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Neighborhood Health Care Access and Sexually Transmitted Infections among Women in the Southern United States: A Cross-Sectional Multilevel Analysis

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Abstract

Introduction—The United States (US) has experienced an increase in reportable sexually transmitted infections (STIs) while simultaneously experiencing a decline in safety net services for STI testing and treatment. This multilevel study assessed relationships between neighborhood-level access to health care and STIs among a predominantly HIV-seropositive cohort of women living in the South.

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Conflicts of Interest
There are no known conflicts to disclose.

Author Contributions
DFH conceptualized the study, analyzed and interpreted data, and led manuscript development. AE, NB, DAH, CR, GMW, HB, EG, and AAA contributed meaningfully to the interpretation of data and revision of manuscript. All authors approve the final version.

Methods—This cross-sectional multilevel analysis included baseline data from HIV-seropositive and HIV-seronegative women enrolled in the Women's Interagency HIV Study sites in Alabama, Florida, Georgia, Mississippi, and North Carolina between 2013 and 2015 (N=666). Administrative data (e.g., US Census) described health care access (e.g., percentage of residents with a primary care provider, percentage of residents with health insurance) in the census tracts where women lived. STIs (chlamydia, gonorrhea, trichomoniasis, or early syphilis) were diagnosed using laboratory testing. Generalized estimating equations were used to determine relationships between tract-level characteristics and STIs. Analyses were conducted using SAS 9.4.

Results—Seventy percent of participants were HIV-seropositive. Eleven percent of participants had an STI. A four-unit increase in the percentage of residents with a primary care provider was associated with 39% lower STI risk (RR=0.61, 95% CI=0.38–0.99). The percentage of tract residents with health insurance was not associated with STIs (RR=0.98, 95% CI=0.91–1.05). Relationships did not vary by HIV status.

Conclusions—Greater neighborhood health care access was associated with fewer STIs. Research should establish the causality of this relationship and pathways through which neighborhood health care access influences STIs. Structural interventions and programs increasing linkage to care may reduce STIs.

Keywords

Multilevel analysis; HIV-infected; sexually transmitted infections; women; health care access

Introduction

The United States (US) has experienced a dramatic increase in the rate of reportable sexually transmitted infections (STIs) in the past decade.[1] STIs cost the US health care system nearly $16 billion a year, contribute to comorbidities (e.g., pelvic inflammatory disease), ongoing transmission of STIs including HIV, and may result in congenital or neonatal transmission of STIs.[1, 2] There are marked racial and geographic disparities in the distribution of STIs in the US.[1] In 2015, the rate of newly identified infections (per 100,000 female adults/adolescents) among Black/African American women, as compared to White women, was nearly 10-fold greater for gonorrhea (371.9 vs. 38.2 cases), 9-fold greater for syphilis (5.3 vs. 0.6 cases), and 5-fold greater for chlamydia (1,384.8 vs. 256.7 cases).[1] The South consistently reports high rates of STIs; over 70% of states reporting the highest rates of chlamydia and gonorrhea in 2015 were in this region.[1]

The US has also simultaneously experienced a decline in safety net services for STI testing and treatment.[1] In 2012, more than half of state and local STI programs underwent budget cuts which resulted in clinic closures and reductions in clinic hours, contact tracing, and screening for common STIs.[1] People using STI clinic services are more likely to be poor, uninsured, non-White, and represent some of the most financially and medically vulnerable populations in the US.[3–5] Natural experiments suggest that divestment in local STI testing services results in under-identification and treatment of active STI cases.[6, 7] In this changing landscape, access to health care may be an important determinant of STI testing and treatment. Notably, in 2015, over 72% of reported chlamydia, gonorrhea, and syphilis cases were detected in venues other than STI clinics (e.g., private physician offices).[1]

Although the implementation of the Patient Protection and Affordable Care Act (ACA) has the potential to increase access to health care, including STI screening and treatment, by decreasing the number of low-income people who lack health insurance, implementation of the ACA, especially in the South, has been limited by the lack of Medicaid expansion.[8, 9] Furthermore, it is unclear how current legislation seeking to "repeal and replace" the ACA would impact insurance coverage and access to care for millions of individuals.[10] People without insurance are more likely to report poor access to health care (e.g., not having a primary care provider) and unmet needs for health care.[8, 11] Poor health care access may promote ongoing STI transmission and endemicity by increasing the proportion of the population with untreated STIs, thereby increasing the likelihood that a woman will be exposed to an infected sexual partner.[5] People with or at increased risk for HIV and other STIs tend to live closer to their sexual partners than do people from lower risk populations,[12] and a growing body of research suggests that features of the social (e.g., neighborhood socioeconomic advantage) and built (e.g., health care infrastructure) environment are associated with STIs as well as unmet needs for health care.[11, 13–15] To date, no multilevel studies have explored relationships between neighborhood-level health care access and STIs. An understanding of whether and how neighborhood health care access is associated with having an STI can inform local STI prevention programming and structural interventions, including health care policy.

This multilevel study explored relationships between neighborhood-level access to health care and having an STI among a predominantly African American, low-income cohort of women living in the South. The present analysis sought to evaluate whether:

1. neighborhood health care access (defined as the percentage of census tract residents with a primary care provider and the percentage of census tract residents with health insurance) was associated with having an STI, and;

2. relationships between neighborhood health care access and having an STI varied by HIV status. Neighborhood factors may be less influential for women with HIV, who may be more likely to receive STI screening and treatment as part of their HIV-related clinical care.[16]

This analysis was guided by the Gelberg-Andersen Model for Vulnerable Populations (G-AMVP).[17] The G-AMVP has been used successfully to describe *predisposing*, *enabling*, and *need* predictors of infectious disease and health care utilization among vulnerable populations (e.g., minorities, people living in poverty) in the US.[11, 18, 19] *Predisposing* characteristics include individual-level factors existing prior to the perception of illness (e.g., sociodemographics) and variables that reflect vulnerability (e.g., substance use). *Enabling* characteristics include facilitators or barriers to care (e.g., neighborhood health care access). *Need* includes factors that may initiate health care seeking (e.g., HIV infection).

Materials and Methods

The Women's Interagency HIV Study (WIHS) is a multisite, prospective cohort study designed to characterize the impact and progression of HIV among US women.[20, 21] Between October 2013 and September 2015, clinical research sites in Alabama, Florida, Georgia, Mississippi, and North Carolina enrolled women with HIV, as well as HIV-seronegative women. WIHS eligibility criteria included being a woman between 25–60 years old. Women with HIV were antiretroviral therapy (ART)-naïve or started highly active antiretroviral therapy (HAART) after December 31, 2004; had never used didanosine, zalcitabine, or stavudine (unless during pregnancy or for pre- or post-exposure HIV prophylaxis); and had documented pre-HAART CD4 counts and HIV viral load. HIV-seronegative women reported that either she or her sexual partner met at least one factor associated with increased risk of HIV acquisition in the last five years (e.g., illicit drug use, STI diagnosis).

Participants were recruited by WIHS using several strategies, including clinic and community-based organization referrals. Institutional Review Board (IRB) approval was obtained at each of the collaborating institutions and written informed consent was obtained prior to initiation of study procedures. Methods are described in detail elsewhere.[20, 21] This secondary analysis, approved by the University of North Carolina at Chapel Hill IRB, is restricted to WIHS participants who provided written informed consent to collect and geocode their residential address.

Measures

Outcome: Current Sexually Transmitted Infection—The binary outcome, having a current STI, was defined as a laboratory-confirmed diagnosis of: chlamydia, gonorrhea, trichomoniasis, or early syphilis (titer and confirmatory test results consistent with primary, secondary, or early latent [<1 year duration] infection) at baseline. Participants with an STI were referred to medical providers for treatment.

Census Tract Enabling Characteristics—Participant residential addresses were geocoded (i.e., latitude-longitude coordinates) and linked to census tracts. Measures capturing health care access and socioeconomic advantage in the census tracts where women lived were created using existing data sources (e.g., US Census) and reflect G-AMVP enabling factors (e.g., community resources).[17]

Census tract estimates capturing the percentage of census tract residents who reported they had at least one person who they considered to be their personal doctor or health care provider were created by PolicyMap using nationally representative Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance (BRFSS) data for 2013.[22] Multilevel models with post-stratification (including state-level estimates of residents having a primary care provider and tract-level estimates of income, age, and race/ethnicity) were used to create tract estimates.[22]

We created three measures of census tract health insurance coverage using American Community Survey (ACS) 5-year estimates (2009–2013) aligning with US Census categorizations of health insurance coverage.[23] Any health insurance coverage was defined as the percentage of tract residents aged 18–64 reporting any health insurance (i.e., employer-based, direct-purchase, Medicare, Medicaid/Means-tested public coverage, Tricare/Military health care, or VA health care). Private coverage was defined as the percentage of tract residents aged 18–64 reporting employer-based, direct-purchase, Tricare or other military health insurance. Public coverage was defined as the percentage of tract residents aged 18–64 reporting coverage through Medicaid, Medicare, VA Health Care, or individual state health plans.

Measures of census tract socioeconomic advantage were created using ACS 2013 5-year estimates: percentage of residents living above the poverty level, percentage of residents 25 or older with a high school degree or greater, percentage of residents over age 16 who were employed. Because these measures were correlated, we used principal component analysis (PCA) with orthogonal rotation (varimax) to capture underlying constructs and avoid multicollinearity. The PCA produced one component with eigenvalue >1 which accounted for 75% of the variability explained by these factors. Continuous, standardized component scores were extracted for each participant and included in multivariable models.

Participant Characteristics—WIHS collected all demographic and behavioral data using interviewer-administered questionnaires. Participant-level characteristics that might confound or modify relationships between tract-level health care access and having an STI aligning with the G-AMVP were determined a priori via a literature review.[2, 11, 17–19] Behaviors reflected the past six months and covariates were binary unless otherwise noted.

Participant predisposing characteristics included: age in years (continuous, mean-centered); non-Hispanic African American race/ethnicity; less than high school education or equivalent; being a sexual minority (gay or bisexual), and; alcohol or substance use (>7 drinks in the past week or any use of crack, cocaine, heroin, marijuana, hallucinogens, club drugs, methamphetamines, or recreational prescription drug use in the last six months).

Participant enabling characteristics included having health insurance (any public, veteran, private, or student health insurance) and competing needs for medical care (delaying or not getting needed health care due to cost).

Need was measured as being HIV-seropositive, defined as a reactive serologic enzyme-linked immunosorbent assay test and a confirmed positive western blot or a detectable plasma HIV-1 ribonucleic acid. We treated HIV status as an effect modifier in order to evaluate whether HIV status modified the magnitude or direction of the relationship between neighborhood health care access and having an STI.

Analysis

T-tests and chi-square tests were used to compare distributions of census tract and participant characteristics by HIV status. We modeled bivariate and multivariable relationships using generalized estimating equations with a binomial distribution and log link (to estimate risk ratios [RRs]) and an exchangeable correlation structure. In each model, participants were nested within census tracts, which were nested within sites. Tract-level insurance variables were correlated (Pearson r≥0.7) and as a result, modeled separately. We ran three multivariable models: each model included the mean-centered tract-level percentage of residents with a primary care provider, one of the tract-level mean-centered insurance variables (i.e., percentage of residents with any insurance, private insurance, or public insurance), and all individual-level variables.

Because an aim of this study was to determine whether the magnitudes or directions of relationships between tract-level characteristics and having a current STI vary by HIV status, we tested statistically for multiplicative interactions between neighborhood health care access and having an STI by HIV status by entering cross-level interaction terms for HIV status and each tract-level health care access measure stepwise (e.g., HIV status*percentage of tract residents with a primary care provider, HIV status*percentage of tract residents with any insurance), retaining interaction terms with $p<0.05$ in the final multivariable model.

Because past research suggests that neighborhood socioeconomic characteristics are associated with STIs as well as health care access, we also evaluated whether the relationships between census tract health care access and having an STI were independent of census tract socioeconomic advantage.[11, 12, 14, 15] As a sensitivity analysis, we re-ran each of the three final multivariable models controlling for census tract socioeconomic advantage, comparing RR estimates for tract health care access variables in models controlling for and without tract-level socioeconomic advantage. We determined a priori that differences in magnitude <10% suggested that relationships between census tract health care access and having an STI were independent of census tract socioeconomic advantage. All analyses were conducted using SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

A total of 845 women were enrolled in the Southern US. One hundred and seventy-nine women were excluded from these analyses because they 1) did not have geocoded address data (n=116; the majority of these women did not consent for geocoding [n=65, 56.0%]) or 2) were missing one or more STI laboratory test results (n=63). A comparison of all participant-level characteristics included in the multivariable models for participants excluded from the analyses, as compared to the analytic sample, indicated that participants excluded from these analyses because they were missing geocoded address data were more likely to report alcohol or substance use (48.1% vs. 37.9%, $p<0.05$). Participants enrolled at study sites other than Georgia had higher rates of missing STI data, as did HIV-seropositive participants ($p<0.05$). We included these variables in all multivariable models in order to minimize potential confounding.

In the final analytic sample (N=666), participants lived in census tracts where, on average, 68.6% of residents had health insurance and 74.0% had a primary care provider (Table 1). Eleven percent of participants (n=76) tested positive for at least one STI at baseline. The mean age of participants was 43.5 years (standard deviation [SD]=9.4), 70.7% were HIV-seropositive, and 84.6% identified as non-Hispanic African American. Participants with HIV were less likely to report being a sexual minority (6.4% vs. 16.4%), alcohol or illicit substance use (34.5% vs. 47.2%), and unmet needs for medical care (22.5% vs. 45.1%) in the past six months, but were more likely to have health insurance (63.8% vs. 50.3%) than HIV-seronegative participants (p>0.05). There were no differences by HIV status (p>0.05) in tract characteristics, nor in current STI status.

We ran three different multivariable models; each included the percentage of tract residents with a primary care provider and one of the three variables capturing tract health insurance coverage (i.e., any insurance, private insurance, public insurance). The effect estimates and corresponding confidence intervals (CIs) for tract-level percentage of residents having a primary care provider and tract-level insurance coverage were comparable (i.e., within 3%), regardless of the operationalization of tract-level health insurance coverage used (results not presented). For brevity, models including the percentage of residents with a primary care provider and the percentage of tract residents with any insurance are presented (Table 2).

In bivariate analyses, the tract percentage of residents with a primary care provider was inversely associated with having an STI (RR=0.61, 95% CI=0.38–0.97). In the multivariable model controlling for participant-level characteristics, a four-unit increase in the percentage of tract residents with a primary care provider (e.g., from 74 to 78 percent) was associated with a 39% lower risk of having an STI (RR=0.61, 95% CI=0.38–0.99). The percentage of tract residents with health insurance was not associated with STIs in bivariate (RR=0.96, 95% CI=0.90–1.02) nor multivariable models (RR=0.98, 95% CI=0.91–1.05). Relationships between neighborhood-level health care access and STIs did not vary by HIV status (all interaction terms p>0.05). Tract socioeconomic advantage was not associated with STIs in bivariate (RR=0.85, 95% CI=0.69–1.04) nor multivariable models (RR=0.87, 95% CI=0.65–1.15). Risk ratios for tract-level health care access characteristics in models with and and without tract-level socioeconomic advantage were within 3% for all comparisons, suggesting that relationships between tract-level health care access and STIs were independent of socioeconomic advantage.

Discussion

In this multilevel analysis controlling for participant-level characteristics, we found that residing in census tracts where a greater percentage of residents have a primary care provider was associated with lower risk of having an STI among women living in the South. This relationship did not vary by HIV status.

Individuals living in areas with more health care infrastructure are more likely to have a primary care provider, and in turn, utilize preventative health care services.[24] Residents living in neighborhoods with greater linkages to primary care providers may be more likely to receive STI testing and treatment as part of their regular care, and may face fewer barriers to accessing STI testing and treatment.[13, 24–26] We hypothesized that neighborhood health care access would be less influential for women with HIV, who may be more likely to receive STI screening and treatment as part of their HIV-related clinical care. However, the relationship between tract percentage of residents having a primary care provider and having an STI did not vary by HIV status. Recent research indicates that testing for STIs among persons with HIV is low, suggesting that missed opportunities for STI screening and treatment persist regardless of HIV status.[16, 27]

In 2014, the year in which the majority of participants were enrolled, nearly 90% of Americans reported having health insurance.[23] Study participants on average lived in tracts where only 67% of residents reported any health insurance coverage. Living in neighborhoods with high percentages of uninsured residents is associated with lower health care access and more unmet health needs, even among the insured.[28] Areas with low insurance coverage may face challenges attracting and maintaining health care resources, such as clinics and health care providers.[9,10] Surprisingly, tract insurance coverage was not associated with STIs, regardless of HIV status. It is likely that we did not have the power in our sample to detect relationships between neighborhood insurance coverage and STIs because 90% of study participants lived in tracts with health insurance coverage *below* the national average. This research captures neighborhood health care access prior to implementation of the ACA. Future studies could explore relationships of changes in tract-level insurance coverage to women's sexual health over time.[9]

These findings are subject to limitations. Although WIHS provides a high quality sample of women with or at increased risk of HIV infection in the Southern US, study participants agree to long-term follow-up and may not be representative of the general population. Past history of STI diagnosis (within five years) was one possible WIHS eligibility criteria for HIV-seronegative women. Participants excluded from this analysis due to a lack of geocoded address data may have lived in qualitatively different neighborhoods. However, participants with and without geocoded address data were not statistically different with respect to STI status ($p>0.05$). We did not have sufficient prevalence to assess relationships between neighborhood health care access and each STI type (e.g., chlamydia alone). However, past research supports that the geographic distributions of STIs share common spatial cores.[29] In addition, we are unable to quantify the underlying STI prevalence in participant's sexual networks. Census tract estimates capturing the percentage of residents having a primary care provider were constructed using BRFSS data, which rely predominantly on land-lines to conduct sampling frameworks and collect data; findings may not extend to cell phone only households.[30] However, systematic review suggests that BRFSS estimates of self-reported behaviors and conditions are comparable to other national surveys.[30] Due to the cross-sectional nature of our study, we are unable to draw conclusions regarding the causality of relationships between tract characteristics and STIs.

Collectively, our findings underscore the importance of neighborhood health care access in women's sexual health. Additional research is needed to establish the causal direction of relationships between neighborhood factors and STI risk, and to elucidate the pathways through which neighborhood health care access reduces vulnerability to STIs among women living in the South. If future research supports our findings, neighborhood-level programs increasing access and linkage to health care may reduce STIs and improve women's sexual health.

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Short Summary

In a predominantly HIV-seropositive cohort of women living in the southern US, women living in neighborhoods with better health care access were less likely to have sexually transmitted infections.

Table 1

Distributions of baseline census tract and participant characteristics among 666 women enrolled in the Women's Interagency HIV Study Southern sites

Characteristics of participants and census tracts	Overall n (%) or mean (SD) N=666	HIV-seropositive n (%) or mean (SD) n=471	HIV-seronegative n (%) or mean (SD) n=195
Outcomes			
Laboratory confirmed sexually transmitted infection	76 (11.4)	55 (11.7)	21 (10.8)
Chlamydia	8 (1.2)	4 (0.8)	4 (2.0)
Gonorrhea	6 (0.9)	5 (1.1)	1 (0.5)
Trichomoniasis	44 (6.6)	32 (6.8)	12 (6.1)
Syphilis	21 (3.2)	17 (3.6)	4 (2.0)
Census tract enabling characteristics			
Health care access[1]			
Percentage of residents with a primary care provider	74.0 (2.3)	74.0 (2.3)	74.9 (2.3)
Percentage of residents with any health insurance	68.6 (12.0)	68.5 (11.8)	69.0 (12.6)
Percentage of residents with private health insurance	50.4 (17.4)	50.1 (16.7)	51.1 (19.1)
Percentage of residents with public insurance	15.4 (9.0)	15.3 (9.0)	15.2 (9.0)
Socioeconomic advantage			
Percentage of residents with annual incomes above poverty level	70.8 (13.8)	71.2 (13.3)	69.8 (14.8)
Percentage of residents with a high school degree or greater	80.2 (10.2)	80.2 (10.1)	80.4 (10.4)
Percentage of residents who are employed	83.8 (8.0)	84.0 (7.8)	83.1 (8.6)
Participant characteristics[2]			
Enabling			
Health insurance	398 (59.8)	300 (63.8)[3]	98 (50.3)[3]
Competing needs for medical care	194 (29.2)	106 (22.5)[3]	88 (45.1)[3]
Predisposing			
Age in years	43.5 (9.4)	44.0 (9.2)	42.5 (9.7)
Non-Hispanic African American	554 (83.2)	388 (82.4)	166 (85.1)
Less than high school education	202 (30.3)	147 (31.2)	55 (28.2)
Sexual minority	62 (9.3)	30 (6.4)[3]	32 (16.4)[3]
Alcohol or illicit substance use	254 (38.2)	162 (34.5)[3]	92 (47.2)[3]
Need			
HIV-seropositive	471 (70.7)	--	--

[1] 1 participant missing census tract insurance.

[2] 1 participant missing health insurance and unmet need and alcohol or illicit substance use.

[3] Comparison by HIV status, $p<0.05$.

Table 2

Bivariate and multivariable relationships between neighborhood health care access and having a sexually transmitted infection at baseline among women enrolled in the Women's Interagency HIV Study Southern sites

Characteristics of census tracts and participants	Bivariate Model RR (95% CI)	Multivariable Model[1] aRR (95%CI)[1]	Sensitivity Analysis[1] aRR (95%CI)[1]
Census tract enabling characteristics			
Percentage of residents with a primary care provider (4 unit increase)	**0.61 (0.38–0.97)**[2]	**0.61 (0.38–0.99)**[2]	**0.59 (0.35–0.97)**[2]
Percentage of residents with any health insurance (4 unit increase)	0.96 (0.90–1.02)	0.98 (0.91–1.05)	1.01 (0.92–1.11)
Socioeconomic advantage component (1 standard deviation increase)[3]	0.85 (0.69–1.04)	--	0.87 (0.65–1.15)
Participant characteristics			
Enabling			
Health insurance	1.13 (0.72–1.75)	1.09 (0.73–1.65)	1.10 (0.73–1.66)
Competing needs for medical care	0.66 (0.39–1.11)	0.68 (0.40–1.14)	0.68 (0.40–1.14)
Predisposing			
Age in years	1.02 (1.00–1.05)	1.02 (0.99–1.04)	1.02 (0.99–1.04)
Non-Hispanic African American	1.51 (0.77–2.94)	1.33 (0.69–2.57)	1.30 (0.67–2.50)
Less than high school education	1.27 (0.81–1.97)	1.12 (0.72–1.74)	1.09 (0.69–1.70)
Sexual minority	1.00 (0.47–2.12)	0.86 (0.39–1.89)	0.85 (0.39–1.88)
Alcohol or illicit substance use	1.49 (0.98–2.28)	1.52 (1.00–2.30)	1.48 (0.97–2.25)
Need			
HIV-seropositive	1.08 (0.76–1.74)	1.02 (0.63–1.63)	1.03 (0.64–1.65)
Model fit			
QIC	--	471.32	472.40
QICu	--	471.86	472.95

[1] Multivariable modeling was restricted to participants with no missing data for predictor variables (n=664).

[2] Bold text indicates statistical significance (confidence intervals do not cross 1)

[3] Component includes tract percentage of residents living above the poverty level, percentage of residents 25 or older with a high school degree or greater, percentage of residents over age 16 who were employed.