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Are Neighborhood Sociocultural Factors Influencing the Spatial Pattern of Gonorrhea in North Carolina?

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PURPOSE: To determine if the spatial pattern of gonorrhea observed for North Carolina was influenced by neighborhood-level sociocultural determinants of health, including race/ethnicity.
METHODS: A generalized linear mixed model with spatially correlated random effects was fit to measure the influence of socio-cultural factors on the spatial pattern of gonorrhea reported to the North Carolina State Health Department (January 1, 2005 to March 31, 2008).
RESULTS: Neighborhood gonorrhea rates increased as the percent single mothers increased (25th to 75th neighborhood percentile Relative Rate 1.18, 95% CI 1.12, 1.25), and decreased as socioeconomic status increased (Relative Rate 0.89, 95% CI 0.84, 0.95). Increasing numbers of men in neighborhoods with more women than men did not change the gonorrhea rate, but was associated with decreased rates in neighborhoods with more men than women. Living in the mountains was protective for all race/ethnicities. Rurality was associated with decreased rates for Blacks and increased rates for Native Americans outside the mountains.
PURPOSE: Neighborhood-level sociocultural factors, primarily those indicative of neighborhood deprivation, explained a significant proportion of the spatial pattern of gonorrhea in both urban and rural communities. Race/ethnicity was an important proxy for social and cultural factors not captured by measures of socioeconomic status.
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KEY WORDS: Bayesian Analysis, Gonorrhea, Social Epidemiology, Spatial Analysis.

INTRODUCTION

Sexually transmitted infections (STIs) tend to cluster in geographically definable core areas, or risk spaces (1–15). These core areas often are located in low socioeconomic status (SES) urban neighborhoods (4, 7, 9, 16, 17), suggesting that sociocultural determinants of health may influence the clustered spatial pattern observed for STIs.

Several sociocultural risk factors have been associated with gonorrhea in urban environments, including individual level factors such as SES and community level (e.g., county or state), factors such as prevalence of infection (18), percent urbanicity (19), neighborhood instability (20), gender imbalance with more women than men, low social capital (21, 22), and a high percentage of black or Hispanic residents (5, 23). For instance, low SES can impair timely access to STI services, thereby increasing the duration of infection and ultimately the prevalence of infection within a sexual network. Prevalence of an STI has a direct impact on the incidence of infection. As STI prevalence increases, the likelihood of finding a sexual partner that has an STI also increases. The power to negotiate the terms and conditions around sex is affected by both an imbalanced sex ratio and the proportion of single parents in a community (18). An imbalanced sex ratio, with more women than men, may increase the practice of high-risk behaviors, including unprotected sex and the exchange of sex for resources (money, food, shelter, father/mother figure, etc.) (24–26). The association between the spatial distribution of sociocultural factors with the spatial pattern of STIs has been studied for urban environments but not for rural environments.

Rurality may influence STI transmission through the low density and availability of partners within a sexual network, as well as the culture and social norms around sex and relationships within a community. Rurality may also act as a proxy for low physician density, poor access to STI

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Selected Abbreviations and Acronyms

STIs = sexually transmitted infections
SES = socioeconomic status
RUCAs = rural-urban commuting area codes
RR = relative rate
CI = confidence interval

health services, or community racial/ethnic homogeneity and hence, partner STI prevalence.

Race/ethnicity itself is not causally associated with STIs (27); however, it can provide strong predictive power of STI risk (28–33). For instance, in North Carolina, racial/ethnic differences in gonorrhea rates have persisted over time (18, 29), suggesting that race/ethnicity is a proxy for other STI risk factors. Possible explanatory factors include partner STI prevalence, assortative mixing, historic segregation, racism, unequal access to health care, or high incarceration rates (18, 29, 32, 34).

Our primary objective was to determine whether the spatial pattern of gonorrhea observed for North Carolina was influenced by neighborhood-level sociocultural determinants of health (Figure 1). A secondary objective was to investigate the influence of race/ethnicity on the spatial pattern of gonorrhea, after accounting for known, measurable social factors.

METHODS

Gonorrhea and Population Data

In North Carolina, health care providers and laboratories are required to report suspected and newly identified cases of gonorrhea to the local health department. Basic demographic information is collected for each case on a case report card that is forwarded to the local health department, county health department, state health department, and finally to the Centers for Disease Control and Prevention. The North Carolina Department of Health and Human Services, Epidemiology Section, Branch of HIV/STD Prevention & Care, provided individual-level, deidentified, and geomasked (35, 36) gonorrhea case data for this analysis. These data were aggregated by race/ethnicity, census tract, and 3-month time intervals from January 1, 2005, to March 31, 2008.

Census tract level population estimates for the state of North Carolina were obtained from the U.S. Census Bureau for the year 2000 and from the Environmental Systems Research Institute, Inc (Redlands, CA) for the year 2007. A linear interpolation of population estimates from 2000 to a projected estimate for 2007 and an extrapolation to 2008 were used to approximate yearly underlying populations. Underlying population estimates were used as the offset during Poisson modeling.

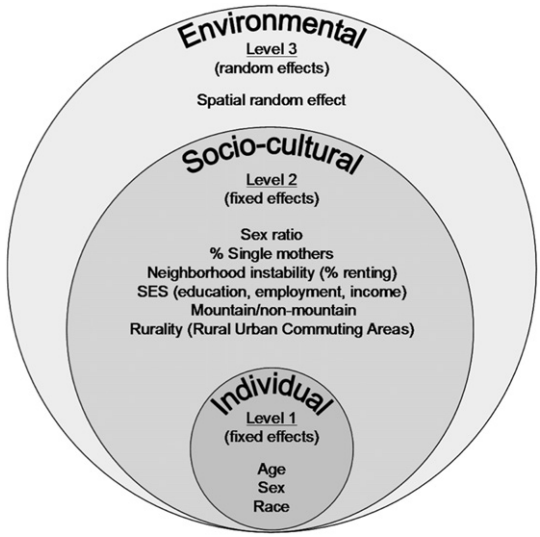

FIGURE 1. Conceptual model of the sociocultural and environmental factors thought to influence neighborhood gonorrhea rates in North Carolina and how they were modeled in a generalized linear mixed model with spatial random effects.

Social Determinants

Male-to-female sex-ratio (males/females; sex ratio), percent female head of household with a child (single mother), and percent renting were obtained at the neighborhood-level (census tract) for the year 2000 from the U.S. Census Bureau. The relative rate was a linear function of the logged male-to-female sex-ratio with a change point at 1 (or 0 on the log scale) and constant after 2 males per female. The proportion of renters was used as an indication of neighborhood instability with the assumption that as this proportion increases, neighborhood instability also increases because of greater neighbor turnover, resulting in lower social capital. To construct an indicator for SES, we performed a principal components analysis of three census variables including percent less than high school education, percent with a household income less than $30,000 per year, and percent unemployed. Only the first component was retained as a continuous indicator, which accounted for 66% of the total variation.

Rural Urban Commuting Areas

Rural urban commuting areas (RUCAs) at the census tract level were used to define rurality (37). RUCAs are separated into 10 primary and 30 secondary categories and classified according to population density, urbanization, as well as the percent of residents that commute daily to an urban area. RUCAs were used as opposed to other classifications of rurality, such as percent rural, because they account for daily commuting patterns, which may be an important factor when considering social and sexual networks. For the purpose of