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Close to Home: The Use of an Area-Based Socioeconomic Measure as an Indicator of Chlamydia Risk in Virginia

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Abstract

Objectives. There is a lack of socioeconomic data collected through routine public health surveillance in Virginia. This analysis utilizes area-based socioeconomic measures to characterize chlamydia cases in Virginia at the census tract level. This methodology can provide policymakers with the ability to track and improve social disparities in health.

Methods. From the Virginia Department of Health the researcher obtained reported cases of chlamydia infection for a five-year period (2005 – 2009). This data was geocoded to the tract level using Centrus GeoStan. In addition, the researcher obtained census tract-level population data from Geolytics and tract-level poverty data from the United States Census Bureau. Tracts were stratified into discrete poverty levels, age standardized incidence rates were calculated for each stratum of poverty, and 95% confidence intervals based on the gamma distribution were calculated.

Results. The discrete levels of poverty were categorized as 0 – 4.9% (488 tracts, 20% chlamydia cases), 5.0 – 9.9% (422 tracts, 24% of chlamydia cases), 10.0 – 19.9% (410 tracts, 30% chlamydia cases), and 20 – 100% (205 tracts, 26% chlamydia cases). Risk of chlamydia infection increases relative to that of the first level (0 – 4.9%) as the percent of impoverished residents in a census tract rises to 5.0 – 9.9% (1.59x greater risk), 10.0 – 19.9% (2.23x greater risk), and 20 – 100% (4.69x greater risk).

Conclusions. This study produces policy-relevant results that contribute to national efforts to better monitor the implications of socioeconomic equalities in the United States.

Introduction

According to the World Health Organization, Chlamydia trachomatis is the most common cause of sexually transmitted infection. The Center for Disease Control and Prevention has reported a steady rise in Chlamydia rates from 1986 through 2005. Chlamydia is the most reported bacterial sexually transmitted infection in the United States[i], with an estimated 2.8 million[ii] new cases per year Typically asymptomatic, Chlamydia infection is believed to be underreported despite increased screening and education efforts. Chlamydia alone is responsible for an annual disease burden of $10 billion in worldwide treatment costs. That figure does not include the costs associated with any follow-on conditions, such as infertility and arthritis, for which those who have had the Chlamydia infection are at higher risk[iii].

Two metropolitan areas with historically high rates of Chlamydia infection, Richmond and Hampton Roads, are located in the state of Virginia. Within the past 20 years, both cities held a spot among the top ten most infected cities, with Hampton Roads peaking in second place[iv],[v]. Upwards of 32,000 new cases are reported annually in Virginia from among its roughly 8 million inhabitants.

Chlamydia reporting is mandated by law across the United States, yet the lack of money received at the state level to support these reporting programs results in a wide variety of reporting processes and accompanying disparities in data quality. Surveillance in the state of Virginia falls under the Sexually Transmitted Disease (STD) Prevention Program administered by the Virginia Department of Health (VDH)[vi]. Physicians and/or lab directors must report all known cases of chlamydia to their local health department within three days. This morbidity report requests the patient's address, which can be geocoded, as well as age, race, and other identifiers of analytical interest[vii]. However, no indicators of socioeconomic status are reported.

This study replicates methods developed by for the Harvard School of Public Health's Public Health Disparities Geocoding Project. It provides a framework for comparing disease rates and measures of poverty at the census tract-level. Dr. Nancy Krieger developed this method in response to a lack of socioeconomic data in US public health surveillance systems. Widely implemented, this method would allow for the monitoring of socioeconomic inequalities in US health, which could lead to the uncovering of their contributions, if any, to racial/ethnic and gender inequalities in health[viii]. This type of scholarship contributes to overarching objective #2 of the US Department of Health and Human Services' *Healthy People* program goals, which calls for the achievement of health equity, the elimination of health disparities, and the improvement of health for all groups by 2020[ix].

Methods

From the Virginia Department of Health the researcher obtained reported cases of state-level chlamydia infection for a five-year period (2005 – 2009). This data was geocoded to the census tract level using Centrus Geostan. In addition the researcher obtained tract level poverty data from the United States Census Bureau. Population data for each Census tract was retrieved through Geolytics, a commercially-available demographics dataset based on the 2000 Census dataset.

Each Census tract is designed to have between 2,500 and 8,000 residents sharing relatively homogenous housing and socioeconomic conditions. They are demarcated by some physical feature, like a street or a power line. Tract boundaries remain from census to census unless population fluctuations necessitate the splitting of a single, larger tract into two or more smaller tracts[x].

Poverty in Virginia, year 2000

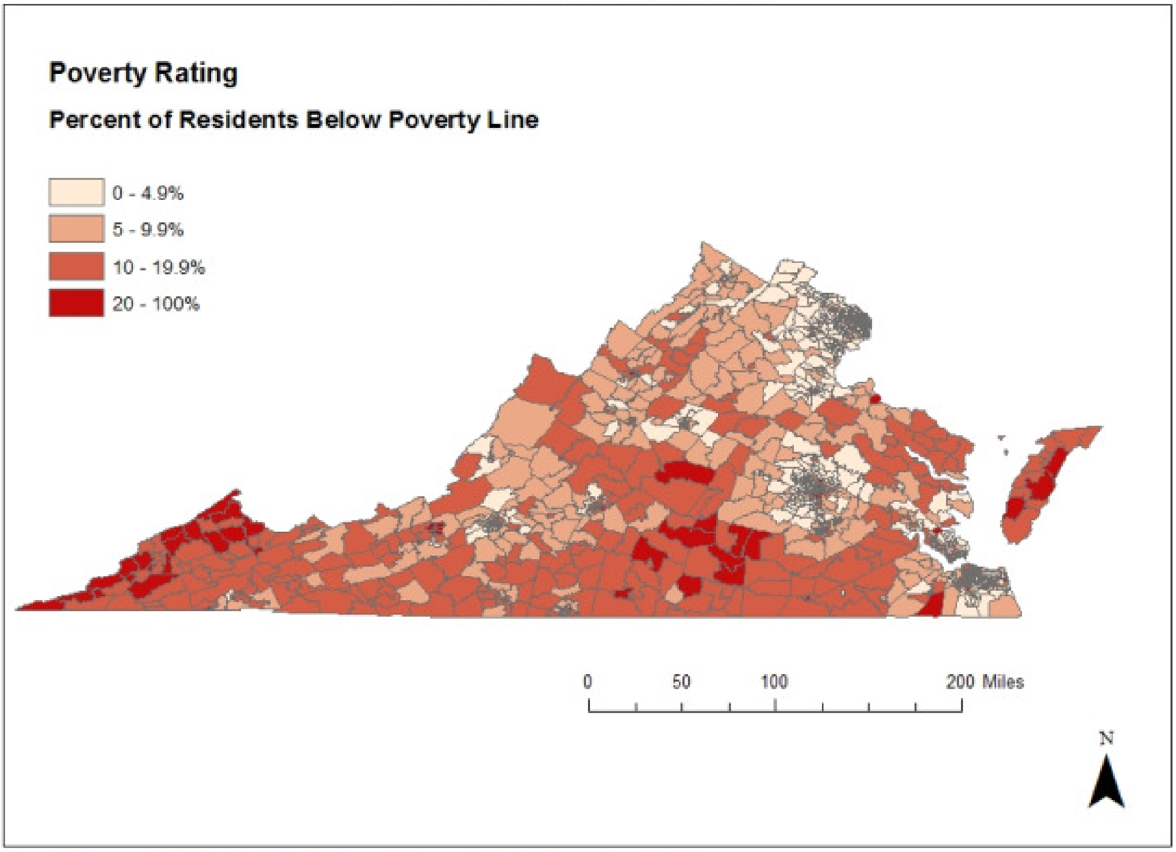

Figure 1. Percent of Virginia Residents Below the Poverty Line by Census Tract, 2000

Using SAS 9.2, a business analytics software, the researcher aggregated the reported cases from 2005 – 2009 to the census tract level. This aggregation, both spatial and temporal, serves to reduce the potential for the identification of any individual cases. Chlamydia was reported in all Census tracts in the state of Virginia between 2005 and 2009.

Outcomes were geocoded to the census tract level. Any tract without poverty data was at this point excluded from the analysis. The tracts were then stratified into discrete poverty levels (0 – 4.9%, 5.0 – 9.9%, 10.0 – 19.9%, 20 – 100%), identified by the percent of the population living below the poverty line. This created an area-based socioeconomic measure with which to characterize the cases and population by tract. The largest range of values appeared in the 20 – 100% category. This categorization was utilized to maintain consistency with the U.S. Department of Commerce designation of poverty areas. Poverty Areas are associated with differences in racial and ethnic make-up, employment rate, family structure, and

Figure 2. Age-Standardized Rates of Chlamydia Infection per 1000 people

Poverty Index	Age-Standardized Rate	Lower 95% Confidence Interval	Upper 95% Confidence Interval
0 – 4.9%	15.35	15.15	15.55
5 – 9.9%	24.33	24.04	24.62
10 – 19.9%	34.17	33.80	34.54
20 – 100%	71.99	71.16	72.82

education, all of which can contribute to changes in the rate of chlamydia infection[xi].

Age-standardized rates were calculated for each stratum of poverty using the year 2000 standard population. Five age groups (0 – 14, 15 – 24, 25 – 44, and 45 – 64) were selected to maintain consistency with VDH reporting and to facilitate comparison between age groups of interest. It was important for the researcher to age standardize data in order to control for the varying of age differences in data, as chlamydia affects certain age groups disproportionately. This provided a more reliable estimate for comparison. Next, incidence rate ratios were calculated for each stratum of poverty, and 95% confidence intervals based on inverse gamma distribution were calculated. This technique was utilized to avoid "impossible" lower limits, those that are less than zero, that traditional confidence interval calculations can return. Developed by Michael P. Fay and Eric J. Feuer, the 'gamma' confidence intervals are considered to produce a more conservative estimation of the confidence intervals than other, similar methods. By assuming that the direct standardized rate is a linear combination of independent Poisson random variables that follows a Poisson distribution, it can be understood that the age-standardized rate follows a gamma distribution[xii]. The ultimate methodology is that of Rosenberg and Anderson, who implement the year 2000 standard[xiii].

Results

The chlamydia data set consisted of 112,908 cases of chlamydia across the 1540 Census tracts in the state of Virginia between 2005 and 2009. Sixteen tracts were excluded due to lack of poverty data, leaving 1524 usable tracts containing 112,851 cases for analysis.

Poverty level by tract was visualized using ArcGIS 10 (figure 1). In summary, the discrete levels of poverty were categorized as 0 – 4.9% (488 tracts, 20% chlamydia cases), 5.0 – 9.9% (422 tracts, 24% of chlamydia cases), 10.0 – 19.9% (410 tracts, 30% chlamydia cases), and 20 – 100% (205 tracts, 26% chlamydia cases).

Age-standardized rates and their accompanying gamma confidence intervals were calculated using SAS 9.2 (figure 2).

Figure 4. Chlamydia Risk Relative to Areas of Lowest Poverty

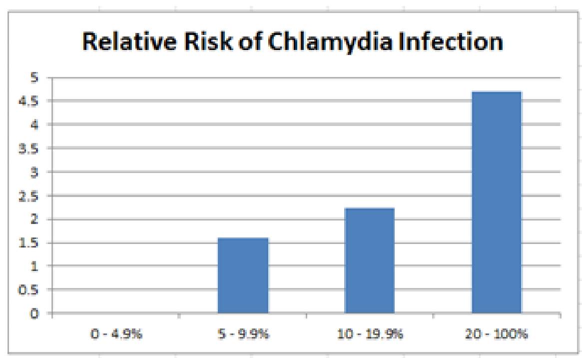

Figure 3. Risk of Chlamydia Relative to Least-Impoverished Areas

Poverty Index	Age-Standardized Rate Ratio	Lower 95% Confidence Interval	Upper 95% Confidence Interval
0 – 4.9%	*	.98	1.02
5 – 9.9%	1.59	1.56	1.61
10 – 19.9%	2.23	2.19	2.26
20 – 100%	4.69	4.61	4.77

Risk of chlamydia infection increases relative to that of the first level (0 – 4.9%) as the percent of impoverished residents in a census tract rises to 5.0 – 9.9% (1.59x greater risk), 10.0 – 19.9% (2.23x greater risk), and 20 – 100% (4.69x greater risk) (Figures 3,4).

Discussion

These results can be applied immediately to pressing policy questions. For example, since 1995, the Center for Disease Control's Infertility Prevention Project (IPP) has allocated federal funds in support of the administration of Nucleic Acid Amplification Tests (NAATs) for chlamydia[xiv]. Ideally, these tests would be administered to all sexually active females aged 15 -24, as chlamydia affects women in this age group disproportionately. However, IPP only funds 100,000 tests per year for the state of Virginia's roughly 8 million residents.

Some known risk factors, including age, number of partners, and residence in areas with known chlamydia history, are used to target test distribution. However, in 2009, only 7.2% of women tested for Chlamydia in the state of Virginia tested positively[xv]. Positivity rates in region III, in which Virginia is included, have seen only modest increases while the morbidity rate has remained the same[xvi]. Chlamydia's asymptomatic nature and association with infertility necessitate early screening and warrant the targeting of available tests to the most at-risk populations. The inclusion of more effective indicators, like poverty, in the test distribution process should contribute to a higher positivity rate in the tests administrated. Over time, with education and other prevention efforts also aimed at those same areas, a lower overall morbidity rate can be reached.

Particularly powerful and clear in its simplicity, the relative risk statistic can be useful to those public health professionals responsible for not only vetting potential indicators but also subsequently communicating their efficacy to policymakers. Timely, easy-to-understand results will help avoid the two most common pitfalls associated with the use of statistics in decision-making: over-reliance and complete disregard.

Lack of information, due either to lack of geocodable information or residence in an area without poverty data, is an unlikely source of bias for these results. 100% of the cases were correctly geocoded, and only sixteen tracts (1.04%) were excluded due to lack of poverty data.

Similarly, the use of "area-based socioeconomic measures (ABSMs)," in this case the percentage of residents in a census tract living below the poverty line, is unlikely to bias results. In capturing a mix of individual-level and area-based effects, ABSMs can avoid the false assumptions inherent in the application of an individual-level measure to a wider area. As Dr. Krieger discussed in her seminal article, they encompass three factors: composition (poor people having poor health because they are poor), context (poor people in poor areas being poor because a concentration of poverty creates or exacerbates harmful social interactions), and location of public goods[xvii].

The semi-permanence of tracts allows for a decline in socioeconomic and housing homogeneity as neighborhoods mature. However, the federal government uses census tracts to determine medically underserved areas[xviii] as well as eligibility for the Low Income Housing Tax Credit[xix]. Census tracts do have real-life implications for residents.

The research presents a baseline analysis at the census tract level. Additional analysis could include testing the statistical significance of the results, drawing attention to the disparities presented in such a way that encourages future involvement by academics.

Further analysis could also include the introduction of spatial statistics. The Moran's I tests whether the individual cases are clustered, dispersed in any statistically significant way, or randomly distributed. Should the cases be clustered, hot spot analysis could then be conducted. Hot spot analysis compares each feature with its surrounding features, suggesting 'hot spots' in areas exhibiting like high values and 'cool spots' where there are like low values, resulting in a clear product for visual assessment. Such spatial analysis would result in a more detailed imaging of the spatial patterning of chlamydia infection not limited to census tract boundaries.

In conclusion, this study produces policy-relevant results that contribute to national efforts to better monitor the implications of socioeconomic equalities in the United States.

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