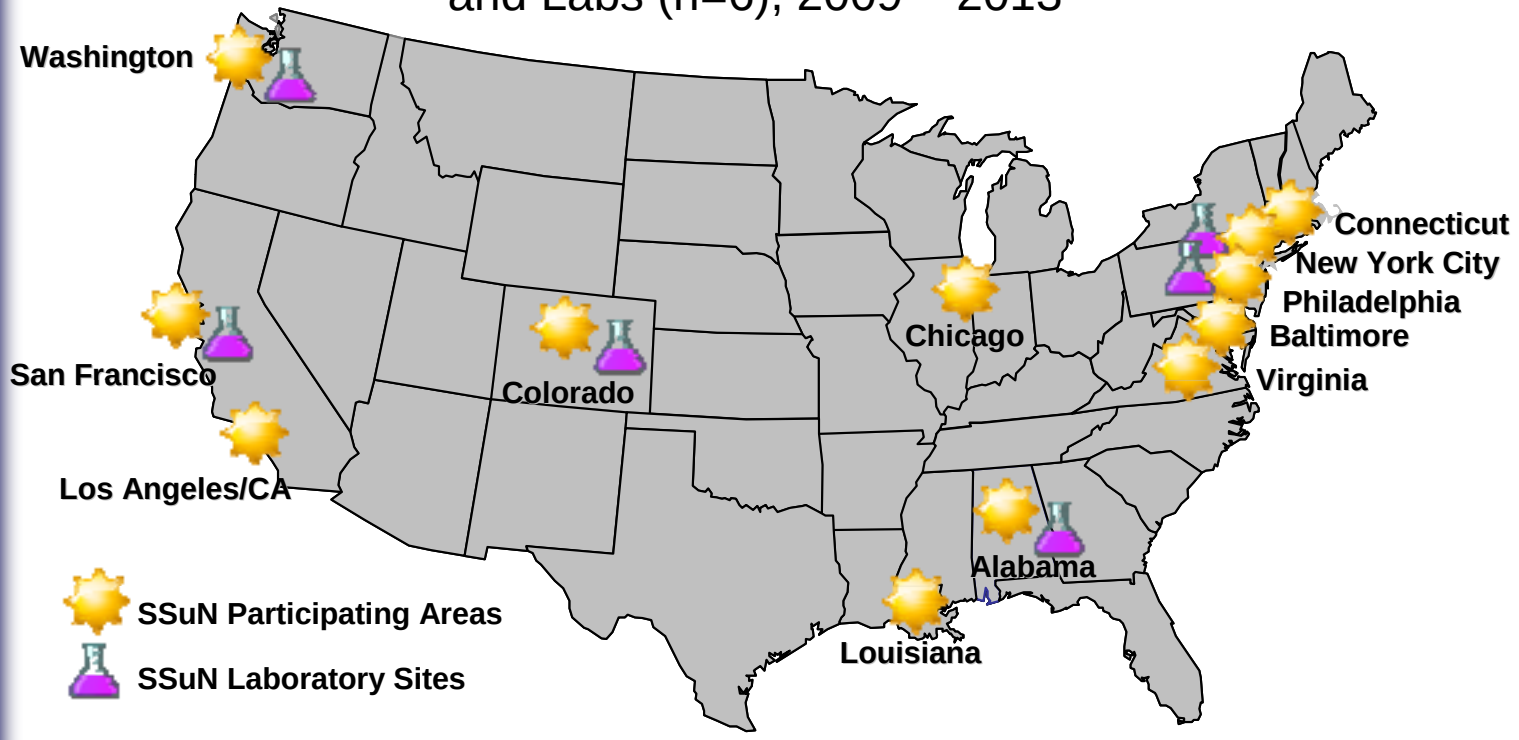
Individual-Level Data Source

- STD Surveillance Network (SSuN)
- National program to enhance STD surveillance capacity
- Traditional Case Reporting
  - Mandatory in all states
  - Typically only report
    - Sex
    - Age
    - Race
- Enhanced Surveillance
  - Patient demographics
  - STD history
  - Risk behaviors
  - Co-morbidities



National SSuN Cycle II Sites

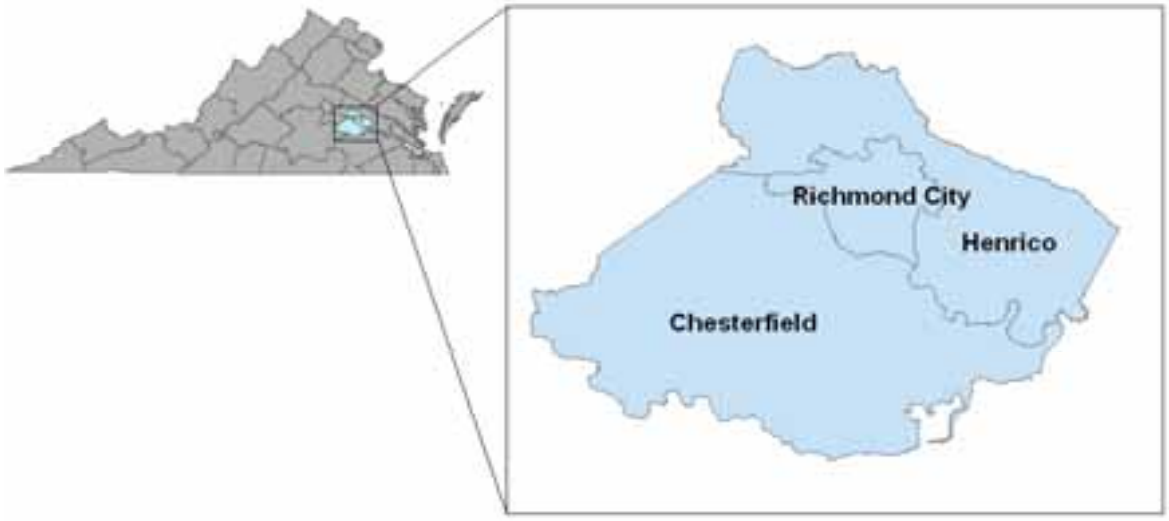
SSuN Cycle 2 Participating Project Areas (n=12) and Labs (n=6), 2009 – 2013



- Enhanced data collected as part of SSuN now captures 20% of all gonorrhea cases diagnosed in the United States annually.

SSuN Data Collection

- Three participating localities in Virginia:
  - Richmond City
  - Henrico County
  - Chesterfield County
- Demographic and behavioral risk data:
  - All patients presenting to STD clinics asked to fill out SSuN interview form during registration
    - Completion not mandatory for service



Patient-Level Variables

- Demographics
  - Age
  - Sex
  - Race/ethnicity
  - Education
  - Employment
  - Sexuality
- Risk Behaviors
  - Condom use
  - Number of partners
  - Drug use
  - Anonymous sex
  - Trade for sex

Data Exclusions

- Limited to data obtained from first interviews conducted during 2008-2009
- Limited to male and female genders (excludes transgender)
- Limited to heterosexual orientation (excludes gay and bisexual)
- Limited to 15-49 years of age
- Limited to Virginia residents
- Limited to NH white, NH black, and Hispanic race/ethnicity

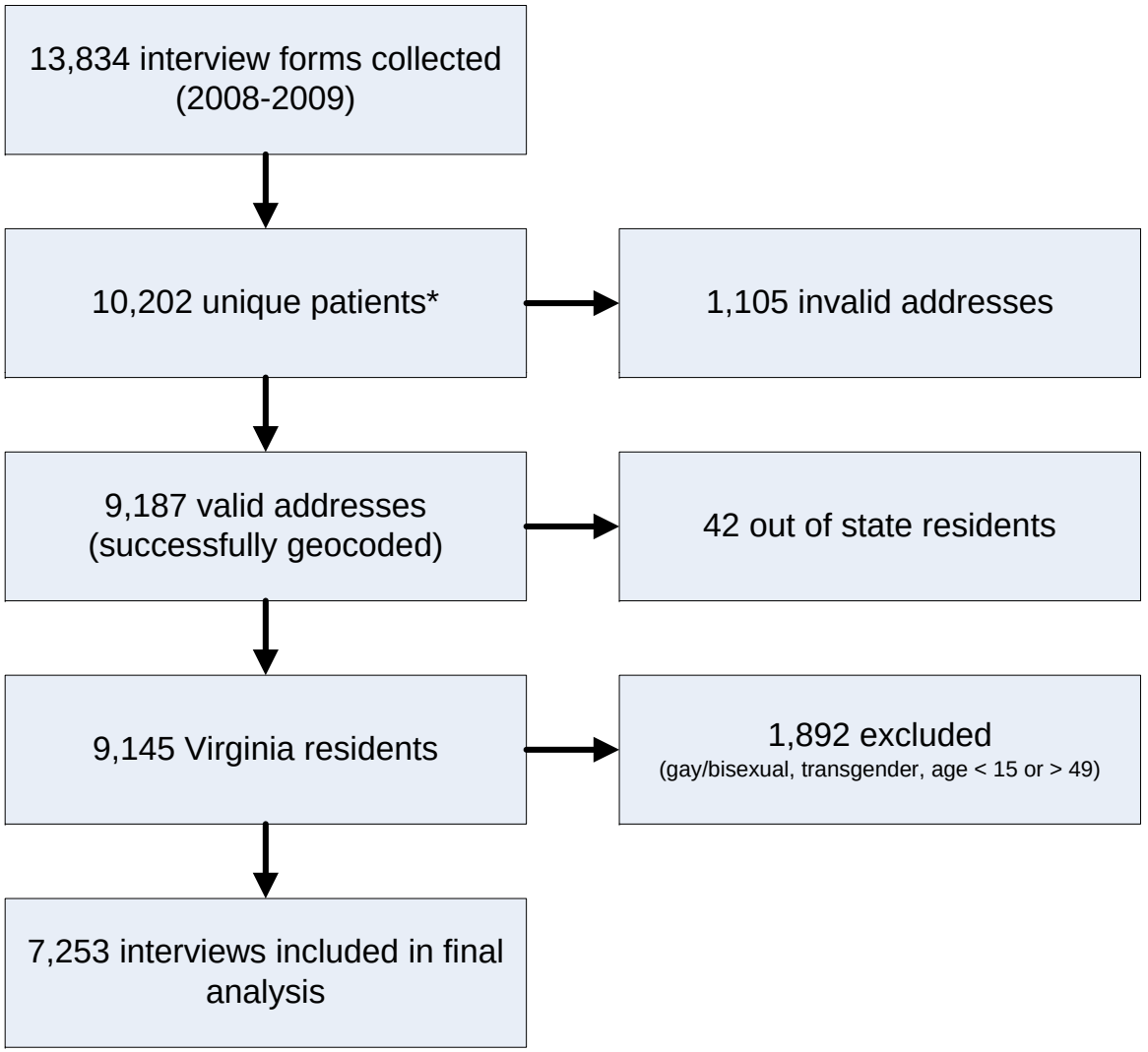
Population-Level Data Source

- 2000 US Census
- ABSMs (census tract)
  - Sex ratio (males / females)
    - 15-49 years of age
  - Poverty (% living below poverty)
  - Education (% less than HS)
  - Racial composition (% black)
  - Marriage rates (% married)
  - Unemployment (% currently unemployed)

Operational Definitions

- Outcome Measures
  - How many sex partners have you had in the last 3 months? (1 vs. 2 or more)
  - Did you use a condom the last time you had intercourse (sex)?
- Determinant
  - Sex ratio (census tract)
- Covariates/Confounders
  - Sex
  - Race/ethnicity
  - Employment
  - Education

Geocoding Results



* Data from the first interview form administered was used when a patient had multiple forms completed over several visits during the time period.

Methods

Geocoding Analysis

- Variables significantly associated with invalid addresses information (& failure to geocode)
  - Age (younger)
  - Sex (males)
  - Race (Hispanic)
  - Education (less than HS)
  - Other missing data
- Not associated with outcome variables

Statistical Methods

- Bivariate Analyses
  - Population-level correlations between sex ratios and GC rates
  - Associations between high-risk sexual behaviors and all potential individual-level predictors
  - Associations between sex ratios and individual-level characteristics (including sex behaviors)
- Multi-level logistic regression
  - Binomial outcome variables: condom use, number sexual partners
  - Patient-level factors (Level 1): race/ethnicity, sex, age, education, employment
  - Census tract factors (Level 2): sex ratio

Virginia Census Tract Analysis

- For all Virginia Census tracts, significant bivariate associations were found between gonorrhea rates and the following population-level predictors:
  - Sex ratios (15-49 years of age)
  - Percent living in poverty
  - Percent black
  - Percent with less than HS education
  - Percent unemployment

Population-Level Data

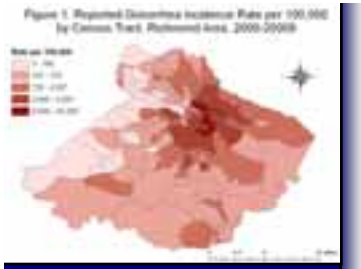
- Interview respondents came from 344 census tracts
  - Average of 26.6 interviewed patients from each census tract (range 1-263)

Population-Level Contextual Characteristics by Census Tract (N=344)

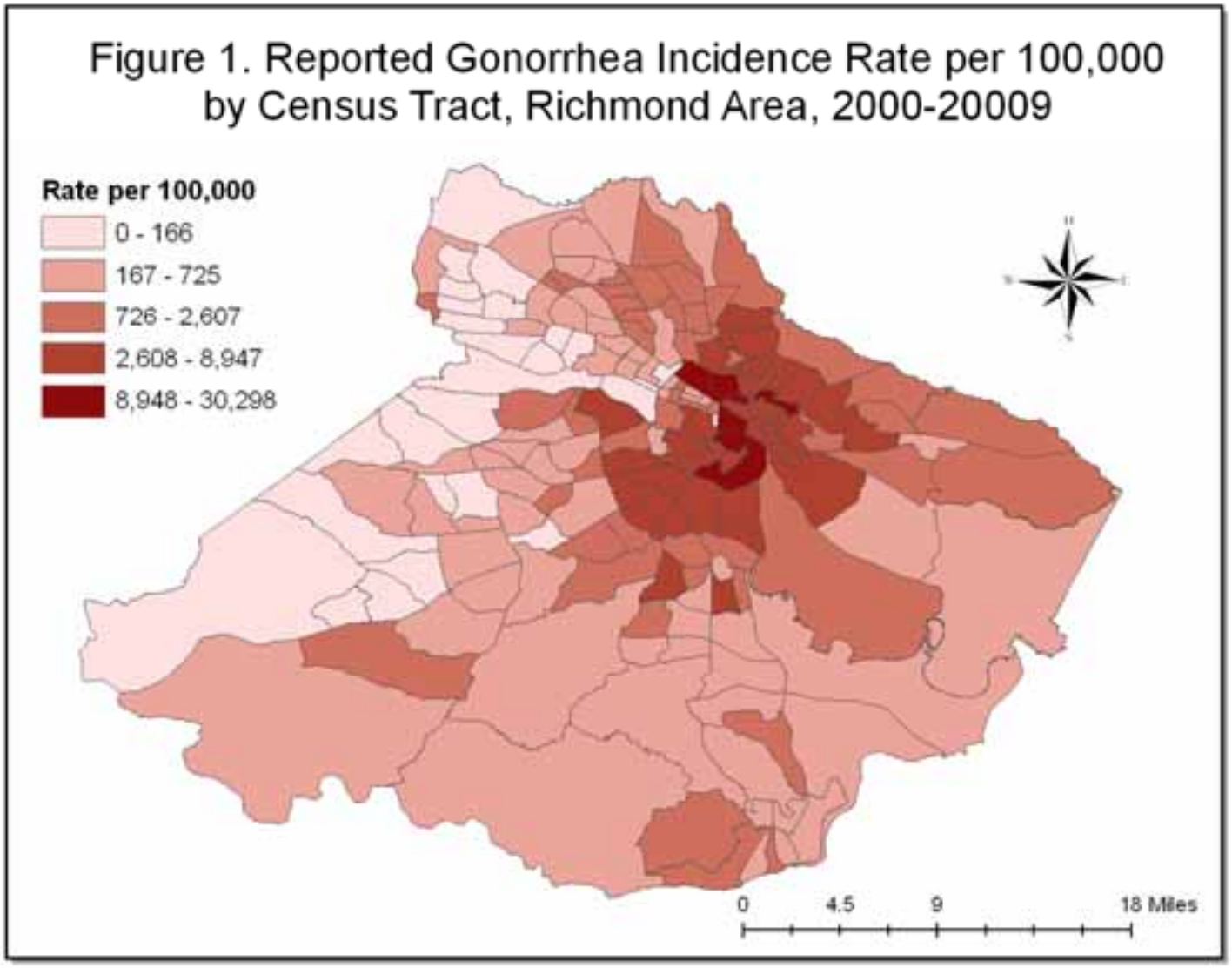
Variable	Mean	SD	Min	Max	Median
Sex Ratio (15-49 years)	0.97	0.25	0.38	3.79	0.94
Percent Living Below Poverty	11.63	11.71	0.37	78.67	7.94
Percent Black	32.85	28.69	0.00	99.07	24.09
Percent Less Than HS Education	20.31	12.76	0.27	64.73	18.01
Percent Married	54.19	14.22	8.29	79.73	57.34
Percent Unemployed	5.39	6.23	0.00	46.56	3.59

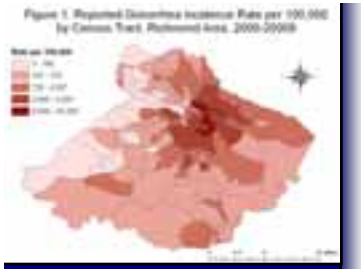
Population-Level Data

- Because of non-normality, recategorized continuous variables into tertiles
- Significant associations found between census tract-level sex ratios and the following predictors:
  - Percent married
  - Percent living in poverty
  - Percent unemployed
  - Percent black



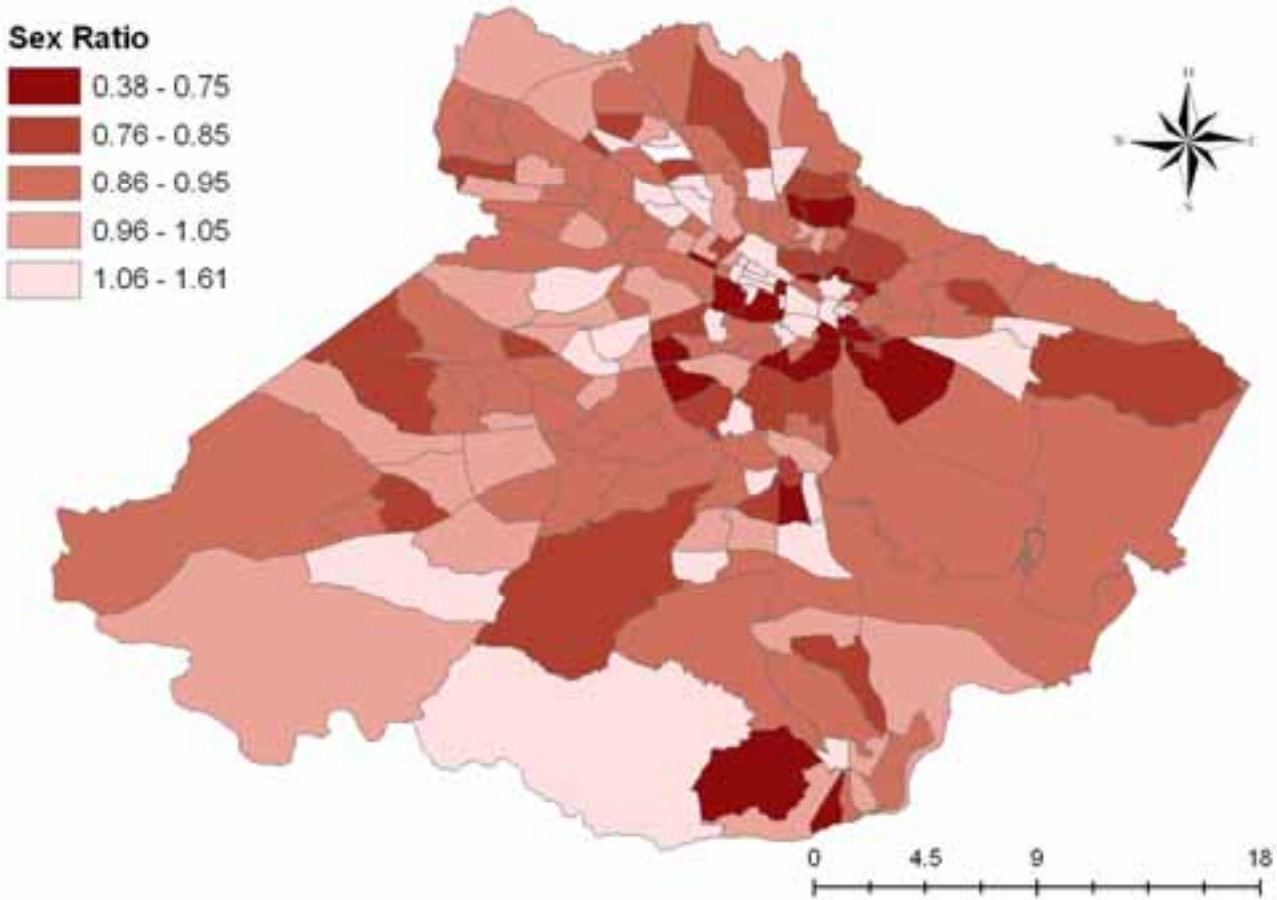
Mapping Population-Level Data

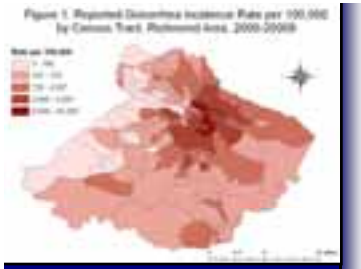




Mapping Population-Level Data

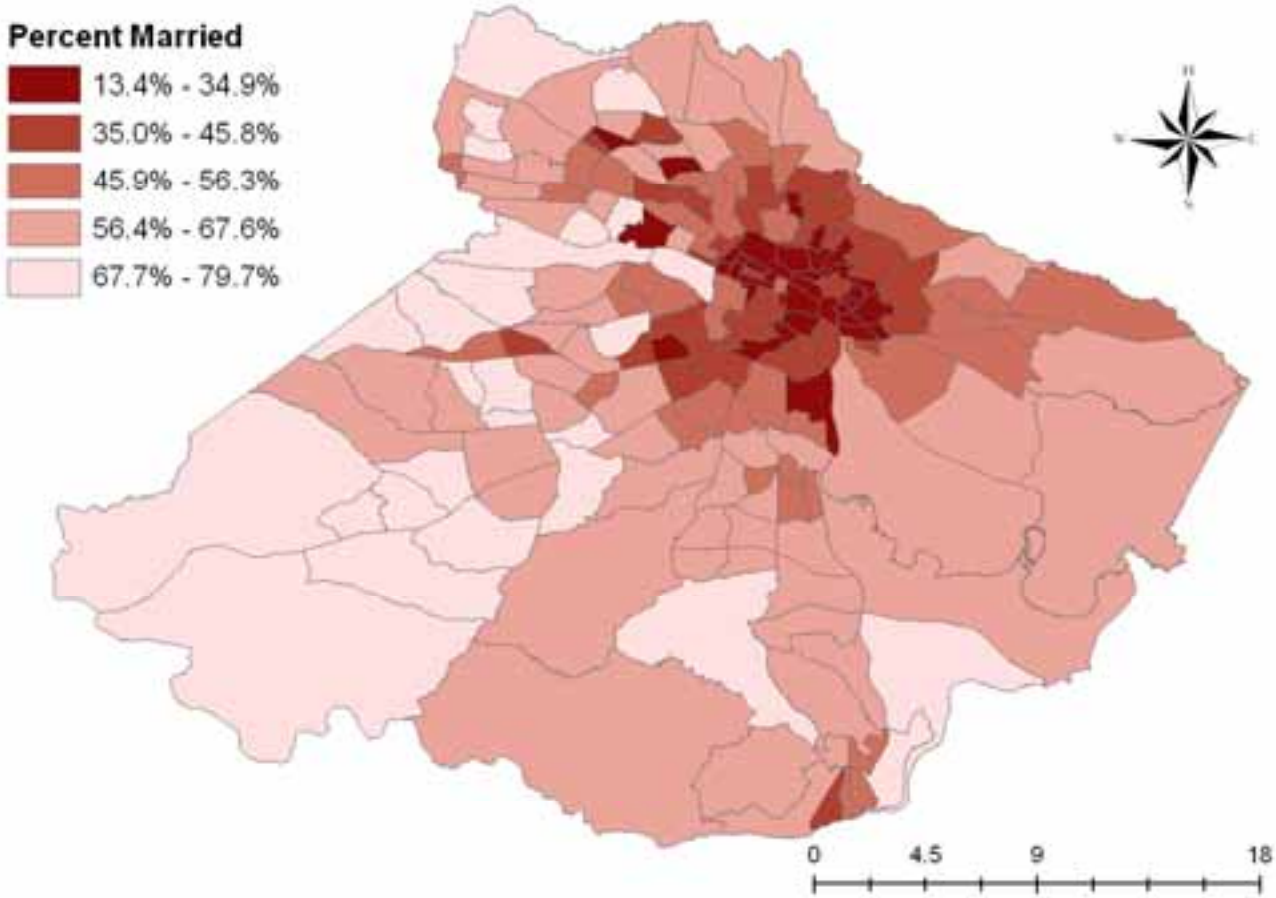
Figure 2. Sex Ratios for Population Aged 15-49 Years
by Census Tract, Richmond Area, 2000

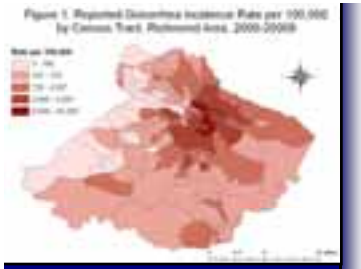




Mapping Population-Level Data

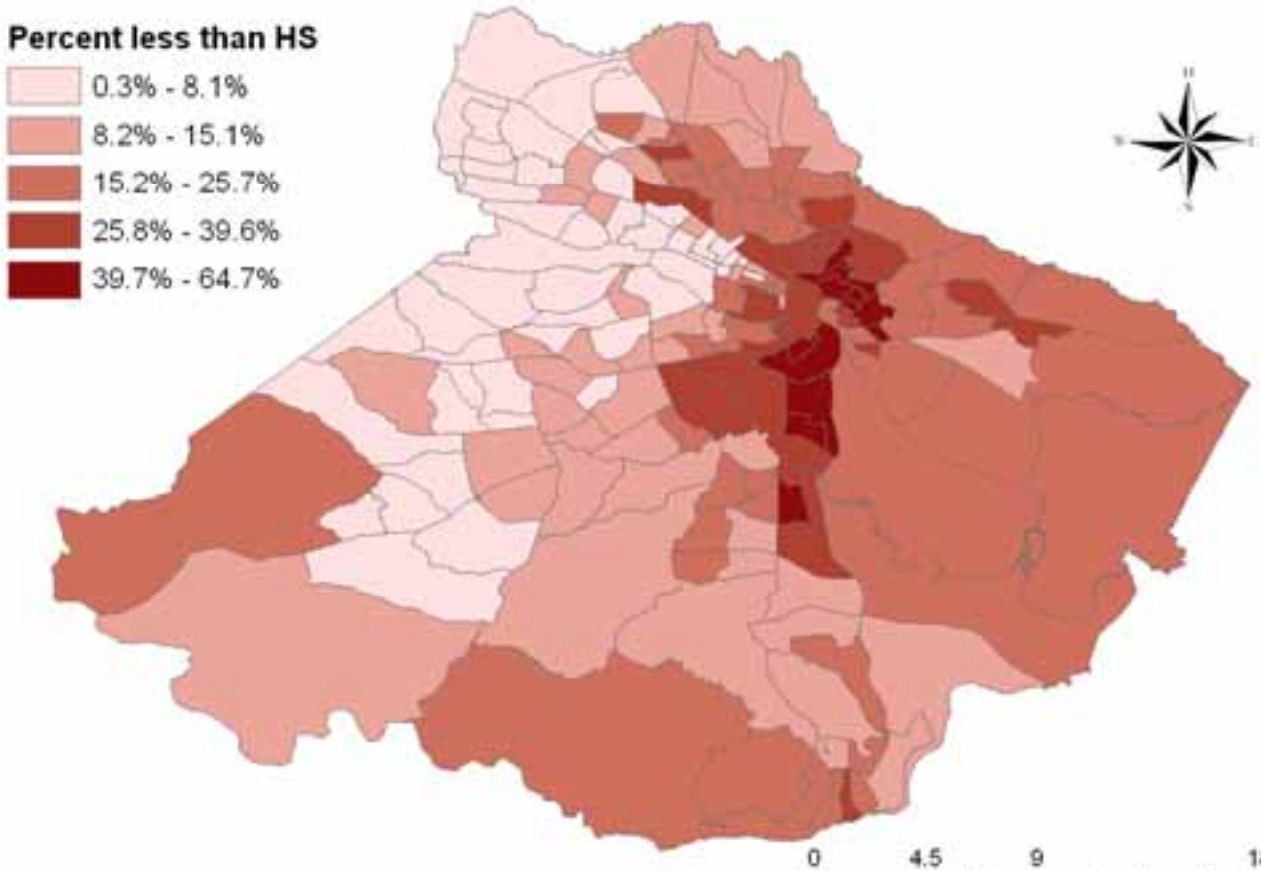
Figure 3. Percent of Population Currently Married
by Census Tract, Richmond Area, 2000

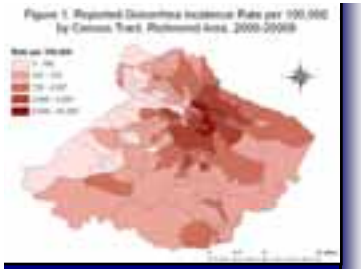




Mapping Population-Level Data

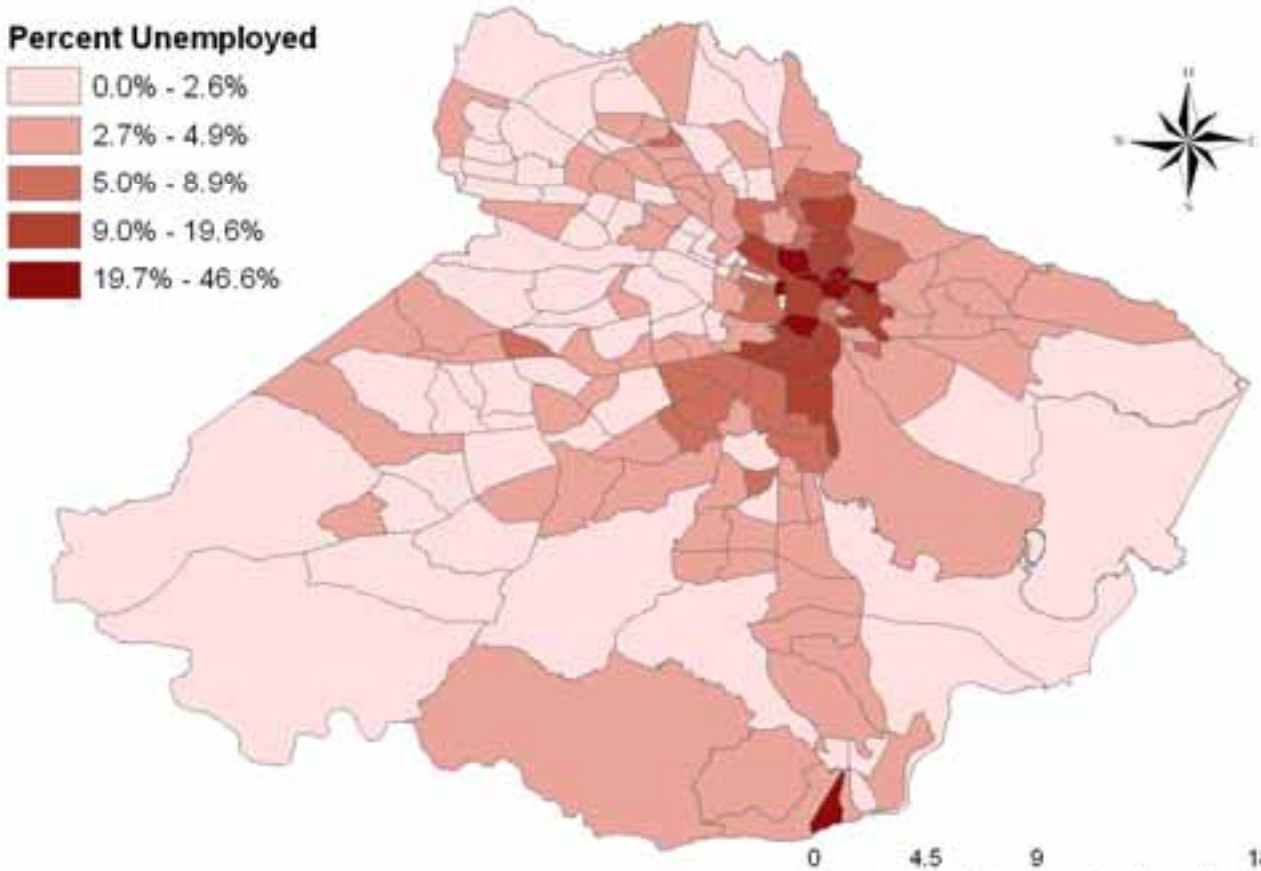
Figure 4. Percent of Population Without High School Education by Census Tract, Richmond Area, 2000

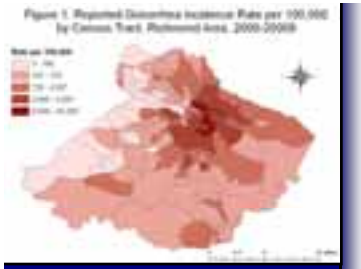




Mapping Population-Level Data

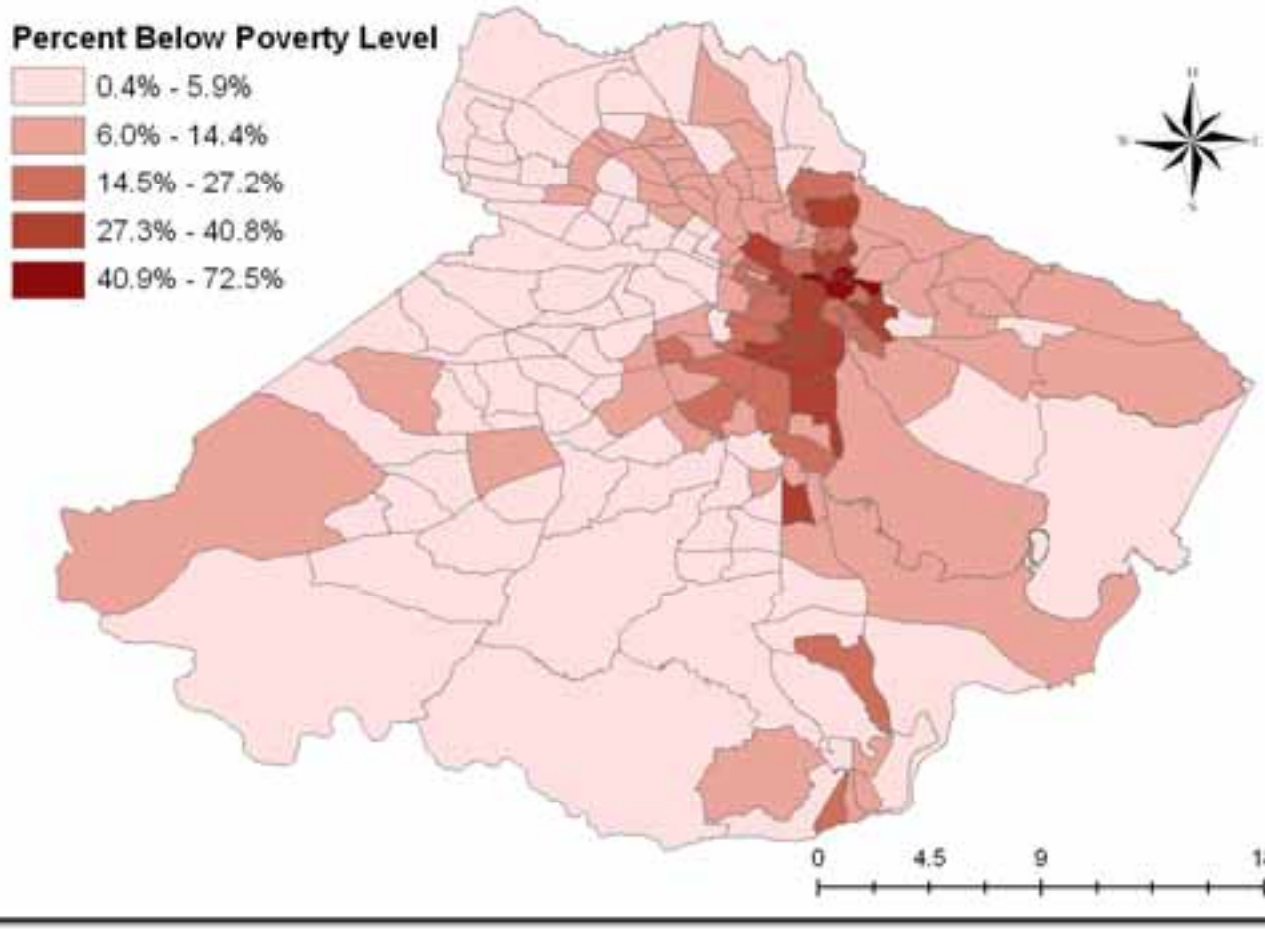
Figure 5. Percent of Civilian Population Unemployed by Census Tract, Richmond Area, 2000

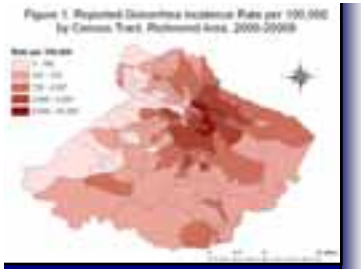




Mapping Population-Level Data

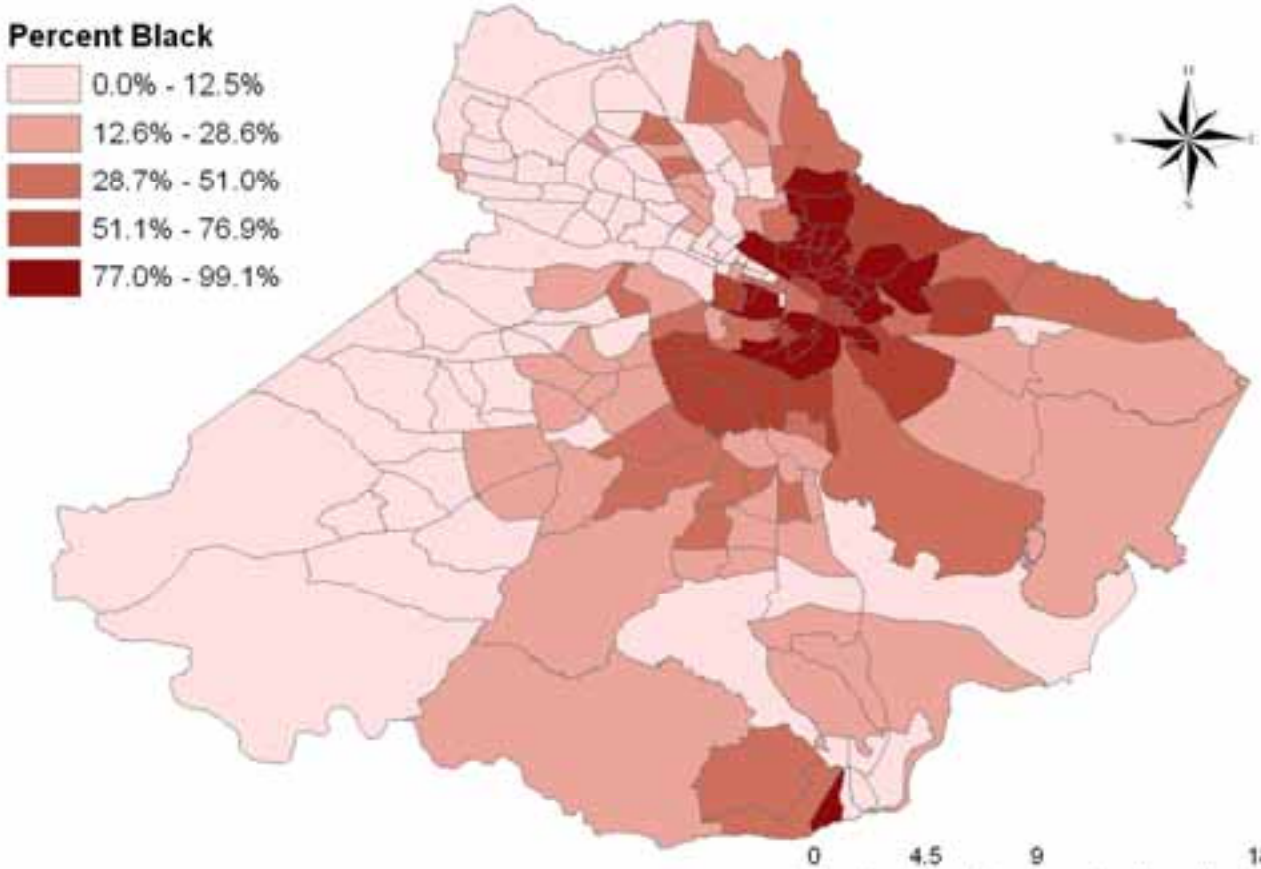
Figure 6. Percent of Population Living Below the Poverty Level by Census Tract, Richmond Area, 2000





Mapping Population-Level Data

Figure 7. Percent of Population Living Below the Poverty Level by Census Tract, Richmond Area, 2000



Preliminary Analyses

Patient Characteristics by Condom Use (N = 7,074)

Variable	Condom Use Last Sex N	%	p-value
Race/Ethnicity			
NH Black	1,645	31.11	0.2564
NH White	266	28.48	
Hispanic	132	31.50	
Sex			
Male	1,010	31.97	0.0421
Female	1,033	29.67	
Age Group			
15-19 years	471	34.91	<.0001
20-29 years	1,102	31.54	
30-49 years	470	26.14	
Education			
< High school	337	28.66	<.0001
High school graduate/GED	759	28.19	
> High school	886	34.58	
Employment			
Employed	1,203	32.45	<.0001
Unemployed	402	25.65	
Student	174	34.39	
Other	137	29.59	

Preliminary Analyses

Patient Characteristics by Number of Sex Partners in Past 3 Months (N = 7,074)

	1 partner		2 or more partners		
Variable	N	%	N	%	p-value
Race/Ethnicity					
NH Black	2,892	54.79	2,395	45.30	<.0001
NH White	483	53.97	412	46.03	
Hispanic	293	67.51	141	32.49	
Sex					
Male	1,448	45.85	1,710	54.15	<.0001
Female	2,220	64.20	1,238	35.80	
Age Group					
15-19 years	735	54.44	615	45.56	<.0001
20-29 years	1,880	53.61	1,627	46.39	
30-49 years	1,053	59.86	706	40.14	
Education					
< High school	656	56.26	510	43.74	0.1075
High school graduate/GE	1,530	56.60	1,173	43.40	
> High school	1,358	53.82	1,165	46.18	
Employment					
Employed	2,072	56.12	1,620	43.88	0.0033
Unemployed	825	52.92	734	47.08	
Student	255	52.15	234	47.85	
Other	291	61.39	183	38.61	

Patient Characteristics by Categorized Sex Ratios*, Statified by Sex (N = 7,074)

	Men (N=3,411)				Women (N=3,663)			
Variable	Low	Med	High	p-value	Low	Med	High	p-value
Race/Ethnicity								
NH Black	86.92	72.46	65.79	<.0001	87.04	76.14	68.45	<.0001
NH White	8.38	17.91	26.34		7.88	15.21	20.99	
Hispanic	4.70	9.63	7.86		5.08	8.66	10.56	
Age Group								
15-19 years	16.23	14.39	14.02	0.3587	23.17	26.50	26.47	0.0019
20-29 years	54.82	53.83	56.23		51.98	45.62	52.14	
30-49 years	28.95	31.78	29.75		24.85	27.88	21.39	
Education								
< High school	20.63	18.85	18.70	<.0001	18.89	17.69	15.06	<.0001
High school graduate/GED	48.28	44.53	36.72		42.58	36.46	34.59	
> High school	31.10	36.62	44.58		38.53	45.85	50.35	
Employment								
Employed	59.15	62.17	65.36	0.1472	56.23	56.47	59.85	0.0452
Unemployed	30.27	27.54	24.58		24.50	21.43	18.54	
Student	6.12	6.08	5.59		9.01	10.49	10.22	
Other	4.46	4.20	4.47		10.25	11.61	11.39	
Number of sex partners in the last 3 months								
1 partner	45.77	45.31	46.73	0.8502	64.63	62.63	65.05	0.5154
2 or more partners	54.23	54.69	53.27		35.37	37.37	34.95	
Condom use at last intercourse								
Yes	30.04	34.51	33.05	0.0594	29.43	28.78	31.44	0.4875
No	69.96	65.49	66.95		70.57	71.22	68.56	

* Low Sex Ratio: <0.899; Medium Sex Ratio: 0.899-0.978; High Sex Ratio: >0.978 (based on tertile distribution)

Results

Patient Characteristics by Mean Sex Ratios, Statified by Sex (N = 7,074)

	Men (N=3,411)		Women (N=3,663)	
Variable	mean	p-value	mean	p-value
Race/Ethnicity				
NH Black	0.903	<.0001	0.893	<.0001
NH White	0.999		0.980	
Hispanic	0.952		0.962	
Age Group				
15-19 years	0.912	0.5123	0.921	0.0534
20-29 years	0.922		0.908	
30-49 years	0.923		0.896	
Education				
< High school	0.915	<.0001	0.888	<.0001
High school graduate/GED	0.906		0.893	
> High school	0.947		0.932	
Employment				
Employed	0.927	0.1417	0.912	0.0329
Unemployed	0.913		0.886	
Student	0.936		0.915	
Other	0.899		0.912	
Number of sex partners in the last 3 months				
1 partner	0.916	0.6316	0.911	0.2446
2 or more partners	0.920		0.902	
Condom use at last intercourse				
Yes	0.929	0.1879	0.913	0.3475
No	0.918		0.906	

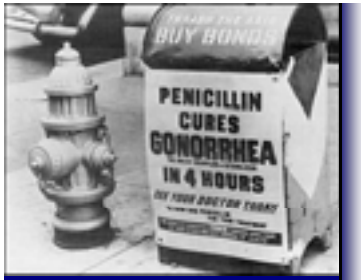
Multi-Level Modeling Results

Adjusted Odds Ratios for Condom Use, Statified by Sex (N = 6,093)

	Overall		Men		Women	
Variable	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)
Sex Ratio						
low (<0.899)	0.98	(0.95 , 1.02)	0.98	(0.94 , 1.02)	0.99	(0.94 , 1.03)
med (0.899-0.978)	1.00	(0.97 , 1.04)	1.03	(0.98 , 1.08)	0.97	(0.92 , 1.02)
high (>0.978)	1.00		1.00		1.00	

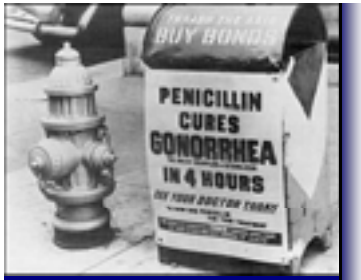
Adjusted Odds Ratios for More than 2 Sex Partners, Statified by Sex (N=6,053)

	Overall		Men		Women	
Variable	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)
Sex Ratio						
low (<0.899)	1.01	(0.97 , 1.04)	0.99	(0.94 , 1.04)	1.02	(0.97 , 1.07)
med (0.899-0.978)	1.02	(0.99 , 1.06)	1.01	(0.96 , 1.07)	1.03	(0.98 , 1.09)
high (>0.978)	1.00		1.00		1.00	



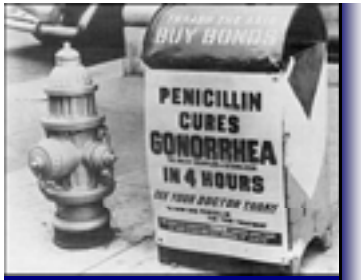
Summary of Results

- At the population level…
  - Sex ratios significantly associated with gonorrhea rates, poverty, black race, marriage rates, education
- At the individual level…
  - Condom use associated with age, sex, education, and employment
  - Number of sex partners associated with race/ethnicity, sex, age, and employment
- After multi-level analysis…
  - No significant association between sex ratios and high-risk sexual behaviors



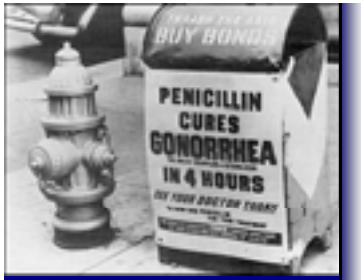
Study Limitations

- Population limited to individuals who visited STD clinics
- Limited information on interview forms
  - Self-reported behaviors
  - Missing information on marital status
- 2000 Census data



Future Directions

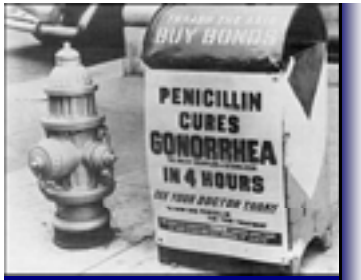
- Improved data sources
  - Geolytics population estimate data
- Other contextual factors
  - Neighborhood deterioration (broken windows)
  - Incarceration and crime rates
  - Racial and economic segregation



Parting Thoughts

…until underlying social determinants are addressed, the success of interventions to address racial disparities in STD risk and infection will be limited.

- Hogben and Leichliter (2008)


BUY BONDS
PENICILLIN
CURES
GONORRHEA
IN 4 HOURS

Questions?


WHEREVER YOU GO...
N
W
E
S
VENEREAL DISEASE IS THERE