What Has Geography Got to Do with It? Using GWR to Explore Place-specific Associations with Prenatal Care Utilization

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Abstract

We use a geographically weighted regression (GWR) approach to examine how the relationships between a set of predictors and prenatal care vary across the US. At its most fundamental, GWR is valuable because it facilitates the identification of areas most in need of increasing the percent of women who use prenatal care services on time and in addition which predictors are associated with prenatal care at specific locations. The output from GWR is a set of statistics that can be mapped and tested, depicting the spatial variation of a relationship. From GWR output, maps can be created of the local R-square, local estimated regression coefficients, and local t-statistics. Our work complements existing prenatal care research in providing an ecological, place-sensitive analysis. GWR offers a more nuanced examination of prenatal care and provides empirical evidence in support of locally tailored health policy formation and program implementation, which may improve program effectiveness.

Introduction

Receiving prenatal care on time is essential for a healthy mother and her baby. Although there has been some debate in the literature regarding the actual effectiveness of prenatal care on preventing babies from experiencing poor birth outcomes (Kogan, Martin, and Alexander 1998; Lauderdale, VanderWeele, Siddique, and Lantos 2010; Nguyen and Chongsuvivatwong 1997), prenatal care can help identify risk factors associated with low birth weight and infant mortality, as well as identify other pregnancy complications that may occur at any time during the pregnancy (Laditka, Laditka, Bennett, and Probst 2005; Lauderdale, VanderWeele, Siddique, and Lantos 2010). When women receive prenatal care, they are provided with educational information regarding infant delivery, care, and nutrition (Alexander, Kogan, and Himes 1999; Butz, Funkhouser, Caleb, and Rosenstein 1993). Even though receiving prenatal care on time can provide many benefits for mothers and their babies, not all women receive prenatal care during the recommended first trimester of pregnancy, and some women do not receive prenatal care at all. There is also great variation in prenatal care use across different areas of the country, which is not evident from the annual averages of prenatal care use (Hemminki, McNellis, and Hoffman 1987).

Increasing the proportion of pregnant women who receive early and adequate prenatal care has been one of the objectives of both Healthy People 2000 and Healthy People 2010 and has been proposed to be included in the 2020 objectives (Centers for Disease Control and Prevention and Health Resources and Services Administration 1999; Centers for Disease Control and Prevention and Health Resources and Services Administration 2010). While the proportion of pregnant women who receive prenatal care during the first trimester of pregnancy has been increasing (76% in 1990 to 83% in 1998), vast racial/ethnic and socioeconomic differences in use of timely prenatal care remain (Alexander, Kogan, and Nabukera 2002). For example, the percentage of women receiving prenatal care during the first trimester of pregnancy in 1990 and 1998 are 61 and 73 percent of Black women, 60 and 69 percent of American Indian/Alaskan Native women, and 60 and 74 percent of Hispanic women (Centers for Disease Control and Prevention and Health Resources and Services Administration 1999; Centers for Disease Control and Prevention and Health Resources and Services Administration 2010). Women who have the greatest risk of experiencing poor pregnancy outcomes due to their socioeconomic status are the same women who have had less improvements in their use of prenatal care (Alexander, Kogan, and Nabukera 2002; Kogan, Martin, and Alexander 1998). If we are to attain the Healthy People targets, we need a better understanding of the use of prenatal care in the U.S. and identifying the factors associated with late or no prenatal care can help health policy makers determine how to best deliver to all mothers the prenatal care that they need.

This paper will adopt a spatial explicit approach to the study of prenatal care in and around the year 2000. Specifically, we use a geographically weighted regression (GWR) approach to identify the factors that are associated with county-level percentages of mothers who receive late or no prenatal care and examine how the relationships between a set of predictors and prenatal care vary across the U.S. That is, while a standard OLS regression can identify associations between predictors and the outcome, and spatial econometric approaches permit the incorporation of spatial dependence into a model, both analytical approaches generate a single model result or 'global' fit. GWR is preferred over these other types of regression analyses; because it can identify whether or not the factors associated with late or no prenatal care vary 'locally' in different areas across the U.S. Moreover, understanding the local patterns and relationships can help the analyst better specify their global model. At its most fundamental, GWR is valuable because it facilitates the identification of areas most in need of increasing the percent of women who use prenatal care services on time and which predictors are associated at specific locations. This more nuanced examination can be beneficial for county or state health policy planning and program implementation.

In this study we are interested in answering three research questions: (1) How does the percentage of the population without health insurance effect the percentage of mothers receiving late or no prenatal care? (2) Is the racial/ethnic composition of a county associated with the percentage of mothers receiving late or no prenatal care? and (3) Are the associations above constant or non-stationary across different parts of the U.S.?

Literature Review

Following the argument by Link and Phelan (1995), socioeconomic status should play an important role in understanding why women do not receive prenatal care. Many studies reported multiple risk factors for why mothers receive prenatal care after their first trimester of pregnancy or not at all, and many of these risk factors are interrelated. For example, women may have low levels of education, which leads them to obtain jobs without health insurance coverage or the flexibility to take time off for medical appointments and treatment. If women have low incomes or are unemployed they may not have access to an adequate means of transportation to get to their prenatal care appointments (Phillippi 2009). Women with higher levels of education and higher incomes were more likely to receive prenatal care during their first trimester of pregnancy (Ayoola, Nettleman, Stommel, and Canady 2010; Sunil, Spears, Hook, Castillo, and Torres 2010).

The survey used by Sunil and colleagues identified financial barriers as one of the main reasons why some women were receiving delayed prenatal care or not at all, which includes not having money to pay for prenatal care and not having health insurance (2010). Epstein et al. (2009) also identified living in poverty as one of the major barriers for not receiving prenatal care on time. Lack of insurance coverage during pregnancy was an important factor for why pregnant women were not receiving adequate prenatal care in the survey analyzed by Egerter et al. (2002). They found that women without health insurance coverage during their pregnancy were three times as likely as women with private health insurance coverage to begin prenatal care after the first trimester (Egerter, Braveman, and Marchi 2002).

Compared to mothers who live in urban areas, mothers from rural areas are more likely to not have health insurance coverage, be poor, less educated, and younger, which are all risk factors for not receiving prenatal care on time (Hulme and Blegen 1999; Larson and Correa-de-Araujo 2006). Moreover, fewer Ob-Gyn doctors in rural areas translates in to greater transportation (both distance and time cost) barriers and greater difficulties accessing prenatal care for rural mothers (Braveman, Marchi, Egerter, Pearl, and Neuhaus 2000; Davis, Baksh, Bloebaum, Streeter, and Rolfs 2004). For example, Miller and colleagues (1996) found that women who live in rural areas are more likely to receive prenatal care late or not all, regardless of their maternal risk profile.

In addition to socioeconomic status, health insurance coverage, and availability of Ob-Gyn doctors, race/ethnicity has been identified as a crucial determinant of receiving prenatal care. Specifically, African American women are less likely to enter prenatal care during their first trimester of pregnancy, compared to their white counter parts (73% vs. 88%) (Mathews, Curtain, and MacDorman 2000). Not only are African American women less likely to receive prenatal care compared to white women, but also they are more likely to start prenatal care in their third trimester of pregnancy (Daniels, Noe, and Mayberry 2006) and have pregnancy complications (Haas, Udvarhelyi, and Epstein 1993; LaVeist, Keith, and Gutierrez 1995). Clarke and colleagues (1995), using the same data as Miller et al. (1996), found that African American women in rural areas are more likely to have late or no prenatal care compared to white and Hispanic women.

In a recent study based on the Pregnancy Risk Assessment Monitoring System (PRAMS) data, which is representative of resident women of childbearing age in 29 states, Ayoola and colleagues (2010) found that non-Hispanic white women were the most likely to receive prenatal care on time, followed by American Indian/Alaskan Native women, black women, and Hispanic women, with Asian women being the least likely to receive prenatal care on time. However, Johnson and colleagues (2010) report that American Indian/Alaskan Native mothers have the highest rates of late or no prenatal care use compared to women of all other races.

While the earlier studies have examined the associations of socioeconomic status, access to care, and race/ethnicity with receiving prenatal care, we identify two major shortcomings in the literature. First, while some studies use ecological-level data, few adopt an explicitly spatial perspective in their analysis. We use geographically weighted regression techniques to help better understand place-specific conditions across the U.S. In doing so, we investigate the underexplored non-stationarity among variables of interest, which can provide nuanced local insights to the health researchers and policy-makers. Second, our analysis focuses on insurance status and race/ethnicity, predictors that are often residual to measures of socioeconomic status. A GWR approach will be used to examine the following three hypotheses: (1) counties with higher percent of uninsured persons tend to have higher percentages of women receiving late or no prenatal care; (2) higher concentrations of minorities are associated with higher percent of mothers' late or no prenatal care receipt; and (3) these relationships are stronger in some counties in the US than others.

Data

The data was compiled from multiple sources for the counties in the continental U.S for which data was available (N=3,106). The dependent variable, *percent late or no prenatal care*, is a three-year county average (1999-2001) and was extracted from the Office on Women's Health Quick Health Data Online (U.S. Department of Health and Human Services) whose data comes from the National Center for Health Statistics (NCHS) National Vital Statistics System Detail Natality Files. The variable is measured as the percentage of mothers who received prenatal care after the first trimester of their pregnancy or did not receive any prenatal care at all. The measure is based on the county of residence of the mother.

The *percent uninsured* is the percentage of the total population who do not have health insurance, according to the U.S. Census Bureau's 2000 Small Area Health Insurance Estimates Program. Data on the number of Ob-Gyn doctors per county come from the Area Resource File (2000). The *Ob-Gyn per 100,000 Females Ages 15-44* is the total number of Ob-Gyn doctors in a county, divided by the female population ages 15-44, and then multiplied by 100,000.

The *percentage of females with less than high school* (the percentage of females 25 years and over with less than a high school degree), the *percentage of unemployed females* (percentage of the female population 16 years and over who are in the labor force and are unemployed), and the *percentage of females in poverty* (percentage of females who are in poverty of the total female population for whom poverty status is determined) measures were highly correlated. In order to avoid problems with multicollinearity, we decided to use factor analysis to create a composite measure of *female disadvantage* using these three census variables.

All of the other measures used in this analysis come from the U.S. Census Bureau's 2000 Summary Files 1 and 3. All of the race/ethnicity variables used in this analysis are the percentage of females ages 15-44 who chose one race/ethnicity and identify as black (*percent black females 15-44)*, American Indian/Alaskan Native (*AIAN females 15-44*), and Asian (*Asian females 15-44*). The *percent Hispanic females 15-44* reflects the percentage of the female population ages 15-44 who identify as Hispanic; this measure combines Hispanics reporting white race and black race in this category. The *percent foreign born* is the percentage of the total population who indicated that they were either a U.S. citizen by naturalization or were not a citizen of the U.S. Persons who are born abroad of American parents are not considered foreign born.

Methods

Our three hypotheses are tested using both ordinary least squares (OLS) regression and GWR. While OLS is a traditional approach, the underlying independent and homoskedastic assumptions associated with the use of spatial data need not hold and alternative estimation strategies are required, including strategies based on local and global specifications (the former allowing us to examine spatial non-stationarity). That is, GWR extends OLS by taking spatial structure into account and can estimate local rather than global model parameters. The GWR model can be expressed as:

$$y_i = \beta_{0i}(u_i, v_i) + \sum_{n=1}^{k} \beta_{ni}(u_{i,} v_i) x_{ni} + \varepsilon_i$$

where y_i is the percentage of mothers receiving late or no prenatal care for county i, (u_i, v_i) denotes the coordinates of the centroid of county i, β_{0i} and β_{ni} represents the local estimated intercept and effect of variable n for county i, respectively. To calibrate this formula, the bi-square weighting kernel function is used (Brunsdon, Fotheringham, and Charlton 1998). The counties near to i have a stronger influence in the estimation of $\beta_{ni}(u_{i,} v_i)$ than do those located farther from i. This model demonstrates a strength of GWR—that localized parameter estimates can be obtained for any location—which in turn allows for the creation of a map showing the continuous surface of parameter values and an examination the spatial variability (non-stationarity) of these parameters (Fotheringham, Brunsdon, and Charlton 2002).

We will use the Akaike Information Criterion (AIC) (Akaike 1974) to compare OLS with GWR. The AIC comparison will reveal whether the spatial perspective significantly improves the model fit. Both OLS and GWR models are implemented in the software of GWR 3.0 (Fotheringham, Brunsdon, and Charlton 2002). To test for spatial non-stationarity, we adopt the Monte Carlo approach where the locations of the observations are permutated (Brunsdon, Fotheringham, and Charlton 1998; Fotheringham, Brunsdon, and Charlton 2002; Hope 1968).

Our analytic strategy is to present the descriptive statistics of the variables used in this analysis, followed by the OLS (global) modeling outputs. These results not only provide a basic understanding of the data, but also offer a basis for the comparison with the GWR results. The GWR results can best be summarized through the maps of the parameter estimates (Fotheringham, Brunsdon, and Charlton 2002) and the Monte Carlo tests. We provide maps of the local R-squared and for each of the independent variables with a statistically significant Monte Carlo test.

Results

Descriptive Statistics and Global Model Results

The descriptive statistics for the county-level percentage of mothers who receive late or no prenatal care and the other measures are provided in Table 1. On average, 17.39 percent of mothers in the U.S. receive prenatal care late or do not receive prenatal care at all. The county-level percentages of mothers who receive late or no prenatal care range from zero percent to 54.05 percent. Because the female disadvantage measure was created using factor analysis, the mean is 0 and the standard deviation is 1. On average, 14.75 percent of the US population does not have health insurance coverage. There is an average of 26.96 Ob-Gyn doctors per 100,000 females ages 15-44. As for the racial/ethnic composition of US counties, on average, US counties have a 1.98 percent black, 0.36 percent American Indian/Alaskan native, 0.21 percent Asian, and 1.36 percent Hispanic female population ages 15-44. The total foreign born population in the US is 3.4 percent.

[Table 1 Here]

The OLS regression model results are provided in Table 2. These are the results of the global model. Every one percentage point increase in the population who is uninsured is associated with a 0.58 percent increase in mothers receiving late or no prenatal care. However, the female disadvantage composite measure was not significantly related to receiving prenatal care after the first trimester of pregnancy or not receiving prenatal care at al. As expected, the number of Ob-Gyn doctors that are available in counties is significantly associated with prenatal care. Specifically, with every one Ob-Gyn doctor increase per 100,000 females ages 15-44, the percentage of females receiving late or no prenatal care decreases by 0.01 percent.

[Table 2 here]

As for how the racial/ethnic and foreign born composition of a county is associated with the percentage of mothers receiving late or no prenatal care, the findings are consistent with our hypotheses. Increases in the percentage of black and American Indian/Alaskan native women ages 15-44 are associated with increases in the percentage of mothers receiving late or no prenatal care by 0.21 and 0.89 percentage points, respectively. As a county's percentage of Asian females ages 15-44 increases by one percentage point, the percentage of mothers receiving late or no prenatal care decreases by 2.26 percentage points, while increases in the female Hispanic population of that same age group are not significantly associated with late or no prenatal care. With every one percentage point increase in the foreign born population, the percentage of mothers receiving late or no prenatal care increases by 0.30 percentage points.

We tested for multicollinearity utilizing the variance inflation factor (VIF), and the VIFs in Table 2 indicated that multicollinearity is not biasing the OLS estimations. The highest value is 3.69, which is well below the common cut-point of 10 (Menard 2002). This OLS model explains 35 percent of the total variance in the percentage of mothers who receive late or no prenatal care at the county level with the AIC 19617.91. Though the OLS modeling offers some evidence for our hypotheses, it is still not clear if the spatial non-stationarity is a concern in our analysis. It is necessary to investigate the homoskedastic assumptions underlying the OLS with local modeling.

Local Model Results

The GWR 5-number parameter summary and Monte Carlo significance tests for spatial variability of parameter test results are displayed in Table 3. The Monte Carlo tests indicated that the associations between our independent and dependent variables are non-stationary across space, with the exception of the Ob-Gyn per 100,000 females ages 15-44 measure. Explicitly, the associations we found in OLS could not be generalized to anywhere in the US except for in the case of the association between Ob-Gyn per 100,000 females ages 15-44 and late or no prenatal care. In contrast to OLS, the GWR model explains 55 percent of the total variance among the dependent variable and has an AIC of 18943.49. These diagnostics suggested that the GWR local model is statistically preferable to the OLS global model.

[Table 3 here]

Figure 1 displays the local R-square values across the contiguous US counties. As shown in the first map, the total variance explained by the local model ranges from 21.2 to 78.3 percent. As you may recall, the total variance explained in the OLS model was 35 percent. This model fits the data well in many areas of the US, including the Northeast, black belt, the Midwest, and in Florida. Not surprising, these are many of the areas where significant associations were found and are areas that can be targeted to help increase the percentage of mothers who begin using prenatal care during the first trimester of pregnancy. This model does not fit the data as well in Texas and the Appalachia region. These are areas that may benefit from a model with additional covariates that may explain why mothers receive prenatal care late or not at all, and could be tested in future research. Herein lies the value of the GWR approach, without the ability to map the local R-square, we would not know where our model could be improved with additional covariates.

[Figure 1 here]

Figure 1 displays the spatially varying association between percent uninsured and late or no prenatal care. Consistent with our hypothesis, we find that as the percentage uninsured increases in a county, the percentage of mothers receiving late or no prenatal care also increases in the majority of the significant areas. The significant associations for this measure cover a large portion of the US compared to all of the other measures in our model. That is, insurance status is a relevant variable in most places, though the strength of the association varied across the country, and we even found a negative effect in the Florida panhandle, Alabama, and Mississippi. The findings displayed in this map are very important—as they not only provide information on areas that could benefit from increases in timely prenatal care, but they also provide information on areas that can be targeted to make improvements on health insurance availability, which can in turn, improve the use of prenatal care among mothers.

The next map in Figure 1 displays the effect of the female disadvantage composite measure on the percentage of mothers receiving late or no prenatal care. While no statistically significant effect was found in the OLS model, in many parts of the country, the more disadvantaged the female population, the higher the percentage of women receiving late or no prenatal care. Without the use of the GWR approach, we would not been able to identify this effect, even though the literature supported this finding. The fourth map in Figure 1 shows the effect of the percent foreign born on late or no prenatal care. As we found in the OLS model, as the percent foreign born increases in a county, the percentage of women receiving prenatal care after the first trimester of pregnancy or not at all also increases. This relationship is significant in many areas of the West and Midwest, including all of the border states.

The effect of the race/ethnicity variables on late or no prenatal care are displayed in Figure 2. In the first map, we see that the association between the percentage of black females ages 15-44 and late or no prenatal care is significant across the majority of the black belt area of the U.S. (in this case positive association). In the second map, we see that there is a strong positive association between the percentage of American Indian/Alaskan Native females ages

15-44 and late or no prenatal care across many counties in the Midwest and West. This is not surprising, because these are areas where many of the reservations are located.

[Figure 2 here]

As was found in the OLS model, as the percentage of Asian females ages 15-44 increases in a county, the percentage of mothers receiving late or no prenatal care also increases. This strong relationship was found in many counties across the United States including counties located in the southern coastal states, the Midwest, and West. We do find a very strong positive association in North Dakota, Texas, and Wisconsin. These are areas they benefit from some culturally sensitive prenatal care targeting efforts.

The varying association between percent Hispanic females ages 15-44 and late or no prenatal care is displayed in the fourth map. Here we find both a significant positive and negative association in the local model, but no significant relationship in the OLS (global) model. This is one example of why local modeling is appropriate and potentially revealing, as without it this approach, the varying relationship between percent Hispanic and late or no prenatal care would remain hidden. That is, the GWR map challenges the global model result by showing the local association between the percentage of Hispanic females and receipt of prenatal care.

Discussion

The OLS and GWR results enable us to address our research questions. All three hypotheses were confirmed. Specifically, the percent of the population who was uninsured was positively associated with the percent of women receiving late or no prenatal care in the global model, and was consistent with the findings of Egerter et al. (2002). The GWR maps help confirm this association. While this association is almost ubiquitous across the U.S., it was not significant in many counties in the South.

In addition, not only did we find that the racial/ethnic composition of a county was associated with the receipt of prenatal care; we also demonstrated that the association for specific race/ethnic groups varies across the U.S. Our findings were similar to those by Mathews and colleagues (2000) and Daniels and colleagues (2006). While Ayoola et al. (2010) found that Asian females are the most likely to receive late or no prenatal care, we found that as the percentage of Asian females ages 15-44 increases in a county, the percentage of females receiving late or no prenatal care decreases. These differences may be attributed to differences in the level of analyses, where the Ayoola study uses individual data and our analysis is at the county-level, or because our analysis includes data on all states in the continental US, where the Ayoola study only includes data on 29 states.

Late or no prenatal care is detrimental to in-utero development, the health of the mother, the health of the infant once born and potentially to late life outcomes too. Initiation of prenatal care in the first trimester of pregnancy is an important part of infant and maternal well-being (Epstein, Grant, Schiff, and Kasehagen 2009). We can ensure that all women have access to timely prenatal care by tailoring provision to the via policy attention to the multiple barriers identified in this paper. This can potentially reduce the risk of low birth weight babies and infant mortality.

One way that we may be able to improve prenatal care use in the US is to address many of these issues before women become pregnant, such as investing more in education and insurance coverage. This way, women will have a better understanding of the importance of prenatal care and have the means to be able to obtain it. Other changes can be made to help reduce the racial/ethnic and socioeconomic disparities in early use of prenatal care. Efforts can be made to promote more culturally competent care (Brach and Fraser 2000) and improvements can be made to make prenatal care providers more accessible to women of low socioeconomic status by providing efficient transportation options and locating prenatal care providers in areas where services are lacking.

Using GWR, this study contributes to the prenatal care research in three ways. First, the local modeling has not only confirmed the findings in earlier research, but also addressed the recent concern in public health about both spatial inequality and the need for place-specific or place-sensitive forms of analysis (Goovaerts 2008; Young and Gotway 2010). That is, the parameter maps above suggest that some factors are more important than others in certain areas in the U.S. Second, this study is ecological, based on county-level data. This type of analytical approach is important and can provide insights not necessarily apparent from individual-level data alone. Third, this study can help shed light on where to focus and where to tweak prenatal care policy by revealing the non-stationary associations. Explicitly, our findings offer an empirical basis for the locally tailored policy formation, which may improve program effectiveness.

This study has some limitations. First, as an ecological analysis we cannot use our findings to make inferences about individual behaviors. Second, while the data used in this study are maintained by Federal agencies, and are high quality, sampling error in the data collection designs may still be a concern.

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Table 1. Descriptive Statistics for the Percentage of Mothers Who Receive Late or No Prenatal Care

	Mean	Std. Deviation	Minimum	Maximum
% Late or No Prenatal Care	17.388	7.040	0.000	54.050
% Uninsured	14.747	4.991	3.800	38.000
Female Disadvantage Composite	0.000	1.000	-2.057	5.745
Ob-Gyn Per 100,000 Females Ages 15-44	26.963	38.620	0.000	746.580
% Black Females Ages 15-44	1.982	3.417	0.000	24.600
% AIAN Females Ages 15-44	0.364	1.430	0.000	20.620
% Asian Females Ages 15-44	0.211	0.421	0.000	7.330
% Hispanic Females Ages 15-44	1.361	2.655	0.000	22.600
% Foreign Born	3.441	4.834	0.000	50.900

Valid Number of Observations = 3106

Table 2. OLS Regression Model Predicting the Percentage of Mothers Who Receive Late or No Prenatal Care (Global Regression Model) N= 3106

	Estimate		Std. Error	Beta	VIF
Intercept	7.218	***	0.405		
% Uninsured	0.583	***	0.030	0.437	2.999
Female Disadvantage Composite	0.000		0.000	-0.031	2.572
Ob-Gyn Per 100,000 Females Ages 15-44	-0.006	*	0.003	-0.037	1.274
% Black Females Ages 15-44	0.211	***	0.035	0.108	1.646
% AIAN Females Ages 15-44	0.892	***	0.078	0.182	1.217
% Asian Females Ages 15-44	-2.260	***	0.352	-0.135	2.079
% Hispanic Females Ages 15-44	-0.026		0.068	-0.009	3.130
% Foreign Born	0.296	***	0.041	0.196	3.692
Adjusted R-Square	0.350				
Akaike Information Criterion	19617.912				

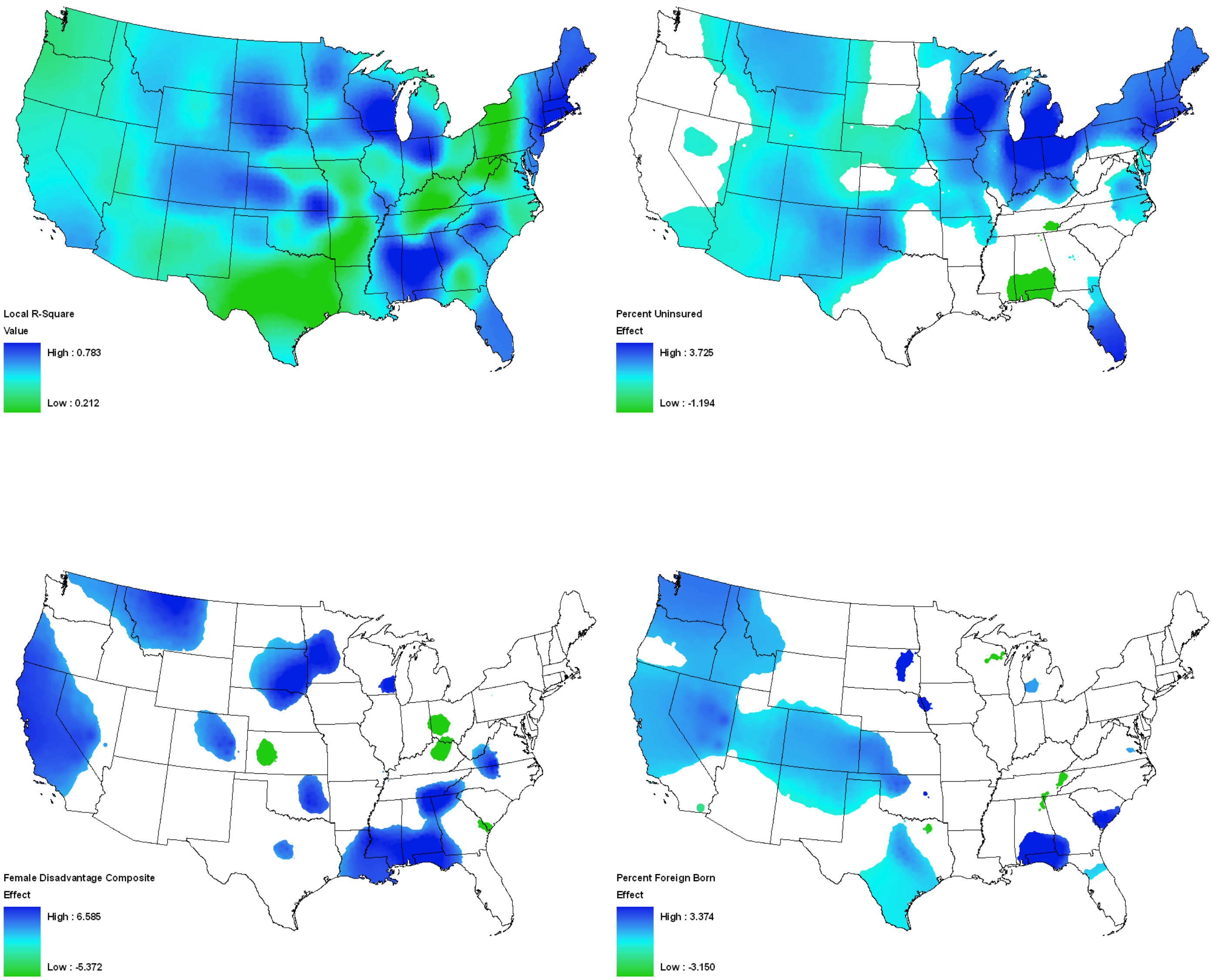
Note: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

Table 3. Geographically Weighted Regression 5-Number Parameter Summary Results and Monte Carlo Significance Test for Spatial Variability of Parameters (N=3106)

	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Status	
Intercept	-17.321	2.945	7.662	13.426	25.718	Non-Stationary	***
% Uninsured	-1.195	0.203	0.540	0.981	3.727	Non-Stationary	***
Female Disadvantage Composite	-5.382	-0.383	0.626	2.284	6.606	Non-Stationary	***
Ob-Gyn Per 100,000 Females Ages 15-44	-0.077	-0.017	-0.005	0.007	0.104	Non-Stationary	
% Black Females Ages 15-44	-16.434	-0.057	0.427	0.819	18.428	Non-Stationary	***
% AIAN Females Ages 15-44	-96.058	-2.570	-0.044	0.983	33.996	Non-Stationary	***
% Asian Females Ages 15-44	-30.353	-6.375	-2.860	-0.066	23.579	Non-Stationary	***
% Hispanic Females Ages 15-44	-11.072	-1.260	0.049	1.851	14.404	Non-Stationary	***
% Foreign Born	-3.190	-0.199	0.346	0.800	3.383	Non-Stationary	***
Adjusted R-Square	0.549						
Akaike Information Criterion	18943.490						

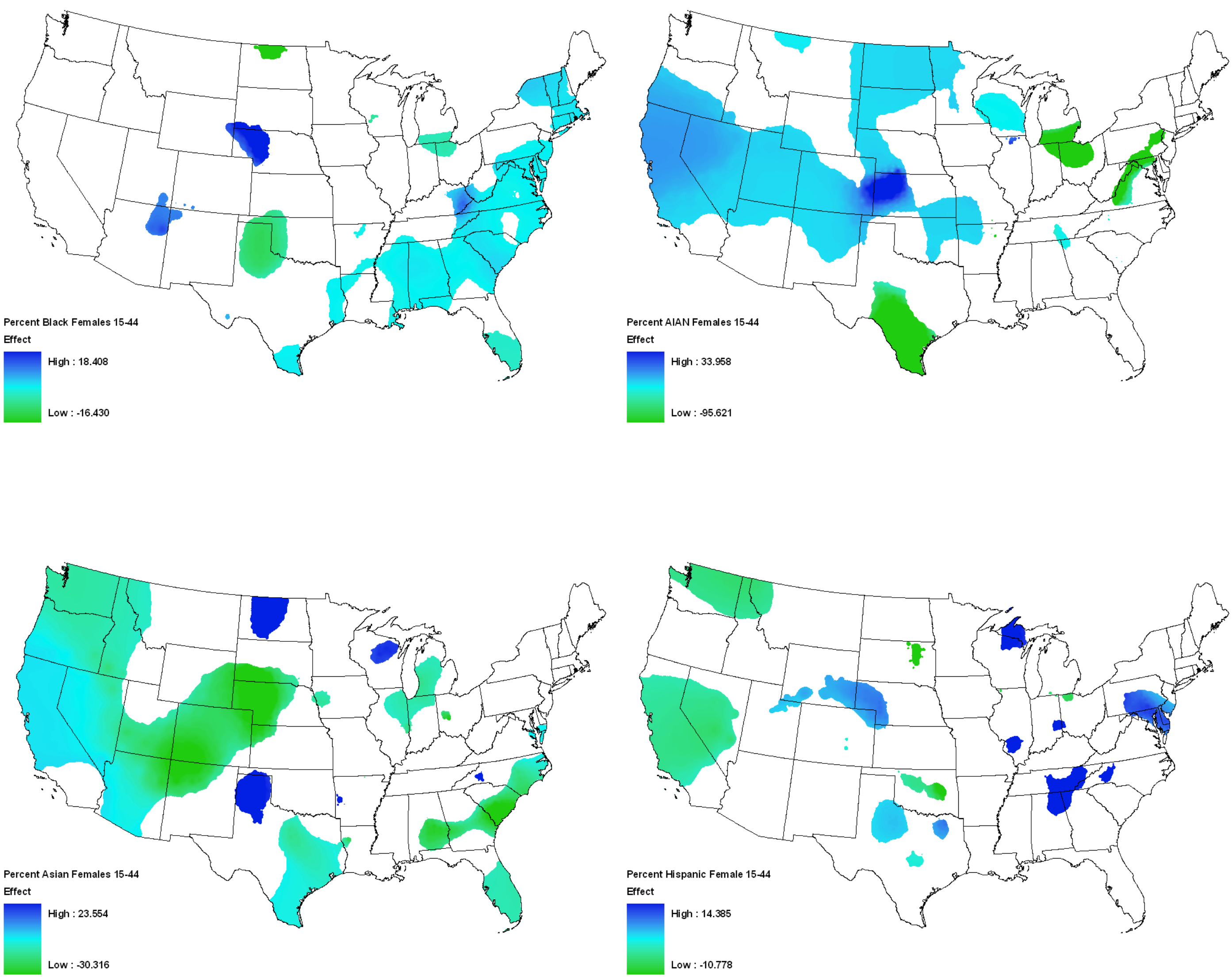
Note: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

Figure 1. Map of Local R-Square and GWR Estimates for Percent Uninsured, Ob-Gyn per 100,000 Females Ages 15-44, and Female Disadvantage Composite



Note: Significant Areas at +/- 1.96 level.

Figure 2. Map of GWR Estimates for Percent Black Females Ages 15-44, Percent American Indian/Alaskan Native Females Ages 15-44, Percent Asian Females Ages 15-44, and Percent Hispanic Females Ages 15-44



Note: Significant Areas at +/- 1.96 level.