2-11-2022

An Exploratory Quantitative Analysis of Chlamydia Rates and Female Access to Contraceptive Services in the United States, 2015

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February 11, 2022

Abstract

Purpose: Chlamydia rates have steadily increased over the past two decades in the United States. Access to contraceptives is essential for preventing transmission. This project examined the relationship between female access to contraceptive services at publicly-funded health clinics and chlamydia rates the county level in 2015. This project also examined associations between chlamydia rates and contraceptive access across rural and urban counties and by U.S. region.

Methods: Data on chlamydia rates, publicly-funded clinics, and contraceptive clients in 2015 were obtained from open-access databases and published reports by the Center for Disease Control and Prevention (CDC) and the Guttmacher Institute. Simple linear regression models were used to examine associations between the number of women that obtained contraceptive services at publicly-funded clinics within the 15-44 year-old female population and chlamydia rates.

Results: Regression results indicated a positive association between female contraceptive client rates and chlamydia rates in the U.S. ($p < .0001$). Significant associations were found in the West, where for every 1 female contraceptive client per 100 reproductive-aged women, there were 1.34 chlamydia cases per 100,000 population ($p = 0.017$). In the Midwest, for every 1 female contraceptive client per 100 reproductive-aged women, there were 6.89 more chlamydia cases per 100,000 population ($p < .0001$). Positive associations were also found in rural counties ($p < .0001$) and urban counties ($p < .0001$), separately.

Conclusions: In 2015, access to publicly-funded contraceptive services by women was associated with higher chlamydia rates at the county level in the U.S. There was a significant relationship between contraceptive access and chlamydia in Midwest and Western regions and across rural and urban counties. Further research is needed to understand the factors that affect infection rates and access to contraceptive services at county and regional levels, including geographic distribution of publicly-funded clinics and access to STI testing services at clinics.

Introduction

As chlamydia rates have continued to rise over the last two decades in the United States, impacting women at nearly twice the rate of men, it is critical to understand the many causal and preventive factors of disease transmission. [1] Access to contraceptives, primarily condoms, and other sexual and reproductive health services significantly affects the detection and management of sexually transmitted infections (STIs).[2] Publicly-funded clinics are essential providers for family planning services, especially for low-income and uninsured women.[3] This study examines the relationship between access to contraceptive services at publicly-funded clinics among reproductive-aged (15-44 year-old)[i] women and overall chlamydia case rates at the county level in the U.S. in 2015.

Background

Chlamydia is one of the most frequently reported STIs in the U.S. and infection rates have steadily increased over the past ten years. From 2014-2018, chlamydia cases increased 19% nationally.[1] In 2019, 64% of new cases were among women.[2] Women are more likely to receive a chlamydia diagnosis due to CDC recommendations for annual chlamydia screenings for sexually active women under 25 years-old and they present with symptoms more often than men.[2] Still, most chlamydia cases are asymptomatic. Female access to STI screening services and physical barrier contraceptives (condoms) is critical, as untreated chlamydia infections can lead to pelvic inflammatory disease, infertility, and ectopic pregnancy.[2] While condoms are relatively low-cost and widely available compared to other contraceptive methods, access varies across populations, particularly among the 15-19 year-old age group, which has the second-highest reported chlamydia rate nationally.[1,4]

Previous studies of STI diagnosis and screening rates at the county level in the U.S. have found that chlamydia rates are significantly higher across rural and urban counties in the South.[5,6] A study of STI screening services provided in various outpatient settings from 2009-2016 found that STI testing rates were highest in the South and lowest in the Midwest.[6] In some states, legislation that restricts the types of sexual health services, such as STI treatment, available to individuals with public insurance can impact STI rates and disease management, especially in rural areas.[7]

Contraceptive Services and Title X-Funded Clinics

Publicly-funded health clinics, including federally qualified health centers, local health department clinics, and not-profits like Planned Parenthood, provide sexual and reproductive health services to millions of women in the U.S. annually. In 2015, one-third of publicly-funded family planning clinics in the country received partial or full funding through Title X, the federal

[i] The World Health Organization uses 'women of reproductive age' to refer to females 15-49 years old while the Centers for Disease Control and Prevention uses this descriptor for women 15-44 years old. These precise age ranges are not inclusive of all people that become pregnant and give birth. For the purpose of this study's population analyses, I use 'reproductive-aged women' to describe data representing females between the ages of 15 and 44.

family planning program.[8] The Guttmacher Institute estimates[9] that contraceptives provided by Title X-funded clinics prevented nearly 44,000 chlamydia infections in 2016. Changes to Title X funding criteria introduced by the Trump administration in 2019 effectively blocked sexual and reproductive health providers from accessing federal funds if they provided abortion services, referred clients to abortion providers, or shared clinical space with providers.[10] The financial and operational impact on clinics was immediate. The Kaiser Family Foundation reports that 26% of Title X grantees, including 1,272 clinics, withdrew from the Title X network in order to maintain their standards of care and avoid medical liability issues.[3,9] At least 800,000 low-income and 300,000 uninsured clients lost access to sexual and reproductive health services and 400,000 fewer women obtained contraception through Title X-funded clinics.[10] From 2018 to 2020, clients that received chlamydia screenings at federally-funded family planning clinics in the U.S. dropped 10%.[17,11] Some clinics that withdrew from the Title X program before or during 2019 obtained alternative funding through philanthropic campaigns, charging service fees to clients, or making successful appeals to receive state funds.[12,13,14] Despite efforts to fill funding gaps, clinics continue to struggle to maintain essential operations and many clients are at risk of facing additional barriers to care in the form of service fees or reduced appointment hours.

Access to Sexual and Reproductive Health Services in Rural Areas

Beatty et al. found[15] a positive association between the STI screening, treatment, and contraceptive services provided by local health department clinics and chlamydia rates in U.S. counties. However, high detection rates may be evidence of increased access to screening services, rather than a causal effect of limited contraceptive access.[13] Though rural clinics offering sexual and reproductive health care have increased services in response to rising STI rates in recent years, clinics and services are still limited in some areas.[14,15] Individuals seeking STI treatment in rural areas are more likely to experience delays in receiving care or not receive treatment at all, especially if they have to travel more than 10 miles to the nearest clinic.[16] While there is a strong association between STI prevalence and the number of federally-qualified health centers (FQHCs) per county,[16] the relationship between infection rates and the number of FQHCs per capita (100,000 population) is not statistically significant, which suggests that high-morbidity areas are potentially underserved.

Rationale

Access to physical barrier contraceptives is critical in limiting the transmission of STIs. Publicly-funded health clinics, including those funded by Title X, are critical service providers, particularly for low-income and uninsured populations.[17] The separation of abortion-related services from Title X-funded clinics mandated by the Trump administration in 2019 made it impossible for many publicly-funded clinics to continue to meet grant eligibility requirements and provide a full range of sexual and reproductive health services to their clients. Examining the association between access to contraceptives at publicly funded clinics in 2015 and chlamydia rates by county may provide insight as to the public health consequences expected from the 2019 Title X revisions. One possible health consequence could be an increase in the rate of STIs in

counties that lost Title X-funded services. By using data on the number of female clients that obtained contraceptive services per 100 women of reproductive age per county, this project may reveal more about the relationship between the availability of STI prevention services and population density. The results of this project may be of interest to sexual and reproductive health advocacy groups and state legislators with the ability to direct funds to sexual and reproductive health services and develop policies that insure sustained access to family planning clinics.

This study addresses the following question: at the county level, is the total number of female contraceptive clients served at publicly funded health clinics associated with the population chlamydia rate?

Methods

Sources

All data used in this study were at the county-level and obtained from open access online sources. Chlamydia cases and rates per 100,000 population for each county in the U.S. in 2015 were obtained from the Centers for Disease Control and Prevention National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention's (CDC NCHHSTP) AtlasPlus database.[18] Data on publicly-funded health clinics[ii] and number of female clients[iii] that accessed contraceptive services through publicly-funded clinics in U.S. counties were obtained from a Guttmacher Institute report. The CDC's National Center for Health Statistics 2013 U.S. urban-rural county classification scheme was used to categorize U.S. counties based on population size.[19] Population data on reproductive aged (15-44 year-old) women per county in 2015 were obtained from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program.[20]

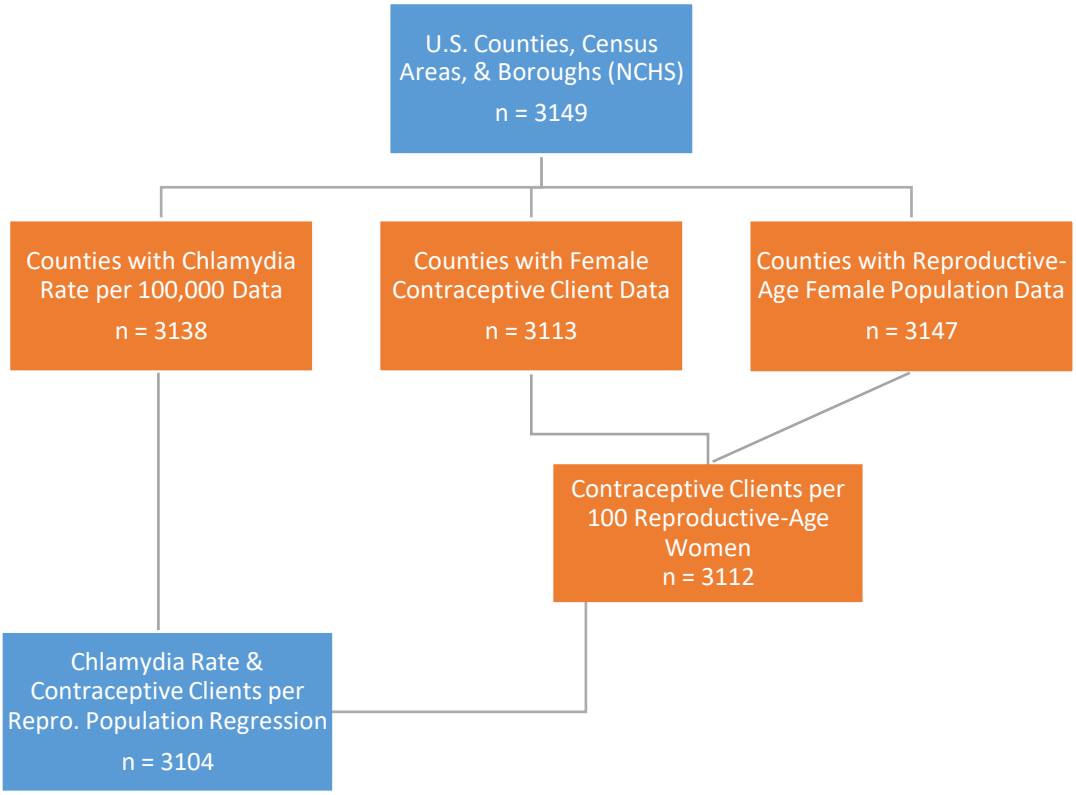
The Guttmacher Institute report on publicly-funded clinics and female contraceptive clients at publicly-funded clinics included data collected by the Office of Population Affairs (OPA); U.S. Department of Health and Human Services; the Health Resources and Services Administration (HRSA); and the Indian Health Service (IHS). Some data obtained from the HRSA were at the agency level, not at the individual clinic level. Therefore, the client totals provided by these agencies were distributed across clinic sites that provided contraceptive services within each agency's geographic area. For the 10% of clinics for which no 2015 data were available, the Guttmacher Institute used the number of contraceptive clients reported during the previous round of data collection in 2010 (461 clinic sites) or by imputing a number based on the number of women served by clinics similar in type and funding status in similar areas (according to region and population density; 605 clinic sites).[8]

[ii] The Guttmacher Institute defines a *publicly-funded clinic* as "a site that offers contraceptive services to the general public and uses public funds (e.g. federal, state, or local funding through programs such as Title X, Medicaid or the federally qualified health center program) to provide free or reduced-fee services to clients" (Frost et al., 2017).
[iii] The Guttmacher Institute defines a *female contraceptive client* as "a woman who made at least one initial or subsequent visit for contraceptive services during the 12-month reporting period covered by this data collection effort [2015]" (Frost et al., 2017).

Sample

The CDC National Center for Health Statistics data set included 3,149 total U.S. counties (also known as census areas and boroughs). Population data for reproductive-aged U.S. women were available for 3,147 counties. Chlamydia rates were available for 3,138 counties and female contraceptive client data were available for 3,113 counties. After merging all of these data sets by Federal Information Processing System (FIPS) code, I had complete data on 3,104 counties for the analysis (Figure 1).

Figure 1. Flow Chart of Missing Data and Number of Observations Used in Regression Models.



To examine associations across rural and urban counties, the six categories of county classifications defined by the CDC NCHS[21] were collapsed into two groups: rural, defined as a county with a population between 0 and 49,999 people, and urban, defined as a county with a population equal to or over 50,000 people. To examine the proportion of female clients that received contraceptive services at publicly-funded clinics in relation to the total reproductive-aged female population per county, I used per 100 reproductive-aged women for the analysis.

Using SAS, I calculated descriptive statistics of chlamydia case rates, female contraceptive clients at publicly-funded health clinics, and female contraceptive clients per 100 reproductive-aged women. I used a simple linear regression to examine the relationship between the number of female clients that obtained contraceptives at publicly-funded clinics per 100 women ages 15-44 (predictor variable) and chlamydia rate per 100,000 population (outcome variable) at the county level. I then log transformed the dependent and independent variables to

see if this resulted in a better model fit with more normally distributed residuals. I performed diagnostic tests to ensure the assumptions of linear regression were met (Figures 2-5). These revealed that the assumption of homoscedasticity was not met when the regression model used the full range of dependent variable values (Figure 2). When the data were restricted to counties with chlamydia rates under 1000 cases per 100,000 population, the assumption of homoscedasticity was met (Figure 4). Both regression models indicated a positive association between dependent and independent variables. The regression results based on the full range of observations, including outliers, were used in the final analysis to ensure the greatest number of counties were represented. Finally, I conducted a stratified analysis of chlamydia rates and female contraceptive clients per 100 reproductive-aged women, examining the four U.S. regions and rural versus urban counties separately.

As the distribution of data points for chlamydia rates, female contraceptive clients, and clients per reproductive-aged female population was skewed and the results of all analyses included outliers, I used median and interquartile range (IQR) statistics to analyze the average values and variability of the data.

Results

In 2015, 63% (n=1981) of all U.S. counties, census areas, and boroughs were rural according to NCHS county classifications based on population size. Of all Northeast counties, 60% (n=131) were urban while in the South, 58% (n=832) of counties were rural. In the Midwest and West, 71% (n=753) and 68% (n=309) of counties were rural, respectively.

Chlamydia Rates

In 2015, the median chlamydia rate in U.S. counties (n=3138) was 291.9 cases (interquartile range [IQR]: 195.1 to 441.6) per 100,000 population. The highest rates, ranging from 1831.3 to 2876.7 cases per 100,000 population, were in counties in Alaska and South Dakota. The highest median rate in counties in the Northeast region (n=218) was 260.3 cases (IQR: 198.4 to 339.5) per 100,000 population, in the South (n=1424), 354 cases (IQR: 243 to 538.8) per 100,000 population, in Midwest counties (n=1055), 231.25 cases (IQR: 167.3 to 327.6) per 100,000 population, and in the West (n=452), 293.8 cases (IQR: 170.1 to 418.2) per 100,000 population (Figure 6; Table 1). In urban counties (n=1166), the median chlamydia rate was 337.25 cases (IQR: 237.7 to 493) per 100,000 population and in rural counties (n=1981), 262 cases (IQR: 171.05 to 397.05) per 100,000 population (Figure 6; Table 1).

Contraceptive Client Rates

The median rate of female contraceptive clients at publicly-funded clinics per 100 women of reproductive age (15-44 years old) was 7.4 (IQR: 2.42 to 13.8) in the U.S. (Figure 7). Several counties in the South, Midwest, and West had the highest rates of female contraceptive clients per 100 reproductive-aged women, ranging from 158-358 clients per 100 women of reproductive age. The median rate of female contraceptive clients per 100 reproductive-age women was 8.73 (IQR: 4.61 to 12.29) in the Northeast, 8.93 (IQR: 4.66 to 15.2) in the South, 3.43 (IQR: 0 to

8.41) in the Midwest, and 11.76 (IQR: 5.45 to 20.22) in the West (Figure 7; Table 2). In urban counties, the median female contraceptive clients per 100 reproductive-age women was 7.09 (IQR: 3.57 to 11.5) and in rural counties, 8.00 (IQR: 0.83 to 15.26) (Figure 7; Table 2).

Relationship between Female Contraceptive Client and Chlamydia Rates

The fit of the regression model for the number of female contraceptive clients at publicly-funded clinics (dependent variable) on chlamydia rates (independent variable) was poor (R^2 = 0.02), but the relationship between the dependent and independent variables was significant (F(1, 3102)=76.71, p <.0001). It was found that for every 1 female that received contraceptive services per 100 reproductive aged women, there were 2.42 chlamydia cases per 100,000 (p <.0001) in U.S. counties (Table 3). There was a positive association between female contraceptive client rates at publicly funded-clinics and chlamydia rates overall in the U.S. in 2015.

A simple regression model was used to test the association between chlamydia rates and female contraceptive client rates in rural and urban counties, separately. The fit of the model for rural counties was poor (R^2 = 0.03), but the relationship was significant (F(1, 1944)= 65.15, p <.0001), indicating that for every 1 female that received contraceptive services at a publicly-funded clinic, chlamydia cases per 100,000 were 2.56 higher in rural counties. The fit of the model for urban counties was also poor (R^2 = 0.01), but the relationship between the contraceptive client rate and chlamydia rate was statistically significant (F(1, 1156)= 21.55, p <.0001), indicating that for every 1 female contraceptive clients per 100 reproductive-aged women, chlamydia cases per 100,000 were 2.63 higher (Table 3).

For counties in the Northeast, the fit of the regression model was poor (R^2 = 0.01) and the relationship between variables was not significant (F(1, 215)= 3.29, p = 0.07). For Southern counties, the slope of the fitted regression model was also poor (R^2 = 0.002) and the results were not significant (F(1, 1408)= 3.32, p = 0.06). For counties in the West, the fit of the regression model was poor (R^2 = 0.01), but the relationship between variables was significant (F(1, 433)= 5.65, p = 0.017). It was found that for every 1 female that received contraceptive services at a publicly-funded clinic per 100 reproductive-aged women, chlamydia cases per 100,000 were 1.34 higher. The fit of the model for Midwest counties was adequate (R^2 = 0.11) and the relationship between contraceptive client rates and chlamydia rates was significant (F(1, 1040)= 132.54, p <0.0001). For every 1 female that received contraceptive services at a publicly-funded clinic per 100 reproductive-aged women, chlamydia cases per 100,000 population were 6.89 higher in the Midwest (Table 3).

Missing Data and Null Values

Data on chlamydia rates and number of female contraceptive clients at publicly-funded clinics were missing for 1% of all counties and zero clients were reported for 18% of counties. One-third of counties in the Midwest (n=364), 12% (n=58) of counties in the West, and 10% of counties in the South reported zero publicly-funded clinics and zero contraceptive clients (Table

4). Most counties that reported zero clinics and zero contraceptive clients were rural (80%; n= 466).

Discussion

Summary of Findings

There was a significant relationship between women's access to contraceptive services and chlamydia rates in the U.S. in 2015. There was also a positive association between contraceptive clients and chlamydia in the Midwest, which had the lowest chlamydia rates and lowest contraceptive client per 100 reproductive-aged women rate of the four U.S. regions (Table 1). There was also a significant relationship between chlamydia and contraceptive client rates in the West, which had the highest rate of female contraceptive clients per population and second highest chlamydia rate of all regions (Table 1). Separate analyses of rural and urban counties indicated significant associations between contraceptive client rates and infection rates across both county types. Urban counties had higher chlamydia rates and rural counties had marginally higher rates of female contraceptive clients per 100 reproductive-aged women (Table 2).

Consistency with Previous Studies

The low chlamydia rates observed in the Midwest were consistent with previous study results that indicated notably low STI diagnosis and screening rates in the region.[6] Reports on contraceptive access in some Midwest states show that condoms are widely available at local health department clinics, but other hormonal and long-acting reversible contraceptive methods are not.[22] Low female contraceptive client rates may represent limited access to services due to a lack of publicly-funded clinics in one-third of counties in the region, as well as limited contraceptive options in existing clinics. Women may have obtained contraceptive services from other providers, such as pharmacies or private gynecology practices, depending on the type and cost of the contraception they were seeking.

Previous analyses of STI prevalence by U.S. region suggest that Western counties with lower population density (classified as rural counties in this study) are less likely to have substantial clusters of chlamydia cases.[5] This study does not examine chlamydia rates in urban versus rural counties within each U.S. region. The proportion of rural to urban counties in the West and the likelihood of higher chlamydia rates in population-dense counties are not accounted for in these results, but this suggests an opportunity to examine infection rates in urban and rural counties by region.

Studies on the social determinants of STI prevalence and prevention efforts have found disparities in the effectiveness of interventions in rural areas and across racial groups due to program design that is not inclusive of nor informed by the communities it is meant to reach.[23] My findings appear to contrast with the prior evidence of inverse relationships between STI rates and access to preventive care. Instead they suggest that seeking preventive services including contraception and perhaps, diagnostic screenings, is associated with more confirmed cases. This study does not specifically examine factors that impact access to STI testing in rural versus urban

counties, which may explain the varied observations of the relationship between access to preventive care and infection rates.

Interpretation of Findings

The overall regression results for chlamydia rates and female contraceptive client rates indicate that women's access to contraceptive services at publicly-funded clinics was associated with increased detection of chlamydia infections in the U.S. in 2015. This suggests that STI screening services were available at publicly-funded clinics where women were obtaining contraception. Alternatively, there may have been a significant portion of the population that obtained STI screening services (and potentially a chlamydia diagnosis) at publicly-funded clinic and did not obtain contraceptive services.

Regression results for counties in the West indicate that the rate at which female contraceptive clients obtained services at publicly-funded clinics was consistent with the rate of chlamydia detection in 2015. Similar to the results of the overall analysis of U.S. counties, any potential relationship between chlamydia detection rates and accessibility of STI testing services assumes the general population accessed screenings at publicly-funded clinics. Of all regions, the West had the highest female contraceptive client rate and a high chlamydia rate compared to the Northeast and Midwest. Most counties (88%) in the West had at least one publicly-funded clinic that provided contraceptive services in 2015 (Table 4), which may have contributed to the high contraceptive access rates. However, the high proportion of rural counties, the high population density of several urban counties, and the large geographic area of many Western counties in the region (Figure 8) could mean that chlamydia cases and women's access to contraceptive services occurred in clusters and were not evenly distributed across the region. This variation is not apparent in regression results.

The relatively low chlamydia rates reported in the Midwest in 2015 are consistent with previous research that observed low STI rates in the region.[6] One-third of Midwest counties did not have publicly-funded clinics with contraceptive services and therefore reported zero contraceptive clients (Table 4). The majority (81%) of Midwest counties without publicly-funded clinics were rural, which is consistent with previous findings that indicate limited access to healthcare in rural areas.[14,15] Women in counties without publicly-funded health clinics may have sought contraceptive services from other sources such as pharmacies or private gynecology practices, gone without contraception, or traveled to the nearest clinic in a neighboring county. The low rates of female contraceptive clients at publicly-funded clinics in the region could indicate that women are accessing contraception from pharmacies or private practices in general. The reported chlamydia rates in this data set may not reflect the actual number of cases in rural Midwest counties, especially as the majority of chlamydia infections are asymptomatic. Lower chlamydia rates may be a result of limited access to clinics and STI testing than an indicator of effective infection prevention.

I was surprised to find higher female contraceptive client rates in rural counties as it suggests that publicly-funded contraceptive services are more accessible in these rural areas. This result is particularly interesting given that a quarter (23%) of rural counties reported zero publicly-funded clinics that offered contraceptive services and zero female contraceptive clients in 2015 (Table 4). While women in counties without publicly-funded clinics may have sought

contraception from other sources, women who were unable to afford over-the-counter contraception or a co-pay or service fee required at a private practice may have relied on publicly-funded clinics for care. Given the association between rurality and lower socioeconomic status,[24] higher rates of female contraceptive clients at publicly-funded clinics may be a result of limited alternative sources for contraceptive services due to financial constraints. The median contraceptive client rates and regression results in this study do not capture this.

Limitations

Several limitations in this study are related to data quality issues. First, chlamydia rates by gender at the county-level were not available in the CDC NCHHSTP AtlasPlus database for the year 2015. The use of total chlamydia rates by county for all genders instead of females only may affect the strength of the associations found between access to publicly-funded contraceptive services and chlamydia rates. The required estimations of female contraceptive client data for 10% of publicly-funded clinics may also affect the accuracy of results compared to an analysis using the actual contraceptive client rates in those counties.

The data on contraceptive services accessed at publicly-funded clinics at the county level are not categorized by type of contraception. National data on the impact of Title X funding indicates that male condoms are the third most-used contraceptive method by female family planning clinic clients age 20-44 in the U.S.[11] However, the data used in this project include a variety of contraceptive methods and services, not only physical barrier contraceptives which significantly affect STI rates. A comprehensive examination of the relationship between contraceptive access and STI rates by county would ideally include information on primary contraceptive methods used.

I did not test the regression residuals for spatial autocorrelation or use a regression model that accounted for spatial dependencies. Thus assumption of independent residuals was not met.

Strengths

A strength of this study is the credibility of its data sources. The CDC's National Center for HIV, Viral Hepatitis, STD, and TB Prevention AtlasPlus database is the standard source for data on STI rates at the national, state, and county levels. This study also uses the most recent data available on women obtaining contraceptive services through publicly-funded clinics at the county level. This study's focus on accessibility of family planning services is timely given the restrictions on Title X funding enacted under the Trump administration and the Biden administration's commitment to expand family planning funding and address disparities in access to reproductive healthcare.[25] This study also examines access to contraceptive services in rural counties and contributes to the growing body of research on care access in rural areas of the U.S.

Conclusions and Implications for Future Research

In conclusion, I found that female access to contraceptive services at publicly-funded clinics and chlamydia rates were positively associated across rural and urban counties in the U.S. There was also significant relationship between female contraceptive client rates and chlamydia rates in the Midwest and West. A substantial number of rural counties and counties in the Midwest did not have any publicly-funded clinics that provided contraceptive services, suggesting that women's access to contraceptive services may be affected by the location and number of clinics per county. Chlamydia detection rates by region may be affected by the geographic distribution of clinics offering screening services.

These findings suggest chlamydia detection may be impacted by the accessibility of STI screenings at publicly-funded clinics and in other healthcare settings. Future studies should consider using multivariate and spatial regression models to examine chlamydia rates and publicly-funded clinics that offer contraceptive services and STI testing services at the county level. This may help us better understand any associations between access to contraceptive services and STI detection. Future research on the relationship between STI rates and access to contraceptives at the county level should use regression models that account for spatial correlation. A comprehensive study on STI rates and access to screenings and contraceptives in rural Midwest counties could improve our understanding of the social, economic, and environmental factors that contribute to lower chlamydia rates in this region. Finally, given the reduction in federal family planning funding under the Trump administration and imminent expansion of family planning funds under the Biden administration, a longitudinal study of STI rates and access to contraceptive services and STI testing at publicly-funded clinics at the county and state levels may reveal the impact of federal and state policy shifts on access to sexual and reproductive care, including the location of publicly-funded clinics and availability STI screening and contraceptive services.

Appendix

Figure 2. Residuals and Chlamydia Rate Scatterplot Using Full Range of Chlamydia Data

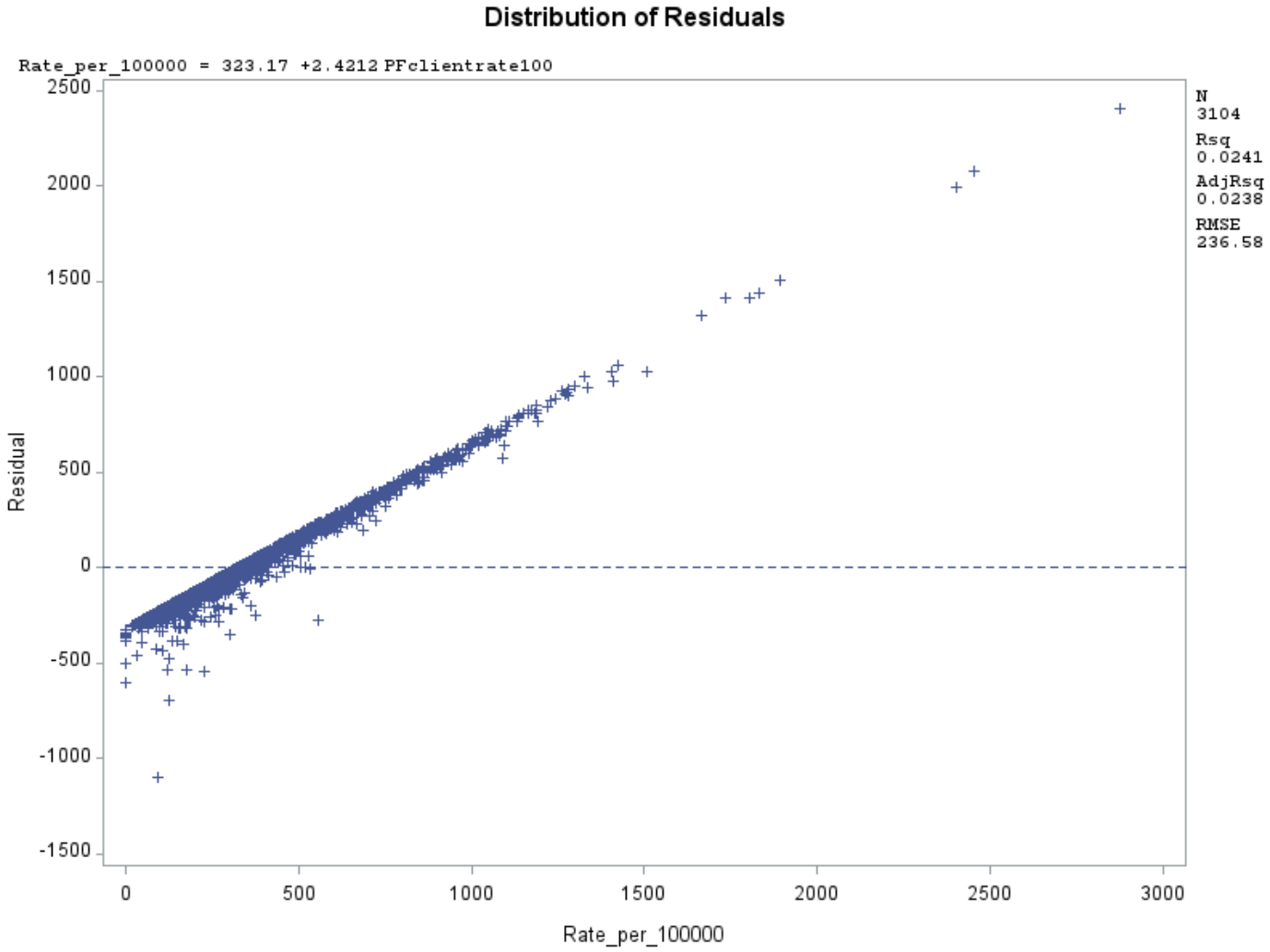
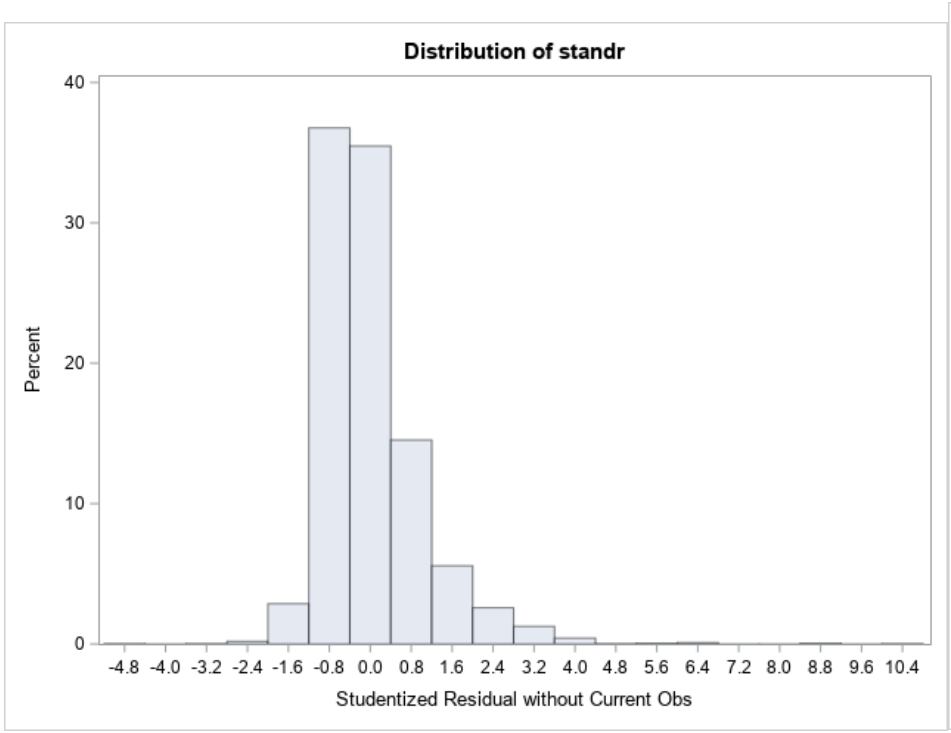


Figure 3. Distribution of Standardized/Studentized Residuals Histogram & Q-Q Plot – Using Full Range of Chlamydia Data



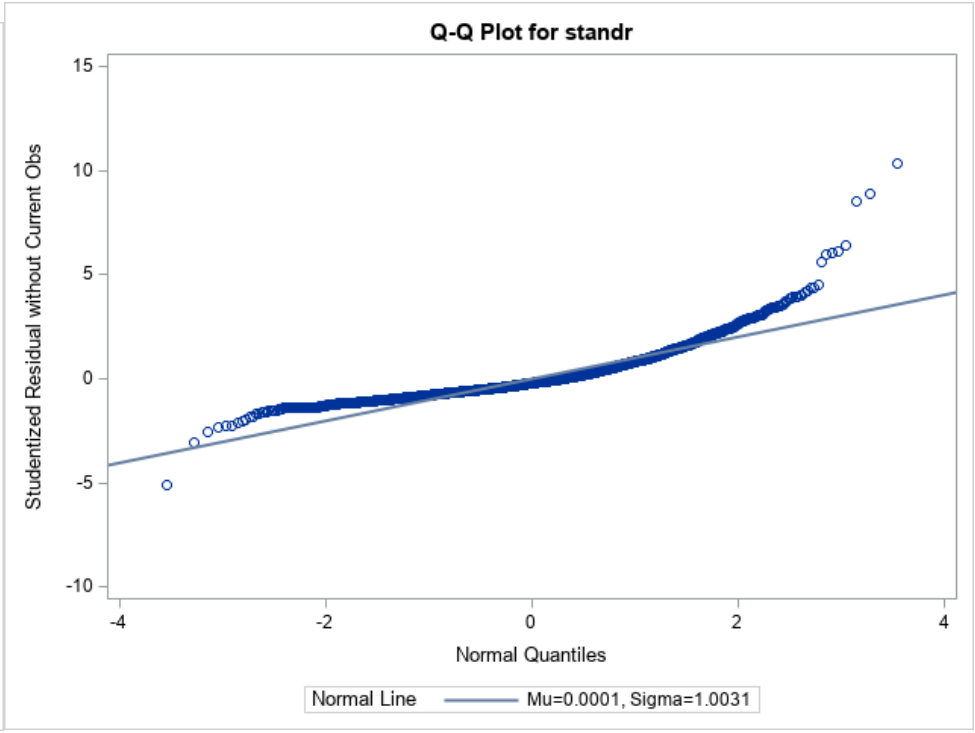


Figure 4. Female Contraceptive Client Residuals and Chlamydia Rate Scatterplot for Counties with Chlamydia Rate <1000 Cases per 100,000

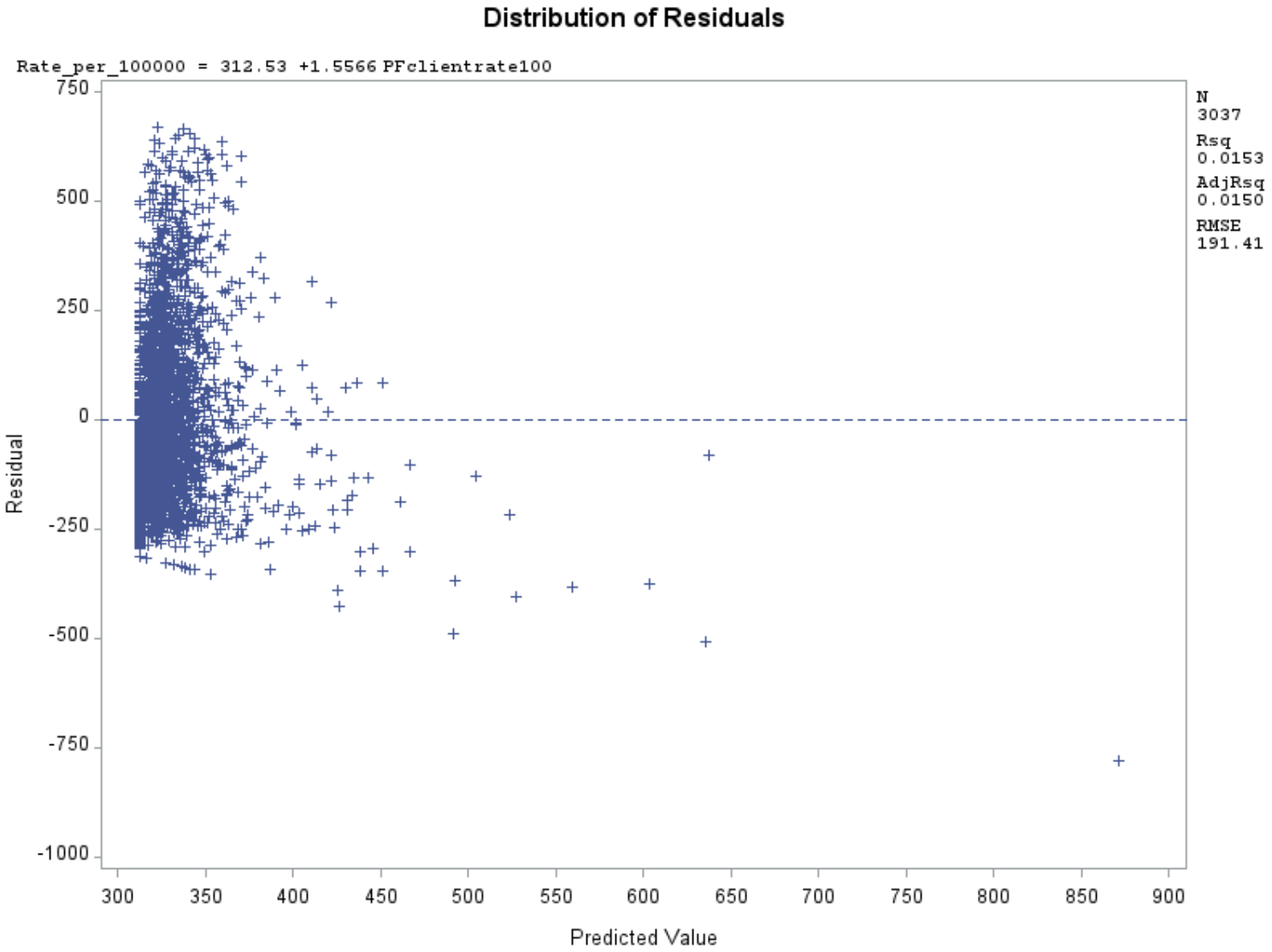
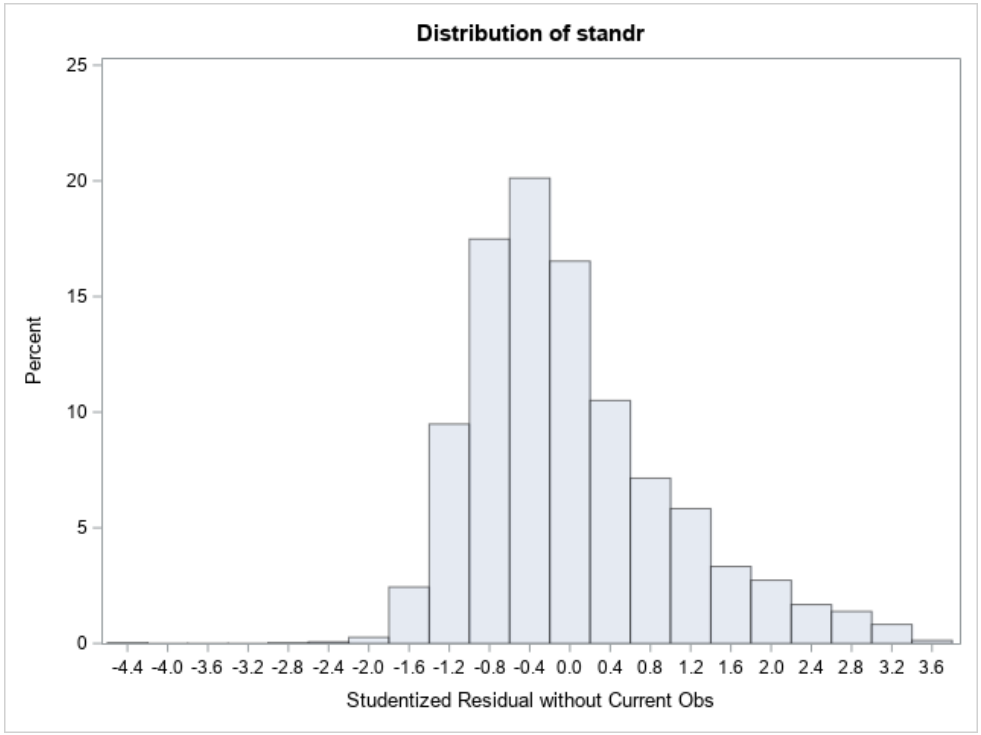


Figure 5. Distribution of Standardized Residuals Histogram & Q-Q Plots for Counties with Chlamydia Rate <1000 Cases per 100,000



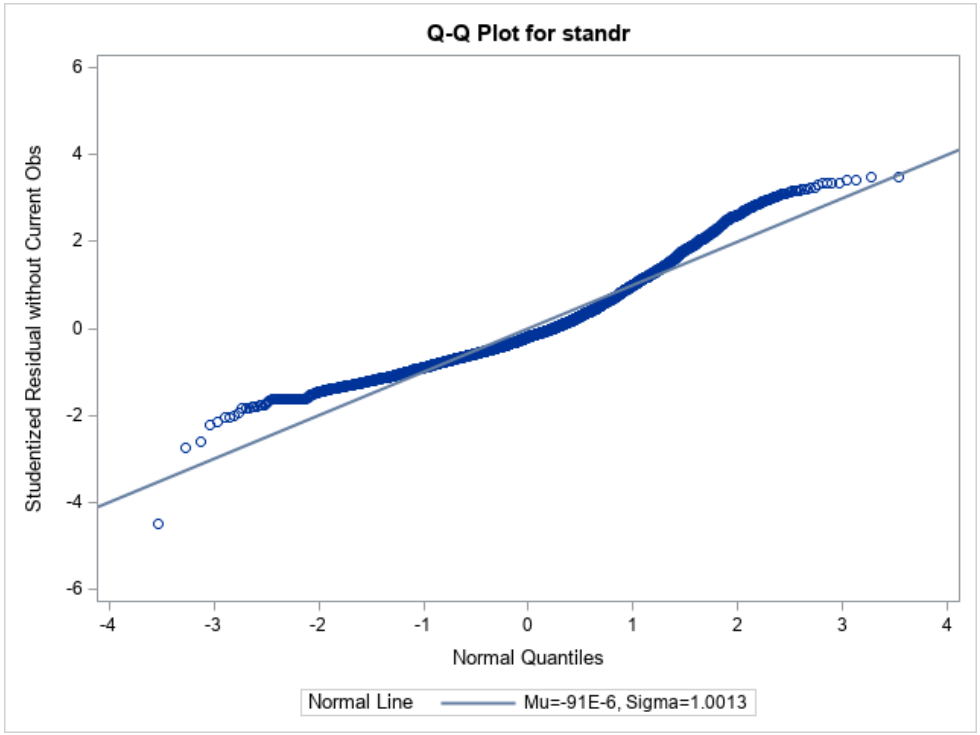
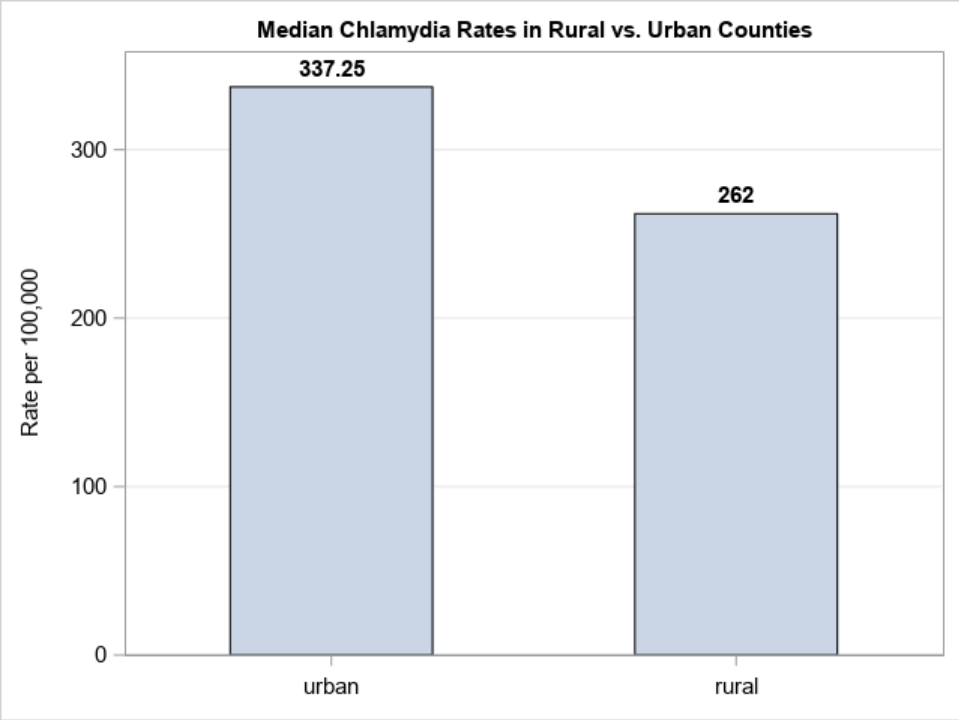


Figure 6. Median Chlamydia Rates by U.S. Region and in Rural vs. Urban Counties



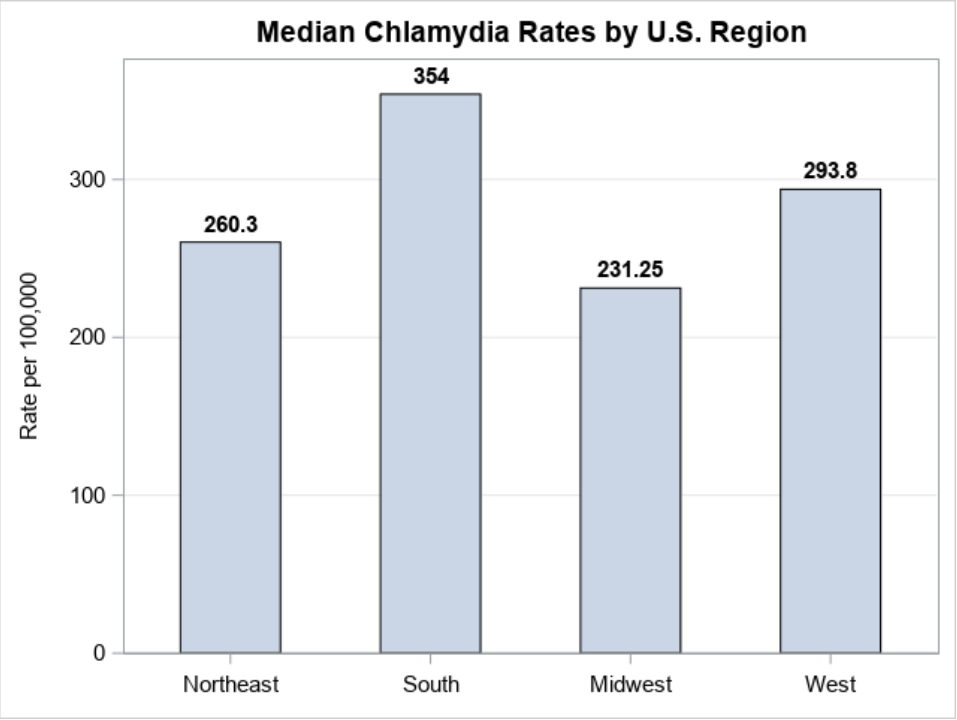
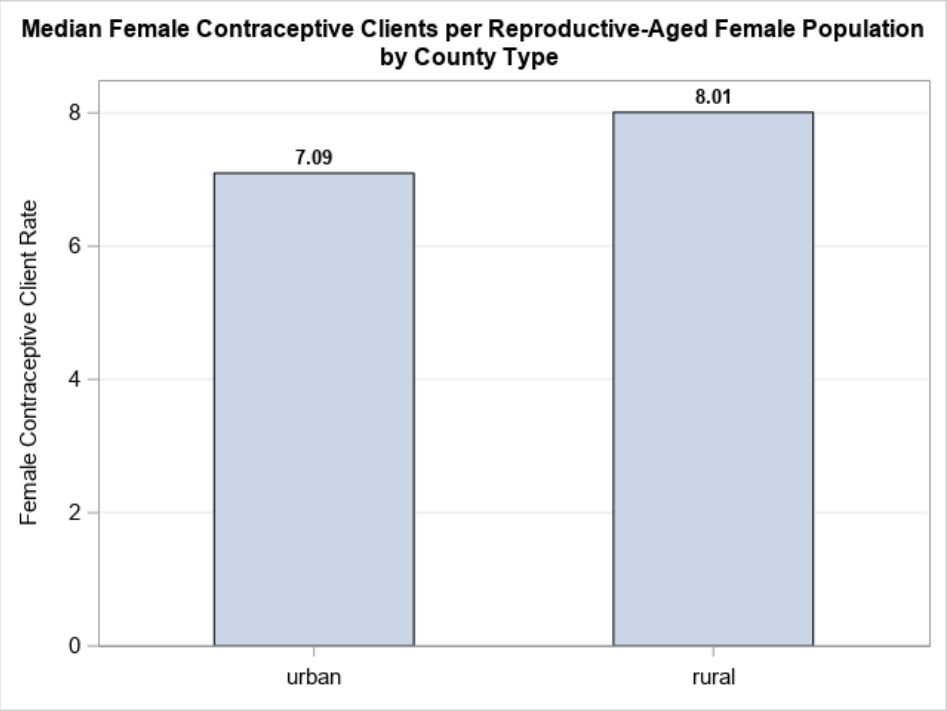


Figure 7. Median Female Contraceptive Clients per 100 Reproductive-Aged Women Population by U.S. Region and in Rural vs. Urban Counties.



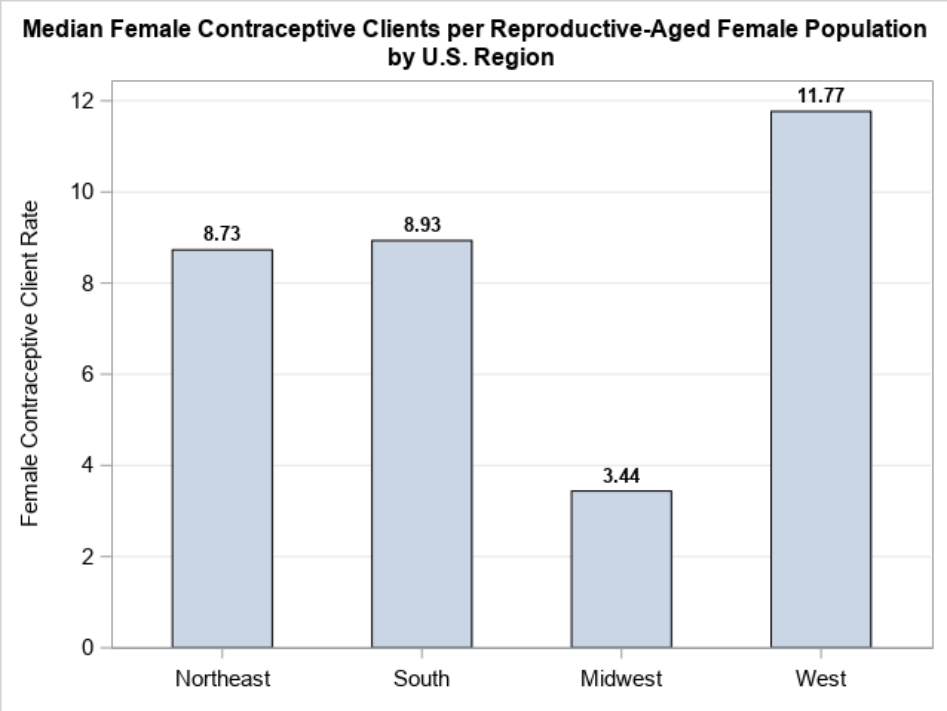


Table 1. Descriptive Statistics for Chlamydia Rate, Publicly-Funded Clinics, Female Contraceptive Clients, and Client per Reproductive Women Population Rate by Region.

Region	N	Variable	N	Mean	Std Dev	Median	Quartile Range	Lower Quartile	Upper Quartile	Min.	Max.
Northeast	218	Chlamydia Rate	218	290.47	157.27	260.30	141.10	198.40	339.50	0.30	1220.60
		Clients	217	4969.82	10686.23	1820.00	3730.00	690.00	4420.00	0	85660.00
		Clinics	218	7.24	12.26	4.00	5.00	2.00	7.00	0	85.00
		Client per Repro. Pop Rate	217	9.82	8.25	8.73	7.68	4.61	12.29	0	64.43
South	1424	Chlamydia Rate	1421	414.785	243.74	354.00	295.80	243.00	538.80	0	1735.00
		Clients	1412	1315.81	3679.50	480.00	935.00	200.00	1135.00	0	86560.00
		Clinics	1422	2.65	3.64	2.00	2.00	1.00	3.00	0	48.00
		Client per Repro. Pop Rate	1411	12.14	15.33	8.93	10.60	4.66	15.26	0	208.79
Midwest	1055	Chlamydia Rate	1054	275.73	199.36	231.25	160.30	167.30	327.60	0	2404.40
		Clients	1042	914.79	4715.85	100.00	540.00	0	540.00	0	130190.00
		Clinics	1054	1.83	6.21	1.00	2.00	0	2.00	0	175.00
		Client per Repro. Pop Rate	1042	6.02	9.76	3.43	8.41	0	8.41	0	158.70
West	452	Chlamydia Rate	445	334.81	280.74	293.80	248.10	170.10	418.20	0	2876.70
		Clients	442	5299.32	22599.91	485.00	1960.00	100.00	2060.00	0	384270.00
		Clinics	449	7.60	20.37	3.00	5.00	1.00	6.00	0	345.00
		Client per Repro. Pop Rate	442	16.74	23.63	11.76	14.76	5.45	20.22	0	358.62

Table 2. Descriptive Statistics for Chlamydia Rate, Publicly-Funded Clinics, Female Contraceptive Clients, and Client per Reproductive Women Population Rate by County Classification.

	N	Variable	N	Mean	Std. Dev	Median	Quartile Range	Lower Quartile	Upper Quartile	Min.	Max.
Total	3143	Chlamydia Rate (per 100,000)	3138	348.10	239.02	291.90	246.50	195.10	441.60	0	2876.70
		Clients	3113	2001.89	9831.11	360.00	1110.00	70.00	1180.00	0	384270.00
		Clinics	3143	3.40	9.65	2.00	2.00	1.00	3.00	0	345.00
		Client per Repro. Pop Rate	3112	10.58	15.35	7.40	11.41	2.42	13.84	0	358.62
Urban	1168	Chlamydia Rate (per 100,000)	1166	391.70	220.89	337.25	255.30	237.70	493.00	0	1735.00
		Contraceptive Clients	1160	4634.25	15732.97	1250.00	3215.00	280.00	3495.00	0	384270.00
		Clinics	1167	6.26	15.21	3.00	5.00	1.00	6.00	0	345.00
		Client per Repro. Pop Rate	1159	9.21	11.33	7.09	7.92	3.57	11.50	0	207.36
Rural	1981	Chlamydia Rate (per 100,000)	1972	322.32	245.55	262.00	226.00	171.05	397.05	0	2876.70
		Clients	1953	438.38	744.47	210.00	570.00	20.00	590.00	0	17970.00
		Clinics	1976	1.71	1.97	1.00	1.00	1.00	2.00	0	27.00
		Client per Repro. Pop Rate	1953	11.40	17.26	8.00	14.42	0.83	15.26	0	358.62

Table 3. Female Contraceptive Client Rate (dependent) and Chlamydia Rate (independent) Regression Results

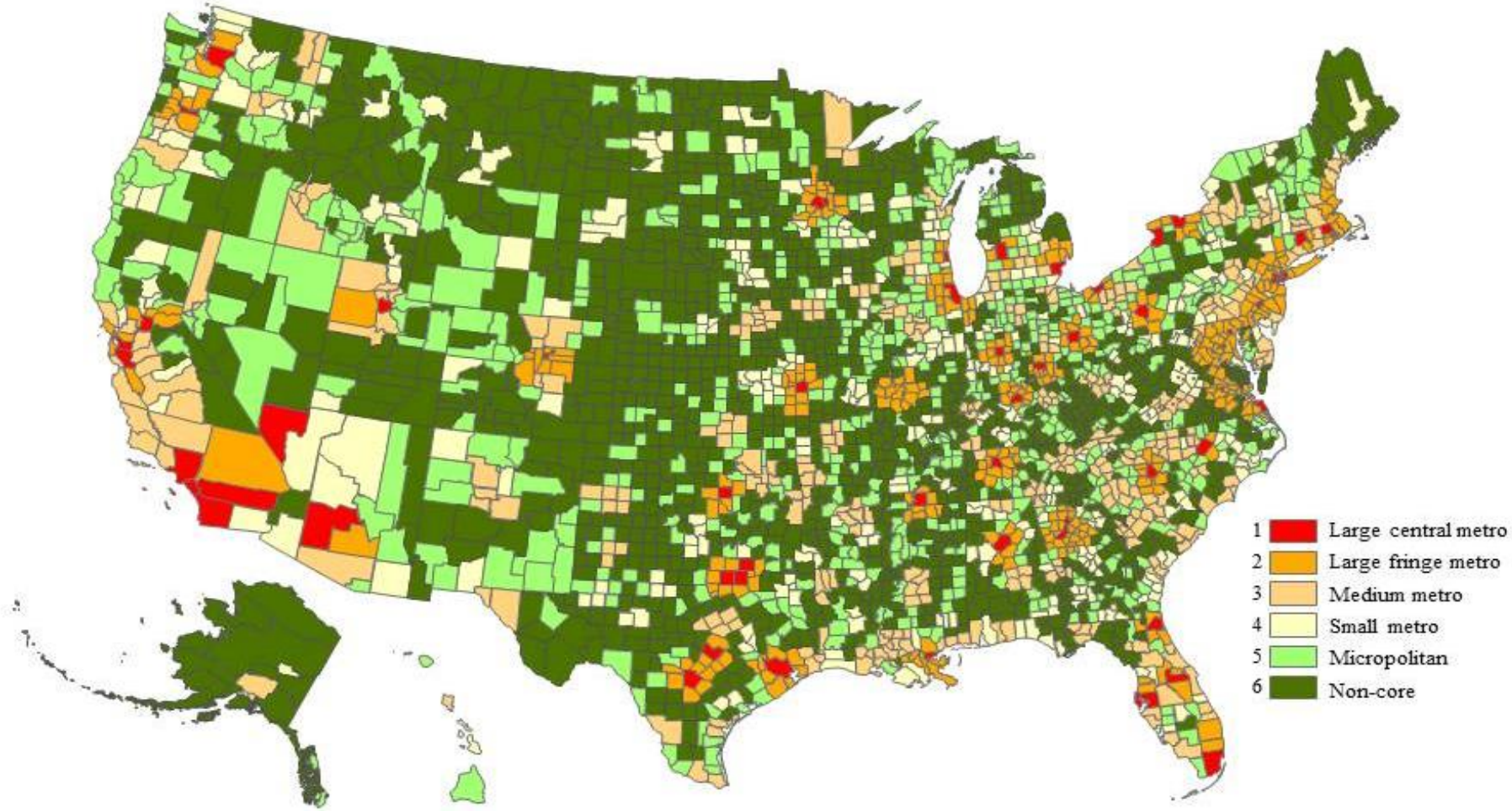
	N	Client Rate Parameter Est.	Std. Error	P-Value	Degrees of Freedom (Model, Error)	Intercept Parameter Est.	Intercept Std. Error	R^2	F-Value
Overall	3104	2.42	0.27	<.0001	1, 3102	323.16	5.15	0.02	76.71
Rural	1946	2.56	0.31	<.0001	1, 1944	293.66	6.57	0.03	65.15
Urban	1158	2.63	0.56	<.0001	1, 1156	367.96	8.30	0.01	21.55
Northeast	217	2.34	1.29	0.07	1, 215	267.90	16.55	0.01	3.29
South	1410	0.77	0.42	0.06	1, 1408	405.36	8.29	0.002	3.32
Midwest	1042	6.89	0.59	<.0001	1, 1040	234.77	6.87	0.11	132.54
West	435	1.34	0.56	0.01	1, 433	314.71	16.36	0.01	5.65

Table 4. Counties with Missing Data and Null Values by Region and County Type

	N	Missing Chlamydia Rate	Missing Contraceptive Clients	Chlamydia Rate=0	Contraceptive Clients=0*
Overall	3149	11 (<1%)	36 (1%)	43 (1%)	581 (18%)
Rural	1981	9 (<1%)	28 (1%)	40 (2%)	466 (23%)
Urban	1168	2 (<1%)	8 (<1%)	3 (<1%)	115 (9%)
Northeast	218	0	1 (<1%)	0	12 (5%)
South	1424	3 (<1%)	12 (<1%)	11 (<1%)	147 (10%)
Midwest	1055	1(<1%)	13 (1%)	16 (1%)	364 (34%)
West	452	7 (1%)	10 (2%)	16 (3%)	58 (12%)

*All counties reporting zero female contraceptive clients had zero publicly-funded clinics in 2015.

Figure 8. NCHS 2013 Urban-Rural County Classifications, U.S Map



Source: National Center for Health Statistics. NCHS Urban-Rural Classification Scheme for Counties. Centers for Disease Control and Prevention. https://www.cdc.gov/nchs/data_access/urban_rural.htm#2013_Urban-Rural_Classification_Scheme_for_Counties

Table 5. NCHS 2013 Rural-Urban County Classification Index

Study County Classification Code	**NCHS Classification**	**Population Size**
Urban	1 – Large central metro	≥ 1 million or more population and 1) contains entire population of the largest principal city of the metropolitan statistical area (MSA) or 2) entire population is in the largest principal city of the MSA, or 3) contains at least 250,000 inhabitants of any principal city of the MSA
	2 – Large fringe metro	≥ 1 million or more population, but did not qualify as large central metro counties
	3 – Medium metro	250,000–999,999 population
	4 – Small metro	< 250,000 population
Rural	5 - Micropolitan	≤ 50,000 population in micropolitan statistical areas
	6 – Non-core	≤ 50,000 population, not in micropolitan statistical areas

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