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Original article

Correlates of county-level nonviral sexually transmitted infection hot spots in the US: application of hot spot analysis and spatial logistic regression

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ABSTRACT

Purpose: We used a combination of hot spot analysis (HSA) and spatial regression to examine county-level hot spot correlates for the most commonly reported nonviral sexually transmitted infections (STIs) in the 48 contiguous states in the United States (US).

Methods: We obtained reported county-level total case rates of chlamydia, gonorrhea, and primary and secondary (P&S) syphilis in all counties in the 48 contiguous states from national surveillance data and computed temporally smoothed rates using 2008–2012 data. Covariates were obtained from county-level multiyear (2008–2012) American Community Surveys from the US census. We conducted HSA to identify hot spot counties for all three STIs. We then applied spatial logistic regression with the spatial error model to determine the association between the identified hot spots and the covariates.

Results: HSA indicated that $\geq 84\%$ of hot spots for each STI were in the South. Spatial regression results indicated that, a 10-unit increase in the percentage of Black non-Hispanics was associated with $\approx 42\%$ ($P < 0.01$) [$\approx 22\%$ ($P < 0.01$), for Hispanics] increase in the odds of being a hot spot county for chlamydia and gonorrhea, and $\approx 27\%$ ($P < 0.01$) [$\approx 11\%$ ($P < 0.01$) for Hispanics] for P&S syphilis. Compared with the other regions (West, Midwest, and Northeast), counties in the South were 6.5 ($P < 0.01$; chlamydia), 9.6 ($P < 0.01$; gonorrhea), and 4.7 ($P < 0.01$; P&S syphilis) times more likely to be hot spots.

Conclusion: Our study provides important information on hot spot clusters of nonviral STIs in the entire United States, including associations between hot spot counties and sociodemographic factors.

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Introduction

Chlamydia, gonorrhea, and syphilis are the most commonly reported curable sexually transmitted infections (STIs) in the United States (US). In 2008, they accounted for approximately \$718 million in direct medical costs [1]. In the last few years, reported rates of chlamydia, gonorrhea, and syphilis have increased. However, research consistently shows that these infections are not equally distributed geographically or

demographically [2,3]. According to surveillance data, the highest rates of chlamydia and gonorrhea are in the South and among non-Hispanic Blacks. In addition, disproportionately high rates of primary and secondary (P&S) syphilis have been reported in the West and among males [2].

To identify high concentrations of STI burden in communities, several studies have used spatial analytical methods and geographic information systems [4–16]. From the US national perspective, one way of identifying statistically significant clusters of high STI rates is the use of hot spot analysis (HSA), using counties as the geographic unit [17]. A “hot-spot” is a specific geographic unit that has a statistically significantly higher value and is also surrounded by neighboring units that have significantly high values, while a “cold-spot” is the inverse. From a practical and programmatic standpoint, a major advantage of HSA is the ability to delineate specific geographic units based on statistically significant differences. Other thematic maps that identify different levels of morbidity (such as those based on “quantiles” or

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“Jenks natural breaks”) do not offer rigorously estimated categorical differences [18]. Because the choice of a cutoff morbidity is largely arbitrary and/or subjective, using maps based on “quantiles” or “Jenks natural breaks” to identify and target counties for STI prevention efforts might not be cost-effective. In addition, morbidity measures between two geographic units found in two adjacent categories of morbidity that were created using “quantiles” or “Jenks natural breaks” might not be significantly different.

HSA can be used to inform interventions. In a recent study, HSA was used to target locations of statistically significant clusters of Women, Infant, and Children—eligible nonparticipants in the state of California [19]. However, HSA studies of US-wide nonviral STIs using counties as the geographic unit are lacking. In addition, although the association between STI rates and sociodemographic factors at the county and state level has been reported [9,20–25], studies examining the association between hot spot counties and sociodemographic factors using data from the entire US is lacking. To fill in these STI research gaps, the present study has two objectives: 1) to use HSA to identify chlamydia, gonorrhea, and P&S syphilis hot spot counties in the 48 contiguous states in the US; 2) to examine the county-level correlates of the identified hot spot counties for each of the STIs.

Methods

Data

We obtained reported county-level total case rates of chlamydia, gonorrhea, and P&S syphilis in all counties in the 48 contiguous states from the National Notifiable Disease Surveillance System for 2008–2012. We computed temporally smoothed rates as the sum of all cases divided by the sum of the resident population across the years, and then multiplied by 100,000 [23,24] for each county. The temporally smoothed rates for the years selected were used for three reasons. First, the

sociodemographic variables that are available for all counties in the US for the years we analyzed, which have increased statistical reliability for small areas/populations [26], were the five-year estimates provided by the American Community Surveys. Second, temporal smoothing is one way of reducing the small population problem often associated with small counties. Finally, temporal smoothing provides a more representative measure of the burden of the disease over a long period, compared with the burden recorded over a one-year period [13,22,24]. Figure 1 shows quintile choropleth maps of the temporally smoothed rates.

Following published literature [9,22–24], we assembled select county-level sociodemographic variables from American Community Surveys—five-year estimates for 2008–2012. The sociodemographic variables included percent Black (non-Hispanic), percent White (non-Hispanic, referent race category), percent Hispanic, percent American Indian, percent American Asian, percent unemployed, percent families below poverty level, percent completing high school or higher, per capita income, percent insured, median household income, percent aged 18 to 24 years, percent aged 25–44 years, birth rate, population density, and a commute index (i.e., percent with > 1 hour commute time) [9,22,23].

Based on our preliminary results and the reported disproportionate burden of STIs in the South when compared with the other regions [2], we explored potential differences between the counties in the Southern states and the counties in the states of the other regions (West, Midwest, and Northeast, based on Census region classification). In the context of the rural-urban STI morbidity continuum, several studies have examined the burden of STIs in the rural [15,27–35] and urban [15,28,29,34,36–42] areas. To explore potential differences in the hot spots for each STI between metro (urban) and nonmetro (rural) counties, we used the 2013 rural-urban continuum codes developed by the United States Department of Agriculture (Economic Research Services) to identify metro (i.e., rural-urban continuum codes 1–3 [43]) and nonmetro (i.e., rural-urban continuum codes 4–9 [43]) counties [43]. See Table 1 for more details.

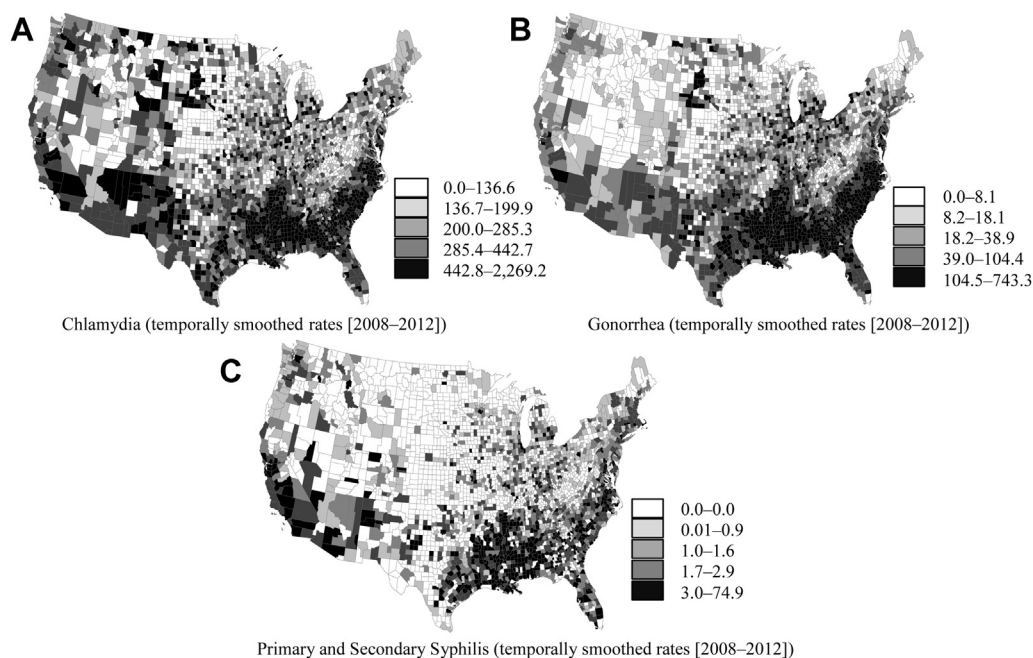


Fig. 1. Quintile choropleth maps of county-level reported temporally smoothed (2008–2012) total nonviral sexually transmitted infection (A: chlamydia, B: gonorrhea, and C: primary and secondary syphilis) rates for the 48 contiguous states in the US.

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